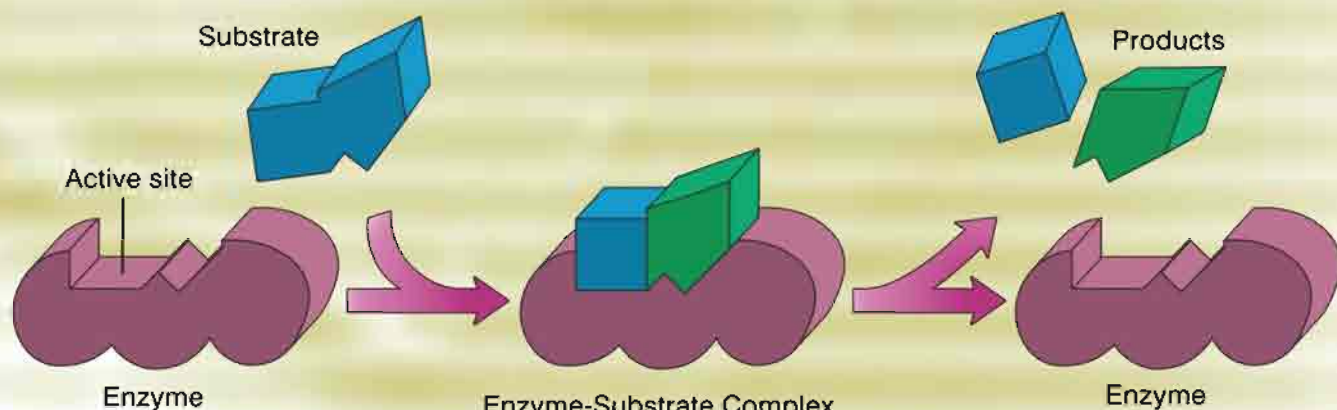
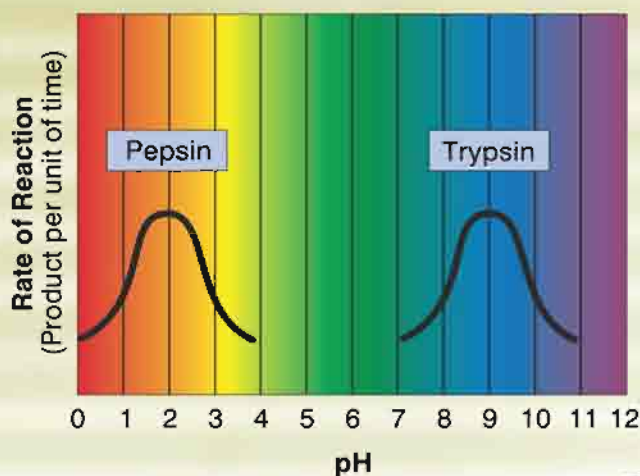
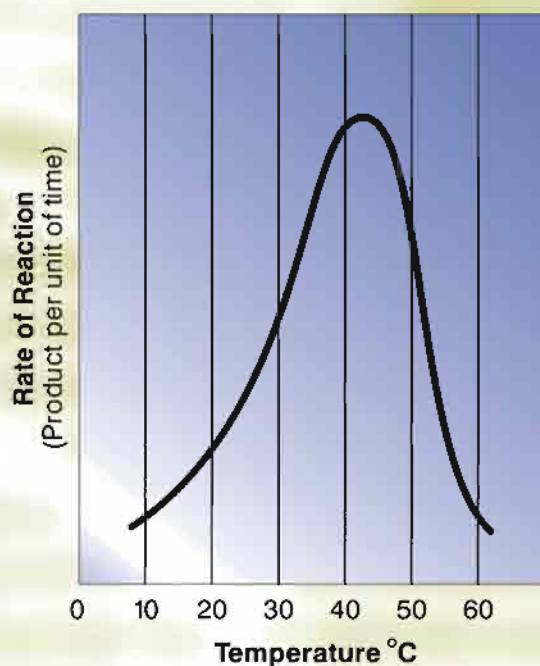


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RATE OF ENZYMATIC REACTION

• Solved Paper :
J&K COMMON ENTRANCE TEST, 2009
• Typical Model Papers

Shalu Mishra
CPMT, 2009

December 2009
Year—12 Issue—142

Editor
MAHENDRA JAIN

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—Editor

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In This Issue

Regulars

Editorial	1194
Science and Technology	1195
Latest General Knowledge	1197
Inspiring Young Talent—	
Topper : U.P. CPMT 2009 (11th Rank)—Shalu Mishra	1201
Science Tips	1203

Physics

Optic I (A) : Refraction at Plane Surfaces	1206
Solved Paper :	
Jammu and Kashmir Common Entrance Test, 2009	1216
Typical Model Paper	1222
Typical Model Paper	1228

Chemistry

Solid State	1234
Solved Paper :	
Jammu and Kashmir Common Entrance Test, 2009	1242
Typical Model Paper	1246
Typical Model Paper	1251

Zoology

Biological Catalysts	1257
Disorders Caused by Protozoans	1262
Nutrition	1265
Typical Model Paper	1272
Typical Model Paper	1275

Botany

Secondary Growth in Thickness	1278
Mineral Requirements of Plant	1282
Family—Brassicaceae	1285
Typical Model Paper	1287
Typical Model Paper	1290
Typical Model Paper	1293

Biology

Solved Paper :	
Jammu and Kashmir Common Entrance, Test, 2009	1297

Other Features

Assertion and Reason Type Questions	1301
True or False	1304
Do You Know ?	1308
Correct Solution and Prize Winners of CSV Quiz No. 136	1313
CSV Quiz Contest No. 139	1314
General Awareness	1317

Dear Readers,

The December issue of your favourite magazine '**Competition Science Vision**' is in your hands. We are glad that due to the painstaking efforts of our experienced and worthy authors this issue is totally examination-oriented and very useful for various pre-medical tests. We advise our readers to go through it intelligently and understand the text. They will be richly benefited.

We remain closely in contact of our toppers and other high ranking readers through our interviews with them. It is very heartening that in their opinion, CSV provides them unique guidance in various pre-medical tests. It is our modest claim that the contents and the quality of reading material in all the four subjects viz., Physics, Chemistry, Botany and Zoology are unique and unparalleled. The magazine undoubtedly will improve your performance and give an extra edge over other competitors in any medical or even engineering test.

Success comes to those who earnestly work for it. It requires hardwork, devotion and self-confidence. The unfailing guidance of CSV is always with you. It is for you to avail it.

Read CSV regularly and intelligently. It gives you the power to master your career and shape your destiny.

With best wishes for your brilliant success.

Sincerely yours,

Mahendra Jain
(Editor)

FORTHCOMING COMPETITIVE EXAMS.

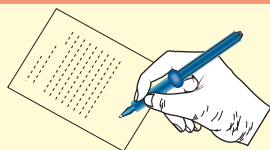
2009

Shreyas Gramin Bank Clerk-cum-Cashiers Exam.	(Nov. 8)
Madhya Pradesh Civil Judge (Mains) Examination	(Nov. 8)
National Talent Search Exam., 2009 (For VIII Class Studying Students)	(Nov. 8)
Madhya Pradesh National Means-cum-Merit Scholarship Examination, 2009-10	(Nov. 8)
S.B.I. Clerical Cadre Exam., 2009	(Nov. 8 & 15)
S.S.C. Auditors and Accountants Exam. (Indian Audit and Account Deptt.)	(Nov. 15)
Madhya Pradesh State Service (Mains) Exam., 2008	(Nov. 16)
Corporation Bank Probationary Officers Exam.	(Nov. 22)
Rajasthan State Eligibility Test (SET), 2009	(Nov. 22)
Rajasthan Gramin Bank Officers Scale-I Examination	(Nov. 22)
Uttarakhand Review Officers/Assistant Review Officer Preliminary Exam.	(Nov. 22)
Chhattisgarh Shikshakarmi Selection Test, 2009 for Category 1, 2 & 3	(Nov. 27)
Rajasthan Gramin Bank Clerk-cum-Cashier Exam.	(Nov. 29)
Corporation Bank Clerical Cadre Exam.	(Nov. 29)
Indian Air Force Airman Selection Test [Group 'X' (Technical) Trades]	(Nov.)
Haryana School Teachers' Eligibility Test Dec. 2009 for Elementary Teachers	(Dec. 12)
Haryana School Teachers' Eligibility Test Dec. 2009 for Masters/Mistresses	(Dec. 13)
Oriental Bank of Commerce P.O. Exam.	(Dec. 13)

S.S.C. Tax Assistant Examination, 2009	(Dec. 13)
Haryana School Teachers' Eligibility Test Dec. 2009 for Lecturers	(Dec. 19)
Rashtriya Military Schools Common Entrance Test (Class VI)	(Dec. 20)
CSIR-UGC National Eligibility Test, 2009 (Science Subjects)	(Dec. 20)
Vijaya Bank Probationary Clerks Exam.	(Dec. 20)
KVS Post Graduate Teachers Exam.	(Dec. 26)
Oriental Bank of Commerce Clerical Cadre Recruitment Examination	(Dec. 27)
(Online Closing Date : 10 Nov., 2009)	
UGC National Eligibility Test for Junior Research Fellowship and Eligibility for Lectureship	(Dec. 27)
Jaipur Thar Gramin Bank Office Assistants Exam.	(Dec. 27)
KVS Trained Graduate Teachers Exam.	(Dec. 27)
KVS Primary Teachers Exam.	(Dec. 28)

2010

AFMC, Pune B.Sc. (Nursing)/General Nursing and Midwifery (GNM) Course 2010	(Jan./Feb.)
Jawahar Navodaya Vidyalaya Entrance Test, 2010 for Class-VI	(Feb. 7)
UPSC Combined Defence Service Exam. (I), 2010	(Feb. 14)
National Defence Academy Examination (II), 2010	(April 18)



Accept the Challenge of Terrorism

Some years back terrorism was used for plunderers. This word was considered by society as unsocial. But in the present it is being considered like a life philosophy and taken as a movement. Any person whose desires are not fulfilled finds it convenient to take to the path of terrorism.

Terrorists can lay hands even on the highest placed persons like ministers of Central Government or their relations.

Terrorism has become virtually a world problem. Let aside journeys or life outside, the situation is that we cannot feel safe from terrorism even inside home. The sword of terrorism, as a matter of fact, hangs over our head everywhere. All the countries of the world seem concerned about this world wide problem. But the unfortunate part of it is that terrorism is getting shelter everywhere. In America to face terrorism many new means and instruments have been deployed. Terrorist attacks on the U.S. in 2001 forced it to review its strategy to curb terrorism. It has largely succeeded in it, as no terrorist attack was made on it thereafter.

Historically terrorism is the expression of discontentment, rebellion and indiscipline. In practice it has an instrument of rebellion in the field of political selfishness and vested interests. Murder, kidnapping, rape, plunder are its different forms. To get things go our way and compel people to agree with us terrorism is becoming a popular means. At its root there is **politically inspired religious fanaticism** which is made up of vote politics. After analysing the causes at the root of terrorism, religious fanaticism, regionalism, inequalities, linguistic differences come before us. The collective influence of discipline and social tendencies and balanced thinking have become blunt or have become ineffective and the antisocial elements have got encouragement. With the view of aim terrorism can be divided into two parts—positive and

negative terrorism. In the positive form of terrorism there is some self interest on a wide scale, i.e., in its basic motive is welfare of the society. The type of terrorism which aims at liberation from the foreign rule will come under this category. Only foreign government is affected by such terrorism while the general public and social life are

Terrorism has made life hell for all. We are living a life of uncertainty, not knowing when we shall fall a victim to a terrorist's explosive device. We find ourselves helpless in the face of terrorism. But concerted action on the part of government buttressed by people's cooperation can break the neck of terrorism. Let there be no doubt about it.

almost unaffected. There was a section of the Indian freedom fighters known as revolutionary and its effect on **freedom fight**. Some people tried to call them terrorists but the majority did not like to call them terrorists and gave them the name of revolutionaries. Probably they were given this name by keeping their goal in view.

Negative terrorism is that which is followed for some narrow interests and general public interest is kept aside.

In short, terrorism is a big **curse** of the society and negative terrorism a black spot. Definitely while we look at terrorism we begin to doubt that we are living the life of primitives. At times we seem to behave worse than the primitives. All the efforts made in the direction of the development of the civilization have gone in vain.

Terrorism has become a danger for our life every moment. Terrorism is always lurking all our life and we

can't say at what moment who becomes its victim. Sometime back Benazeer Bhutto of Pakistan fell a victim to it.

Earlier Rajiv Gandhi also fell a victim to terrorism. Thousands of lives have been devoured by the monster of terrorism during the last few years across the world.

Terrorism has in the world become more dangerous than the atomic bomb. The most disturbing factor about terrorism is that it has very badly and adversely affected our moral life. We fear to talk plainly about terrorism and its effects because danger of terrorism is always lurking around us.

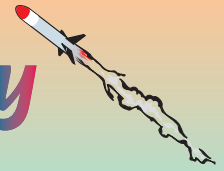
We have begun to accept in a natural way the terrorists and their evil actions. This is the reason why we are not able to organise ourselves as a group against terrorism. It seems as if we have mortgaged our understanding and ourselves. This situation is altogether intolerable. This is the life of danger and terror which is either escaping from life or embracing death. We are sure that our young men and women will come forward to face terrorism and the dangers posed by it.

Our young men and women once in the past have given a befitting reply and put an end to it. In Japan and Vietnam the foreign rulers created an atmosphere of terrorism. In India, the British government was based on terrorism. Young men and women with their organized efforts challenged terrorists and put an end to it. We are sure that our young men and women with full determination will organise themselves to accept the challenge of terrorism and will succeed in making public life free from its dangers. If they miss this opportunity to accept the challenge they should understand that their future will also be fully in the grip of uncertainty.



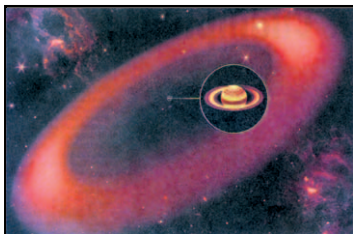


Science and Technology



Giant Ring Found Around Saturn

Stunned astronomers have discovered a mega-ring around Saturn. The Spitzer Space Telescope has discovered this biggest ring, never-before-seen. The thin array of ice and dust particles lies at the far reaches of the Saturnian system. The ring is very diffuse and does not reflect much visible light, but the infrared Spitzer Telescope was able to detect it. This is the largest ring identified so far in the solar system. The circle starts about six million km from Saturn and extends outward by another 12 million km within the orbit of Saturn's another moon, Phoebe. This is one super-sized ring.



Saturn Spectacle : A never-before-seen ring around Saturn, spotted by NASA's Spitzer Space Telescope. Inset is an enlarged image of Saturn, as seen by the W. M. Keck Observatory at Hawaii, in infrared light.

- It would take about 1 billion Earths to fill the ring.
- Ring's orbit is tilted at 27° from the main ring plane.
- Starts 6 million km away from Saturn; extends outward by 12 million km.
- Vertical height of the ring is about 20 times the diameter of the planet.

Until now, the champion planetary rings in the Solar System were the so-called, 'Gossamer Rings', surrounding the Jupiter, the Solar System's largest planet and Saturn's E-ring. Phoebe's (Saturn's moon) ring is far fainter than both and appears to comprise dust from rocks bashed off the little moon (Phoebe) by interplanetary

debris or other particles. Scientists believe that this ring's genesis is Phoebe.

Although the ring-dust is very cold—minus 316 degrees Fahrenheit—it shines with thermal radiation. The bulk of the ring material starts about 3.7 million miles from the planet and extends outward about another 7.4 million miles. Before this discovery, the Saturn was known to have seven main rings named 'A' through 'E' and several faint unnamed rings. Saturn's moon Phoebe orbits within this ring and is believed to be the source of the material.

The scientists believe that this huge ring can explain the mystery of Impetus, Saturn's bizarre two-tonne, black-and-white moon. Migrating dust from the ring could spiral into Impetus, coating one side of it with a dark material that, over the life of the Solar System, could be several metres thick.

Astronomers have long suspected that there is a connection between Saturn's outer moon, Phoebe and the dark material on Impetus. This new ring provides convincing evidence of that relationship. The other side of Impetus is turning progressively whiter, just the other half is becoming darker.

There is a so-called thermal segregation theory to explain this. It suggests that the dark side of Impetus, by absorbing more sunlight, is able to warm sufficiently to cause local water ice to evaporate. The vapour then circulates to condense on the nearest cold spot, on the icy bright side of the moon. As a result, the dark side loses its surface ice, and thus becomes darker, while the bright side accumulates ice, and gets brighter.

Only a Fine Line between Genius and Madness

There is no great genius without some touch of madness. A new research has found that there is indeed only a fine line between genius

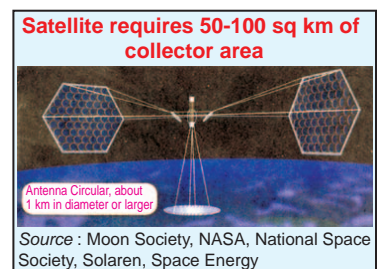
and madness as both share a particular gene.

Scientists of Semmelweis University, Hungary have discovered that creative people have a gene, called 'Neuregulin-1', in common which is also linked to psychosis and depression—in fact, it plays a role in brain development, but a variant of it is linked to mental illness like schizophrenia illness and bipolar disorder. This research shows that a genetic variant associated with psychosis may have some beneficial functions.

Molecular factors, that are closely associated with severe mental disorders but are present in many healthy people, may have an advantage enabling us to think more creatively.

Space-based Solar Power—A Huge Project

Earth's supplies of coal, petroleum and other fossil fuels will eventually be exhausted, while the sun's energy will not. Several methods of using solar energy have been developed. Part of solar energy is lost on its way through the atmosphere by reflection and absorption. Scientists have been working on a big project. This is space-based solar power system that will convert energy in space, outside the atmosphere to avoid such losses.



Giant solar sails in orbit will beam energy in the form of microwaves down to Earth without being dependent on weather and seasons. One or more satellites will orbit at 36,000 km above Earth's surface (geostationary orbit). Orbit speed will be the same as

Earth's, which rotates one time in 24 hours. Solar sails will catch sun's energy uninterrupted, transform it into microwaves that can penetrate clouds. Microwaves will be received on Earth by giant collectors with diode surface. This will greatly solve Earth's energy problem.

Gene Behind Woman Infertility Identified

A team of researchers of Virginia Commonwealth University (U.S.A.) has identified a gene which causes infertility. The team has found the role of the gene, 'Smad-3', in regulating molecular signals involved with ovarian follicle development, which may one day help shed light on the causes of fertility issues in humans.

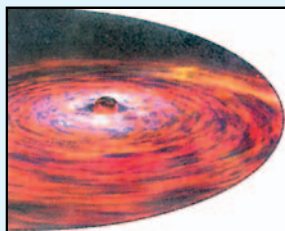
In the study published in the research journal '*Biology of Reproduction*', the scientists have examined the role of Smad-3 in the early stages of follicular growth to understand the molecular mechanisms that could influence fertility. Specially, they looked at the signalling pathways in the follicles' response to follicle stimulating hormone, or FSH—one of the hormones involved in fertility which is responsible for helping a woman's body develop a matured egg.

Scientists Measured the Size of Neutron Star of 10,000 Light Year Away

A neutron star is the final stage of a very massive star. When the massive star burns up its fuel, it collapses to become a neutron star. There are between 100 million and 1,000 million neutron stars in our Galaxy. On average, a neutron star is very small—approximately 10 km in diameter—and 10,000 light year away from the Earth; thus making it extremely difficult to study and measure its size. Hence, it is not possible to gauge the exact size of neutron stars. An international team of researchers of University of Maryland (U.S.A.), University of Australia and Tata Institute of Fundamental Research (TIFR), Mumbai did this by studying the pattern of X-ray bursts given off by the star, which leads to the discovery that the pattern X-rays generated might reveal their true size.

10,000 Light Year Away A Fallen Star

What is a Neutron Star ? A neutron star is the collapsed stage of a very massive star. It is small, far away from earth, and the densest object in



the universe—a teaspoon of neutron star matter would weigh as much a mountain. Neutron stars are so bright that they can radiate as much X-ray energy in one minute as the amount of light radiated by the Sun in approximately one week.

The team is led by Indian scientist, Professor Sudip Bhattacharya of TIFR, Mumbai. The team studied more than 900 bursts from 43 neutron stars with the help of a NASA satellite. The team's research revealed the unsuspected property of X-ray bursts given off by the stars. Since these X-rays cannot reach the Earth, because of a blanket created by the atmosphere so, NASA's satellite was used to receive data.

The scientists modelled how the temperature of the bursts changed as they faded and found it varied in relation to the radius of the star. This achievement is a breakthrough.

Magnetic Nanoparticles Kill Cancer Cells

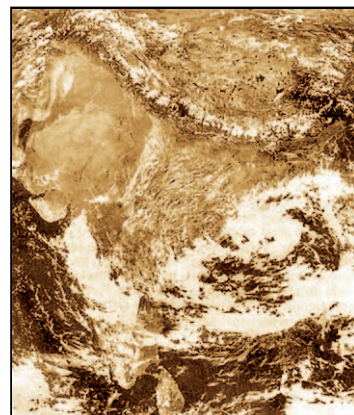
British scientists are developing ways to use nanoparticles as tiny magnets that can heat up and kill cancer cells without harming healthy cells around them.

The researchers have found that iron oxide nanoparticles can be attached to cancer-seeking antibodies or injected into cancer-seeking stem cells, which take them straight to the tumors they need to kill. Heating the cells to just to 5 or 6 degree celsius above body temperature, in a new device, called magnetic alternating current hyperthermia (MACH) machine, can kill the cancer cells. MACH device is like microwave, heating only targeted cells.

'This offers a new way to treat cancer', said the team leader, Professor Felix Pirani of University College, London. He added, "If we get the magnetic particles to migrate to cancer cells, we can kill only them, leaving the healthy cells unharmed—the ultimate targeted therapy."

Exceptional Performance of Oceansat-2

All the three payloads on board India's Oceansat-2 satellite have been providing images of excellent quality of India and oceans around the world. The payloads are the ocean colour monitor, scatterometer and radio occultation sounder for atmospheric studies (ROSA).



The first images from Oceansat-2 present a mosaic of India.

The colour monitor has a camera that provides informations on chlorophyll concentration in the seas and helps in locating habitats of fish where the fishermen can go and fish. The scatterometer is a microwave sensor that measures the velocity of winds and their directions over the seas and is useful in monitoring the movement of polar sea-ice. ROSA measures parameters relating to lower atmosphere and ionosphere.

An ISRO press release said the data provided by the payloads helped in monitoring the turbidity and suspended sediments in the seas and facilitated meteorological studies. Satellite is collecting data nicely over the entire globe. Oceansat was launched on September 23, 2009.





Latest General Knowledge

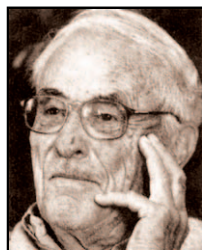
AWARDS/PRIZES

Nobel Prize in Physics, 2009

This year's Nobel Prize in Physics is awarded for two scientific achievements that have helped to shape the foundations of today's networked societies.



Charles Kao



Willard Boyle

Professor Charles Kao, Shanghai-born British-American, got the prize for a discovery that led to a breakthrough in fibre optics, determining how to transmit light over long distances *via* optical glass fibres.



George Smith

Professor Willard Boyle, a Canadian-American and Professor George Smith of the United States were honoured for inventing the first successful imaging technology using a digital sensor.

The award's 10 million kronor (\$ 1.4 million) purse will be split among the three, with Professor Kao taking half and Professors Boyle and Smith getting a quarter each.

Their achievements have allowed vast amounts of information to be sent around the globe almost instantaneously as trillions of signals make their way through tiny glass fibres now long enough to encircle the planet.

Nobel Prize in Chemistry, 2009

Three scientists, including India-born Venkatraman Ramakrishnan won the Nobel Prize in Chemistry, 2009 for

the detailed mapping of ribosome—the cell's own protein factory. Americans Dr. V. Ramakrishnan and Professor Thomas A. Steitz and Israeli Ada E. Yonath shared the 10 million kronor (\$ 1.4 million) prize for showing how the ribosome, which produces protein, functions at the atomic level.

Dr. Ramakrishnan is a senior scientist at the Medical Research Council (MRC) Laboratory of Molecular Biology in Cambridge, England.



Venkatraman Ramakrishnan



Thomas A. Steitz

Three scientists have produced atom-by-atom maps of the mysterious, life-giving ribosome. This breakthrough is vital for the development of new antibiotics. As ribosomes are crucial to life and they are the major target for new antibiotics.



Ada E. Yonath

A ribosome is about 25 nanometres (a millionth of a millimetre) in size. A cell contains tens of thousands of ribosomes. Ribosomes are the locations where proteins are produced. All three scientists have used a method called X-ray crystallography to map the position for each of the hundreds of thousands of atoms that make-up the ribosome.

Nobel Prize in Medicine, 2009

Americans Elizabeth H. Blackburn, Carol W. Greider and Jack W. Szostak won the 2009 Nobel Prize in Medicine for discovering a key mechanism in the genetic operations of cells, an insight that has inspired new lines of research into cancer.

Professor Blackburn is now in University of California, San Francisco,



Elizabeth H. Blackburn



Carol W. Greider

Professor Greider is in Johns Hopkins University, Baltimore and Professor Szostak is at the Harvard Medical School. Professor Greider is Professor Blackburn's student.



Jack W. Szostak

The trio worked together on research into DNA and chromosomes and their later work on telomerase, the enzyme that makes the telomere DNA earned them the Nobel Prize.

They solved a major problem in biology : how the chromosomes can be copied in a complete way during cell divisions and how they are protected against degradation. The Nobel Laureates have shown that the solution is to be found at the ends of chromosomes—the telomeres—and in an enzyme that forms them—telomerase.

Nobel Prize in Economics, 2009

Americans Elinor Ostrom and Oliver Williamson won the Nobel Economics Prize, 2009 for their analyses of economic governance—the rules by which people exercise authority in companies and economic systems. They showed that economic analysis could shed light on most forms of social organisations.

Ms. Ostrom is working in Indiana University. She devoted her career to study the interaction of people and natural resources. She demonstrated

how common resources could be successfully managed by groups using it. She is the first woman to win the Economics Nobel.



Elinor Ostrom **Oliver Williamson**

In accordance with Professor Williamson's theory, large private corporations exist primarily because they are efficient. They are established because they make owners, workers, suppliers and customers better off than they would be under alternative institutional arrangements.

Nobel Prize in Literature, 2009

Herta Mueller, a member of Romania's ethnic German minority who was persecuted for her critical depictions of life behind the Iron Curtain, won the 2009 Nobel Prize in Literature. She is honoured for the work that with the concentration of poetry and the frankness of prose, depicts the landscape of the dispossessed.



Herta Mueller

She is the Romania-born German writer, who charted the hardships and humiliations of Nicolae Ceausescu's brutal regime. There is a real power to the way she writes. She has an incredible message. Part of her writings, is her own background as a victim of persecution in Romania, but then she also has her own background as a stranger in her own country.

Nobel Peace Prize, 2009

United States President Barack Obama sensationally won the Nobel Peace Prize, 2009, just nine months into his term. The jury hailed, "Mr. Obama's extraordinary efforts in international diplomacy and to hasten nuclear disarmament. Only very rarely has a person to the same extent, as Obama,



President Barack Obama

captured the world's attention and given its people hope for a better future. He has brought the Israeli and Palestinian leaders together for a meeting, approved new diplomatic engagement with Iran, Myanmar and North Korea and signalled a new willingness to attack growing environmental problems."

However, the criticism surged quickly over how the award could be given so soon.

Right Livelihood Award (Alternative Nobel), 2009

Four activists, on October 13, 2009, were named co-winners of the 2009 Right Livelihood Award, the so-called 'Alternative Nobel', for their work in campaigning against nuclear weapons, protecting the rain forests of Congo, raising awareness about climate change and campaigning for women's health.

Alyn Ware of New Zealand, Rene Ngongo of the Democratic Republic of Congo (DRC) and David Suzuki of Canada share the award with Australian-born physician Catherine Hamlin. Mr. Ware, Mr. Ngongo and Mr. Hamlin were each to receive €50,000 euros (\$73,000) in cash while Mr. Suzuki was to receive an honorary prize.

Man Booker Prize

British novelist Hilary Mantel's historical doorstopper, 'Wolf Hall', set in the court of Henry VIII, has won this year's £50,000 Man Booker Prize beating five other contenders, including two previous Booker winners. For the first time in many years, there was no Asian writer in contention.

BOOKS

Water and the Laws in India— Edited by *Ramaswamy R. Iyer* (Water is a natural resource, the scarcity or mismanagement of which could be a major constraint for food security and economic development. What are the legal dimensions of water resource management? What are the prospects for water law reform now and in the foreseeable future? This book seeks to address these and related questions from a theoretical as well as a practical perspective. As many as 25 eminent scholars, with a lot of

research and administrative experience to their credit have contributed to this volume.)

Passages— Edited by *M. Kannan and Jennifer Clare* (The book is a collection of papers that focusses on the relationship between Tamil and Sanskrit).

Global Democracy for Sustaining Global Capitalism— *J. Micuel Andrew and Rita Dulei Rahman* (The authors bring out the economic inequalities and plead for global democracy).

The Cult of Nothingness— *Rogerpol Droit* (This is an interesting study of Buddhism in the context of contemporary western thinkers).

DAYS

November 1—World Ecology Day

November 8—Legal Service Day

November 14—Children's Day, World Diabetic Day

November 19—World Citizen's Day, National Integration Day

November 21—World Fisheries Day

November 24—N.C.C. Day

November 26—Law Day

APPOINTMENTS

Sandeep Patil—Former Indian Cricketer, Sandeep Patil, succeeded Dav Whatmore as Director, Cricket Operations, National Cricket Academy (NCA), Bangalore. Whatmore's tenure ended on October 31.

Mike Nithavrianakis (*New U.K. Deputy High Comm.*)—Mr. Mike Nithavrianakis is the new British Deputy High Commissioner in South India. India is the U.K.'s biggest visa operation world-wide and the busy visa operation in Chennai serves customers from Sri Lanka and across South India.

Sam Pitroda—I.T. expert Sam Pitroda took over as the Advisor to the Prime Minister for Infrastructure, Innovation and Information.

PERSONS IN THE NEWS

Venkatraman Ramakrishnan (*Nobel Laureate*)—He became the ninth person of Indian origin to win the

coveted Nobel Prize. Venkatraman Ramakrishnan ('Venki') won the Nobel Prize 2009 in Chemistry with Professor Steitz of Yale University (U.S.A.) and Professor Yonath of Weizmann Institute (Israel) "for studies of the structure and function of the ribosome".

Venkatraman Ramakrishnan

Born	: 1952
	Chidambaram, Tamil Nadu, India
Residence	: United Kingdom
Citizenship	: United States
Fields:	Biochemistry and Biophysics
Institutions	: MRC Laboratory of Molecular Biology, Cambridge, England
Alma mater	: Maharaja Sayajirao University of Baroda, Ohio University
Known for	: Structure and function of the ribosome; macromolecular crystallography
Notable awards	: Louis-Jeantet Prize for Medicine (2007) Nobel Prize in Chemistry (2009)

Venkatraman Ramakrishnan was born in Chidambaram in Cuddalore district of Tamil Nadu. He moved to Baroda (Vadodara), Gujarat at the age of three. He took his school and college education in Vadodara. In 1971, he moved to U.S.A. and took Ph.D. degree in Physics from Ohio University in 1976. He then spent two years studying Biology as a graduate student in California University, making a transition from Physics to Biology. He worked as a scientist in Brookhaven National Laboratory, New York. In 1995, he joined Utah University as the Professor of Biochemistry. In 1999, he moved to his current position in Cambridge.

Ramakrishnan is a Fellow of the Royal Society (F.R.S.), London, Fellow of U.S. National Academy of Sciences and Fellow of Trinity College, Cambridge. He received several medals and honours from all over the world.

Ramakrishnan married Vera Rosenberry, an author and illustrator of children's books. He has a step-daughter, Tania Kapka, who is a doctor in Oregon, and a son, Raman Ramakrishnan, who is a cellist in New York.

Sujata Koirala (*New Deputy P.M., Nepal*)—Sujata Koirala, Nepal's Foreign Minister and daughter of Nepali Congress President Girija Prasad Koirala, took over as the Deputy Prime Minister of Nepal in the CPN (UML)—led coalition government. After taking oath, Ms. Sujata Koirala said, "The Nepali Congress is happy, as the Party which was in the fourth position in the Cabinet, has now come to the second position. Her appointment meant more to the Party than to her as an individual."



Sujata Koirala

At present, Sujata is a very strong and active politician of Nepali Congress. She observed the evolution of political and democratic development in Nepal. She passed an exiled life in India and then adopted the political career in 1990. She holds more than enough political capabilities and has been emerging as the most powerful personality in the Nepali Congress and the nation.

PLACE IN THE NEWS

Rio-de-Janeiro (*2016 Olympic Host*)—In a bow towards global inclusiveness, the International Olympic Committee voted for Rio-de-Janeiro (Brazilian capital) to host the 2016 Summer Olympic Games. The decision deserves to be celebrated not

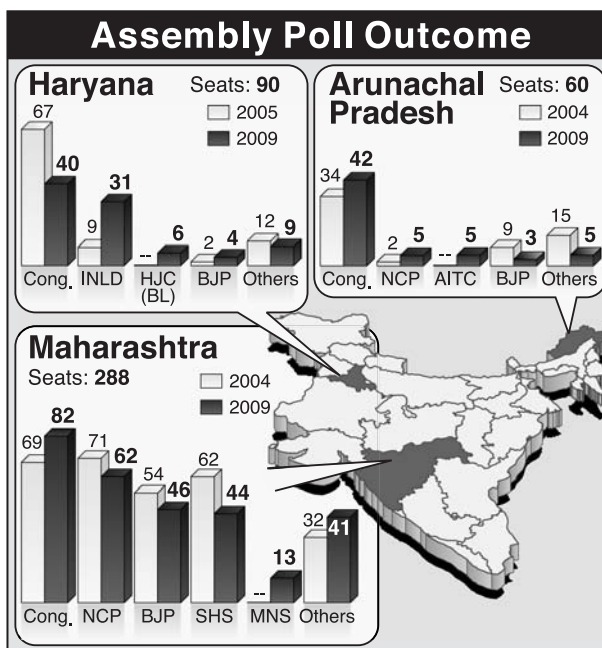
just by Brazilians : it marks the end of a longstanding script that, for whatever reason, shut South America out of the list of Games' host. That the IOC session in Copenhagen overwhelmingly picked Rio-de-Janeiro ahead of Chicago and Tokyo, not to speak of Madrid, which lost 32-66 in a direct contest in the final round of voting is significant.

The IOC gets the bulk of its revenue, running into billions of dollars, from television rights every four years.

DEATH

Rao Birender Singh (*Former C.M., Haryana*)—Haryana's former Chief Minister, Rao Birender Singh (88) passed away in Gurgaon as a result of cardiac arrest. He is survived by three sons and a daughter. He had been the Chief Minister of Haryana since March 24 till November 2, 1967. He was the founder of Haryana Vishal Party.

Born at Nangal in Rewari district of Haryana, he completed his higher education in St. Stephens College, Delhi. Rao Birender Singh, who remained a minister in the Punjab Government since 1956 till 1961, served many key posts, including the Speaker of the Haryana Legislature Assembly and Union Agriculture Minister.



ELECTIONS

Assembly Elections in Maharashtra, Arunachal Pradesh and Haryana

Results of the Assembly elections in Maharashtra, Arunachal Pradesh and Haryana were declared on October 22, 2009. Standing at mid-point in a House of 288 in Maharashtra, the Congress Party securing 82 seats, is set to form a government with decade-old ally Nationalist Congress Party (NCP). The NCP bagged 62 seats.

In Arunachal Pradesh, the Congress won 42 seats out of 60 seats. In a House of 90 seats in Haryana, the Congress Party won 40 seats and it is struck five short of the bare majority mark.

SPORTS

Cricket

World Cup Groupings—The International Cricket Council (ICC) announced the groupings on October 7, 2009 for the 2011 ODI World Cup to be staged in this sub-continent. This 14-team-event will be jointly hosted by India, Sri Lanka and Bangladesh.

India will host 29 of the tournament's 49 matches, including a semi-final and the final and Sri Lanka will stage the other semi-final. Bangladesh is due to stage the opening ceremony on February 18, 2011 and the opening game the next day as well as two quarter finals.

India will stage matches at eight venues, Sri Lanka has 12 matches at

three venues and Bangladesh eight matches at two venues.

The Groups : Group A—Australia, Pakistan, New Zealand, Sri Lanka, Zimbabwe, Canada, Kenya.

Group B—India, South Africa, England, West Indies, Bangladesh, Ireland, Netherlands.

ICC allotted two matches and the final to the Mumbai Cricket Association. Distribution of the matches is as follows :

Mumbai Cricket Association (final + 2 games), Punjab Cricket Association, Mohali (semi-final + 2 games), Gujarat Cricket Association, Ahmedabad (quarter final + 2 games), Delhi and Districts Cricket Association (1 India game + 3 games), Tamil Nadu Cricket Association, Chennai (1 India game + 3 games), Karnataka State Cricket Association, Bangalore (1 India game + 3 games), Vidarbha Cricket Association, Nagpur (1 India game + 3 games) and Cricket Association of Bengal, Kolkata (1 India game + 3 games).

Lankan team arriving on Nov. 8—The Sri Lankan Cricket Team will arrive in Mumbai on November 8, 2009 for the series against India which includes three Tests, five ODIs and two Twenty-20 games.

The Itinerary : Nov. 11-13 : Three-day match Vs. Board President's XI at Ahmedabad.

Tests : Nov. 16-20 : First Test at Ahmedabad; **Nov. 24-28** : Second Test at Kanpur; **Dec. 2-6** : Third Test in Mumbai.

Twenty-20 : Dec. 9 : First T20 at Mohali (d/n); **Dec. 12** : Second T20 at Nagpur (d/n).

ODIs : Dec. 15 : First ODI at Rajkot; **Dec. 18** : Second ODI at Vizag (d/n); **Dec. 21** : Third ODI at Cuttack (d/n); **Dec. 24** : Fourth ODI in Kolkata (d/n); **Dec. 27** : Fifth ODI in New Delhi (d/n).

Hero Honda Cup (India-Australia)—Hero Honda Cup seven match one-day international series between India and Australia started in Vadodara on October 25, 2009.

ICC Champions Trophy Tournament—The final of this tournament was played in Centurion on October 6, 2009. Australia retained the ICC Champions Trophy with an emphatic six-wicket victory over New Zealand in the final at Super Sport Park. Shane Watson was the Australian hero.

Snooker

National Snooker Championship—Asserting his supremacy, Pankaj Advani won the third crown in a row when he beat Sourabh Kothari in a thrilling title clash of the National Snooker Championship in Agra on October 4, 2009.

Aquatics

National Aquatics Championship—Karnataka extended its unbeaten streak 1991 to one more year as it completed its campaign on a glorious note at the LNCPE pool, Kariyavattom in Kerala on the concluding day of the 63rd National Aquatics Championship on October 10, 2009. Rehan Poncha (Karnataka), who won his 5th gold medal in an unbeaten run, and Richa Mishra (Police), who finished with four gold medals and one silver, were adjusted the best swimmers of the meet.

●●●

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“Hardwork, guidance of teachers, practice of question-solving, support of family and faith in God are the essential elements of my success.”

—Shalu Mishra

Topper—U.P. CPMT 2009 (Rank-11)

['Competition Science Vision' arranged an exclusive interview with Miss Shalu Mishra who has the credit of being successful in U.P. CPMT with a high rank. In addition, she has also cleared other pre-medical tests with high ranks viz., CBSE PMT (235 AIR), Manipal (203 AIR) and Uttarakhand PMT (86 Rank). For her brilliant success she deserves all praise and our heartiest congratulations. This important interview is presented here in its original form.]

CSV—Congratulations on your brilliant success.

Shalu—Thank you.

CSV—Before knowing your result what did you think about those who achieve top positions ?

Shalu—I used to think that top rankers are very extraordinary, brilliant and hard working persons.

CSV—Achieving top position has come as surprise to you or were you confident of achieving it ?

Shalu—Yes, it has come as a surprise. But I was confident of achieving a good rank in U.P. CPMT 2009.

CSV—What do you think is the secret of your success ?

Shalu—Hardwork, practice of questions, correct guidance of my teachers, support of my family and faith in God.

CSV—In how many attempts did you get this success ?

Shalu—It was my third attempt.

CSV—What were the shortcomings in your preparation for earlier attempts ? How did you make up for them this time ?

Shalu—I did not pay much attention to Biology especially Botany. But this year I gave much preference to Biology during my preparation and revised it many times.

CSV—From where did you get the inspiration of choosing a medical career ?

Shalu—It was my dream to serve the poor people not getting proper treatment. So, I opted for a medical career.

CSV—From when did you start the preparation for it ?

Shalu—I started my preparation for medical entrance exams after Intermediate.

CSV—What planning did you make for preparation ? Please tell something in detail.



— CSV is very much helpful in understanding the basic concepts and is very useful in taking a quick review of all subjects. Interview of toppers impart motivation and guidance.

—Shalu Mishra

Shalu—I revised Biology many times. For Physics and Chemistry I paid attention to the problems, asked in previous year medical entrance exams.

CSV—How much time did you devote daily and regularly for Physics, Chemistry, Zoology and Botany ?

Shalu—My study hours were not fixed but atleast 3-4 hours a day. I used to read 2 subjects a day, while studying I usually preferred either Zoology or Botany with one of Physics and Chemistry.

CSV—Out of the above four subjects, to which subject did you give more weightage and why ?

Shalu—I gave more importance to Biology especially to Botany because in all medical entrance examination Biology is given more preference than Physics and Chemistry.

CSV—Did you make complete study of all topics or of some selective topics ?

Shalu—I read all the topics but paid more attention to topics which are usually asked in medical competitive exams.

Bio-Data

Name—Shalu Mishra

Father's Name—Mr. Ram Kripal Mishra

Mother's Name—Mrs. Shobha Mishra

Educational Qualifications—

H.S./Std. X—90.2% (City Montessori Inter College, Lucknow), 2005.

Inter/Std. XII—92% (City Montessori Inter College, Lucknow), 2007.

Special Achievements—

- 11th rank in UP CPMT
- AIPMT CBSE (Mains) 235 (AIR)
- Manipal 203 (AIR)
- Uttarakhand PMT—86

CSV—How did you give final touches to your preparation ?

Shalu—During the final round of my preparation I revised all the important Biology topics, i.e., from which more question had been asked in earlier exams. For Physics and Chemistry I went through 10 years question paper.

CSV—Did you prepare notes ?

Shalu—Yes, I prepared notes of the topics which I used to forget and which appeared difficult to me.

CSV—What was your attitude for solving numerical questions ? What weightage did you give them ?

Shalu—For solving numerical questions I gave weightage to problems which had come in earlier or previous year medical entrance exams. I improved my calculation speed.

CSV—How much time is sufficient for preparing for this examination ?

Shalu—Two years time is sufficient for preparing, if you get correct guidance.

Personal Qualities

Hobby—Listening music

Ideal Person—My father and mother

Strong Point—Hardwork

Weak Point—Nervousness

CSV—From what level of education should an aspirant begin preparing for it ?

Shalu—A student should start preparing for it right from XI standard.

CSV—What was your order of preference for various branches for which this test is held ?

Shalu—MBBS, BDS, BAMS, BHMS.

CSV—Please mention various books in each subject and magazines on which you based your preparation.

Shalu—Botany from M. P. Kaushik, Zoology from Ramesh Gupta. For Physics and Chemistry Nootan and O.P. Tandon competitive books. CSV was base of my preparation in all the four subjects as it is examination-oriented at all steps.

CSV—Did you take coaching in your preparation ?

Shalu—Yes, New Light Coaching, Kanpur.

CSV—What help do the science magazines render in the preparations for this examination ?

Shalu—I used science magazine CSV for solving MCQs. Further it helped me in clearing my basic concepts.

CSV—What will be your criterion for selecting a magazine for these examination ?

Shalu—Select magazine which has contents of syllabus.

CSV—What is your opinion about our Competition Science Vision ? How much helpful and useful do you find it ?

Shalu—It helped me a great deal in understanding basic concepts. Further it helps in taking a quick review of all topics. Besides above

qualities it contains interviews of top rankers which imparts one with motivation and guidance during preparation.

CSV—Please suggest in what way CSV can be made more useful for medical aspirants.

Shalu—By adding more contents of NCERT text books and information related to history of ancient India and new discoveries in field of science.

CSV—Please mention your position in the merit list as well as the marks obtained in different subjects. What was your aggregate percentage of marks ?

Shalu—11th position in U.P. CPMT

Physics—47/50

Chemistry—47/50

Zoology—44/50

Botany—49/50

Total—187/200 = 93.5%.

CSV—What books/magazines/newspapers did you read for G.K. preparations ?

Shalu—Competition Science Vision.

CSV—Whom would you like to give the credit for your success ?

Shalu—I would like to give credit of my success to my family, teachers and most important to my God.

CSV—Please tell us something about your family.

Shalu—I have mummy, papa, elder sister and younger brother. My father is D.C. in trade tax department, mother is a housewife. My elder sister Anshu is preparing for Civil Service Exams and younger brother Toshi is doing B. Tech. from Allahabad.

CSV—What in your frank opinion has been the biggest mistake in your preparation for this test ?

Shalu—My calculation speed was very slow. During 1st year of my preparation I made no attempt of improving it.

CSV—What message would you like to give for our readers of CSV ?

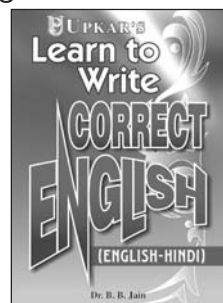
Shalu—For achieving success in PMT read each and every topic of CSV.



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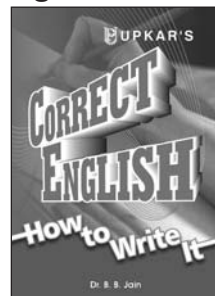
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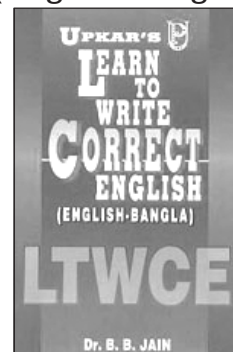
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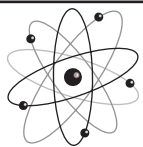
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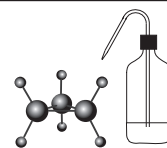
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SCIENCE TIPS



Physics

1. The solid angle subtended at the centre of a sphere of radius r by an area ΔS on the surface of the sphere is given by

$$\Rightarrow \Omega = \frac{\Delta S}{r^2} \text{ steradian}$$

2. Can you practically obtain wattless current ?

⇒ No, due to presence of resistance in the circuit

3. Unit used to express the distance of stars is

⇒ Parsec

4. Why a transformer cannot be used in direct current circuit ?

⇒ Because D.C. cannot produce a changing magnetic field in the core

5. The Poynting vector $S = \frac{EB}{\mu_0}$ is related to

⇒ Flow of energy in an electromagnetic wave and represents its intensity

6. Why are calibration marks not equidistant on the scale of a hot-wire ammeter ?

⇒ Because heat produced in the wire is proportional to the square of current

7. If $y = ax^b$, the graph between $\log x$ and $\log y$ will a straight line. Its gradient and intercept on y -axis respectively are

⇒ b , $\log a$ [$\log y = \log a + \log x$, compare it with $y = mx + c$]

8. The difference of temperature of two bodies is 35°C . What will be this difference in $^\circ\text{F}$?

⇒ 63°F

9. Relative velocity is 'velocity' and **not** the ratio of

⇒ Two velocities

10. If earth were to stop rotating what will happen to the value of ' g ' the acceleration due to gravity at Delhi ?

⇒ ' g ' will increase

11. The average velocity of a particle is equal to its instantaneous velocity. Its time-displacement graph will be a

⇒ Straight line (since velocity is uniform)

12. Can a sail boat be propelled by air blown at the sail from a big fan attached to the boat ?

⇒ No, it cannot be propelled

13. The numerical ratio of speed and velocity of an object can be

⇒ Greater than or equal to 1

14. A nucleus ${}_nX^m$ emits one α and two β particles. The resulting nucleus will be

⇒ ${}_nX^{m-4}$

15. The evidence of quantisation of charge is from

⇒ Millikan's oil drop experiments

16. If m is the mass and c the speed of light, then mc^2 has the dimensions of

⇒ Energy

17. When an electric dipole does not experience any torque in a uniform electric field ?

⇒ When it aligns parallel to the electric field

18. What distance does light travel in air during the time it travels a distance d in a medium of refractive index μ ?

⇒ It will travel a distance equal to μd

19. The direction of electric dipole moment vector of an electric dipole is

⇒ From negative charge to positive charge

20. Is diffraction the property of all types of waves ?

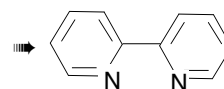
⇒ Yes, all type of waves exhibit diffraction

Chemistry

21. Which aromatic amine is used as a developer in the photography ?

⇒ Orthophenylene diamine

22. What is 2, 2'-bipyridyl reagent ?



23. Which organic compound is used with radiator water in cold countries ?

⇒ Ethylene glycol

24. What is mustard gas ?

**⇒ $\text{Cl}-\text{CH}_2-\text{CH}_2-\text{S}-\text{CH}_2-\text{CH}_2-\text{Cl}$
Bis (1-chloroethyl) sulphide or
2, 2-dichlorodiethyl sulphide**

25. What does 'HSAB' stand for ?

⇒ Hard-Soft Acids-Bases

26. Who was the first to give correct explanation of the phenomenon of optical activity ?

⇒ Louis Pasteur (1843)

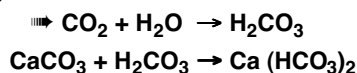
27. What is the cat's-eye ?

⇒ A greenish-yellow gem-stone basically chrysoberyl, $\text{Be Al}_2\text{O}_4$

28. The compounds which contain polar as well as non-polar regions are known as

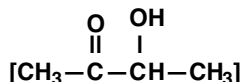
⇒ Amphipathic

29. Which chemical reactions are mainly responsible for chemical weathering of rocks ?



30. What are acyloins ?

$\Rightarrow \alpha$ -hydroxy ketones



31. What is the catalytic reaction of H_2 and CO to produce high-molecular weight hydrocarbons, known as ?

\Rightarrow Fischer-Tropsch reaction

32. What is Ziegler-Natta catalyst ?

\Rightarrow A complex of the triethyl aluminium and TiCl_4

33. What is the common name of trans-butenedioic acid ?

\Rightarrow Fumaric acid

34. The catalyst which is used in hardening of oils is

\Rightarrow Raney Nickel

35. What is the value of gas constant, 'R' in SI unit ?

$\Rightarrow 8.31441 \text{ J mol}^{-1} \text{ K}^{-1}$

36. What is Fenton's reagent ?

\Rightarrow A mixture of ferrous sulphate and hydrogen peroxide
[$\text{H}_2\text{O}_2 + \text{FeSO}_4$]

37. What is the relation between freezing point of a liquid and the melting point of its solid state ?

\Rightarrow Freezing point = melting point

38. What is Wohl-Ziegler bromination ?

\Rightarrow The bromination of allylic and benzylic positions by N-bromosuccinamide (NBS)

39. What is the process reverse to condensation known as ?

\Rightarrow Vaporisation

40. Phenyl esters on treatment with anhydrous AlCl_3 are converted to o or p-hydroxy ketones. This reaction is known as

\Rightarrow Fries Rearrangement

Zoology

41. What is called that disease in which plaque deposits form in the coronary arteries that supply blood to the heart ?

\Rightarrow Coronary heart disease

42. The energy used in the Miller-Urey experiment was

\Rightarrow Electric spark

43. What is called that virus which can reproduce without killing its host ?

\Rightarrow Temperate virus

44. In allopatric speciation, the initial barrier to gene flow is

\Rightarrow Geographic

45. Which form of coelom is formed by the splitting of embryonic mesoderm ?

\Rightarrow Schizocoel

46. Physical and chemical agents that interact with DNA to cause mutations are called

\Rightarrow Mutagens

47. What is the another term for adaptive evolution ?

\Rightarrow Microevolution

48. An Operon is

\Rightarrow Cluster of structural genes with related functions

49. What causes acne vulgaris affecting face of most teenagers ?

\Rightarrow Sebaceous glands

50. The protein coat that encloses the viral genes is called

\Rightarrow Capsid

51. What is called the point of the surface of an animal egg farthest from the nucleus ?

\Rightarrow Vegetal pole

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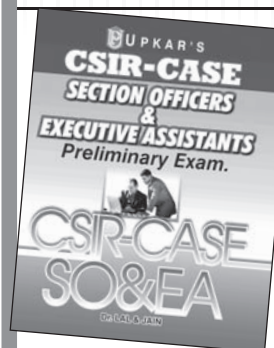
52. Transfer of the genetic code from *mRNA* to a sequence of amino acids in a polypeptide is the
Translation
53. What are called the receptor cells for both hearing and balance ?
Mechanoreceptors
54. Genetic information in a DNA molecule is coded in the
Sequence of nucleotides
55. What is called the branch of medicine dealing with the study of signs and symptoms ?
Semeiology
56. The most abundant lipid in a cell membrane is
Phospholipid
57. Where are the mature sperms stored ?
In epididymes
58. Control over the concentrations of salt and water in the body is
Osmoregulation
59. What is called the cutting or division of a stricture ?
Coaretotomy
60. Not enough blood proteins due to low-protein diet may develop
Hypotension or chronic low blood pressure
71. Most artificial fertilizers always contain trace element. What does chilean nitrate, for example, contain ?
Boron
72. What is the common name of *Aldrovanda* ?
Water-flea-trap
73. What is the time between infection of host and assembly of new phages called ?
Eclipse period
74. What are isoenzymes ?
Enzymes having slightly different molecular structure but similar catalytic action
75. Which phase of cell cycle consists of G_1 , S and G_2 stages ?
Interphase
76. What structure connects the two adjacent cells in plant ?
Plasmodesmata
77. What does phloem transport usually from the leaves in a healthy plant ?
Organic nutrients
78. What does dendrochronology determine ?
Age of tree by radiocarbon dating
79. What does primary lysosome mean ?
Lysosomes containing inactive enzymes
80. What are nonseptate fungal hyphae ?
Fungi having no cross walls in their hyphae

Botany

61. Which part or structure becomes a seed immediately after fertilization ?
Ovule
62. What does taxonomy deal with ?
Naming of organisms
63. What are called stacks of the circular thylakoids ?
Grana
64. What is obligate intercellular parasite ?
They cannot multiply outside a living cell
65. What causes separation of the complementary chains of a DNA molecule ?
Denaturation
66. What does AZT stand for ?
Azidothymidine
67. What is called the surrounding membrane of a vacuole ?
Tonoplast
68. What does phloem transport usually from the leaves to roots ?
Organic nutrients
69. Why are mitochondria yellow in colour ?
Due to presence of riboflavin
70. What is endogamy ?
Pollination of a flower by another flower but of the same plant

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OPTICS-I(A)

(Refraction at Plane Surfaces)

The bending of the ray of light passing from one medium to the other medium is called **refraction**.

Laws of refraction—There are two laws of refraction.

(i) The incident ray, the normal to the surface at the point of incidence and the refracted ray, all lie in the same plane called the plane of incidence or plane of refraction.

(ii) The ratio of sine of the angle of incidence (i) to the sine of angle of refraction (r) is a constant and is called refractive index.

i.e.,
$$\frac{\sin i}{\sin r} = \mu \text{ (a constant) for two media}$$

Snell's law can be written as

$${}_1\mu_2 = \frac{\mu_2}{\mu_1} = \frac{\sin i}{\sin r}$$

Physically ${}_1\mu_2 = \frac{\text{Velocity of light in the 1st medium}}{\text{Velocity of light in the 2nd medium}}$

$$\Rightarrow \mu_1 \times \sin i = \mu_2 \times \sin r$$

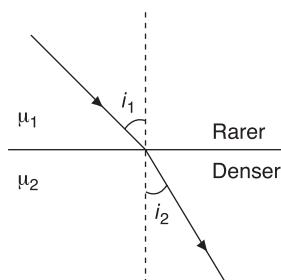
i.e. $\mu \sin \theta = \text{constant}$

Also, in vector form : $\hat{i} \times \hat{n} = \mu (\hat{r} \times \hat{n})$

Important Points

(i) If medium 1 is a vacuum (or, in practice air) we refer ${}_1\mu_2$ as the absolute refractive index of medium 2 and denote it by μ_2 or simply μ (If no other medium is there).

(ii) We can write Snell's law as



$$\mu \sin i = \text{constant} \quad \dots(a)$$

For two media $\mu_1 \sin i_1 = \mu_2 \sin i_2$

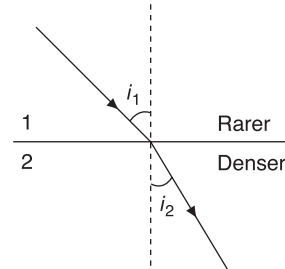
or
$$\frac{\mu_2}{\mu_1} = \frac{\sin i_1}{\sin i_2} = {}_1\mu_2 \quad \dots(b)$$

(iii) From the equation (a) we can see that $i_1 > i_2$. If $\mu_2 > \mu_1$, i.e., if a ray of light passes from rare to denser medium it bends towards normal and *vice-versa*.

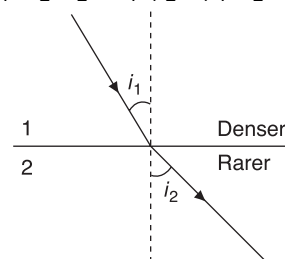
(iv) Equation (b) can be written as

$${}_1\mu_2 = \frac{\sin i_1}{\sin i_2} = \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{\mu_2}{\mu_1} \quad \dots(c)$$

Here, v_1 is the speed of light in medium 1 and v_2 in medium 2. Similarly, λ_1 and λ_2 are the corresponding wavelengths.



$$[i_1 > i_2; v_2 < v_1; \mu_2 > \mu_1; \lambda_2 < \lambda_1]$$



$$[i_1 < i_2; v_2 > v_1; \mu_2 < \mu_1; \lambda_2 > \lambda_1]$$

(v) In general speed of light in any medium is less than its speed in vacuum. It is convenient to define refractive index μ of a medium as

$$\mu = \frac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}} = \frac{c}{v}$$

(vi) As a ray of light moves from medium 1 to medium 2, its wavelength changes but its frequency remains constant.

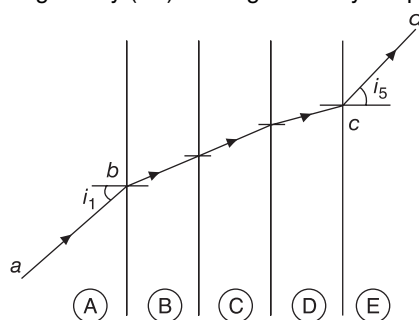
$$[\mu_2 > \mu_1; v_1 > v_2; \lambda_1 > \lambda_2]$$

(vii) ${}_1\mu_2 = \frac{\mu_2}{\mu_1}$ and ${}_2\mu_1 = \frac{\mu_1}{\mu_2} \therefore [{}_1\mu_2 = \frac{1}{{}_2\mu_1}]$

(viii) ${}_1\mu_2 = \frac{\mu_2}{\mu_1}$, ${}_2\mu_3 = \frac{\mu_3}{\mu_2}$ and ${}_3\mu_1 = \frac{\mu_1}{\mu_3}$

$$\therefore {}_1\mu_2 \times {}_2\mu_3 \times {}_3\mu_1 = 1$$

(ix) If the boundaries of the media are parallel to the emergent ray (cd) although laterally displaced, is



parallel to the incident ray ab . If $\mu_A = \mu_E$ we can also directly apply the Snell's law. ($\mu \sin i = \text{constant}$) in medium A and E, i.e.,

$$\mu_A \sin i_A = \mu_E \sin i_E$$

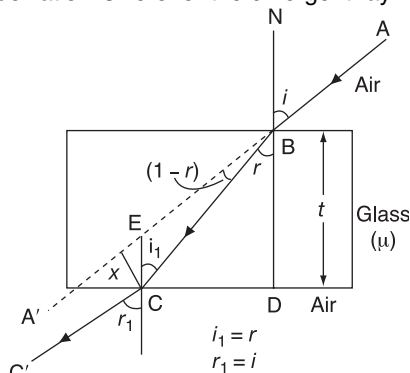
So, $i_1 = i_5$

If $\mu_A = \mu_E$

Refraction of Light at a Parallel Faced Slab

(1) **Deviation**—When a ray of light passes obliquely through a parallel faced slab, then the deviation (D) of the ray in the slab is $D = i - r$

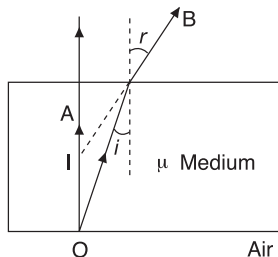
The deviation is zero for the emergent ray.



(2) **Lateral shift**—A ray of light passing obliquely through a parallel faced slab of thickness ' t ' and absolute R.I. μ , suffers a lateral shift (or displacement) in its path = $CE = x$.

$$x = \frac{t}{\cos r} \sin (i - r)$$

(3) **Apparent depth and apparent shift through a slab**—When an object 'O' in the denser medium of thickness (t) and absolute refractive index (μ) is viewed almost normally to the surface, from the outside rarer (air) medium, then its image is seen at I. AO is the real depth of the object. AI is the apparent depth and OI is called the apparent shift.



$$\begin{aligned} \text{Now, } \mu &= \frac{\text{Real depth}}{\text{Apparent depth}} \\ &= \frac{AO}{AI} = \frac{t}{AI} \end{aligned}$$

$$\therefore \text{Apparent depth, } AI = t/\mu$$

$$\text{Apparent shift, } OI = \left(t - \frac{t}{\mu}\right) = t \left(1 - \frac{1}{\mu}\right)$$

(4) **Multiple slabs**—If $t_1, t_2, t_3 \dots$ are the thicknesses of each of the slabs and $\mu_1, \mu_2, \mu_3 \dots$ are the absolute refractive indices of material of each slab, then object 'O' viewed from rarer (air) medium is seen at I. Then as seen from air

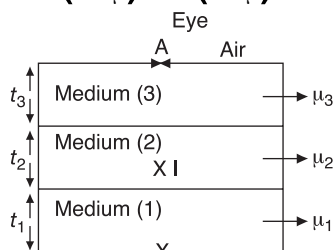
Apparent depth

$$A = \frac{t_1}{\mu_1} + \frac{t_2}{\mu_2} + \frac{t_3}{\mu_3} + \dots$$

AO = Real depth

AI = Apparent depth

OI = Apparent shift

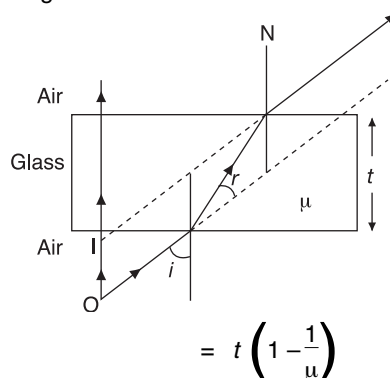


Apparent shift

$$OI = t_1 \left(1 - \frac{1}{\mu_1}\right) + t_2 \left(1 - \frac{1}{\mu_2}\right) + t_3 \left(1 - \frac{1}{\mu_3}\right) + \dots$$

$$= \sum t_i \left(1 - \frac{1}{\mu_i}\right), i = 1, 2, \dots$$

(5) **Apparent depth and apparent shift through a parallel faced slab** (with object in rarer medium)—The object O (in air) when seen through a parallel faced slab of thickness (t) and R. I. (μ) is seen to be at I, and apparent shift (OI) along normal



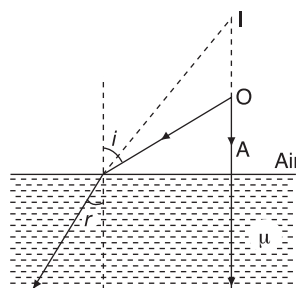
Note : Same relations are also true when the object in a rarer medium is seen through a parallel faced slab.

(6) **Apparent depth of an object in rarer medium when seen from within a denser medium** (near normal rays)—When an object 'O' in rarer medium is seen from within a denser medium (say water) then the image of 'O' appears to be raised up to I.

The real depth = AO

Apparent depth = AI

$$\begin{aligned} \text{Now, } \frac{AO}{AI} &= \mu_a \\ &= \frac{1}{\mu} \end{aligned}$$



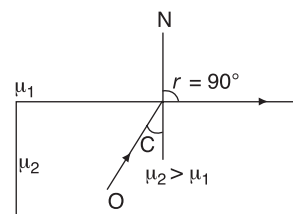
(7) **Critical angle (C)**—For the ray travelling from the denser to the rarer medium ($\mu_2 > \mu_1$), for refraction at A,

If $i = C$,

$$r = 90^\circ$$

$$\sin C = \frac{\mu_1}{\mu_2} = \frac{1}{\mu_2}$$

$$\text{or } \mu_2 = \frac{1}{\sin C}$$



Note : If the rarer medium is air $\mu_1 = 1$ and the denser medium has an absolute R. I. $\mu_2 = \mu$. Then,

$$\sin C = \frac{1}{\mu}$$

(8) **Total internal reflection**—For a ray of light to suffer total internal reflection, the necessary conditions are :

- The ray must travel from a denser to a rarer medium.
- The angle of incidence in denser medium should be greater than the critical angle.

Examples of Total Internal Reflection (TIR)

(i) **Field of vision of fish (or swimmer)**—A fish (diver) inside the water can see the whole world through a cone with

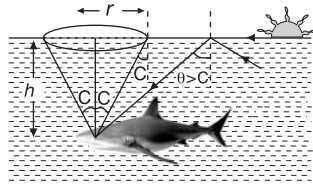
(a) Apex angle

$$= 2C = 98^\circ$$

(b) Radius of base

$$r = \frac{h}{\cot C} = h \tan C$$

$$= \frac{h}{\sqrt{\mu^2 - 1}}$$



(c) Area of base $A = \frac{\pi h^2}{(\mu^2 - 1)}$

For water

$$\mu = \frac{4}{3}$$

So,

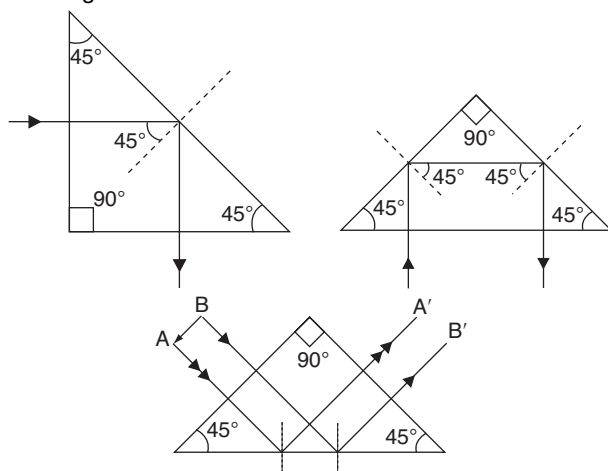
$$r = \frac{3h}{\sqrt{7}}$$

and

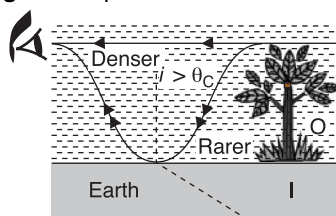
$$A = \frac{9\pi h^2}{7}$$

(ii) **Brilliance of diamond**—The refractive index of diamond is about 2.4 so that critical angle for it is very small about 24° . Hence, due to repeated internal reflections diamond sparkles.

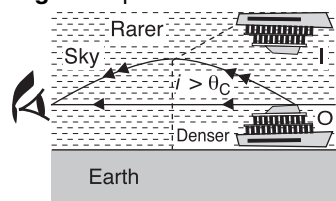
(iii) **Porro prism**—A right angled isosceles prism, which is used in periscopes or binoculars. It is used to deviate light rays through 90° and 180° and also to erect the image.



(iv) **Mirage**—An optical illusion in deserts :



(v) **Looming**—An optical illusion in cold countries :



Prism

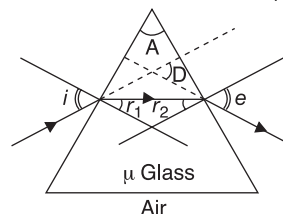
Prism is a transparent medium bounded by refracting surfaces, such that the incident surface (on which light ray is incident) and emergent surface (from which light rays emerges) are plane and non parallel. Commonly used prism (Equilateral prism; right angle prism, right angled isosceles prism).

Refraction of light at a prism—For refraction of a monochromatic ray of light through a prism.

$$i + e = A + D \quad \dots(i)$$

$$r_1 + r_2 = A \quad \dots(ii)$$

For a given prism, the angle of deviation D depends upon the angle of incidence (i) and for a particular value of i , the deviation becomes a minimum ($D = D_m$) called the angle of minimum deviation and then the ray passes symmetrically through the prism.



\therefore When

$$D = D_m$$

Then,

$$i = e$$

and

$$r_1 = r_2$$

$$\mu = \frac{\sin \left(\frac{A + D_m}{2} \right)}{\sin (A/2)}$$

Then,

where μ is the absolute refractive index of glass.

Important Points

(i) For a thin prism $A \leq 10^\circ$, $D = (\mu - 1) A$

(ii) Grazing incidence for a prism

For grazing incidence $i_1 = 90^\circ$

Then,

$$r_1 = C$$

= critical angle for glass of the prism

Then,

$$A = (C + r_2)$$

(iii) For refraction at face PR,

$$\frac{\sin e}{\sin r_2} = \mu$$

\therefore

$$\sin e = \mu \sin r_2$$

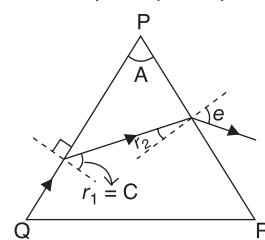
$$= \mu \sin (A - C)$$

(iv) For maximum deviation by a prism the angle of incidence

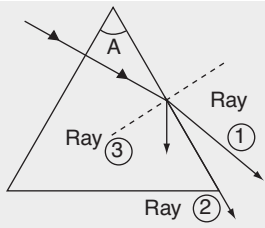
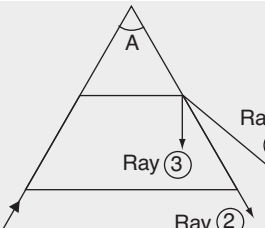
(a) must be 90°

or

(b) correspond to grazing emergence.



Grazing emergence and TIR (total internal refraction) through a prism—When light ray falls on one surface of a prism, it is not necessary that it will exit out from the prism. It may or may not exit out as shown on next page.

Normal Incidence	Grazing Incidence
 <p>Ray 1 : General emergence $A < C$ and $\mu < \operatorname{cosec} A$ Ray 2 : Grazing emergence $A = C$ and $\mu = \operatorname{cosec} A$ Ray 3 : TIR $A > C$ and $\mu > \operatorname{cosec} A$ $A =$ angle of prism and $C =$ critical angle for the material of the prism</p>	 <p>Ray 1 : General emergence $A < 2C$ and $\mu < \operatorname{cosec} (A/2)$ Ray 2 : Grazing emergence $A = 2C$ and $\mu = \operatorname{cosec} (A/2)$ Ray 3 : TIR $A > 2C$ and $\mu > \operatorname{cosec} (A/2)$</p>

Important points—For the condition of grazing emergence, minimum angle of incidence

$$i_{\min} = \sin^{-1} [\sqrt{\mu^2 - 1} \sin A - \cos A]$$

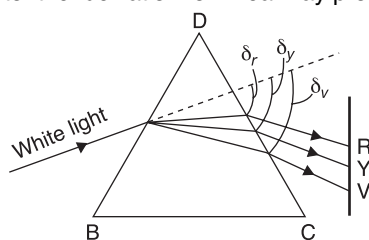
Dispersion through a prism—The splitting of white light into its constituent colours is called dispersion of light. This phenomenon arises due to the fact that refractive index varies with wavelength. It has been observed that μ decreases with the increase of wavelength, i.e., $\mu_{\text{blue}} > \mu_{\text{red}}$. This display of colours is known as spectrum of light. The angle between the two emergent rays is known as angular dispersion of these colours. The angular dispersion

$$\theta = \delta_V - \delta_R$$

Dispersive power—The ratio of angular dispersion between two colours to the deviation of mean ray produced by the prism is called the dispersive power of material of the prism for those colours.

Dispersive power (ω)

$$= \frac{\delta_V - \delta_R}{\delta_y}$$



SOME TYPICAL SOLVED EXAMPLES

Example 1. (a) Show that the lateral displacement of a ray of light passing obliquely through a parallel glass slab of thickness t and absolute refractive index μ is given by

$$t \left[1 - \frac{\cos i}{\sqrt{\mu^2 - \sin^2 i}} \right] \sin i.$$

Solution :

where δ_y is the deviation of mean ray, δ_V and δ_R are the deviation of violet and red rays respectively.

$$\text{Again } (\omega) = \frac{\mu_V - \mu_R}{(\mu_y - 1)}$$

Deviation without dispersion—Deviation without dispersion means an achromatic combination of two prisms in which net or resultant dispersion is zero and deviation is produced. For the two prisms

$$(\mu_V - \mu_R) A + (\mu'_V - \mu'_R) A' = 0$$

or

$$A' = - \frac{(\mu_V - \mu_R)}{(\mu'_V - \mu'_R)} A$$

and

$$\omega \delta + \omega' \delta' = 0$$

where ω and ω' are the dispersive powers of two prisms and δ and δ' are their mean deviations.

Dispersion without deviation—A combination of two prism in which the deviation produced for the mean ray by the first prism is equal and opposite to that produced by the second prism is called a direct vision prism. This combination produces dispersion without deviation.

For deviation to be zero

$$\delta + \delta' = 0$$

or

$$(\mu - 1) A + (\mu' - 1) A' = 0$$

or

$$A' = - \frac{(\mu - 1)}{(\mu' - 1)} A$$

Spectra and spectrometer—The pattern produced by a beam emerging from a prism after refraction is called **Spectrum**. This effect is produced due to dispersion which is the splitting of incident non-monochromatic ray into its constituent colours. Visible spectrum which lies within the range of red and violet colours is part of much larger electromagnetic spectrum.

Types of Spectra

Line—Due to the source in atomic state.

Band—Due to the source in molecular state.

Continuous—Due to white hot solid.

In emission spectrum, bright colours or lines, emitted from a source are observed.

In absorption spectrum, there are dark gaps indicating frequencies absorbed.

Spectrometer—Consists of a collimator, a prism and a telescope. It is used to observe the spectrum and also to measure deviations.

Example 2. (a) A slab of glass 20 cm thick and refractive index 1.5 is kept in front of a plane mirror and a pin is kept in front of it in air at a distance of 40 cm from the mirror. Find the position of the image as formed by the mirror.

Solution :

Example 1. (b) Crown glass has $\mu_v = 1.538$; $\mu_r = 1.52$; quartz glass has $\mu_v = 1.557$; $\mu_r = 1.542$.

Given a quartz prism of refracting angle 4° . Find :

- (i) the angle of the crown glass prism to form a direct vision combination for white light and
- (ii) the angular width of the spectrum produced by this combination.

Solution :

Example 2. (b) The dispersive powers of flint glass and crown glass are 0.053 and 0.034 respectively and their mean refractive indices are 1.68 and 1.53 for white light. Calculate :

- (i) the angle of the flint glass prism required to form an achromatic combination with a crown glass prism of refracting angle 4° and

- (ii) the net mean deviation produced by the combination.

Solution :

Example 3. The base of a tank is horizontal plate of glass 8 cm thick ($\mu = 1.6$). Above this is a layer of liquid of thickness 4.5 cm ($\mu = 1.5$) and upon this floats a layer of water 12 cm thick ($\mu = 4/3$). Looking from above, what is the apparent position of the spot on the bottom of the tank, and where should the eye be held to see this spot ?

Solution :

Example 5. A 60° glass prism has a refractive index of 1.5. Calculate :

- (i) the angle of incidence for minimum deviation,
- (ii) the minimum deviation and
- (iii) the angle of emergence of the light at maximum deviation.

Solution :

Example 4. The refracting angle of a prism is A and refractive index of the prism is $\cot(A/2)$. Show that the angle of minimum deviation is $(180^\circ - 2A)$.

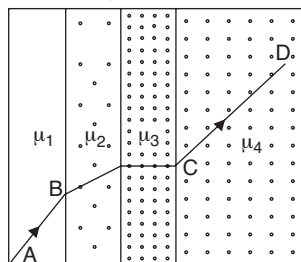
Solution :

OBJECTIVE QUESTIONS

1. Velocity of light in glass whose refractive index with respect to air is 1.5 is 2×10^8 m/s and in certain liquid the velocity of light found to be 2.50×10^8 m/s. The refractive index of the liquid with respect to air is—

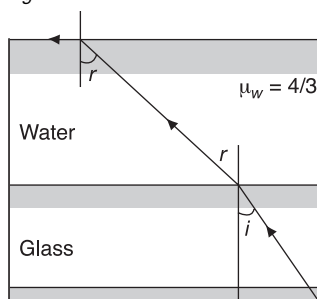
(A) 0.64 (B) 0.80
(C) 1.20 (D) 1.44

2. A ray of light passes through four transparent media with refractive indices μ_1, μ_2, μ_3 and μ_4 as shown in the figure. The surfaces of all media are parallel. If the emergent ray CD is parallel to the incident ray AB, we must have—



(A) $\mu_1 = \mu_2$ (B) $\mu_2 = \mu_3$
(C) $\mu_3 = \mu_4$ (D) $\mu_4 = \mu_1$

3. A ray of light is incident at the glass-water interface at an angle i , it emerges finally parallel to the surface of water, then the value of μ_g would be—



(A) $(4/3) \sin i$ (B) $1/\sin i$
(C) $4/3$ (D) 1

4. A ray of light passes from vacuum into a medium of refractive index μ , the angle of incidence is found to be twice the angle of refraction. Then the angle of incidence is—
- (A) $\cos^{-1}(\mu/2)$
(B) $2 \cos^{-1}(\mu/2)$
(C) $2 \sin^{-1}(\mu)$
(D) $2 \sin^{-1}(\mu/2)$

5. A ray of light falls on the surface of a spherical glass paper weight

making an angle α with the normal and is refracted in the medium at an angle β . The angle of deviation of the emergent ray from the direction of the incident ray is—

(A) $(\alpha - \beta)$ (B) $2(\alpha - \beta)$
(C) $(\alpha - \beta)/2$ (D) $(\alpha + \beta)$

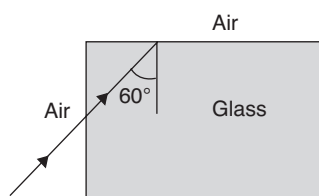
6. A rectangular slab of refractive index μ is placed over another slab of refractive index 3, both slabs being identical in dimensions. If a coin is placed below the lower slab, for what value of μ will the coin appear to be placed at the interface between the slabs when viewed from the top?

(A) 1.8 (B) 2
(C) 1.5 (D) 2.5

7. Water ($\mu_w = \frac{4}{3}$) is filled in a beaker upto a height of 10 cm. A plane mirror fixed at a height of 5 cm from the surface of water. Distance of image from the mirror after reflection from it of an object O at the bottom of the beaker is—

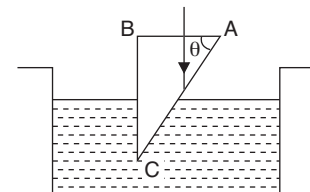
(A) 15 cm (B) 12.5 cm
(C) 7.5 cm (D) 10 cm

8. A light ray from air is incident (as shown in figure) at one end of a glass fibre (refractive index $\mu = 1.5$) making an incidence angle of 60° on the lateral surface, so that it undergoes a total internal reflection. How much time would it take to traverse the straight fibre of length 1 km?



(A) $3.33 \mu \text{ sec}$ (B) $6.67 \mu \text{ sec}$
(C) $5.77 \mu \text{ sec}$ (D) $3.85 \mu \text{ sec}$

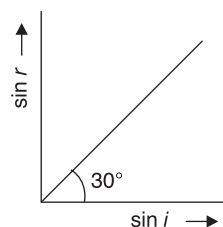
9. A glass prism of refractive index 1.5 is immersed in water



($\mu = 4/3$). A light beam incident normally on the face AB is totally reflected to reach the face BC if—

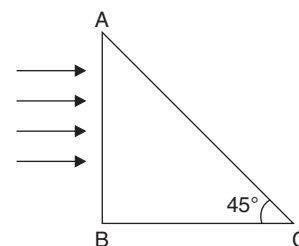
(A) $\sin \theta > 8/9$
(B) $2/3 < \sin \theta < 8/9$
(C) $\sin \theta \leq 2/3$
(D) $\cos \theta \geq 8/9$

10. When light is incident on a medium at angle i and refracted into a second medium at an angle r , the graph of $\sin i$ versus $\sin r$ is as shown in the graph. From this, one can conclude that—



- (A) Velocity of light in the second medium is 1.73 times the velocity of light in the I medium
(B) Velocity of light in the I medium is 1.73 times the velocity in the II medium
(C) The critical angle for the two media is given by $i_c = \sqrt{3}$
(D) $\sin i_c = \frac{1}{2}$

11. A beam of light consisting of red, green and blue colours is incident on a right angled prism. The refractive indices of the material of the prism for the above red, green and blue wavelengths are 1.39, 1.44 and 1.47 respectively. The prism will—



- (A) Separate part of red colour from the green and the blue colours
(B) Separate part of the blue colour from the red and green colours

- (C) Separate all the colours from one another
(D) Not separate even partially any colour from the other two colours
12. An air bubble in a glass slab ($\mu = 1.5$) is 6 cm deep when viewed from one face and 4 cm deep when viewed from the opposite face. The thickness of the glass plate is—
(A) 10 cm
(B) 6.67 cm
(C) 15 cm
(D) None of these
13. One face of a rectangular glass plate 6 cm thick is silvered. An object held 8 cm in front of the first face, forms an image 12 cm behind the silvered face. The refractive index of the glass is—
(A) 0.4 (B) 0.8
(C) 1.2 (D) 1.6
14. A ray of light is incident on a glass sphere of refractive index $3/2$. What should be the angle of incidence so that the ray which enters the sphere doesn't come out of the sphere?
(A) $\tan^{-1} \left(\frac{2}{3} \right)$
(B) $\sin^{-1} \left(\frac{2}{3} \right)$
(C) 90°
(D) $\cos^{-1} \left(\frac{1}{3} \right)$
15. The image of point P when viewed from top of two slabs ($\mu = 1.5$) of thick 1.5 each will be—
(A) 2.0 cm above P
(B) 1.5 cm above P
(C) 2.0 cm below P
(D) 1 cm above P
16. When light rays are incident on a prism at an angle of 45° , the minimum deviation is obtained. If refractive index of the material of prism is $\sqrt{2}$, then the angle of prism will be—
(A) 30° (B) 40°
(C) 50° (D) 60°

17. Angle of minimum deviation for a prism of refractive index 1.5 is equal to the angle of prism. The angle of prism is—

$$(\cos 41^\circ = 0.75)$$

- (A) 62° (B) 41°
(C) 82° (D) 31°
18. A prism ($\mu = 1.5$) has the refracting angle of 30° . The deviation of a monochromatic ray incident normally on its one surface will be—
(sin $48^\circ 36' = 0.75$)

- (A) $18^\circ 36'$ (B) $20^\circ 30'$
(C) 18° (D) $22^\circ 1'$

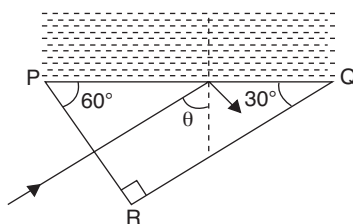
19. The refracting angle of prism is A and refractive index of material of prism is $\cot \frac{A}{2}$. The angle of minimum deviation is—

- (A) $180^\circ - 3A$ (B) $180^\circ + 2A$
(C) $90^\circ - A$ (D) $180^\circ - 2A$

20. A ray of light passes through an equilateral glass prism in such a manner that the angle of incidence is equal to the angle of emergence and each of these angles is equal to $3/4$ of the angle of the prism. The angle of deviation is—

- (A) 45° (B) 39°
(C) 20° (D) 30°

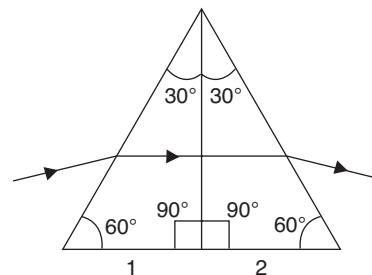
21. PQR is a right angled prism with other angles as 60° and 30° . Refractive index of prism is 1.5. PQ has a thin layer of liquid on it. Light falls normally on the face PR. For total internal reflection, maximum refractive index of liquid is—



- (A) 1.4 (B) 1.3
(C) 1.2 (D) 1.6

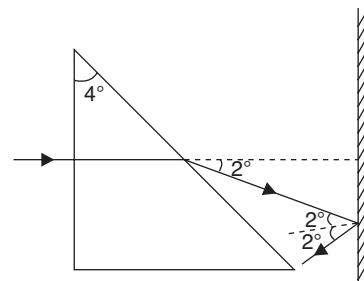
22. Two identical prisms 1 and 2, each with angles 30° , 60° and 90° are placed in contact as shown in figure. A ray of light passed through the combination in the position of minimum deviation

and suffers a deviation of 30° . If the prism 2 is removed, then the angle of deviation of the same ray is—



- (A) Equal to 15°
(B) Smaller than 30°
(C) More than 15°
(D) Equal to 30°

23. A prism having an apex angle 4° and refractive index 1.5 is located in front of a vertical plane mirror as shown in figure. Through what total angle is the ray deviated after reflection from the mirror?



- (A) 176° (B) 4°
(C) 178° (D) 2°

24. A ray of light is incident to the hypotenuse of a right-angled prism after travelling parallel to the base inside the prism. If μ is the refractive index of the material of the prism, the maximum value of the base angle for which light is totally reflected from the hypotenuse is—

- (A) $\sin^{-1} \left(\frac{1}{\mu} \right)$
(B) $\tan^{-1} \left(\frac{1}{\mu} \right)$
(C) $\sin^{-1} \left(\frac{\mu - 1}{\mu} \right)$
(D) $\cos^{-1} \left(\frac{1}{\mu} \right)$

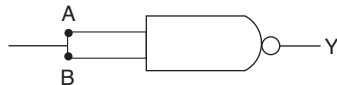
25. The light is incident at an angle of 60° on a prism of which the refracting angle 30° . If it suffers

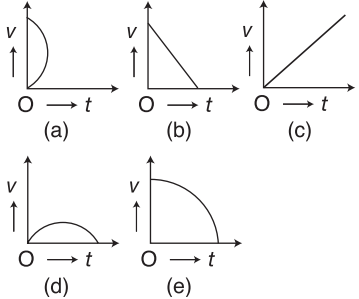
deviation of 30° , the refractive index of material of prism will be—

- (A) $\sqrt{2}$ (B) $2\sqrt{3}$
(C) 2 (D) $\sqrt{3}$

ANSWERS WITH HINTS

PHYSICS

- Heater coil A takes t_1 sec to boil certain quantity of water. Heater coil B takes t_2 sec to boil same quantity of water. If A and B are connected in series, the time taken to boil the same quantity of water by the combination is—
 (A) $\sqrt{t_1 t_2}$ (B) $t_1 + t_2$
 (C) $\frac{1}{2}(t_1 + t_2)$ (D) $\frac{t_1 t_2}{t_1 + t_2}$
- A copper wire and a silicon wire were heated from room temperature to 60°C . Then—
 (A) Resistance of both the wires decreases
 (B) Resistance of both the wires increases
 (C) Resistance of copper wire decreases and that of silicon wire increases
 (D) Resistance of copper wire increases and that of silicon wire decreases
- The mutual electrostatic potential energy between two protons which are at a distance of 9×10^{-15} m, in ${}_{92}\text{U}^{235}$ nucleus is—
 (A) 1.56×10^{-14} J
 (B) 5.5×10^{-14} J
 (C) 2.56×10^{-14} J
 (D) 4.56×10^{-14} J
- The S.I. units of electron mobility are—
 (A) $\text{m}^2\text{s}^{-1}\text{V}^{-1}$ (B) msv^{-1}
 (C) ms^{-1}V (D) $\text{m}^2\text{s}^{-2}\text{V}^{-2}$
- Energy stored per unit volume of a parallel plate capacitor having plate area A and plate separation 'd' when charged to a potential of V volts is—
 (Air space in between the plates)
 (A) $\frac{1}{2} C^2 V^2$ (B) $\frac{q^2}{4C}$
 (C) $\frac{1}{2} \epsilon_0 \left(\frac{V}{d}\right)$ (D) $\frac{1}{2} \epsilon_0 \left(\frac{V^2}{d^2}\right)$
- The tungsten filaments of two electric bulbs are of the same length. If one of them gives 25W power and the other 60W power then—
 (A) Both the filaments are of same thickness
 (B) 25W bulb has thicker filament
 (C) 60W bulb has thicker filament
 (D) Both the filaments have same cross-section area
- Work done in taking a mass from one point to another in a gravitational field depends on—
 (A) The end points only
 (B) The path followed
 (C) The velocity of the mass
 (D) Both the length of the path and the end points
- A child stands at one end of a boat moving with a speed 'v' in still water. If the child starts running towards the other end of the boat with a speed 'u', the centre of mass of the system (boat and child) will move with a speed—
 (A) $v - u$ (B) v
 (C) u (D) $v + u$
- A particle is describing uniform circular motion. Its acceleration is—
 (A) Along the radius of circular path pointing towards the centre
 (B) Along the tangent to the circular path
 (C) Along the radius of the circular path pointing away from the centre
 (D) Zero
- I_1 and I_2 are the moments of inertia of two circular discs about their central axes perpendicular to their surfaces. Their angular frequencies of rotation are ω_1 and ω_2 respectively. If they are brought in contact face to face with their axes of rotation coinciding with each other, the angular frequency of the composite disc will be—
 (A) $\frac{I_1 + I_2}{\omega_1 + \omega_2}$ (B) $\frac{I_2 \omega_1 - I_1 \omega_2}{I_1 - I_2}$
 (C) $\frac{I_2 \omega_1 + I_1 \omega_2}{I_1 + I_2}$ (D) $\frac{I_1 \omega_1 + I_2 \omega_2}{I_1 + I_2}$
- In planetary motion, the quantity that remains unchanged is—
 (A) Radius of the orbit
 (B) Speed along the orbit
 (C) Total angular momentum
 (D) Angular speed
- A particle moves in x-y plane under the action of a force \vec{F} such that the value of its linear momentum \vec{p} at any time t is $p_x = 2 \cos t$, $p_y = 2 \sin t$. The angle θ between \vec{F} and \vec{p} at a given time t will be—
 (A) 90° (B) 0°
 (C) 180° (D) 30°
- The weakest bond in solids is—
 (A) Van der Waals (B) Metallic
 (C) Covalent (D) Ionic
- In a transistor, the base is—
 (A) A conductor with high conductivity
 (B) An insulator
 (C) An extrinsic semiconductor
 (D) An intrinsic semiconductor
- A particle of mass M at rest decays into two particles of masses m_1 and m_2 , having non-zero velocities. The ratio of the de-Broglie wavelengths of particles λ_1/λ_2 is—
 (A) m_1/m_2 (B) m_2/m_1
 (C) $1 : 1$ (D) $\sqrt{m_1}/\sqrt{m_2}$
- The following figure represents—

 (A) OR gate (B) NOT gate
 (C) NOR gate (D) AND gate
- Two particles of different masses, initially at rest, start moving towards each other under their gravitational attraction. At an instant when the speeds of the particles are v and $2v$, the speed of the centre of mass is—
 (A) Zero (B) v
 (C) $1.5v$ (D) $3v$

18. When a wave undergoes refraction—
 (A) Its frequency does not change
 (B) Its amplitude changes
 (C) Its velocity changes
 (D) Both amplitude and frequency change
19. The maximum range of a projectile is 100 m. The maximum height reached by it is—
 (A) 100 m (B) 25 m
 (C) 50 m (D) 75 m
20. The equation $y = A \sin k(vt - x)$ represents $\left(k = \frac{2\pi}{\lambda}\right)$ —
 (A) A plane progressive wave travelling along negative X-direction
 (B) A plane progressive wave travelling along positive X-direction
 (C) A stationary wave
 (D) A plane progressive wave travelling along positive Y-direction
21. A Carnot's engine working between 27°C and 127°C has a work output of 200 J per cycle. The energy supplied to the engine from the source in each cycle is—
 (A) 400 J (B) 800 J
 (C) 600 J (D) 500 J
22. A particle is executing linear simple harmonic motion. The fraction of the total energy that is potential, when its displacement is $\frac{1}{4}$ of its amplitude is—
 (A) $\frac{1}{16}$ (B) $\frac{1}{8}$
 (C) $\frac{1}{2}$ (D) $\frac{1}{4}$
23. The third overtone of an open organ pipe is in resonance with the second overtone of a closed organ pipe. If the length of the open pipe is 8 cm, then the length of the closed pipe is—
 (A) 10 cm (B) 8 cm
 (C) 12 cm (D) 5 cm
24. The correct vector relation between linear velocity \vec{v} and angular velocity $\vec{\omega}$ in rigid body dynamics is—
 (\vec{r} is the position vector)
 (A) $\vec{\omega} = \vec{v} \times \vec{r}$ (B) $\vec{v} = \vec{r} \times \vec{\omega}$
 (C) $\vec{v} = \vec{\omega} \times \vec{r}$ (D) $\vec{r} = \vec{v} \times \vec{\omega}$
25. Magnitudes of four pairs of displacement vectors are given. Which pair of displacement vectors, under vector addition, fails to give a resultant vector of magnitude 3 cm ?
 (A) 2 cm, 7 cm (B) 1 cm, 4 cm
 (C) 2 cm, 3 cm (D) 2 cm, 4 cm
26. The quantities RC and L/R (where R, L and C stand for resistance, inductance and capacitance respectively) have the dimension of—
 (A) Force
 (B) Linear momentum
 (C) Linear velocity
 (D) Time
27. Which of the following cannot be speed-time graph ?

28. If a transparent parallel plate of uniform thickness ' t ' and refractive index μ is interposed perpendicularly in the path of a light beam, the optical path is—
 (A) Increased by $(\mu - 1)t$
 (B) Decreased by μt
 (C) Decreased by $(\mu - 1)t$
 (D) Increased by μt
29. If the width of the slit in single slit diffraction experiment is doubled, then the central maximum of diffraction pattern becomes—
 (A) Broader and brighter
 (B) Sharper and brighter
 (C) Sharper and fainter
 (D) Broader and fainter
30. The relationship between phase difference $\Delta\phi$ and the path difference Δx between two interfering waves is given by—
 (λ = wavelength)
 (A) $\Delta x = \left(\frac{\lambda}{2\pi}\right) \Delta\phi$
 (B) $\Delta x = \left(\frac{2\pi}{\lambda}\right) \Delta\phi$
 (C) $\Delta\phi = \left(\frac{\lambda}{\pi}\right) \Delta x$
 (D) $\Delta\phi = (2\pi) \Delta x$
31. The velocity of an electromagnetic wave in vacuum can be changed by changing—
 (A) Frequency
 (B) Amplitude
 (C) Wavelength
 (D) None of the above
32. In Young's double slit experiment, the fringe width with light of wavelength 6000 \AA is 3 mm. The fringe width, when the wavelength of light is changed to 4000 \AA is—
 (A) 3 mm (B) 1 mm
 (C) 2 mm (D) 4 mm
33. Transverse nature of light was confirmed by the phenomenon of—
 (A) Refraction of light
 (B) Diffraction of light
 (C) Dispersion of light
 (D) Polarization of light
34. Water flows through a pipe of varying cross section. Then the ratio of speeds of water at two points 1 and 2 where the radii of the pipe are r_1 and r_2 is—
 (A) $\frac{r_2^2}{r_1^2}$ (B) $\frac{r_2}{r_1}$
 (C) $\frac{r_1^2}{r_2^2}$ (D) $\frac{r_1}{r_2}$
35. A satellite moving round the earth in a circular orbit of radius ' r ' and speed ' v ' suddenly loses some of its energy. Then—
 (A) ' r ' will increase and ' v ' will decrease
 (B) Both ' r ' and ' v ' will decrease
 (C) Both ' r ' and ' v ' will increase
 (D) ' r ' will decrease and ' v ' will increase

36. A body is projected up from the surface of the earth with a velocity equal to $\frac{3}{4}$ th of its escape velocity. If R be the radius of earth, the height it reaches is—
 (A) $\frac{3R}{10}$ (B) $\frac{9R}{7}$
 (C) $\frac{8R}{5}$ (D) $\frac{9R}{5}$
37. The stress required to double the length of a wire of Young's modulus ' Y ' is—
 (A) $Y/2$ (B) $2Y$
 (C) Y (D) $4Y$
38. A piece of ice with a stone embedded inside it, is floating in water contained in a vessel. When the ice melts completely, the level of water in the vessel—
 (A) Remains unchanged
 (B) Rises
 (C) Falls
 (D) Falls in the beginning and rises to the same level later
39. Electric flux emanating through a surface element $\vec{ds} = 5\hat{i}$ placed in an electric field $\vec{E} = 4\hat{i} + 4\hat{j} + 4\hat{k}$ is—
 (A) 10 units (B) 20 units
 (C) 4 units (D) 16 units
40. A radioactive isotope A with a half life of 1.25×10^{10} years decays into B which is stable. A sample of rock from a planet is found to contain both A and B present in the ratio 1 : 15. The age of the rock is— (in years)
 (A) 9.6×10^{10} (B) 4.2×10^{10}
 (C) 5×10^{10} (D) 1.95×10^{10}
41. The shortest wavelength of X-rays coming from an X-ray tube depends on the—
 (A) Voltage applied to the tube
 (B) Current in the tube
 (C) Atomic number of target element
 (D) Nature of gas in the tube
42. The masses of two particles have same kinetic energies are in the ratio 2 : 1. Then their de Broglie wavelengths are in the ratio—
 (A) 2 : 1 (B) $1 : \sqrt{2}$
 (C) $\sqrt{2} : 1$ (D) $\sqrt{3} : 1$
43. If the photoelectric work function for a metallic surface is 4.125 eV, the cut-off wavelength for photoelectric phenomenon for the surface is—
 (A) 4500 Å (B) 1700 Å
 (C) 2800 Å (D) 3000 Å
44. Balmer series of hydrogen atom lies in—
 (A) Microwave region
 (B) Visible region
 (C) Ultraviolet region
 (D) Infrared region
45. The nuclear force—
 (A) Is purely an electrostatic force
 (B) Obeys inverse square law of distance
 (C) Is equal in strength to gravitational field
 (D) Is short-range force
46. Enriched uranium is used in nuclear reactors because it contains greater proportion of—
 (A) U^{238} (B) U^{235}
 (C) U^{239} (D) U^{233}
47. A parallel plate capacitor is charged to a potential of V volts. The battery is then disconnected and the distance between the plates of the capacitor is increased using an insulating handle. The potential difference between the plates of the capacitor will—
 (A) Increase
 (B) Decrease
 (C) Not change
 (D) Become zero
48. Three charges $-q$, $+Q$ and $-q$ are placed in a straight line as shown :

$$\begin{array}{ccccc} -q & & +Q & & -q \\ & \longleftarrow x & & \longrightarrow x & \end{array}$$

 If the total potential energy of the system is zero, then the ratio $\frac{q}{Q}$ is—
 (A) 2 (B) 5.5
 (C) 4 (D) 1.5
49. When air medium in which two charges kept apart at a distance ' r ' is replaced by a dielectric medium of dielectric constant k , the force between the charges—
 (A) Remains unchanged
 (B) Decreases k times
 (C) Increases k times
 (D) Increases k^2 times
50. The magnitude of electric field required to balance an oil drop of mass m , carrying charge ' q ' is— (g = acceleration due to gravity)
 (A) $\frac{q}{m}$ (B) $\frac{mg}{q^2}$
 (C) mgq (D) $\frac{mg}{q}$
51. A body is moved along a straight line by a machine delivering constant power. The distance moved by the body in time t is proportional to—
 (A) $t^{1/2}$ (B) $t^{3/4}$
 (C) $t^{3/2}$ (D) t^2
52. A cricket ball of mass 0.5 kg strikes a cricket bat normally with a velocity of 20 ms^{-1} and rebounds with a velocity of 10 ms^{-1} . The impulse of the force exerted by the ball on the bat is—
 (A) 15 Ns (B) 25 Ns
 (C) 30 Ns (D) 10 Ns
53. The working principle of rocket propulsion is conservation of—
 (A) Angular momentum
 (B) Mass
 (C) Linear momentum
 (D) Kinetic energy
54. A parallel combination of 0.1 MΩ resistor and a 10 μF capacitor is connected across a 1.5 V source of negligible resistance. The time required for the capacitor to get charged upto 0.75V is approximately (in seconds) is—
 (A) ∞ (B) $\log_e 2$
 (C) $\log_{10} 2$ (D) Zero
55. Assuming earth to be an inertial frame, an example for inertial frame observer is—
 (A) A driver in a train which is slowing down to stop
 (B) A person in a car moving with uniform velocity
 (C) A girl revolving in a merry-go-round
 (D) A passenger in an aircraft which is taking off

56. The relation connecting magnetic susceptibility χ_m and relative permeability μ_r is—
 (A) $\chi_m = \mu_r + 1$
 (B) $\chi_m = \mu_r - 1$
 (C) $\chi_m = \frac{1}{\mu_r}$
 (D) $\chi_m = 3(1 + \mu_r)$
57. The average power dissipated in a pure capacitance A.C. circuit is—
 (A) CV (B) Zero
 (C) $\frac{1}{2} CV^2$ (D) $\frac{1}{4} CV^2$
58. In inelastic collision—
 (A) Momentum, kinetic energy and total energy are conserved
 (B) Momentum, kinetic energy and total energy are not conserved
 (C) Momentum and kinetic energy are conserved but total energy is not conserved
 (D) Momentum is conserved but kinetic energy is not conserved
59. The instantaneous values of current and voltage in an A.C. circuit are given by

$$I = 6 \sin \left(100 \pi t + \frac{\pi}{4} \right),$$

$$V = 5 \sin \left(100 \pi t - \frac{\pi}{4} \right)$$
 then—
 (A) Current leads the voltage by 45°
 (B) Voltage leads the current by 90°
 (C) Current leads the voltage by 90°
 (D) Voltage leads the current by 45°
60. In A.C. circuits Ohm's law is applicable for—
 (A) Instantaneous values of current and voltage only
 (B) R.M.S. values of current and voltage only
 (C) Peak values of current and voltage only
 (D) All values of current and voltage
61. Whenever there is a relative motion between a coil and a magnet, the magnitude of induced e.m.f. set up in the coil does **not** depend upon the—
 (A) Relative speed between the coil and magnet
 (B) Magnetic moment of the coil
 (C) Resistance of the coil
 (D) Number of turns in the coil
62. Two cells, each of e.m.f. E and internal resistance r , are connected in parallel across a resistance R . The power delivered to R is maximum when—
 (A) $R = r/2$ (B) $R = r$
 (C) $R = 2r$ (D) $R = 0$
63. The resistance of an ideal voltmeter is—
 (A) Zero (B) Low
 (C) High (D) Infinity
64. An electron travelling with velocity \vec{v} , enters a region of space in which electric and magnetic fields exist. Then the electron goes undeflected for all values of fields—
 (A) If both electric and magnetic fields are normal to \vec{v}
 (B) If the magnetic field alone is normal to \vec{v}
 (C) If both electric and magnetic fields are parallel to \vec{v}
 (D) If the electric field alone is normal to \vec{v}
65. A charge ' q ' coulomb makes ' n ' revolutions in one second in a circular orbit of radius ' r '. The magnetic field at the centre of the orbit in $NA^{-1}m^{-1}$ is—
 (A) $\frac{2\pi nq}{r} \times 10^{-7}$
 (B) $\frac{2\pi q}{r} \times 10^{-7}$
 (C) $\frac{2\pi q}{nr} \times 10^{-7}$
 (D) $\frac{2\pi nq}{r} \times 10^{-7}$
66. When the cold and hot junctions of a thermocouple are interchanged, the thermo e.m.f.—
 (A) Changes sign
 (B) Remains the same
 (C) Becomes zero
 (D) Is doubled
67. In a moving coil galvanometer, to make the field radial—
 (A) Coil is wound on wooden frame
 (B) Magnetic poles are cylindrically cut
 (C) A horse shoe magnet is used
 (D) The number of windings in the coil is decreased
68. Magnetic field at the centre of a coil in the form of a square of side 2 cm carrying a current of 1.414 A is—
 (A) $8 \times 10^{-5} T$
 (B) $4 \times 10^{-5} T$
 (C) $1.5 \times 10^{-5} T$
 (D) $6 \times 10^{-5} T$
69. When the temperature of a gas is increased—
 (A) Its molecular kinetic energy increases
 (B) Molecular potential energy decreases and molecular kinetic energy also decreases; total energy remaining constant
 (C) Molecular potential energy increases and molecular kinetic energy decreases; total energy remaining constant
 (D) Its molecular potential energy increases
70. The requirement for heat conduction to take place in a solid is—
 (A) Density gradient
 (B) Uniform density
 (C) Temperature gradient
 (D) Uniform temperature
71. Two monoatomic ideal gases A and B occupying the same volume V , are at the same temperature T and pressure P . If they are mixed, the resultant mixture has volume V and temperature T . The pressure of the mixture is—
 (A) P (B) $P/2$
 (C) $4P$ (D) $2P$
72. A certain quantity of heat energy is given to a diatomic ideal gas which expands at constant pres-

sure. The fraction of the heat energy that is converted into work is—

- (A) $\frac{2}{3}$ (B) $\frac{2}{7}$
(C) $\frac{1}{5}$ (D) $\frac{1}{7}$

73. The excess pressure inside a spherical drop of liquid or a spherical bubble of radius R in a liquid of surface tension T is—

- (A) $\frac{T}{4R}$ (B) $\frac{T}{R}$
(C) $\frac{2T}{R}$ (D) $\frac{4T}{R}$

74. Two small spheres of radii ' r ' and ' $4r$ ' fall through a viscous liquid with the same terminal velocity. The ratio between the viscous forces acting on them is—

- (A) 1 : 2 (B) 4 : 1
(C) 1 : 16 (D) 1 : 4

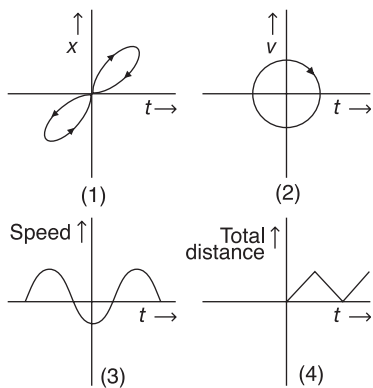
75. A sound wave with frequency 256 Hz falls normally on a perfectly reflecting wall. The shortest distance from the wall at which the air particles will have maximum amplitude of vibrations is nearly— (velocity of sound in air is 336 m/s)

- (A) 32.8 cm
(B) 50 cm
(C) 65.6 cm
(D) 25 cm

ANSWERS WITH HINTS

PHYSICS

1. Which of the following curves represents one-dimensional motion of a particle ?



- (A) 4 (B) 1 and 2
(C) 2 and 3 (D) None of these

2. When the particle moves with uniform velocity which of the following relations are correct ?

- (I) Average speed = Average velocity
(II) Instantaneous speed = Instantaneous velocity
(III) Distance covered = Magnitude of displacement

- (A) I, II, III (B) I, II
(C) II, III (D) I, III

3. A glass marble dropped from a certain height above the horizontal surface reaches the surface in time t and then continues to bounce up and down. The time in which the marble finally comes to rest is—

- (A) $t \left(\frac{1-e}{1+e} \right)$ (B) $t \left(\frac{1+e}{1-e} \right)$
(C) $e^2 t$ (D) $e^0 t$

4. A stone tied to a string of length L is whirled in a vertical circle with the other end of the string at the centre. At a certain instant of time the stone is at its lowest position and has speed u . The magnitude of the change in its velocity as it reaches a position where the string is horizontal is—

- (A) $\sqrt{u^2 - 2gL}$ (B) $\sqrt{2gL}$
(C) $\sqrt{u^2 - gL}$ (D) $\sqrt{2(u^2 - gL)}$

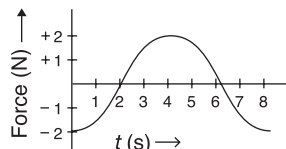
5. An aeroplane moving horizontally with a speed of 180 km/hr drops a food packet while flying at a height of 490 m. The horizontal range is—

- (A) 180 m (B) 980 m
(C) 500 m (D) 675 m

6. Given that $\vec{W} = \vec{F} \cdot \vec{S} = 0$ and $\vec{F} \neq 0$; $\vec{S} \neq 0$ then

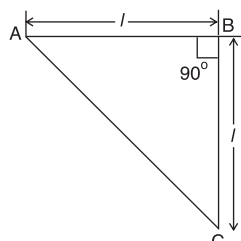
- (A) \vec{F} is equal to \vec{S}
(B) \vec{F} is parallel to \vec{S}
(C) \vec{F} is perpendicular to \vec{S}
(D) None of these

7. A force-time graph for a linear motion is shown in figure. The segments shown are circular. The linear momentum gained between 0 and 8 second is—



- (A) $-2\pi \text{ NS}$ (B) Zero
(C) $+4\pi \text{ NS}$ (D) $+6\pi \text{ NS}$

8. Figure shows a thin metallic triangular sheet ABC. The mass of the sheet is M . The moment of inertia of the sheet about side AC is—



- (A) $\frac{Ml^2}{18}$ (B) $\frac{Ml^2}{12}$
(C) $\frac{Ml^2}{6}$ (D) $\frac{Ml^2}{4}$

9. If the earth were $\frac{1}{4}$ of its distance from the sun, the duration of the year will be—

- (A) 8 year (B) $\frac{1}{8}$ year
(C) 4 year (D) $\frac{1}{4}$ year

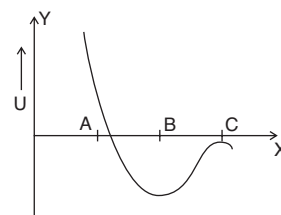
10. How much work per kilogram need to be done to shift a 1 kg mass from the surface of the earth to infinity ? Take acceleration due to gravity = g ; and radius of the earth = R —

- (A) g/R (B) R/g
(C) gR (D) g/R^2

11. Which of the following is a necessary and sufficient condition for simple harmonic motion ?

- (A) Constant period
(B) Constant acceleration
(C) Proportionality between acceleration and displacement from equilibrium position
(D) Proportionality between restoring force and displacement from equilibrium position

12. The potential energy U between two atoms in a diatomic molecule as a function of the distance x between atoms has been shown in the given figure.



The atoms are—

- (A) Attracted when x lies between A and B and repelled when x lies between B and C.
(B) Attracted when x lies between B and C and are repelled when x lies between A and B.
(C) Attracted when they reach B
(D) Repelled when they reach B

13. A mass m suspended from a light spring has a period T for its vertical small vibrations. If four such springs are connected in series and the same mass m is suspended from the combination, the period of small vertical vibrations of m is—

- (A) $4T$ (B) $T/4$
(C) $2T$ (D) $T/2$

14. A wooden ball of density D is immersed in water of density d to a depth h below the surface of

water and then released. Upto what height will the ball jump out of water ?

- (A) $\frac{d}{D} h$ (B) $\left(\frac{d}{D} - 1\right) h$
(C) h (D) Zero

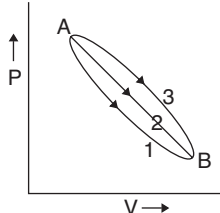
15. A beaker is completely filled with water at 4°C . It will over-flow—

- (A) When heated but not when cooled
(B) When cooled but not when heated
(C) Both when heated or cooled
(D) Neither when heated nor when cooled

16. The total K.E. of all the molecules of helium having a volume V exerting a pressure P is 1500 J. The total KE in joules of all the molecules of N_2 having the same volume V and exerting a pressure $2P$ is—

- (A) 3000 (B) 4000
(C) 5000 (D) 6000

17. A given mass of gas expands from state A to the state B by three paths 1, 2 and 3 as shown in the figure. If W_1 , W_2 and W_3 respectively be the work done by the gas along three paths, then—



- (A) $W_1 = W_2 = W_3$
(B) $W_1 < W_2 < W_3$
(C) $W_1 > W_2 > W_3$
(D) $W_1 < W_2$ and $W_1 > W_3$

18. A uniform metal rod is used as a bar pendulum. If the room temperature rises by 10°C , and the coefficient of linear expansion of the metal of the rod is 2×10^6 per $^\circ\text{C}$, the period of the pendulum will have percentage increase of—

- (A) -2×10^{-3} (B) -1×10^{-3}
(C) 2×10^{-3} (D) 1×10^{-3}

19. A system is caused to change reversibly from an initial to a final

state by adiabatic means only. Then—

- (A) The work done is the same for all adiabatic paths connecting two states
(B) The work done is different for different adiabatic paths connecting the two states
(C) The total internal energy of the system will change according to different paths
(D) There is no workdone since there is no transfer of heat

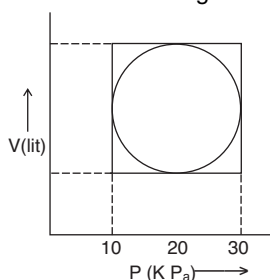
20. A black body is at a temperature of 2800 K. The energy of radiation emitted by this body with wavelength between 499 nm to 500 nm is u_1 between 999 nm to 1000 nm is u_2 and between 1499 nm to 1500 nm is u_3 . The constant $b = 2.80 \times 10^6$ nm K, then—

- (A) $u_1 = 0$ (B) $u_3 = 0$
(C) $u_1 > u_2$ (D) $u_2 > u_1$

21. A convex lens A of focal length 20 cm and a concave lens of focal length 5 cm are kept along the same axis with a distance d between them. A parallel beam of light falling on A leaves B as a parallel beam, then the distance d will be—

- (A) 25 cm (B) 15 cm
(C) 30 cm (D) 50 cm

22. Heat energy absorbed by a system in going through a cyclic process shown in figure is—



- (A) $10^7 \pi \text{ J}$ (B) $10^4 \pi \text{ J}$
(C) $10^2 \pi \text{ J}$ (D) $10^{-3} \pi \text{ J}$

23. In an experiment similar to Young's double slit experiment, interference is observed using waves associated with electrons. The electrons are being produced in an electron gun. In order to increase the fringe width—

- (A) Electron gun voltage is increased
(B) Electron gun voltage is decreased

- (C) The slits be moved away
(D) The screen be moved closer to interfering slits

24. An earth satellite has a velocity component of 7 km/s towards an earth observer. It emits a signal of frequency 100 MHz. This is combined with a signal of same frequency produced by a local oscillator. The approximate, beat frequency (in Hz) will be—

- (A) 1200 (B) 2400
(C) 3600 (D) 4800

25. Two waves are

$$y = 0.25 \sin 316 t$$

$$y = 0.25 \sin 310 t$$

are travelling in the same direction. The number of beats produced per second will be—

- (A) 6 (B) 3
(C) $\frac{3}{\pi}$ (D) 3π

26. The extension in a string obeying Hooke's law is x . The speed of sound wave in the stretched string is v . If the extension in the string is increased to $1.5x$, the speed of sound wave will be—

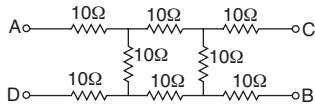
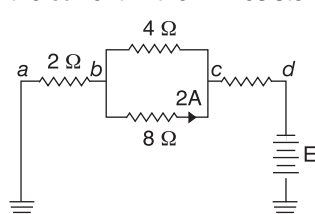
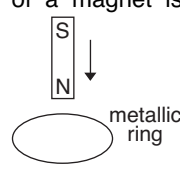
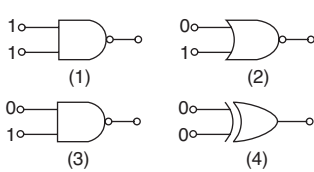
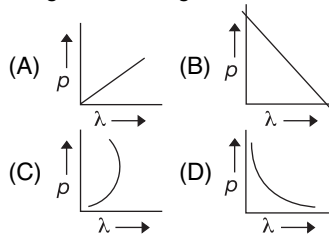
- (A) $1.22v$ (B) $0.61v$
(C) $1.5v$ (D) $0.75v$

27. A musical scale is constructed by providing intermediate frequencies between a note and its octave which—

- (A) Form an arithmetic progression
(B) Form a geometric progression
(C) Bear a simple ratio with their neighbours
(D) Form a harmonic progression

28. A beam of light consisting of two wavelengths 650 nm and 520 nm is used to obtain interference fringes in Young's double slit experiment. The distance between slits is 2 mm and between the plane of slits and screen is 120 cm. The least distance from the central maximum where the bright fringes due to both wavelengths coincide is—

- (A) 117 mm (B) 334 mm
(C) 312 mm (D) 156 mm

29. The ratio of forces between two small spheres with constant charges in air and in a medium of dielectric constant K is—
 (A) $1 : K$ (B) $K : 1$
 (C) $1 : K^2$ (D) $K^2 : 1$
30. The least angle of deviation of a certain glass prism is equal to its refracting angle. The refractive index of glass is 1.5. The angle of the prism is—
 (A) $2 \cos^{-1} \left(\frac{3}{4} \right)$
 (B) $\sin^{-1} \left(\frac{3}{2} \right)$
 (C) $\cos^{-1} \left(\frac{3}{4} \right)$
 (D) $\sin^{-1} \left(\frac{3}{4} \right)$
31. Two equal negative charges $-q$ are fixed at the points $(0, a)$ and $(0, -a)$ on the y -axis. A positive charge Q is released from rest at the point $(2a, 0)$ on x -axis. The charge Q will—
 (A) Execute S.H.M. about the origin
 (B) Move to the origin and remains at rest
 (C) Move to infinity
 (D) Execute oscillatory motion but not S.H.M.
32. A ray of unpolarised light is incident on a glass plate at the polarising angle. Then—
 (A) The reflected and transmitted rays will be completely plane polarised
 (B) The reflected ray will be completely polarised and the transmitted ray will be partially polarised
 (C) The reflected ray will be partially polarised and the transmitted ray will be completely polarised
 (D) The reflected ray and the transmitted ray will be partially polarised
33. A charge of $6.75 \mu\text{C}$ in an electric field is acted upon by a force of 2.5 N . The potential gradient at this point is—
 (A) $3.71 \times 10^{10} \text{ V/m}$
 (B) $3.71 \times 10^5 \text{ V/m}$
 (C) $3.71 \times 10^{15} \text{ V/m}$
 (D) $3.71 \times 10^{12} \text{ V/m}$
34. A 750 Hz , 20 volt , source is connected to a resistance of 100 ohm , an inductance of 0.1803 henry and a capacitance of $10 \mu\text{F}$, all in series. The time in which the resistance (thermal capacity = $2 \text{ joule/}^\circ\text{C}$) will get heated by 10°C is—
 (A) 348 sec (B) 328 sec
 (C) 248 sec (D) 228 sec
35. Resistances of $1, 2$ and 3Ω are connected in the form of a triangle. If a 1.5 V cell of negligible internal resistance is connected across the 3Ω resistor, the current flowing in this resistance will be—
 (A) 0.25 A (B) 0.5 A
 (C) 1.0 A (D) 1.5 A
36. The resistance between points A and B in the circuit shown in the following figure is—

 (A) 10Ω (B) 20Ω
 (C) 30Ω (D) 40Ω
37. In the circuit given in the figure the current in the 2Ω resistor is—

 (A) 2 A (B) 4 A
 (C) 6 A (D) 8 A
38. A proton, a deuteron and an α -particle with same kinetic energy are moving in circular trajectories in a constant magnetic field. If r_p, r_d, r_α denote respectively the radii of the trajectories of these particles, then—
 (A) $r_\alpha = r_p < r_d$ (B) $r_\alpha > r_d > r_p$
 (C) $r_\alpha = r_d > r_p$ (D) $r_p = r_d = r_\alpha$
39. The north pole of a magnet is being brought nearer a metallic ring. The direction of induced current in the ring will be—

 (A) Anticlockwise
 (B) Clockwise
- (C) First-clockwise and then clockwise
 (D) First clockwise and then anti-clockwise
40. Which of the following gates will have an output of 1 ?

 (A) 4 (B) 1
 (C) 3 (D) 2
41. A constant voltage is applied between two points of a uniform metallic wire. Some heat is developed in it. The heat developed is doubled if—
 (A) Both the length and the radius of the wire is doubled
 (B) Both the length and the radius of the wire is halved
 (C) The radius of the wire is doubled
 (D) The length of the wire is doubled
42. For a transistor $I_c = 25 \text{ mA}$; and $I_b = 1 \text{ mA}$. What is the value of α ?
 (A) $25/26$ (B) $26/25$
 (C) $24/25$ (D) $25/24$
43. A radio frequency choke has—
 (A) Air core
 (B) Iron core
 (C) A paramagnetic core
 (D) A diamagnetic core
44. The binding energies per nucleon of deuteron (${}_1\text{H}^2$) and helium atom (${}_2\text{He}^4$) are 1.1 MeV and 7 MeV . If two deuteron atom react to form a single helium atom, then the energy released is—
 (A) 13.9 MeV (B) 26.9 MeV
 (C) 23.6 MeV (D) 19.2 MeV
45. Which of the following figures represents the variation of particle momentum and associated de-Broglie wavelength ?


46. In the four statements given below the only one correct is—
 (A) β -radioactivity is the process in which an electron is emitted from an unstable atom whose atomic number Z remains unchanged
 (B) γ -radioactivity is the process in which the daughter nucleus has atomic number 1 unit more than that of the parent nucleus
 (C) α -radioactivity is the process in which an unstable atom emits the nucleus of helium atom
 (D) α -radioactivity is the process in which a heavy atom emits electromagnetic radiation of very high frequency
47. Which of the following distinguishes the conductors, semiconductors and the insulators ?
 (A) Nature of crystal lattice
 (B) Binding energy of electrons
 (C) Current density
 (D) Width of forbidden energy band
48. An electron with kinetic energy (E eV) collides with a hydrogen atom in the ground state. The collision will be elastic—
 (A) For all values of E
 (B) For $E < 10.2$ eV
 (C) For $E < 13.6$ eV
 (D) Only for $E > 3.4 + eV$
49. In p - n - p transistor the p -type crystal acts as—
 (A) Emitter only
 (B) Base only
 (C) Collector only
 (D) Either emitter or collector
50. Let u_a and u_d represent the energy density (energy per unit volume) in air and in a dielectric K respectively. Then—
 (A) $u_a = u_d$
 (B) $u_a = Ku_d$
 (C) $u_d = Ku_a$
 (D) $u_a = (K - 1)u_d$

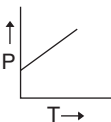
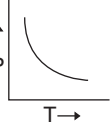
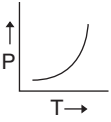
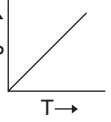
ANSWERS WITH HINTS

PHYSICS

- The farthest objects in our universe are known as quasars. Electromagnetic waves emitted by quasars take billions of years to reach earth. Calculate the distance of a quasar from which electromagnetic waves take three billion years to reach earth—
 (A) 2.84×10^{22} km
 (B) 8.24×10^{22} km
 (C) 4.82×10^{22} km
 (D) 42.8×10^{22} km
- A ball dropped from a height h reaches the ground in time T . What is its height from the ground at time $T/2$?
 (A) $\frac{h}{8}$ (B) $\frac{h}{4}$
 (C) $\frac{h}{2}$ (D) $\frac{3h}{4}$
- The dimensions of intensity of illumination are—
 (A) $[M^1 L^2 T^{-2} Cd^{-1}]$
 (B) $[M^1 L^{-3} T^3 A]$
 (C) $[M^0 L^{-2} T^0 Cd]$
 (D) $[M^2 L^{-2} T^1 \theta]$
- Which of the following is a non-conservative force ?
 (A) Gravitational force
 (B) Electric force
 (C) Elastic force
 (D) Viscosity
- What is the angle between the following pair of vectors ?

$$\vec{A} = \hat{i} + \hat{j} + \hat{k}$$
 and
$$\vec{B} = -2\hat{i} - 2\hat{j} - 2\hat{k}$$

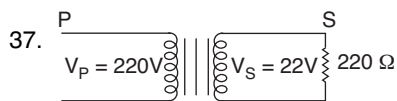
 (A) 180° (B) 270°
 (C) 120° (D) 60°
- A particle of mass m is moving in a horizontal circle of radius r under the centripetal force equal to k/r^2 where k is a constant. What is the total energy of the particle ?
 (A) $\frac{k}{2r}$ (B) $\frac{k}{r}$
 (C) $-\frac{k}{r}$ (D) $-\frac{k}{2r}$
- A ball moving with a momentum of 5 kg ms^{-1} strikes against a wall at an angle of 45° and is reflected at the same angle. What is the change in momentum ?
 (A) 1.01 kg ms^{-1}
 (B) 3.03 kg ms^{-1}
 (C) 7.07 kg ms^{-1}
 (D) 9.09 kg ms^{-1}
- Which of the following quantities must be conserved when the torque acting on a system is zero ?
 (A) Kinetic energy
 (B) Angular momentum
 (C) Angular kinetic energy
 (D) Linear momentum
- Calculate the work done in raising a stone of mass 5 kg and specific gravity 3 lying at the bed of a lake through a height of 5 metre —
 (A) 163.3 J (B) 16.33 J
 (C) 36.16 J (D) 361.6 J
- The Young's modulus of a perfectly rigid body is—
 (A) Zero
 (B) 1
 (C) Infinite
 (D) A value not one of those mentioned above
- Calculate the height above the earth surface at which value of acceleration due to gravity reduces to half its value on the earth surface. Assume the earth to be a sphere of radius 6400 km —
 (A) 9462.6 km (B) 4269.6 km
 (C) 2649.6 km (D) 6249.6 km
- A stone is projected with a velocity u at an angle θ with the horizontal reaches a maximum height H_1 . When it is projected with a velocity u at an angle $(\pi - \theta)$ with the horizontal it reaches a maximum height H_2 . The relation between the horizontal range R of the projectile, H_1 and H_2 is—
 (A) $R = (H_1/H_2)^2$
 (B) $R = 4(H_1 + H_2)$
 (C) $R = 4\sqrt{H_1 H_2}$
 (D) $R = 4(H_1 - H_2)$
- A u -tube contains water and methylated spirit separated by mercury. The mercury columns in the two arms are in level with 10.0 cm of water in one arm and 12.5 cm of spirit in the other arm. What is the relative density of spirit ?
 (A) 0.8 (B) 8.0
 (C) 2.8 (D) 0.5
- A body of 2 kg is moving with initial velocity $(3\hat{i} + 4\hat{j}) \text{ m/s}$. A force $(4\hat{i} - 3\hat{j}) \text{ N}$ is applied to it for 2 second . Which of the following holds for its motion ?
 (A) The magnitude of velocity before and after the application of force is the same
 (B) Velocity remains the same throughout the application of the force
 (C) The direction of motion remains unchanged
 (D) The direction of motion become parallel to the direction of the force
- A square plate of 10 cm side moves parallel to another plate with a velocity of 10 cm s^{-1} , both the plates being immersed in water. If the viscous force is 200 dyne and viscosity of water is 0.01 poise , what is their distance apart ?
 (A) 0.5 cm (B) 0.15 cm
 (C) 0.05 cm (D) 0.005 cm
- A bullet is fired on a target which absorbs it. The bullet gets heated and its temperature rises by θ . Assuming that the whole of the kinetic energy of the bullet is absorbed by the bullet, what will be the rise in temperature if the velocity of the bullet is doubled ?
 (A) $\theta/2$ (B) θ
 (C) 2θ (D) 4θ
- Calculate the rms speed of oxygen molecules at 27°C . Atomic weight of oxygen is 16 —
 (A) $8.43 \times 10^4 \text{ cm s}^{-1}$
 (B) $4.83 \times 10^4 \text{ cm s}^{-1}$

- (C) $3.84 \times 10^4 \text{ cm s}^{-1}$
(D) None of the above
18. Which of the following represents isochoric process for an ideal gas ?
- (A)  (B) 
(C)  (D) 
19. A heavy box having a mass of 300 kg is pulled along a level road for a distance of 10 metre. How many kilo calorie of heat are produced ? (Given : coefficient of sliding friction = 0.2)
(A) 41 kilo calorie
(B) 4.1 kilo calorie
(C) 14 kilo calorie
(D) 1.4 kilo calorie
20. A transverse wave is represented by
 $y = A \sin(kx - \omega t)$
The velocity of the wave is given by—
(A) kx (B) k/ω
(C) ωt (D) ω/k
21. When a music record is whirled fast in a gramophone, the—
(A) Intensity increases
(B) Pitch increases
(C) Quality increases
(D) Pitch decreases
22. A tuning fork produces 5 beats/second with a sonometer wire of 40 cm as well as 44 cm, other factors remaining unchanged. The frequency of the tuning fork is—
(A) 80 Hz (B) 88 Hz
(C) 105 Hz (D) 160 Hz
23. A sphere is hung with a wire. 30° rotation of the sphere about the wire generates a restoring torque of 4.6 Nm. If the moment of inertia of the sphere about the wire is 0.082 kg m^2 , deduce the frequency of angular oscillations—
(A) 1.65 Hz (B) 6.15 Hz
(C) 5.61 Hz (D) 56.1 Hz
24. A fish looking from within water sees the outside world through a circular horizon. If the eye of the fish is $\sqrt{7} \text{ cm}$ below the surface of water, what will be the radius of the circular horizon ?
(A) 3 cm (B) $\sqrt{7} \text{ cm}$
(C) $3 \times \sqrt{7} \text{ cm}$ (D) $3/\sqrt{7} \text{ cm}$
25. Luminous efficiency is maximum for which of the following sources ?
(A) Fluorescent light
(B) Tungsten filament bulb
(C) Sodium vapour lamp
(D) Mercury vapour lamp
26. A blue spot on white sheet is seen through a red filter. What does one see ?
(A) A red spot on black background
(B) A blue spot on red background
(C) A red spot on blue background
(D) A black spot on red background
27. The magnifying power of a compound microscope can be increased, if we use eyepiece of—
(A) Higher focal length
(B) Smaller focal length
(C) Higher diameter
(D) Smaller diameter
28. An electron and a proton pass through a uniform magnetic-field perpendicular to their direction of entering the field with same kinetic energy. What is the nature of trajectory ?
(A) Electron trajectory is more curved than the proton trajectory
(B) Electron trajectory is less curved than the proton trajectory
(C) Both trajectories are equally curved
(D) Both the particles move along straight line paths
29. N-P-N transistors are considered better than P-N-P transistors, because—
(A) These are cheaper
(B) They have less energy loss
(C) The electron flow is copious in them
(D) They have an efficiency to bear more power
30. In Millikan's oil drop experiment, a charged drop of mass $1.8 \times 10^{-14} \text{ kg}$ is stationary between its plates. The distance between the plates is 0.9 cm and potential difference is 2.0 kV. The number of electrons on the drop is—
(A) 50 (B) 500
(C) 2 (D) 5
31. The mass of one curie of U^{234} is—
(A) $1.438 \times 10^{-11} \text{ gram}$
(B) $3.7 \times 10^{-10} \text{ gram}$
(C) $2.348 \times 10^{-23} \text{ gram}$
(D) $6.23 \times 10^{-34} \text{ gram}$
32. Persons inside a car survive when lightning strikes, because—
(A) Charges remain on the outside of the car and do not go inside the car
(B) Charges pass through the metallic car body and go into the earth
(C) Persons are sitting on the insulated (rubber) seats
(D) Car is protected by a lightning rod
33. Which of the following can not the X-rays produce ?
(A) Compton electron
(B) Photoelectron
(C) Electron-positron pair
(D) All the above
34. Some lines that are observed in the solar spectrum are known as Fraunhofer lines. Identify the correct statement—
(A) These are dark lines in the continuous spectrum and are due to absorption
(B) The line tell us about the constituents of the solar corona
(C) The lines disappear during total solar eclipse
(D) All the above statements are correct

35. When a charged particle enters the region of crossed electric and magnetic fields, its path is—
 (A) A cycloid (B) A parabola
 (C) A circle (D) Linear

36. The wavelength of the first line of Balmer series of hydrogen atom is λ . What will be the wavelength of the same line in doubly ionised lithium ?

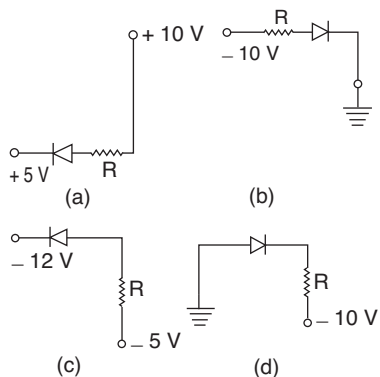
- (A) $\frac{\lambda}{2}$ (B) $\frac{\lambda}{9}$
 (C) $\frac{\lambda}{8}$ (D) $\frac{\lambda}{27}$



The value of current in the primary of the transformer shown above will be—

- (A) 0.01 amp (B) 1 amp
 (C) 0.1 amp (D) 10^{-6} amp

38. In the following circuits for a diode, forward biased are—



- (A) (a), (b) and (c)
 (B) (b), (c) and (d)
 (C) (a), (c) and (d)
 (D) (a), (b), (c) and (d)

39. To safeguard the machinery of a wrist watch from external magnetic fields, its case should be made of—

- (A) Paramagnetic substance
 (B) Diamagnetic substance
 (C) Ferromagnetic substance
 (D) Nonmagnetic substance

40. In relation to the mathematical expression $1 + 1 = 1$, consider the following statements—

1. It is a wrong binary addition.

2. It is correct Boolean expression for AND logic gate.
 3. It is correct Boolean expression for OR logic gate
 4. It is correct Boolean expression for NAND logic gate.

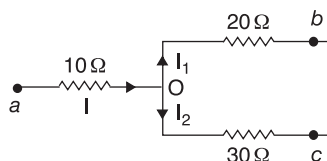
Out of these correct statements are—

- (A) 1 and 4 (B) 1 and 3
 (C) 2 and 3 (D) 2 and 4

41. A cell of emf 2 volt and internal resistance 1.5 ohm is connected across a wire of length 1 metre. The resistance of the wire is 0.5 ohm/m. Determine the potential gradient developed along the wire—

- (A) 0.5 volt/m (B) 5 volt/m
 (C) 0.05 volt/m (D) 5.9 volt/m

42. The figure shows a part of the circuit. The potentials at the points



a, b and c are 30V, 12V and 2V respectively. The current I is—

- (A) 0.4 A (B) 0.6 A
 (C) 1A (D) None of these

43. The change per cent in the resistance of a copper wire when its length is changed by 0.1% will be—

- (A) 0.2% (B) 2%
 (C) 0.1% (D) 1%

44. When a magnetic needle is suspended by an unspun thread at its centre, then it becomes horizontal if a weight of 100 m gm is placed at its free end. If the pole strength of the needle is 10 Am, the vertical component of earth's magnetic field will be—

- (A) 9.8×10^{-5} T
 (B) 4.9×10^{-5} T
 (C) 2.45×10^{-3} T
 (D) 10×10^{-5} T

45. A closely wound solenoid of 1000 turns and area of cross-section 2.0×10^{-4} m² carries a current of 2.0 ampere. It is placed with its horizontal axis at

30° with the direction of a uniform horizontal magnetic field of 0.16 T. What is the torque experienced by the solenoid due to the field ?

- (A) 0.32 J (B) 3.2 J
 (C) 0.032 J (D) 2.3 J

46. The frequency and intensity of the incident beam of light falling on the surface of a photoelectric material is increased by a factor of two. This will—

- (A) Increase the maximum kinetic energy of the photoelectrons as well as photoelectric current by a factor of two
 (B) Increase the maximum kinetic energy of photoelectrons and would increase the photoelectric current by a factor of two
 (C) Increase the maximum kinetic energy of photoelectrons by a factor of two and will have no effect on photoelectric current
 (D) Increase the photoelectric current by a factor of two but will have no effect on kinetic energy of emitted electrons

47. A binary number 10111 means—
 (A) $(13)_2$ (B) $(12)_3$
 (C) $(10)_{23}$ (D) $(23)_{10}$

48. A force $\vec{F} = (6\hat{i} + 2\hat{j} - 3\hat{k})$ acts on a particle and produces a displacement of $\vec{s} = (2\hat{i} - 3\hat{j} + x\hat{k})$. If the work done is zero, the value of x is—

- (A) -2 (B) 2
 (C) $\frac{1}{2}$ (D) 6

49. What is the luminosity of the sun ?

- (A) 7.4×10^{20} W
 (B) 3.90×10^{26} W
 (C) 8.3×10^{25} W
 (D) 1.0×10^{30} W

50. In hydrogen like atom the energy required to excite the electron from first to third orbit is 48.1 eV what is the atomic number of the atom ?

- (A) 2 (B) 3
 (C) 4 (D) 5

SOLID STATE

Introduction

In solid state, the constituent particles are closely packed in some definite geometrical manner with very small voids, and are held together by strong attractive forces. Particle motion is restricted to vibratory motion only. These are characterised by rigidity, incompressibility, slow diffusion and mechanical strength.

Kinds of Solids

(A) **Pseudo solids or amorphous solids**—In these solids the constituent units are not arranged in an orderly manner over a long range. They do not have sharp melting points. They undergo irregular cleavage.

- Though amorphous solids do not possess long range regularity, they may possess small regions of orderly arrangements. These crystalline parts of an otherwise amorphous solid are known as **crystallites**.
- An amorphous solid starts to flow without undergoing a definite or sharp change into liquid state. This is the reason that they are regarded as liquid at all temperatures. They are also known as **super cooled liquids** or **pseudo solids**.
- Amorphous solids are **isotropic** as their physical properties such as electrical conductivity, thermal conductivity, mechanical strength and refractive index are the same in all directions. The liquids are also **isotropic** in nature.
- Glass, pitch, rubber, plastics, starch and proteins are amorphous solids.

(B) **Crystalline solids**—In crystalline solids the constituent units are arranged in an orderly manner in a definite geometry.

- A crystalline substance has a sharp melting point that is, it changes abruptly into liquid state at a fixed temperature.
- Crystalline solids have definite heat of fusion, thus crystalline solids are regarded as true solids.
- Crystalline solids are **anisotropic**, i.e., their physical properties are different if measured through different directions.

Unit Cells of Crystal Lattice

- In crystalline solids, constituent units, also called, lattice points, are arranged in a regular manner in the three dimensional space. Thus such arrangement, known as **space lattice**, consists of repetition of small units again and again, the small repeating units are known as **unit cells**.
- Each unit cell has characteristic distances (a , b and c) along three edges and also characteristic angles (α , β and γ) between three axes.

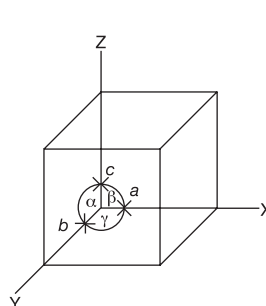


Fig. : Representation of dimensions of a unit cell.

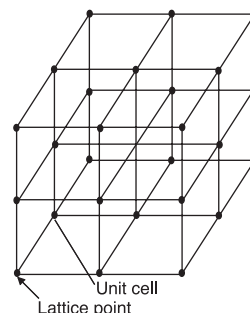


Fig. : Simple crystal lattice and its associated unit cell.

Classification of Crystalline Solids

Crystal Classification	Unit Particles	Interparticle Forces	Properties	Examples
Atomic	Atoms	London dispersion forces	Soft, very low melting, poor thermal and electrical conductors	Noble gases
Molecular	Polar or non-polar molecules	van der Waals forces (London dispersion, dipole-dipole forces)	Fairly soft, low to moderately high melting points, poor thermal and electrical conductors	Dry ice (solid CO_2), solid methane (CH_4)
Ionic	Positive and negative ions	Ionic bonds	Hard and brittle, high melting points, high heats of fusion, poor thermal and electrical conductors	NaCl , ZnS
Covalent	Atoms that are connected in covalent bond network	Covalent bonds	Very hard, very high melting points, poor thermal and electrical conductors	Diamond, quartz, silicon
Metallic	Cations in electron cloud	Metallic bonds	Soft to very hard, low to very high melting points, excellent thermal and electrical conductors, malleable and ductile	All metallic elements, for example, Cu , Fe , Zn

- Fourteen **Bravais** unit cells fall into seven categories :

Category	Edge Lengths	Internal Angles	Examples	No. of Unit Cells	Total Unit Cells
1. Cubic	$(a = b = c)$	$(\alpha = \beta = \gamma = 90^\circ)$	NaCl, KI, Cu, NH_4Cl etc.	Three	$3 + 2 + 2 + 4 + 1 + 1 + 1 = 14$
2. Tetragonal	$(a = b \neq c)$	$(\alpha = \beta = \gamma = 90^\circ)$	NiSO_4 , white tin etc.	Two	
3. Monoclinic	$(a \neq b \neq c)$	$(\alpha = \gamma = 90^\circ, \beta \neq 90^\circ)$	Na_2SO_4 , KClO_3 , FeSO_4 etc.	Two	
4. Orthorhombic	$(a \neq b \neq c)$	$(\alpha = \beta = \gamma = 90^\circ)$	KNO_3 , gallium, mercury chloride etc.	Four	
5. Rhombohedral	$(a = b = c)$	$(\alpha = \beta = \gamma \neq 90^\circ)$	As, Sb, Bi, calcite etc.	One	
6. Hexagonal	$(a = b \neq c)$	$(\alpha = \beta = 90^\circ, \gamma = 120^\circ)$	Zn, ZnO, Cd, Ni etc.	One	
7. Triclinic	$(a \neq b \neq c)$	$(\alpha \neq \beta \neq \gamma \neq 90^\circ)$	CuSO_4 , $\text{K}_2\text{Cr}_2\text{O}_7$ etc.	One	

- Determination of unit cell of a crystal**—Atoms or ions on **corners**, **edges** and **faces** of a unit cell are shared by more than one unit cell. Fraction of an atom or ion that occupies positions in a unit cell are as :

Position of atom or ion in unit cell	Fraction of atom or ion in an unit cell
Corner	1/8
Edge	1/4
Face	1/2
Centre	1

- Total number of atoms (N) per unit cell is given by

$$N = N_b + \frac{N_f}{2} + \frac{N_c}{8}$$

N_b = No. of atoms centered in the body of unit cell

N_f = No. of atoms centered in the faces of unit cell

N_c = No. of atoms of corners of unit cell

- Each unit cell in **simple cubic cell** (scc) structure would have :

$$8 \text{ corners} \times \frac{1}{8} = 1 \text{ atom or ions per unit cell}$$

Example : CsBr, CsCl, CaCl_2 , NH_4Cl etc.

- Each **body centered** cubic unit cell has :

$$8 \text{ corners} \times \frac{1}{8} + 1 \text{ centre} = 2 \text{ atoms or ions per unit cell}$$

Example : Na, K, Rb, Cr etc.

- Each **face centered** cubic unit cell has :

$$8 \text{ corners} \times \frac{1}{8} + 6 \text{ faces} \times \frac{1}{2} = 4 \text{ atoms or ions per unit cell}$$

Example : NaCl, Au, Pb, Pt etc.

- A cubic system (crystal) has 9 planes of symmetry, 13 axes of symmetry and 1 centre of symmetry. Thus it has $(9 + 13 + 1)$ 23 elements of symmetry.

Close Packing of Spheres

- The close packing of constituents in two dimensions are **square close packing** where only 52.4% of the available space is occupied by spheres and **hexagonal close packing** where 60.4% space is occupied by spheres : The latter type of packing is more efficient.
- Close packing of constituents in three dimension are of three kinds namely : (i) Hexagonal close packing (hcp), (ii) cubic close packing (ccp) also known as face centered cubic packing (fcc) (iii) Body centered cubic packing (bcc).

- The maximum available volume occupied by spheres in these three types is :

$$(i) \text{ hcp} = \frac{\pi\sqrt{2}}{6} = 0.74$$

$$(ii) \text{ fcc (ccp)} = \frac{\pi\sqrt{2}}{6} = 0.74$$

$$(iii) \text{ bcc} = \frac{\pi\sqrt{3}}{8} = 0.68$$

- Cubic close packing arrangement is called ABCABC ... and that for hexagonal close packing is known as ABAB These are actually stacking patterns of spheres.

- Interstitial voids**—In hcp as well as ccp only 74% of the available space is occupied by spheres. The remaining space is vacant and constitute interstitial voids or spaces. These are of two kinds in three dimensional close packing.

- (i) **Tetrahedral voids**—In the close packing, the number of tetrahedral voids is double the number of spheres or there are two voids associated with each sphere. If r_{void} is the radius of the sphere that can fit into the void and r_{sphere} is the radius of sphere constituting the void then for the tetrahedral void.

$$\frac{r_{\text{void}}}{r_{\text{sphere}}} = 0.225$$

- (ii) **Octahedral voids**—In a close packing, the number of octahedral voids is equal to the number of spheres or there is only one octahedral void associated with each sphere. Thus for octahedral voids

$$\frac{r_{\text{void}}}{r_{\text{sphere}}} = 0.414$$

- The number of nearest neighbours in contact with a given sphere is known as **coordination number** of that sphere, which is 12 in hcp and ccp and 8 in bcc arrangement.
- The geometrical arrangement of ions in ionic crystal as well as coordination number depend upon the **radius ratio**, i.e., the ratio of the radii of the cations to anions. The ionic solids are found to have coordination number 3, 4, 6, 8 etc.

Coordination number	Radius ratio	Geometry	Example
3	0.155 – 0.225	Planar triangular	B ₂ O ₃
4	0.225 – 0.414	Tetrahedral	ZnS
6	0.414 – 0.732	Octahedral	NaCl
8	0.732 – 1.00	Body centered cubic	CsCl

- **Metallic or ionic radii in unit cell**—We have seen that nickel crystallises in a face centered cubic unit cell with a cell edge length (a) of 0.3524 nm, and this information can be used to calculate the radius of nickel atom as follow :

One of the faces of a face centered cubic unit cell is shown alongside :

According to this figure, the diagonal d across the face of this unit cell is equal to four times the radius r of nickel atom

$$d_{\text{face}} = 4 r_{\text{Ni}}$$

The Pythagorean theorem states that the diagonal across the right triangle is equal to the sum of the squares of other two sides. Therefore

$$d_{\text{face}} = a^2 + a^2$$

$$\text{or } d_{\text{face}} = \sqrt{2} \cdot a$$

$$\therefore 4r_{\text{Ni}} = \sqrt{2} \cdot a$$

$$\begin{aligned} r_{\text{Ni}} &= \frac{\sqrt{2} \cdot a}{4} \\ &= \frac{\sqrt{2} \times 0.3524 \text{ nm}}{4} \\ &= 0.1246 \text{ nm} \end{aligned}$$

A similar approach can be adopted to estimate the size of an ion. Let us start with using a fact that the cell edge length (a) in caesium chloride is 0.4123 nm to calculate the distance between the centres of the Cs⁺ and Cl⁻ ions in CsCl.

CsCl crystallises in a simple cubic cell of Cl⁻ ions with a Cs⁺ ion in the centre of the body of the cell. The diagonal across the body of CsCl unit cell is sum of radii of two Cl⁻ ions and two Cs⁺ ions.

$$d_{\text{body}} = 2r_{\text{Cl}^-} + 2r_{\text{Cs}^+}$$

Three dimensional equivalent of the Pythagorean theorem suggests that the square of the diagonal across the body of a cube is the sum of squares of the three sides

$$d_{\text{body}}^2 = a^2 + a^2 + a^2$$

$$d_{\text{body}} = \sqrt{3} \cdot a$$

If the cell edge length in CsCl is 0.4123 nm, the diagonal across the body of a cube in this unit cell is calculated as :

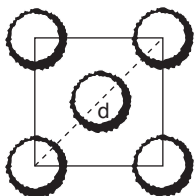


Fig. : The diagonal across the face of a face-centered cubic unit cell is equal to four times the radius of the atoms that form this cell

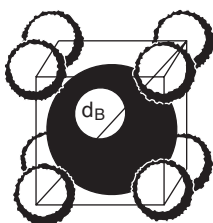


Fig. : The diagonal across the body of the CsCl unit cell is equal to twice the sum of the radii of the Cs⁺ and Cl⁻ ions.

$$\begin{aligned} d_{\text{body}} &= \sqrt{3} a \\ &= \sqrt{3} \times (0.4123 \text{ nm}) \\ &= 0.7141 \text{ nm} \end{aligned}$$

The sum of ionic radii of Cs⁺ and Cl⁻ ions is half this distance

$$\begin{aligned} r_{\text{Cs}^+} + r_{\text{Cl}^-} &= \frac{d_{\text{body}}}{2} \\ &= \frac{0.7141}{2} = 0.3571 \text{ nm} \end{aligned}$$

If we have an estimate on the size of either Cs⁺ or Cl⁻ ion, we can use these results to calculate the radius of the other ion. We know that radius of Cl⁻ ion is 0.181 nm. Substituting this value into the last equation we get

$$\begin{aligned} r_{\text{Cs}^+} + r_{\text{Cl}^-} &= 0.3571 \text{ nm} \\ r_{\text{Cs}^+} + 0.181 \text{ nm} &= 0.3571 \text{ nm} \\ r_{\text{Cs}^+} &= 0.1761 \text{ nm} \end{aligned}$$

Pauling Method of Determining the Ionic Radii

- Pauling selected four ionic solids viz., NaF, KCl, RbBr and CsI. In each salt we see that cation and anion are isoelectronic, i.e., they have the same number of electrons. Pauling proposed that in ionic compounds formed by iso-electronic ions, the ratio of two ionic radii should be inversely proportional to the ratio of **effective nuclear charges** of the two ions. The effective nuclear charge (Z_{eff}) is obtained by subtracting a screening constant from the actual nuclear charge. According to **Slater's rules** the effective nuclear charges of Na⁺ and F⁻ ions come out to be 6.5 and 4.5 respectively. Hence,

$$\frac{r_{\text{Na}^+}}{r_{\text{F}^-}} = \frac{Z_{\text{eff}}(\text{F}^-)}{Z_{\text{eff}}(\text{Na}^+)} = \frac{4.5}{6.5} \quad \dots(\text{A})$$

From X-ray measurement we also know that

$$r_{\text{Na}^+} + r_{\text{F}^-} = 2.31 \text{ \AA} \quad \dots(\text{B})$$

Solving (A) and (B)

$$\begin{aligned} r_{\text{Na}^+} &= 0.95 \text{ \AA} \\ r_{\text{F}^-} &= 1.36 \text{ \AA} \end{aligned}$$

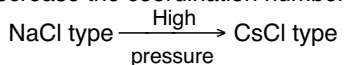
Structural Relationship for Cubic Lattices

	Simple Cubic	Body Centered Cubic	Face Centered Cubic
1. No. of units per unit cell	1	2	4
2. No. of nearest neighbours	6	8	12
3. Volume occupied in three dimensional space	52%	68%	74%
4. Distance between nearest neighbours	a	$a\sqrt{3}/2$	$\frac{\sqrt{2}}{2}a$
5. Atomic radius	$a/2$	$\frac{\sqrt{3}a}{4}$	$\frac{a}{2\sqrt{2}}$

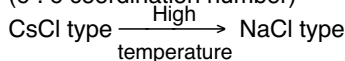
- The Cl^- ions in NaCl are present at the lattice point of a fcc unit cell and Na^+ ions occupy octahedral units. Both ions have coordination number 6. Each unit cell contains 4 Na^+ and 4 Cl^- ions, i.e., 4 NaCl units and edge length (a)

$$\therefore \text{Distance between } \text{Na}^+ \text{ and } \text{Cl}^- = \frac{1}{2} a.$$

- Increase of pressure during crystallisation increases the coordination number, while increase in temperature decrease the coordination number.



(6 : 6 coordination number)



(8 : 8 coordination number)

- Bragg's equation, $n\lambda = 2d \sin Q$, where n = order of reflection and in X-ray reflections ' n ' is generally set as equal to 1 and hence,

$$\lambda = 2d \sin Q.$$

- **Atomic packing factor (f)**—It is defined as the ratio of volume occupied by the atoms (v) in a unit cell to the volume of unit cell (V).

$$f = n \frac{V}{V} \quad (n = \text{No. of atoms per unit cell})$$

For simple cubic lattice

$$f = \frac{1 \times \left(\frac{4}{3} \pi r^3\right)}{a^3}$$

$$= \frac{\frac{4}{3} \pi \left(\frac{a}{2}\right)^3}{a^3} = \frac{\pi}{6}$$

For bcc lattice

$$f = \frac{2 \times \left(\frac{4}{3} \pi r^3\right)}{a^3} = \frac{\pi \sqrt{3}}{8}$$

For fcc lattice

$$f = \frac{4 \times \left(\frac{4}{3} \pi r^3\right)}{a^3} = \frac{\pi}{3\sqrt{2}}$$

- **Density of crystalline solid**—It is defined as the ratio of mass and volume of a unit cell.

$$\rho = \frac{nA/N}{V} = \frac{nA}{VN'} \quad \text{or} \quad \frac{n \times A}{Na^3}$$

where A is the mass number and N is Avogadro's number.

- **Lattice constant (a)**

$$a = (V)^{\frac{1}{3}} = \left(\frac{nA}{N\rho}\right)^{\frac{1}{3}}$$

Imperfections in Solids

- **Electronic imperfection**—The loss of electrons from a covalent bond results in **holes**. This is known as **intrinsic defect** in solids. For example silicon, germanium arsenic etc.
- **Doping**—Addition of very small amount of foreign impurity in the host crystal is termed as doping. It increases electrical conductivity. Doping is of two kinds.

This is termed as **extrinsic imperfection**.

- (i) Doping of group 14 elements with group 15 elements (impurity) produces excess of electrons. This is used for producing ***n*-type semiconductors**, i.e., flow of electrons or negative charge. For example doping of As in Si.
- (ii) Doping of group 14 elements with 13 group elements (doping of Indium in silicon) produces holes, i.e., electron deficiency in the crystals. This is used for producing ***p*-type semiconductors**, i.e., flow of positive charge.

- **Schottky defect**—When equal number of cations and anions are lost from the lattice sites. This imperfection decreases the density and is found in ionic crystal formed by cations and anions of nearly equal size. For example NaCl, KCl etc. This is a **stoichiometric defect**.

- **Frenkel defect**—Displacement of cations from lattice sites to interstitial sites is called Frenkel defect. Here the density remains unaffected but **dielectric constant** increases. Silver halides have Frenkel defect. This is also a **stoichiometric defect**.

- **Non-stoichiometric defects**—These are also known as **Berthollide defects**. Such compounds which have these defects do not obey the law of **constant composition**.

For example : $\text{Fe}_{0.84}\text{O}$ — $\text{Fe}_{0.94}\text{O}$ and $\text{Fe}_{0.9}\text{S}$ etc.

The electrical neutrality is maintained either by having extra electrons or by changing the charge on some metal ions.

- Non-stoichiometric defects are of two kinds :

(A) **Metal excess defects**—Positive ions are in excess. They occur in two ways :

- (i) **F-centres**—A negative ion may be missing from lattice sites, leaving a hole, which is occupied by an electron, thereby maintaining electrical neutrality. These defects are built up in those solids which are likely to show **Schottky defect**. Their general formula is represented as $\text{AX}_{1-\delta}$, where δ is very small fraction. The non-stoichiometric NaCl is yellow, KCl is blue-lilac in colour. Anionic sites occupied by electrons are known as **F-centres**. These compounds acts as *n*-type of semiconductors.

- (ii) **Interstitial cations and extra electrons**—Their general formula may be represented as $\text{A}_{1+\delta}\text{X}$. This defect is somewhat like the **Frenkel defects**, but there are no holes. Extra positive ion occupies interstitial position and extra electron also occupies interstitial position. Examples : ZnO , CdO , Fe_2O_3 , Cr_2O_3 etc.

- (B) **Metal deficiency defects**—These are represented by general formula, $\text{A}_{1-\delta}\text{X}$. These defects are generally shown by compounds of transition elements, as they need change of valency. When a positive ion is missing from lattice site, and the charge balance is maintained by an adjacent metal ion acquiring extra positive charge. Examples : FeO , NiO , $\delta\text{-TiO}$, FeS , CuI etc. They constitute positive holes and, therefore, act as *p*-type of semiconductors.

SOME IMPORTANT NUMERICAL EXAMPLES

Example 1. An ionic solid AX has CsCl structure. The edge length of the unit cell is 4.04 \AA . What will be the distance of closest approach between A^+ and X^- ?

Solution :

Example 6. Prove that the percentage of space occupied by spheres in a simple cubic unit cell is approximately 52.4%.

Solution :

Example 2. A compound formed between A and B crystallises in a cubic structure where 'A' atoms are at corners and B atoms at centre of the cube. What is the formula of the compound ?

Solution :

Example 3. A compound formed by elements X and Y crystallises in a cubic structure where 'X' atoms are at corners of the cube and 'Y' atoms are at face centres. What is the formula of the compound ?

Solution :

Example 4. A solid formed by ions A^+ and B^- has the following arrangement of ions :

- (i) A^+ are arranged in ccp arrangement
- (ii) B^- are occupying all the octahedral voids and half of the tetrahedral voids.

What is the formula of the compound ?

Solution :

Example 5. At room temperature Na crystallises in a body centered cubic lattice with edge length $a = 4.24 \text{ \AA}$. What will be density of sodium ?

Solution :

Example 7. The radii of Zn^{+2} and S^{2-} ions are 0.74 \AA and 1.84 \AA respectively. What kind of sites Zn^{2+} will occupy ?

Solution :

Example 8. In aluminium oxide, the oxide ions (O^{2-}) are arranged in hexagonal close packed (hcp) arrangement and the aluminium occupy $\frac{2}{3}$ of octahedral voids. What is the formula of oxide ?

Solution :

Example 9. An element crystallises in a structure having fcc unit cell of an edge 200 pm . Calculate density if 200 gm of this element contain 24×10^{23} atoms.

Solution :

Example 10. Copper crystal has fcc structure. Atomic radius of copper is 128 pm. What is the edge length ?

Solution :

Some Important Formulae

- Density (ρ) of the crystal = $\frac{n \times A}{N_A \times a^3} \text{ gm cm}^{-3}$
- Neighbour distance (d) and edge length (a) for the unit cell :
 - (i) For simple cubic, $d = a$
 - (ii) For bcc $d = \frac{\sqrt{3}}{2} a = 0.866 a$
 - (iii) For fcc $d = \frac{\sqrt{2}}{2} a = 0.707 a$

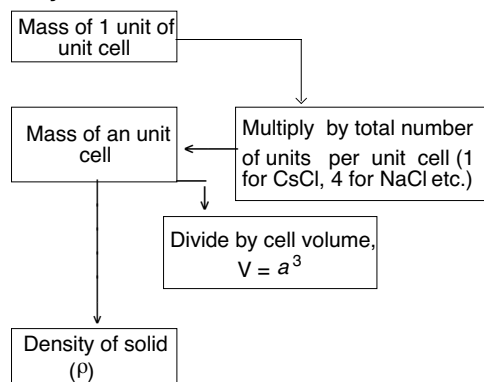
- Relation between atomic radius, $r \left(\frac{d}{2} \right)$ and edge length 'a' :

(i) For simple cubic $r = \frac{a}{2}$

(ii) For bcc $r = \frac{\sqrt{3}}{4} a = 0.433 a$

(iii) For fcc $r = \frac{\sqrt{2}}{4} a = 0.3535 a$

- Relation between **cell-structure, mass, volume and density** of a solid :



- A cubic crystal has a total of 23 elements of symmetry
 - (i) Plane of symmetry = $3 + 6 = 9$
 - (ii) Axis of symmetry = $3 + 4 + 6 = 13$
 - (iii) Centre of symmetry = 1

Total = $9 + 13 + 1 = 23$

Points to Remember

- **Isomorphism**—Two or more solids having similar crystalline forms are called isomorphs. For example Na_2SO_4 and Na_2SeO_4 . The phenomenon is known as **isomorphism**. KNO_3 and NaNO_3 are not isomorphs as they have different crystalline structures.
- **Polymorphism**—A solid substance which exists in two or more than two crystalline forms, is called polymorphic. For example sulphur can exist in many crystalline forms. It occurs in **allotropes**.
- **Diamagnetic solids**—Which are weakly repelled by the magnetic field and do not have any unpaired electron.
- **Paramagnetic substances**—Which are attracted by external magnetic field. They possess unpaired electrons. They also lose magnetism in absence of magnetic field.
- **Ferromagnetic substances**—Which are attracted by the magnetic field and show permanent magnetism even in the absence of magnetic field, e.g., Fe, Co, Ni etc.
- **Antiferromagnetic substances**—Which are expected to have paramagnetism or ferromagnetism on the basis of unpaired electrons but actually they possess zero magnetic moment because equal number of unpaired electrons are aligned in opposite directions. For example : MnO , Mn_2O_3 , MnO_2 etc.
- **Ferrimagnetic substances**—They show small magnetic moment than expected. Here unequal number of unpaired electrons are aligned in opposite directions e.g., Fe_3O_4 , ferrites.
- **Piezoelectric solids**—Some solids when subjected to the mechanical stress, produce electricity. This phenomenon is generally shown by polar crystals.
- **Pyroelectric solids**—Certain crystals which on heating acquire electric charges on opposite faces, are known as pyroelectric substances.
- **Ferroelectric substances**—Solids in which dipoles are spontaneously aligned in a particular direction, even in the absence of electric field, are called ferroelectric substances. For example barium titanate (BaTiO_3), sodium potassium tartrate (Rochelle salt) and potassium dihydrogen phosphate (KH_2PO_4) are ferroelectric solids.
- **Antiferroelectric substances**—If the alternate dipoles are in opposite directions, then the net dipole moment will be zero and the crystal is called **antiferroelectric**. Example : lead zirconate (PbZrO_3).
- **Superconductivity**—The electrical resistance of metals decreases with decrease in temperature and becomes almost zero near absolute zero. Material in this state is known as superconductor. This phenomenon was discovered by **Kammerlingh Onnes** in 1913 when he found that Hg becomes superconducting at 4K. The temperature at which a substance becomes superconductor is known as **transition temperature (T_c)**. Most metals have transition temperature between 2K–5K.
- Superconducting materials have great technological potential. These can be used in electronics, in building magnets, in power transmission and in **levitation transportation** (trains which run in air without rail).
- **Zinc Blende structure**— S^{2-} ions have ccp arrangement and Zn^{2+} ions occupy alternate tetrahedral voids. Coordination numbers of Zn^{2+} and S^{2-} ions are 4 : 4.
- **Fluorite structure**— Ca^{2+} ions in ccp and F^- ions occupy all the tetrahedral voids; C.N. is 8 : 4.
- **Antifluorite structure**—Anions have ccp arrangement and cations occupy all the tetrahedral voids; C.N. is 4 : 8 for Na_2O .
- **NaCl structure**— Cl^- ions have ccp arrangement and Na^+ ions occupy all the octahedral voids; coordination number of Na^+ and Cl^- is 6 : 6.
- **CsCl structure**— Cl^- ions in cubic arrangement and Cs^+ ions occupy cubic voids. C.N. is 8 : 8.

OBJECTIVE QUESTIONS

1. Which of the following is not a crystalline solid ?
(A) CsCl
(B) KBr
(C) Glass
(D) Rhombic sulphur
2. The existence of a substance in more than one solid forms, is known as—
(A) Isomorphism
(B) Amorphism
(C) Polymorphism
(D) None of these
3. The solid NaCl is bad conductor of electricity since—
(A) Solid NaCl is more covalent
(B) In solid NaCl there are no ions
(C) In solid NaCl there are no free electrons
(D) In solid NaCl there is no velocity in ions
4. An element having bcc structure has 12.08×10^{23} unit cells. The number of atoms in these unit cells will be—
(A) 12.08×10^{23}
(B) 12.08×10^{22}
(C) 24.16×10^{23}
(D) 48.38×10^{23}
5. An element having bcc structure has unit-cell edge length 400 pm. What is the density of the element ? (Atomic mass of element = 100 g/mol)
(A) $10.4 \times 10^2 \text{ gm/cm}^3$
(B) 10.4 gm/cm^3
(C) 5.188 gm/cm^3
(D) $5.188 \times 10^2 \text{ gm/cm}^3$
6. The number of atoms contained in a fcc unit cell of monoatomic substance is—
(A) 1
(B) 2
(C) 4
(D) 6
7. The number of molecules in unit cell structure of NaCl is—
(A) One
(B) Two
(C) Three
(D) Four
8. Space lattice of CaF_2 is—
(A) bcc
(B) fcc
(C) Simple cubic
(D) None of these
9. The unit cell with crystallographic dimensions, $a = b \neq c$, $\alpha = \beta = \gamma = 90^\circ$, is—
(A) Monoclinic (B) Tetragonal
(C) Cubic (D) Hexagonal
10. Which of the following will show anisotropy ?
(A) Paper (B) Glass
(C) Wood (D) Barium chloride
11. Which of the following defects, if present lowers the density of the crystal ?
(A) Frenkel defect
(B) Schottky defect
(C) Constitution of F-centres
(D) None of these
12. The radius of Na^+ is $95 \times 10^{-10} \text{ cm}$ and that of Cl^- is $181 \times 10^{-10} \text{ cm}$. The coordination number of Na^+ will be—
(A) Four
(B) Six
(C) Eight
(D) Cannot be predicts
13. Which of the following substances is the ferroelectric one ?
(A) Quartz
(B) Spinel
(C) Barium titanate
(D) All of these
14. A solid is formed by two elements A and B. The atoms B are in ccp arrangement, while atoms A occupy all the tetrahedral sites. The formula of the compound is—
(A) AB (B) AB_2
(C) A_2B (D) None of these
15. Some crystals produce electric signals on application of mechanical stress. This phenomenon is known as—
(A) Ferroelectricity
(B) Pyroelectricity
(C) Piezoelectricity
(D) Ferrielectricity
16. Which of the following is a pseudo-solid ?
(A) Plastic (B) Glass
(C) Starch (D) All of these
17. In which of the following compounds cations are present in cubic voids ?
(A) NaCl (B) CsCl
(C) ZnS (D) None of these
18. Na_2O has—
(A) NaCl type structure
(B) CsCl type structure
(C) Fluorite structure
(D) Antifluorite structure
19. Which of the following compounds has spinel structure ?
(A) $\text{Mg Al}_2\text{O}_4$
(B) $\text{Zn Fe}_2\text{O}_4$
(C) Pb CrO_4
(D) Both (A) and (B)
20. Which of the following is incorrect regarding the structure of magnetite (Fe_3O_4) ?
(A) Oxide ions are arranged in ccp
(B) Fe^{2+} ions occupy octahedral voids
(C) Fe^{3+} ions are equally distributed between octahedral and tetrahedral voids
(D) Fe^{2+} ions occupy octahedral as well as tetrahedral voids
21. An element (density 6.8 gm/cm^3) occurs in bcc structure with cell edge of 290 pm. The number of atoms present in 200 gm of element is—
(A) 2.4×10^{23}
(B) 24.00×10^{22}
(C) 24.09×10^{23}
(D) 12.00×10^{23}
22. The density of a fcc element (atomic mass = 60.2) is 6.25 gm cm^{-3} . The edge length is—
(A) 100 pm (B) 200 pm
(C) 300 pm (D) 400 pm
23. An atom at the edge centre of an unit cell makes a contribution to a particular unit cell. The contribution is—
(A) $\frac{1}{2}$ (B) $\frac{1}{4}$
(C) $\frac{1}{8}$ (D) 1
24. The edge length of a cube is 400 pm. Its body diagonal would be—
(A) 600 pm (B) 566 pm
(C) 693 pm (D) 500 pm
25. In an antifluorite structure the coordination number of anion is—
(A) 4 (B) 6
(C) 8 (D) 12

26. Density of a crystal is given by the formula—
 (A) $\frac{a^3 M}{N_0 Z}$ (B) $\frac{N_0 M}{Z a^3}$
 (C) $\frac{Z M}{N_0 a^3}$ (D) $\frac{a^3 N_0}{Z \times m}$
27. Which of the following statements is not true ?
 (A) Conductivity of semiconductors increases by increase in temperature
 (B) Pure ionic solids are insulators
 (C) NaCl is a diamagnetic substance
 (D) TiO_2 is a paramagnetic substance
28. In a compound, oxide ions have ccp arrangement. Cations A are present in $\frac{1}{8}$ th of the tetrahedral voids and cations B occupy half the octahedral voids. The simplest formula of the compound is—
 (A) AB_2O_4 (B) A_2BO_4
 (C) ABO_2 (D) ABO_4
29. Which of the following is an example of paramagnetic solid ?
 (A) KF (B) NaCl
 (C) CuO (D) TiO_2
30. Which of the following is a ferromagnetic compound ?
 (A) Fe_3O_4 (B) Fe_2O_3
 (C) Cr_2O_3 (D) CrO_2
31. Body centered cubic lattice has a coordination number of—
 (A) 4 (B) 6
 (C) 8 (D) 12
32. Which of the following is an example of body centered cube ?
 (A) Magnesium (B) Zinc
 (C) Copper (D) Sodium
33. Semiconductor obtained by doping arsenic in silicon is known as—
 (A) *n*-type of semiconductor
 (B) *p*-type of semiconductor
 (C) Both (A) and (B)
 (D) None of these
34. Which of the following is molecular solid ?
 (A) H_2O (ice)
 (B) Dry ice
 (C) Solid methane
 (D) All of these
35. An element has cubic lattice. The edge length is 2\AA and density of element is 2.5 gm cm^{-3} . What is the number of unit cell in 200 gm of element ?
 (A) 1×10^{25} (B) 1×10^{22}
 (C) 1×10^{20} (D) None of these
36. Which of the following has non-stoichiometric defects ?
 (A) Frenkel defects
 (B) Schottky defect
 (C) Metal excess defect
 (D) Electronic defect
37. Atomic radius in the body centered structure of an element is— (edge length = a)
 (A) $\frac{a}{2}$ (B) $a \frac{\sqrt{2}}{4}$
 (C) $a \frac{\sqrt{3}}{4}$ (D) a
38. In CsCl crystal, the arrangement of Cl^- ions is—
 (A) Simple cubic (B) fcc
 (C) hcc (D) bcc
39. Units which are present at lattice points of a covalent crystal are—
 (A) Atoms (B) Ions
 (C) Molecules (D) All of these
40. Stacking AB AB corresponds to—
 (A) Tetrahedral packing
 (B) Octahedral packing
 (C) Cubic packing
 (D) Hexagonal packing

ANSWERS

●●●

(Continued from Page 1221)

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CHEMISTRY

1. Which one of the following does **not** undergo iodoform reaction ?

(A) Secondary butyl alcohol
(B) Isopropyl alcohol
(C) Diethyl ketone
(D) Ethyl alcohol

2. Among the following, the alkene on ozonolysis giving rise to only one aldehyde as the product is—

(A) 1-butene
(B) Propene
(C) 2-butene
(D) 2-methyl-prop-1-ene

3. The carboxylic acid of least strength among the following is—

(A) *p*-nitrobenzoic acid
(B) *p*-methyl benzoic acid
(C) *p*-chlorobenzoic acid
(D) *p*-methoxybenzoic acid

4. Glycerol on oxidation with bismuth nitrate forms—

(A) Meso oxalic acid
(B) Glyceraldehyde
(C) Dihydroxy acetone
(D) Tartaric acid

5. Which one of the following does **not** form sodium bisulphite addition product with sodium bisulphite solution ?

(A) CH_2O
(B) $\text{C}_6\text{H}_5\text{COCH}_3$
(C) $\text{C}_6\text{H}_5\text{CHO}$
(D) CH_3CHO

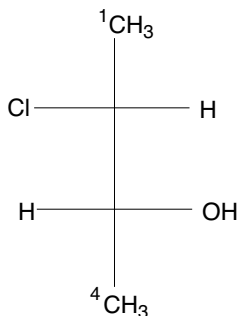
6. The most reactive of the following is—

(A) Acetone
(B) Benzophenone
(C) Benzaldehyde
(D) Acetaldehyde

7. The total number of structural isomers possible for a hydrocarbon of molecular formula C_7H_{16} is—

(A) 12 (B) 8
(C) 10 (D) 6

8. The absolute configurations of the C_2 and C_3 atoms in the molecule with the structure is—



(A) 2S, 3S (B) 2R, 3S
(C) 2S, 3R (D) 2R, 3R

9. The most easily hydrolysed molecule under $\text{S}_{\text{N}}1$ conditions is—

(A) Allyl chloride
(B) Ethyl chloride
(C) Isopropyl chloride
(D) Benzyl chloride

10. The optical rotation of an optically active compound is—

(A) Directly proportional to the length of the polarimeter tube only
(B) Directly proportional to the molar concentration of the compound
(C) Independent of the length of the polarimeter tube and concentration of the compound
(D) Directly proportional to both the length of the polarimeter tube and molar concentration of the compound

11. Hydration of which one of the following yields a ketone ?

(A) Propyne (B) Ethene
(C) Propene (D) Ethyne

12. The most acidic among the following is—

(A) *p*-cresol
(B) *o*-cresol
(C) *p*-nitrophenol
(D) *p*-chlorophenol

13. The shape of XeOF_2 on the basis of VSEPR theory is—

(A) Sea saw (B) V-shaped
(C) Trigonal (D) T-shaped

14. Which one of the following molecules is paramagnetic ?

(A) F_2 (B) B_2
(C) Li_2 (D) N_2

15. Which one of the following has the highest Lewis acid strength ?

(A) BI_3 (B) BBr_3
(C) BF_3 (D) BCl_3

16. Among the following the molecule possessing highest dipole moment is—

(A) CO_2 (B) BF_3
(C) SO_2 (D) Trans-2-butene

17. Among the following the least thermally stable is—

(A) K_2CO_3 (B) Na_2CO_3
(C) BaCO_3 (D) Li_2CO_3

18. The most powerful oxidising agent of the following is—

(A) I_2 (B) F_2
(C) Br_2 (D) Cl_2

19. When an excess and a very dilute aqueous solution of KI is added to a very dilute aqueous solution of silver nitrate, the colloidal particles of silver iodide are associated with the Helmholtz double layer ?

(A) $\text{AgI} : \text{Ag}^+ : \text{NO}_3^-$
(B) $\text{AgI} : \text{K}^+ : \text{NO}_3^-$
(C) $\text{AgI} : \text{NO}_3^- : \text{Ag}^+$
(D) $\text{AgI} : \text{I}^- : \text{K}^+$

20. The standard reduction electrode potentials of the three electrodes P, Q and R are respectively -1.76V , 0.34V and 0.8V . Then—

(A) Metal Q will displace the cation of P from its aqueous solution and deposit the metal P
(B) Both metals Q and R will displace the cation of P from its aqueous solution and deposit the metal P
(C) Metal R will displace the cation of P from its aqueous solution and deposit the metal P
(D) Metal P will displace the cation of R from its aqueous solution and deposit the metal R

21. The van der Waals constants for four gases P, Q, R and S are 4.17, 3.59, 6.71 and 3.8 atm. L².mol⁻². Therefore, the ascending order of their liquefaction is—
 (A) R < P < S < Q
 (B) Q < S < R < P
 (C) Q < S < P < R
 (D) R < P < Q < S
22. If the ratio of the rates of diffusion of two gases A and B is 4 : 1, then the ratio of their densities in the same order is—
 (A) 16 : 1 (B) 1 : 4
 (C) 4 : 1 (D) 1 : 16
23. Which one of the following is non-reducing ?
 (A) H₂S (B) H₂Te
 (C) H₂Se (D) H₂O
24. The ion of least magnetic moment among the following is—
 (A) Cu²⁺ (B) Ni²⁺
 (C) Co²⁺ (D) Mn²⁺
25. The unit cell of a binary alloy composed of A and B metals has a C.C.P. structure with A atoms occupying the corners and B atoms occupying centres of each face of the cube. If during the crystallization of this alloy, in the unit cell two A atoms are missed, the overall composition per unit cell is—
 (A) AB₆ (B) AB₄
 (C) AB₈ (D) A₅B₂₄
26. The atom of which one of the following elements has the highest number of unpaired electrons ?
 (A) ²⁵Mn (B) ²⁴Cr
 (C) ⁹⁶Cm (D) ²⁶Fe
27. The amphoteric oxide among the following is—
 (A) Cr₂O₃ (B) Mn₂O₇
 (C) V₂O₃ (D) CrO
28. The composition of Bell Metal is—
 (A) Cu (80%), Zn (20%)
 (B) Cu (60%), Ni (40%)
 (C) Cu (90%), Sn (10%)
 (D) Cu (80%), Sn (20%)
29. The coordination compound of which one of the following compositions will produce two equivalents of AgCl on reaction with aqueous silver nitrate solution ?
 (A) CoCl₃.3NH₃⁺
 (B) CoCl₃.6NH₃
 (C) CoCl₃.4NH₃
 (D) CoCl₃.5NH₃
30. The oxidation numbers of the sulphur atoms in peroxomonosulphuric acid (H₂SO₅) and peroxodisulphuric acid (H₂S₂O₈) are respectively—
 (A) +8 and +7
 (B) +3 and +3
 (C) +6 and +6
 (D) +4 and +6
31. When 400 ml of 0.2N solution of a weak acid is neutralised by a dilute aqueous solution of sodium hydroxide under standard conditions, 4.4 kJ amount of heat is liberated. Therefore, the standard enthalpy of neutralisation of this weak acid in kJ equiv⁻¹ is—
 (A) -11 (B) -44
 (C) -55 (D) -22
32. Which one of the following is always **not** negative ?
 (A) Enthalpy of combustion
 (B) Enthalpy of formation
 (C) Enthalpy of neutralisation
 (D) Lattice enthalpy
33. In the electrolysis of aqueous solution of CuSO₄ using copper electrodes, the process that takes place at the anode is—
 (A) SO₄²⁻ → SO₄ + 2e⁻
 (B) Cu → Cu⁺ + 1e⁻
 (C) 2OH⁻ → H₂O + $\frac{1}{2}$ O₂ + 2e⁻
 (D) Cu → Cu²⁺ + 2e⁻
34. The **incorrect** statement among the following is—
 (A) The entropy of the universe remains constant
 (B) Heat can be completely converted into work only under specified conditions
 (C) The absolute entropy of a perfectly crystalline solid at absolute zero temperature is zero
 (D) The total energy of an isolated system remains constant
35. The **correct** expression in S.I. system relating the equivalent conductance (Λ_c), specific conductance (k) and equivalent concentration (C) is—
 (A) Λ_c = $\frac{k}{C}$
 (B) Λ_c = $\frac{k \times 1000}{C}$
 (C) Λ_c = $\frac{k \times 10^{-3}}{C}$
 (D) Λ_c = $\frac{k \times 10^6}{C}$
- where C is the number of gm-equivalents in one litre of the solution.
36. The polymer used in the manufacture of 'Orlon' is—
 (A) PTFE (B) PAN
 (C) PMMA (D) PVC
37. The atom of smallest atomic radius among the following is—
 (A) Na (B) K
 (C) Br (D) Li
38. In the Freundlich adsorption isotherm equation

$$\log \frac{x}{m} = \log K + \left(\frac{1}{n}\right) \log P,$$
 the value of n is—
 (A) Any value from 0 to 1
 (B) A negative integer
 (C) A positive integer
 (D) A positive or a negative fractional number
39. Which one of the following is 'd'-block element' ?
 (A) Gd (B) Hs
 (C) Es (D) Cs
40. The 'd' orbital involved in the hybridisation in the PCl₅ molecule is—
 (A) 3d_{x²-y²} (B) 3d_{z²}
 (C) 3d_{xy} (D) 4d_{x²-y²}
41. The optically active coordination complex ion among the following is—
 (A) Trans [Co(en)₂Cl₂]⁺
 (B) Cis [Co(en)(NH₃)₂Cl₂]⁺
 (C) [Co(NH₃)₆]³⁺
 (D) [Fe(CN)₆]⁻³
42. The non-existent metal carbonyl among the following is—
 (A) Cr(CO)₆ (B) Mn(CO)₅
 (C) Ni(CO)₄ (D) Fe(CO)₅

43. Which one of the following complex ions has the highest magnetic moment ?
 (A) $[\text{Cr}(\text{NH}_3)_6]^{3+}$
 (B) $[\text{Fe}(\text{CN})_6]^{3-}$
 (C) $[\text{Fe}(\text{CN})_6]^{4-}$
 (D) $[\text{Zn}(\text{NH}_3)_6]^{2+}$
44. The auto reduction process is **not** used in the metallurgy of—
 (A) Hg (B) Cu
 (C) Pb (D) Fe
45. The **incorrect** statement among the following is—
 (A) Hydrogen is used to reduce NiO
 (B) Zirconium is refined by Van-Arkel method
 (C) The sulphide ore galena is concentrated by hydraulic washing process
 (D) In the metallurgy of iron, the flux used is SiO_2
46. The number of molecules in 18 mg of water in terms of Avogadro number N is—
 (A) $10^{-3} N$ (B) $10^{-2} N$
 (C) $10^{-1} N$ (D) $10 N$
47. How much volume of oxygen at STP in litres is required to burn 4g of methane gas completely ?
 (A) 11.2 (B) 5.6
 (C) 2.8 (D) 8
48. The β -decay of a radioactive element results in the formation of its—
 (A) Isotope
 (B) Isobar
 (C) Isodiapher
 (D) Nuclear isomer
49. The equivalent mass of potassium permanganate in alkaline medium is its—
 (A) $\frac{\text{Molar mass}}{5}$
 (B) $\frac{\text{Molar mass}}{3}$
 (C) $\frac{\text{Molar mass}}{2}$
 (D) Molar mass itself
50. If the de Broglie wavelength of a particle of mass m is 100 times its velocity, then its value in terms of its mass (m) and Planck's constant (h) is—
 (A) $\frac{1}{10} \sqrt{\frac{m}{h}}$ (B) $10 \sqrt{\frac{h}{m}}$
 (C) $\frac{1}{10} \sqrt{\frac{h}{m}}$ (D) $10 \sqrt{\frac{m}{h}}$
51. The set of quantum numbers $n = 4, l = 0, m = 0$ and $s = +\frac{1}{2}$ correspond to the most loosely bound, ground state electron of which one of the following atoms ?
 (A) Na (B) Cl
 (C) Cr (D) Rb
52. In the radioactive decay

$${}_y\text{X}^z \xrightarrow{-8\alpha \text{ and } 6\beta} {}_{82}\text{Pb}^{206}$$

 X, Y and Z are—
 (A) U, 92 and 235
 (B) Th, 90 and 232
 (C) Pu, 94 and 238
 (D) U, 92 and 238
53. The rate constant for a first order reaction is 6.909 min^{-1} . Therefore, the time required in minutes for the participation of 75% of the initial reactant is—
 (A) $\frac{2}{3} \log 2$ (B) $\frac{2}{3} \log 4$
 (C) $\frac{3}{2} \log 2$ (D) $\frac{3}{2} \log 4$
54. At 300 K two pure liquids A and B have vapour pressures respectively 150 mm Hg and 100 mm Hg. In an equimolar liquid mixture of A and B, the mole-fraction of B in the vapour mixture at this temperature is—
 (A) 0.6 (B) 0.5
 (C) 0.8 (D) 0.4
55. 25 g of a solute of molar mass 250 g mol^{-1} is dissolved in 100 ml of water to obtain a solution whose density is $1.25 \text{ g (mL}^{-1})$, the molarity and molality of the solution are respectively—
 (A) 0.75 M and 1 m
 (B) 0.8 M and 1 m
 (C) 1 M and 0.8 m
 (D) 1 M and 0.75 m
56. A solution with negative deviation among the following is—
 (A) Ethanol—Acetone
 (B) Chlorobenzene—Bromobenzene
 (C) Chloroform—Acetone
 (D) Benzene—Toluene
57. The molar mass of the solute sodium hydroxide obtained from the measurement of the osmotic pressure of its aqueous solution at 27°C is 25 g mol^{-1} . Therefore, its ionization percentage in this solution is—
 (A) 75 (B) 60
 (C) 80 (D) 70
58. The standard enthalpies of formation of $\text{A}(\text{NH}_3)$, $\text{B}(\text{CO}_2)$, $\text{C}(\text{HI})$ and $\text{D}(\text{SO}_2)$ are respectively -46.19 , -393.4 , $+24.94$ and $-296.9 \text{ kJ mol}^{-1}$. The increasing order of their stability is—
 (A) $\text{B} < \text{D} < \text{A} < \text{C}$
 (B) $\text{C} < \text{A} < \text{D} < \text{B}$
 (C) $\text{D} < \text{B} < \text{C} < \text{A}$
 (D) $\text{A} < \text{C} < \text{D} < \text{B}$
59. The IUPAC name of the molecule

$$\begin{array}{c} \text{O} \quad \quad \text{CH}_3 \quad \text{O} \\ \parallel \quad \quad | \quad \parallel \\ \text{CH}_3 - \text{C} - \text{C} = \text{C} - \text{C} - \text{OH} \\ | \\ \text{CH}_3 \end{array}$$

 is—
 (A) 4-oxo-2, 3-dimethyl pent-2-en-1-oic acid
 (B) 2-carboxy-3-methyl-pent-2-en-3-one
 (C) 4-carboxy-3-methyl-pent-3-en-2-one
 (D) 2, 3-dimethyl-4-oxo-pent-2-en-1-oic acid
60. Which one of the following is aromatic ?
 (A) Cyclopentadienyl cation
 (B) Cyclooctatetraene
 (C) Cycloheptatriene
 (D) Cycloheptatrienyl cation
61. The percentage of carbon in cast iron is—
 (A) 5–10 (B) 0.25–2.5
 (C) 2.5–4.5 (D) 0.12–0.2
62. The ascending order of stability of the carbanion $\bar{\text{C}}\text{H}_3(\text{P})$, $\text{C}_6\text{H}_5\bar{\text{C}}\text{H}_2$ (Q), $(\text{CH}_3)_2\bar{\text{C}}\text{H}(\text{R})$ and $\text{H}_2\text{C}=\text{CH}=\text{CH}_2(\text{S})$ is—
 (A) $\text{P} < \text{R} < \text{S} < \text{Q}$
 (B) $\text{R} < \text{P} < \text{S} < \text{Q}$
 (C) $\text{R} < \text{P} < \text{Q} < \text{S}$
 (D) $\text{P} < \text{R} < \text{Q} < \text{S}$
63. The descending order of stability of the carbonium ions
 $\text{C}_6\text{H}_5\text{CH}_2^+(\text{I})$
 $p(\text{CH}_3\text{O})\text{C}_6\text{H}_4\text{CH}_2^+(\text{II})$
 $p(\text{NO}_2)\text{C}_6\text{H}_4\text{CH}_2^+(\text{III})$
 and $p(\text{CH}_3)\text{C}_6\text{H}_4\text{CH}_2^+(\text{IV})$ is—
 (A) $\text{IV} > \text{II} > \text{I} > \text{III}$
 (B) $\text{II} > \text{IV} > \text{III} > \text{I}$

- (C) $\text{II} > \text{IV} > \text{I} > \text{III}$
 (D) $\text{IV} > \text{II} > \text{III} > \text{I}$
64. Which one of the following nitro compounds when reacted with nitrous acid produces blue colour ?
 (A) 2-methyl-2-nitropropane
 (B) 2-methyl-1-nitropropane
 (C) 2-nitropropane
 (D) Nitrobenzene
65. The amine of highest basic strength among the following is—
 (A) N-methylaniline
 (B) Benzylamine
 (C) *p*-toluidine
 (D) N, N-dimethylaniline
66. Which one of the following has maximum laevorotatory nature ?
 (A) D-glucose
 (B) D-fructose
 (C) Sucrose
 (D) Invert sugar
67. Electrolytic reduction of nitrobenzene in strongly acidic medium gives the product—
 (A) Hydrobenzene
 (B) Azobenzene
 (C) Phenyl hydroxylamine
 (D) *p*-amino phenol
68. A secondary amine could be prepared readily from the starting material—
 (A) Alkyl isocyanide
 (B) Alkyl cyanide
 (C) Alkanamide
 (D) Phthallimide and alkyl halide
69. The bacteriostatic antibiotic among the following is—
 (A) Erythromycin
 (B) Penicillin
 (C) Aminoglycoside
 (D) Ofloxacin
70. In which one of the following equilibria, the increase of pressure over the equilibrium will favour the backward reaction ?
 (A) Decomposition equilibrium of HI
 (B) Formation equilibrium of SO_3
 (C) Decomposition equilibrium of NH_3
 (D) Formation equilibrium of PCl_5
71. Which one of the following aqueous solutions of salts has the lowest pH value ?
 (A) CH_3COONa (B) NaCl
 (C) $\text{NH}_4\text{OOCCH}_3$ (D) NH_4Cl
72. Which one of the following ions has the highest value of ionic radius ?
 (A) Li^+ (B) B^{3+}
 (C) O^{2-} (D) F^-
73. In the synthesis of ammonia from nitrogen and hydrogen gases, if 6×10^{-2} mole of hydrogen disappears in 10 minute, the number of moles of ammonia formed in 0.3 minutes is—
 (A) 1.8×10^{-2} (B) 1.2×10^{-2}
 (C) 4×10^{-2} (D) 3.6×10^{-2}
74. The solubility product of a sparingly soluble metal hydroxide $\text{M}(\text{OH})_2$ at 298 K is $5 \times 10^{-16} \text{ mol}^3 \text{ dm}^{-9}$. The pH value of its aqueous and saturated solution is—
 (A) 5 (B) 9
 (C) 11.5 (D) 2.5
75. In a reversible reaction, the enthalpy change and the activation energy in the forward direction are respectively $-x \text{ kJ mol}^{-1}$ and $y \text{ kJ mol}^{-1}$. Therefore, the energy of activation in the backward direction in kJ mol^{-1} is—
 (A) $y - x$ (B) $(x + y)$
 (C) $(x - y)$ (D) $-(x + y)$

ANSWERS

(Continued from Page 1215)

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CHEMISTRY

- The mass of 4.00×10^{-3} mole of sucrose ($C_{12}H_{22}O_{11}$) is—
(A) 8.5 g (B) 1.368 g
(C) 13.68 g (D) None of these
- How many grams of HCl will be present in 150 ml of its 0.52 M solution ?
(A) 2.85 g (B) 5.70 g
(C) 8.50 g (D) 3.65 g
- A colourless liquid, at room temperature, reacts with soda lime to form sodium salt of carboxylic acid and ammonia gas. The liquid is—
(A) Propanoic acid
(B) Formamide
(C) Propanamide
(D) Methyl ethanoate
- In the preparation of Grignard reagent from haloalkane, the metal used is—
(A) Mg (B) Zn
(C) Li (D) K
- $C_6H_6 \xrightarrow[H_2SO_4]{HNO_3} X \xrightarrow[FeCl_3]{Cl_2} Y$
In the above sequence, Y can be—
(A) 4-nitrochlorobenzene
(B) 1-nitrochlorobenzene
(C) 3-nitrochlorobenzene
(D) None of these
- Hybridisation state of copper in $[Cu(NH_3)_4]^{2+}$ ion—
(A) sp^3 (B) dsp^2
(C) d^2sp^3 (D) sp^3d
- Arrange the following compounds in order of increasing basicity—
(1) *p*-chloroaniline
(2) *p*-nitroaniline
(3) *p*-methylaniline
(4) *p*-methoxyaniline
(5) Aniline
(A) $4 < 3 < 5 < 1 < 2$
(B) $3 < 4 < 5 < 2 < 1$
(C) $2 < 1 < 5 < 3 < 4$
(D) $2 < 5 < 1 < 4 < 3$
- The specific conductance of a solution is $0.2 \text{ ohm}^{-1} \text{ cm}^{-1}$ and conductivity is 0.04 ohm^{-1} . The cell constant would be—
(A) 1 cm^{-1} (B) 2 cm^{-1}
(C) 5 cm^{-1} (D) 0.2 cm^{-1}
- The rapid interconversion of α -D-glucose and β -D-glucose in solution is known as—
(A) Racemization
(B) Resolution
(C) Fluxional isomerism
(D) Mutarotation
- Which of the following molecule shows paramagnetism ?
(A) O_2 (B) H_2
(C) Cl_2 (D) N_2
- 100 ml of colloidal sol of gold is completely prevented from coagulation by 1ml of 10% NaCl solution by adding 0.25 g starch. Gold number of starch is—
(A) 0.25 (B) 2.5
(C) 25 (D) 250
- $FeSO_4 \cdot 7H_2O$ is—
(A) Green vitriol (B) Blue vitriol
(C) White vitriol (D) Mohr's salt
- An organic compound $A(C_6H_{12})$ which upon ozonolysis followed by reduction gives an aldehyde (C_2H_4O) and ketone (C_4H_8O) is—
(A) 2-hexene
(B) 3-methyl-2-pentene
(C) 4-methyl-2-pentene
(D) 3-methyl-3-pentene
- Which molecule does not show zero dipole moment ?
(A) BF_3 (B) NH_3
(C) CCl_4 (D) CH_4
- $CH_3-CO-CH_2CH_2CH_3 \xrightarrow{\text{Conc. } HNO_3} CH_3COOH + CH_3CH_2COOH$
The cleavage of C—C bond is according to—
(A) Saytzeff's rule
(B) Hofmann's rule
(C) Popoff's rule
(D) Zerewitinoff's rule
- With 63 g of oxalic acid how many litres of $\frac{N}{10}$ solution can be prepared ?
(A) 100 litre (B) 10 litre
(C) 1 litre (D) 1000 litre
- Assign R- and S-configuration to—

$\begin{array}{c} \text{COOH} \\ | \\ \text{H}-\text{C}-\text{NH}_2 \\ | \\ \text{CHO} \\ \text{(I)} \end{array}$

$\begin{array}{c} \text{CH}_3 \\ | \\ \text{H}-\text{C}-\text{COOH} \\ | \\ \text{OH} \\ \text{(II)} \end{array}$

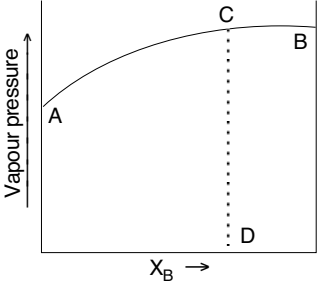
(A) I = R, II = S
(B) I = R, II = R
(C) I = S, II = S
(D) I = S, II = R
- Which pair shows *cis-trans* isomerism ?
(A) Maleic acid—fumaric acid
(B) Lactic—tartaric acid
(C) Malonic—succinic acid
(D) Crotonic—acrylic acid
- The oxidation state of mercury in amalgam is—
(A) Zero (B) One
(C) Two (D) Three
- 1, 2-dichloroethene shows—
(A) Geometrical isomerism
(B) Optical isomerism
(C) Ring-chain isomerism
(D) Resonance
- A certain compound contains elements H, C, O and N in the mass ratio of 1 : 3 : 4 : 7. Its molecular formula is—
(A) $HCONH_2$
(B) CH_3COONH_4
(C) NH_2CONH_2
(D) CH_3NCO
- Chromyl chloride test is carried out to confirm the presence of—
(A) SO_4^{2-} (B) Cr^{3+}
(C) Cl^- (D) Cr^{3+} and Cl^-
- 4.0g of argon (atomic mass = 40) in a bulb at a temperature of TK had a pressure P atm. When the bulb was placed in hotter bath at a temperature 50 K more than the first one, 0.8g of a gas had to be removed to get the original pressure. T is equal to—
(A) 510 K (B) 200 K
(C) 2100 K (D) 73 K

24. In order to separate oxygen from one mole of H_2O the required amount of charge in coulomb would be—
 (A) 1.93×10^5 (B) 9.6×10^4
 (C) 1.8 (D) 3.6
25. In a solid AB having the NaCl structure 'A' atoms occupy the corners of the cubic unit cell. If all the face centered atoms along one of the axes are removed, then the resultant stoichiometry of the solid is—
 (A) AB_2 (B) A_2B
 (C) A_4B_3 (D) A_3B_4
26. The ratio of radii of 3rd and 2nd Bohr's orbit of hydrogen atom is—
 (A) 3 : 2 (B) 4 : 7
 (C) 9 : 4 (D) 9 : 1
27. An e^- has magnetic quantum number as -3 . What is its principle quantum number ?
 (A) 1 (B) 2
 (C) 3 (D) 4
28. Which of the following compounds on treatment with CH_3I produces a compound whose hydrolysis yields $(\text{CH}_3)_4\text{NOH}^{\oplus\ominus}$?
 (A) $(\text{CH}_3)_2\text{NH}$ (B) $(\text{CH}_3)_3\text{N}$
 (C) CH_3NH_2 (D) $(\text{CH}_3)_4\text{N}^{\oplus}$
29. Calculate velocity (cm s^{-1}) of an electron placed in third orbit of the hydrogen atom—
 (A) $14.54 \times 10^7 \text{ cm s}^{-1}$
 (B) $7.32 \times 10^7 \text{ cm s}^{-1}$
 (C) $2.50 \times 10^7 \text{ cm s}^{-1}$
 (D) $5.60 \times 10^7 \text{ cm s}^{-1}$
30. For obtaining blister copper, the Cu_2S should be treated with—
 (A) Only FeS
 (B) Only CuO
 (C) FeS, CuO and Cu_2O
 (D) Only Cu_2O
31. Which of the following reactions is favoured by increasing the temperature as well as the pressure ?
 (A) $2\text{A}_{(\text{g})} + 2\text{B}_{(\text{g})} \rightleftharpoons \text{C}_{(\text{g})} + 3\text{D}_{(\text{g})}; \Delta H = -ve$
 (B) $\text{A}_{(\text{g})} + 2\text{B}_{(\text{g})} \rightleftharpoons 2\text{C}_{(\text{g})} + 2\text{D}_{(\text{g})}; \Delta H = +ve$
 (C) $\text{A}_{(\text{g})} + 2\text{B}_{(\text{g})} \rightleftharpoons \text{C}_{(\text{g})} + 2\text{D}_{(\text{g})}; \Delta H = +ve$
 (D) $\text{A}_{(\text{g})} + 2\text{B}_{(\text{g})} \rightleftharpoons 2\text{C}_{(\text{g})} + 2\text{D}_{(\text{g})}; \Delta H = -ve$
32. Which one of the following will be the most polar bond ?
 (A) N—H (B) Cl—H
 (C) O—H (D) Br—H
33. The structure of glycine in a solution of pH = 8 is—
 (A) $\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$
 (B) $\text{H}_2\text{N}-\text{CH}_2-\text{COO}^-$
 (C) $\text{H}_3\text{N}^+-\text{CH}_2-\text{COOH}$
 (D) $\text{H}_3\text{N}^+-\text{CH}_2-\text{COO}^-$
34. If the solubility of BaSO_4 (formula mass = 233) in water at 25°C is 0.000233 g per 100 ml of solution, then the value of K_{sp} will be—
 (A) 1×10^{-5} (B) 2×10^{-5}
 (C) 1×10^{-10} (D) 2×10^{-10}
35. The bond angle in PX_3 is minimum when X is—
 (A) Cl
 (B) Br
 (C) I
 (D) All have the same bond angle
36. Argentite ore is to be reacted with which of the following compound to obtain it in solution ?
 (A) CH_3CN (B) $\text{C}_6\text{H}_5\text{CN}$
 (C) $[\text{Fe}(\text{CN})_6]^{4-}$ (D) NaCN
37. The compound with highest pK_a is expected to be—
 (A) *p*-nitrophenol
 (B) *p*-chlorophenol
 (C) *p*-methylphenol
 (D) *p*-methoxyphenol
38. The maximum *s*-character is associated with the hybrid orbital of carbon of following compounds—
 (A) C_2H_6 (B) C_2H_4
 (C) C_6H_6 (D) C_2H_2
39. Articles made of copper and bronze slowly tarnish in air and turn green. The green colour is due to the formation of—
 (A) Copper oxide
 (B) Copper sulphide
 (C) Copper oxalate
 (D) Basic copper carbonate
40. IUPAC name of Co_2O_3 —
 (A) Cobaltous Oxide
 (B) Cobaltic Oxide
 (C) Cobalt(II) Oxide
 (D) Cobalt(III) Oxide
41. An ester with molecular formula $\text{C}_4\text{H}_8\text{O}_2$ on hydrolysis gives an acid which reduces Tollen's reagent and an alcohol which gives blue colouration in Victor Meyer's test. The ester is—
 (A) *n*-propyl formate
 (B) Isopropylformate
 (C) Ethylacetate
 (D) Methyl propionate
42. What is the mole fraction of acetone for a solution containing 2.8 mole acetone and 8.2 mole chloroform ?
 (A) 0.20 (B) 0.350
 (C) 0.255 (D) 0.10
43. What is the freezing point of a solution containing 8.1g HBr in 100g water assuming acid to be 90% ionised ($K_f \text{H}_2\text{O} = 1.86$) ?
 (A) 0.85°C (B) -3.53°C
 (C) 0°C (D) -0.35°C
44. Least number of moles will be there in the compound—
 (A) 4g N_2 (B) 16g O_2
 (C) 8g CO_2 (D) 2g H_2
45. Amongst TiF_6^{2-} , CoF_6^{3-} , Cu_2Cl_2 and NiCl_4^{2-} (atomic numbers Ti = 22, Co = 27, Cu = 29, Ni = 28). The colourless species are—
 (A) CoF_6^{3-} and NiCl_4^{2-}
 (B) TiF_6^{2-} and CoF_6^{3-}
 (C) Cu_2Cl_2 and NiCl_4^{2-}
 (D) TiF_6^{2-} and Cu_2Cl_2
46. The constituents of stainless steel are—
 (A) Cu + Sn + Fe
 (B) Fe + Mn
 (C) Fe + Cr + Ni
 (D) Fe + Zn
47. The reaction $\text{MnO}_4^- + e^- \rightleftharpoons \text{MnO}_4^{2-}$ takes place in—
 (A) A basic medium
 (B) An acid medium

- (C) A neutral medium
(D) Both acid and basic medium
48. In electronic transition of H-atom, the wave number of emitted photon is 82200 cm^{-1} . The corresponding transition is—
[R = 109600 cm^{-1}]
(A) $n = 2 \rightarrow n = 1$
- (B) $n = 3 \rightarrow n = 2$
(C) $n = 4 \rightarrow n = 3$
(D) None of these
49. A metal X on heating with nitrogen gas gives Y. Y on treatment with H_2O gives a colourless gas which when passed through
- CuSO_4 solution gives a blue colour. Y is—
(A) $\text{Mg}(\text{NO}_3)_2$ (B) Mg_3N_2
(C) NH_3 (D) MgO
50. Isoelectronic of CO is—
(A) CN^- (B) O_2^+
(C) O_2^- (D) N_2^+

ANSWERS WITH HINTS

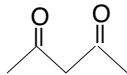
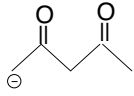
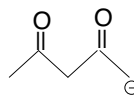
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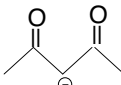
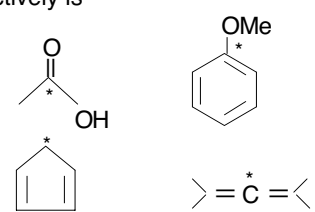
- Number of d -electrons present in Fe^{2+} [$Z = 26$] are not equal to—
 (A) No. of p -electrons in Ne [$Z = 10$]
 (B) No. of s -electrons in Mg [$Z = 12$]
 (C) No. of d -electrons in Fe
 (D) No. of p -electrons in Cl [$Z = 17$]
- White vitriol (hydrated zinc sulphate) is isomorphous with $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$. White vitriol contains 22.95% Zn and 43.9% water of crystallisation. Atomic mass of Zn is—
 (A) 64 (B) 65.87
 (C) 63.5 (D) 60
- Which of the following properties is nearly same for two families?
 Family 1 : Be, Mg, Ca, Sr ...
 Family 2 : He, Ne, Ar, Kr ...
 (A) EN (B) EA
 (C) IP (D) OA
- After filling $4d$ orbitals, an electron will enter in—
 (A) $4p$ (B) $4s$
 (C) $5p$ (D) $4f$
- The observed dipole moment of HCl molecule is 1.03 D. If HCl bond length is 1.275 \AA and the electronic charge is 4.8×10^{-10} e.s.u. what is the per cent polarity of HCl?
 (A) $1.275 \times 1.03 \text{ D}$
 (B) $\frac{4.8 \times 10^{-10} \times 1.275 \times 10^{-8}}{1.03 \text{ D}}$
 (C) $\frac{1.03 \text{ D} \times 100}{4.8 \times 10^{-10} \times 1.275 \times 10^{-8}}$
 (D) $\frac{4.8 \times 10^{-10} \times 100}{1.03 \text{ D}}$
- $^{27}_{13}\text{Al}$ is a stable isotope. $^{29}_{13}\text{Al}$ is expected to disintegrate by—
 (A) α -emission
 (B) β -emission
 (C) Positron emission
 (D) ^1_1H emission
- Ammonia forms complexes with Ag^+ according to the following reactions :
 (I) $[\text{Ag}(\text{H}_2\text{O})_2]^+ + \text{NH}_3(\text{aq}) \rightleftharpoons [\text{Ag}(\text{NH}_3)(\text{H}_2\text{O}(\text{aq}))]^+ + \text{H}_2\text{O}(\text{l})$
 (II) $[\text{Ag}(\text{NH}_3)(\text{H}_2\text{O}(\text{aq}))]^+ + \text{NH}_3(\text{aq}) \rightleftharpoons [\text{Ag}(\text{NH}_3)_2(\text{aq})]^+ + \text{H}_2\text{O}(\text{l})$
 The equilibrium constants of equilibrium (I) and (II) are $2.0 \times 10^{+3}$ and $8.3 \times 10^{+3}$ respectively. The equilibrium constant of the following reaction
 $[\text{Ag}(\text{H}_2\text{O})_2(\text{aq})]^+ + 2 \text{NH}_3(\text{aq}) \rightleftharpoons [\text{Ag}(\text{NH}_3)_2(\text{aq})]^+ + 2 \text{H}_2\text{O}(\text{l})$
 (A) 4.15 (B) $2.0 \times 10^{+3}$
 (C) $8.3 \times 10^{+3}$ (D) $16.6 \times 10^{+6}$
- The boiling points of water, ethyl alcohol and diethyl ether are 100°C , 78.5°C and 34.6°C respectively. The intermolecular forces will be in the order of—
 (A) Water > ethyl alcohol > diethyl ether
 (B) Ethyl alcohol > water > diethyl ether
 (C) Diethyl ether > ethyl alcohol > water
 (D) Diethyl ether > water > ethyl alcohol
- The solubility of silver carbonate in presence of Na_2CO_3 is expressed by the term—
 (A) $[\text{CO}_3^{2-}]$ (B) $2 [\text{Na}^+]$
 (C) $\frac{1}{2} [\text{Ag}^+]$ (D) $2 [\text{Ag}^+]$
- The given diagram is a vapour pressure composition diagram for a binary solution of A and B.

- In the solution A–B interactions are—
 (A) Similar to A–A and B–B interaction
 (B) Greater than A–A and B–B interaction
 (C) Smaller than A–A and B–B interaction
 (D) Unpredictable
- Water contains dissolved CO_2 , its reaction with water is represented as
 $\text{CO}_2 + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{HCO}_3^-$
 K_c for the reaction is 3.8×10^{-7} and $\text{pH} = 6$. What is the value of $\frac{[\text{HCO}_3^-]}{[\text{CO}_2]}$?
 (A) 3.8×10^{-1} (B) 3.8×10^{-13}
 (C) 6.0 (D) 3.8
- When H_2S is passed through nitric acid, the product is—
 (A) Rhombic sulphur
 (B) Prismatic sulphur
 (C) Colloidal sulphur
 (D) Monoclinic sulphur
- In the titration of $\text{K}_2\text{Cr}_2\text{O}_7$ and ferrous sulphate following data are given
 V_1 ml of 1.0 M_1 $\text{K}_2\text{Cr}_2\text{O}_7$ requires V_2 ml of 1.0 M_2 FeSO_4
 The true relation is—
 (A) $6 V_1 N_1 = V_2 N_2$
 (B) $V_1 N_1 = 6 V_2 N_2$
 (C) $V_1 N_1 = V_2 N_2$
 (D) None of these
- One mole of anhydrous MgCl_2 dissolves in water and liberates 25 k cal/mole of heat. ΔH hydration of $\text{MgCl}_2 = -30$ k cal/mole. Heat of dissolution of $\text{MgCl}_2 \cdot \text{H}_2\text{O}$ is—
 (A) + 5 k cal/mole
 (B) – 5 k cal/mole
 (C) 55 k cal/mole
 (D) – 55 k cal/mole
- Which expression is false with regard to vant Hoff's factor?
 (A) $i = \frac{\Delta p_{\text{obs}}}{\Delta p_{\text{cal}}}$
 (B) $i = \frac{m_{\text{obs}}}{m_{\text{cal}}}$
 (C) $i = \frac{\Delta T_{b(\text{obs})}}{\Delta T_{b(\text{cal})}}$
 (D) $i = \frac{\Delta T_{f(\text{obs})}}{\Delta T_{f(\text{cal})}}$

16. The velocity of a reaction is doubled for every 10°C rise in temperature. If temperature is raised to 50°C , the reaction velocity increases by about—
 (A) 12 times (B) 16 times
 (C) 32 times (D) 50 times
17. The charge on the colloidal particle of soap in its solution is developed—
 (A) By preferential adsorption of ions
 (B) The effective ion of soap micelle carries negative charge
 (C) The effective ion of soap micelle carries positive charge
 (D) None of the above
18. In the hydrolytic equilibrium

$$\text{B}^+ + \text{H}_2\text{O} \rightleftharpoons \text{BOH} + \text{H}^+$$

$$K_b = 1 \times 10^{-5}$$
 The hydrolysis constant is—
 (A) 10^{-5} (B) 10^{-19}
 (C) 10^{-10} (D) 10^{-9}
19. Δn_g for the combustion of one mole of ethanol (l) when both the reactants and products are at 298 K will be—
 (A) -1 (B) 0
 (C) +1 (D) +2
20. At 25°C , the standard emf of a cell having reaction involving two electron change is found to be 0.295 V. The equilibrium constant of the reaction is—
 (A) 29.5×10^{-2} (B) 10
 (C) 1×10^{10} (D) 29.5×10^{10}
21. Which of the following is the example of zeolite?
 (A) BaCO_3 (B) ZSM-5
 (C) $\text{Mg}(\text{OH})_2$ (D) Al_2O_3
22. The modern theory of catalysis is based on—
 (A) Active masses
 (B) Atomic and molecular weights
 (C) Size of the particles
 (D) Number of free valencies
23. Activity of radioactive nucleate is 120 particles per min. The activity after one third of its half-life period (particles per min)—
 (A) 96 particles per min.
 (B) 120 particles per min.
 (C) 240 particles per min.
 (D) None of these
24. Liquid benzene (C_6H_6) burns in oxygen according to,

$$2 \text{C}_6\text{H}_6(\text{l}) + 15 \text{O}_2(\text{g}) \rightarrow 12 \text{CO}_2(\text{g}) + 6 \text{H}_2\text{O}(\text{l})$$
 How many litres of O_2 at STP are needed to complete the combustion of 39 g of liquid benzene?
 (A) 11.2 litre (B) 22.4 litre
 (C) 84 litre (D) 74 litre
25. Number of water of crystallisation in Gypsum, Plaster of Paris and Epsom salt respectively are—
 (A) 2; 0.5, 7 (B) 7; 2; 1
 (C) 7; 0.5, 2 (D) 3, 4, 2
26. Which of the following compounds will show geometrical isomerism?
 (A) 2-butene
 (B) Propene
 (C) Butane
 (D) 2-methyl-2-butene
27. In Cr^{2+} , Mn^{3+} , Fe^{2+} and Co^{3+} ions number of unpaired electrons and magnetic moment will be—
 (A) 3; 3.87 (B) 4; 4.90
 (C) 3; 2.83 (D) 1; 1.73
28. The maximum number of isomers for an alkene with molecular formula C_4H_8 is—
 (A) 2 (B) 3
 (C) 4 (D) 5
29. Which of the following ligands is tridentate?
 (A) DMG (B) Bipy
 (C) Acac (D) Dien
30. Reaction of acetic acid with $\text{CH}_3\text{CH}_2\text{MgBr}$ yields—
 (A) An alkane
 (B) An alkene
 (C) An ester
 (D) A tertiary alcohol
31. Which of the following compound effects mercury?
 (A) D_2O (B) H_2O
 (C) O_3 (D) Dil HCl
32. CH_3CONH_2 is dehydrated by P_2O_5 to give—
 (A) CH_3NH_2
 (B) CH_3CN
 (C) CH_3CHO
 (D) $\text{CH}_3-\text{CH}_3 + \text{CO} + \text{NH}_3$
33. The component present in greater proportion in water gas is—
 (A) H_2 (B) CO
 (C) CO_2 (D) CH_4
34. Phenol (1 mole) reacts with bromine to give S-tribromophenol. The amount of bromine required is—
 (A) 3 mole (B) 1.5 mole
 (C) 4.5 mole (D) 6.0 mole
35. Amatol an explosive contains—
 (A) 80% NH_4NO_3 + 20% TNT
 (B) NH_4NO_3 + Al powder
 (C) 80% NH_4NO_3 + 20% $(\text{NH}_4)_2\text{SO}_4$
 (D) NH_4NO_3 + Zn powder
36. Bakelite is obtained from phenol by reacting with—
 (A) Formaldehyde
 (B) Acetaldehyde
 (C) Chloro benzene
 (D) Acetal
37. Which of the following species is not a pseudohalide?
 (A) CNO^- (B) RCOO^-
 (C) OCN^- (D) SCN^-
38. Of cobalt and zinc salts, which are attracted in magnetic field?
 (A) Cobalt salts
 (B) Zinc salts
 (C) Both (A) and (B)
 (D) None of these
39. In estimation of nitrogen by Dumas method 1.18 g of an organic compound gave 224 ml of N_2 at STP. The percentage of nitrogen in the compound is about—
 (A) 20.0 (B) 11.8
 (C) 47.5 (D) 23.7
40. H_2O_2 is '5.6 vol' then—
 (A) It is 1.7% wt by volume
 (B) It is 1N
 (C) Both are true
 (D) None are true
41. Compound  on removal of proton gives a carbanion. The most stable carbanion should be—
 (A) 
 (B) 

- (C) 
- (D) All the above
42. Oxone is—
 (A) CaO (B) N₂O
 (C) Na₂O₂ (D) NaBrO₃
43. Correct set of hybridisation state of the starred carbon atom respectively is—

- (A) sp^2, sp^2, sp^3, sp
 (B) sp^3, sp^2, sp^2, sp
 (C) sp^3, sp, sp, sp^2
 (D) sp^2, sp, sp^2, sp^2
44. Which of the following is not a Lewis acid ?
 (A) SiF₄ (B) FeCl₃
 (C) BF₃ (D) PH₃
45. In the conversion of CH₃Cl to CH₂Cl₂ by chlorination, the chain propagation steps are—
 (A) $\text{CH}_3^\bullet + \text{Cl}_2 \rightarrow \text{CH}_3\text{Cl} + \text{Cl}^\bullet$
 $\text{CH}_3\text{Cl} + \text{Cl}^\bullet \rightarrow \text{CH}_2\text{Cl}_2 + \text{H}^\bullet$
 (B) $\text{CH}_3\text{Cl} + \text{Cl}^\bullet \rightarrow \cdot\text{CH}_2\text{Cl} + \text{HCl}$
 $\cdot\text{CH}_2\text{Cl} + \text{Cl}_2 \rightarrow \text{CH}_2\text{Cl}_2 + \text{Cl}^\bullet$
 (C) Both (A) and (B)
 (D) None of the above
46. Which one of the following is used for drying of ammonia ?
 (A) Conc. H₂SO₄
 (B) CaO
 (C) P₂O₅
 (D) Anhydrous CaCl₂
47. Among the following alkenes highest reactivity on addition of hydrohalic acids is shown by—
 (A) CH₂=CH₂
 (B) (CH₃)₂C=CH₂
 (C) CH₃CH=CHCH₃
 (D) All alkenes
48. In the reaction
 $2\text{KI} + \text{H}_2\text{O} + \text{O}_3 \rightarrow 2\text{KOH} + \text{O}_2 + \text{A}$
 the compound A is—
 (A) KIO₃ (B) I₂O₅
 (C) HIO₃ (D) I₂
49. How many litres of air is needed for complete combustion of 8 litres of acetylene (oxygen in air is 20%) ?
 (A) 40 (B) 60
 (C) 80 (D) 100
50. The reaction
 $3\text{ClO}^-_{(\text{aq})} \longrightarrow \text{ClO}_3^-_{(\text{aq})} + 2\text{Cl}^-_{(\text{aq})}$
 is an example of—
 (A) Oxidation reaction
 (B) Reduction reaction
 (C) Decomposition reaction
 (D) Disproportionation reaction

ANSWERS WITH HINTS

BIOLOGICAL CATALYSTS

Introduction

- Enzymes can be defined as biological catalysts. A catalyst is a substance which speeds up a chemical reaction but remains unchanged itself at the end.
- Enzymes are biological catalysts because they are protein molecules made by living cells. Enzymes are vitally important because in their absence, reactions in the cell would be too slow to sustain life.
- Enzymes are proteins having enormous catalytic power, they greatly enhance the rate at which specific chemical reactions take place. Enzymatic reactions are always reversible.
- Almost all enzymes are globular proteins consisting either a single polypeptide or more polypeptides held together by non-covalent bonds.
- An enzyme is capable of accelerating a specific chemical reaction **by lowering the required activation energy**, but unaltered itself in the process.
- The reactants of enzymatic reactions are called 'substrate'.

Significant Historical Facts of Enzyme

- **Kirchhoff** (1815)—First indicated the occurrence of enzymes in living systems.
- **Louis Pasteur** (1860)—Discovered that the fermentation of food stuffs can be brought about by yeast cells.
- **Kuhne** (1878)—First gave the term 'enzyme'.
- **Buchner** (1897)—First prepared a pure extract of 'Zymase' enzyme from yeast.
- **Nobel Laureate Sumner** (1926)—First prepared pure crystals of 'urease' enzymes from jack beans.
- **Northrop** (1930)—Prepared pure crystals of the enzymes pepsin and trypsin respectively from gastric juice and pancreatic juice.
- Lock and Key or Template hypothesis was given by **Emil Fischer** (1894) and modified by **Koshland** (1971).

Properties of Enzymes

- Enzymes possess the following major properties :
 1. All are globular proteins.
 2. Being proteins, they are coded for by DNA.
 3. Their presence does not alter the nature or properties of the end product(s) of the reaction.
 4. They are very efficient and a very small amount of enzyme brings about the change of a large amount of substrate.
 5. They are highly specific, *i.e.*, an enzyme will generally catalyse only a single reaction.
 6. The catalysed reaction is reversible.

7. Their activity is affected by pH, temperature, substrate concentration and enzyme concentration.
8. Enzymes lower the activation energy of the reactions they catalyse.
9. Enzymes possess active sites where the reaction takes place. These sites have specific shapes.
10. The rate of an enzyme reaction is measured by the amount of substrate changed, or amount of product formed, during a period of time.

Structure

- Enzymes are globular protein molecules that have three-dimensional shape with atleast one surface region having an area with a crevice or pocket.
- The crevice occupies only a small portion of the enzyme's surface and is known as its **active site**.
- Their shape often provide them with one or more active sites (domains) which bind temporarily and usually non-covalently with compatible substrate molecules to form one or more enzyme-substrate (ES) complexes, catalysis occurring only during the brief existence of the complex.
- Active site is so shaped so that a substrate molecule or several molecules fit into it in a very specific way and is held in place by weak mechanical forces, such as hydrogen bonds.
- Binding of the substrate to the enzyme causes a change in an enzyme's shape. This phenomenon of change in enzyme's shape following binding of substrate is called '**induced fit**'. This induced fit theory is supported by X-ray crystallographic evidence.
- Enzymes do nothing but speed up the rates at which the equilibrium positions of reversible reactions are attained.

Catalytically Active RNA Molecule

It is now known that RNA molecules can act as catalysts of reactions, sometimes involving themselves as substrate. When they involve non-self RNA molecules as substrate, as some do, they can be regarded as enzymes in the full sense. Such as Ribozyme is catalytically active RNA molecule. Their discovery in 1981 has widened the extension of the term 'enzyme' beyond proteins. Several ribozymes are self-splicing introns, causing speculation as to their possible roles as intermediates in the evolution of biological systems from prebiotic ones.

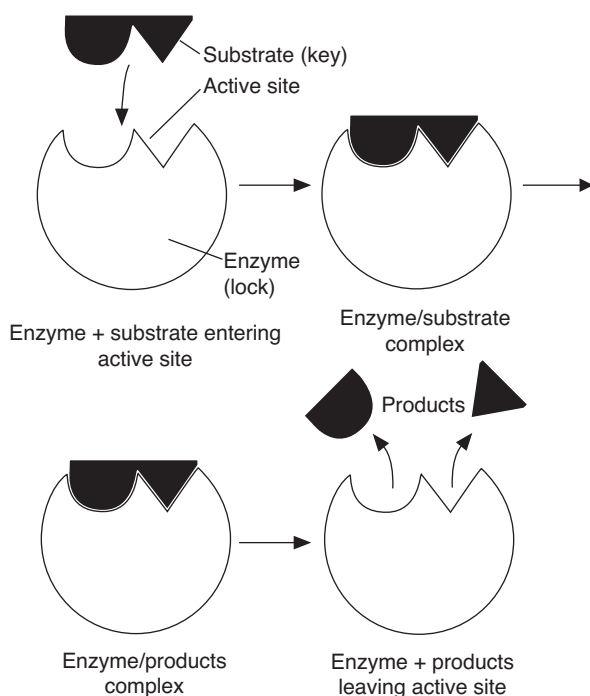
Mechanism of Enzyme Action

- Enzymes are very specific and it was suggested by Fischer that this was because the enzyme had a

particular shape into which the substrates fit exactly. This is after referred to as the '**lock and key**' hypothesis, where the substrate is imagined being like a **key** whose shape is complementary to the enzyme or **lock**. The site where the substrate binds in the enzyme is known as the **active site** and it is this which has the specific shape.

- Most enzymes are far larger molecules than the substrates they act on and the active site is usually only a very small portion of the enzyme, between 3 and 12 amino acids. The remaining amino acids, which make up the bulk of the enzyme, function to maintain the correct globular shape of the molecule.

(a)



(b)

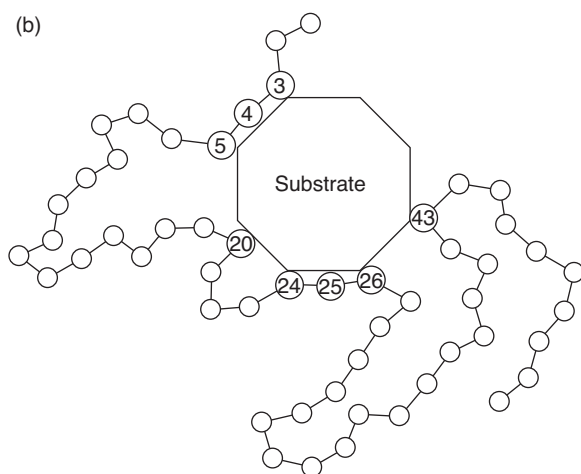


Fig. : (a) Fischer's 'lock and key' hypothesis of enzyme action. (b) A more realistic diagrammatic representation of an enzyme—substrate complex. The positions of the amino acids of the active site are numbered according to their position in the primary structure of the enzyme.

- Once formed, the products no longer fit into the active site and escape into the surrounding medium, leaving the active site free to receive further substrate molecules.
- In 1959 Koshland suggested a modification to the 'lock and key' model known as the '**induced fit hypothesis**'. Working from evidence that suggested that some enzymes and their active sites were physically rather more flexible structures than previously described, he proposed that that active site could be modified as the substrate interacts with the enzyme.
- The amino acids which make up the active site are moulded into a precise shape which enables the enzyme to perform its catalytic function most effectively.

Chemical Nature and Function

- All enzymes are proteins.
- An enzyme molecule may contain one or more polypeptide chains.
- The sequence of amino acids within the polypeptide chains is characteristic for each enzyme and is believed to determine the unique three-dimensional conformation in which the chains are folded.
- This conformation, which is necessary for the activity of the enzyme, is stabilized by interactions of amino acids in different parts of the peptide chains with each other and with the surrounding medium.
- These interactions are relatively weak and may be disrupted readily by high temperatures, acid or alkaline conditions or changes in the polarity of the medium.

Michaelis Constant

At any one instant, the proportion of enzyme molecules bound to substrate will depend upon the substrate concentration. As this is increased, the initial velocity of the reaction (v_0) on addition of enzyme increases upto a maximum value, v_{\max} at which substrate level the enzyme is said to be **saturated** (all active sites maximally occupied) and no further addition of substrate will increase v_0 . The value of substrate concentration at which $v_0 = \frac{1}{2} v_{\max}$ is known as the **Michaelis constant (K_m)** for the enzyme substrate reaction. Low K_m indicates high affinity of the enzyme for the substrate.

- Such changes lead to an unfolding of the peptide chains (denaturation) and a concomitant loss of enzymatic activity, solubility and other properties, characteristic of the active enzyme.
- Because enzyme molecules are generally globular proteins, their shape and functions may be affected by pH changes in the aqueous environments.
- Temperature increase will raise the rate of collision of enzyme and substrate molecules, thus increasing the rate of enzyme-substrate (ES) complex formation and raising the reaction rate.
- This is opposed by increased enzyme denaturation as the optimum temperature for the reaction is exceeded.

Some Representative Enzymes, their Sources and Reaction Specificities		
Enzyme	Some sources	Reaction catalyzed
Pepsin	Gastric juice	Hydrolysis of proteins to peptides and amino acids.
Urease	Jack bean, bacteria	Hydrolysis of urea to ammonia and carbon dioxide.
Amylase	Saliva, pancreatic juice	Hydrolysis of starch to maltose.
Phosphorylase	Muscle, liver plants	Reversible phosphorylation of starch or glycogen to glucose-1-phosphate.
Transaminases	Many animal and plant tissues	Transfer of an amino group from an amino acid to a keto acid.
Phosphohexose isomerase	Muscle, yeast	Interconversion of glucose-6-phosphate and fructose-6-phosphate.
Pyruvic carboxylase	Yeast, bacteria, plants	Decarboxylation of pyruvate to acetaldehyde and carbon dioxide.
Catalase	Erythrocytes, liver	Decomposition of hydrogen peroxide to oxygen and water.
Alcohol dehydrogenase	Liver	Oxidation of ethanol to acetaldehyde.
Xanthine oxidase	Milk, liver	Oxidation of xanthine and hypoxanthine to uric acid.

Factors Affecting Enzyme Activity

- Any condition that affects the three-dimensional shape of an enzyme will effect its activity. Two such factors that affect enzyme activity are temperature and pH.
- The shape of a protein is determined by its hydrogen bonds. Hydrogen bonds are easily disrupted by temperature changes.
- Most higher mammals have enzymes that function best within a relatively narrow temperature range between 35°C and 40°C.
- Below 35°C, the bonds that determine protein shape are not flexible enough to permit the shape change necessary for substrate to fit into reactive site.
- Below 35°C, the bonds that determine protein shape are not flexible enough to permit the shape change necessary for substrate to fit into active site. Above 40°C, the bonds are too weak to hold the protein in proper position and maintain its shape. When proper shape is lost, the enzyme is destroyed, this loss of shape is called **denaturation**.
- Most enzymes also have a pH optimum, usually between 6 and 8. When the pH is too low, the H⁺ ions combine with the R-groups of the enzyme's amino acids, reducing their ability to bind with substrate.

Enzymes Identified with Hereditary Diseases	
Disease name	Defective enzyme
Albinism	Tyrosinase
Phenylketonuria	Phenylalanine hydroxylase
Fructosuria	Fructokinase
Methemoglobinemia	Methemoglobin reductase
Galactosemia	Galactose-1-phosphate uridyl transferase

Cofactors and Coenzymes

- Cofactors** are metal ions.
- Many enzymes use metal ions to change a non-functioning active site to a functioning one. In these enzymes, the attachment of a cofactor causes a shape change in the protein that allows it to combine with its substrate.

The Relationship Between Coenzymes and Vitamins		
Name of coenzyme	Some enzymes with which it reacts	Vitamin needed for synthesis
Adenosine triphosphate	Kinases, muscle enzyme	None
Nicotinamide adenine dinucleotide	Dehydrogenases	Nicotinic acid
Pyridoxal phosphate	Transaminases	Pyridoxine
Biotin	Carboxylases	Biotin
Coenzyme A	Acyl transferases	Panthothenic acid

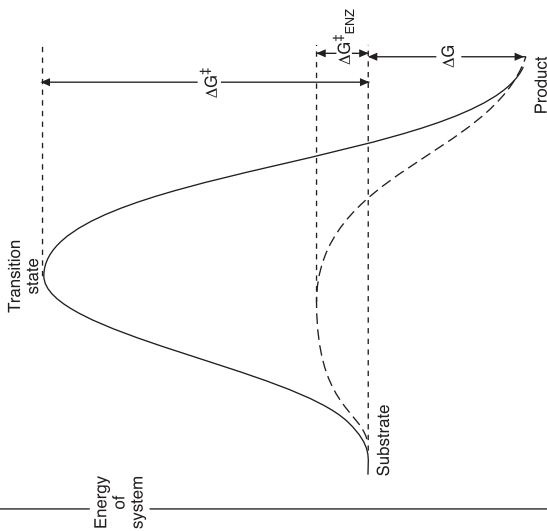
- The cofactors of other enzyme participate in a temporary bonds between the enzyme and its substrate when the enzyme-substrate (ES) complex is formed.
- Coenzymes** are non-protein, organic molecules that participate in enzyme-catalytic reactions, often by transporting electrons in the form of hydrogen atoms, from one enzyme to another.
- Many vitamins function as coenzymes or said to make coenzymes (*e.g.*, **Niacin and Riboflavin**).
- One of the most important, coenzyme in the cell is the hydrogen acceptor Nicotine Adenine Dinucleotide (NAD⁺) is made from a B-Vitamin.
- Some enzyme (*e.g.*, Aspartase) bind just one very specific substrate molecule; others bind a variety of the same kind (*e.g.*, all terminal peptide bonds in the case of exopeptidases). The difference arises from the degree of stereospecificity of the enzyme.
- Many need an attached prosthetic group or a diffusible coenzyme for activity. In such enzymes the protein component is termed the **apoenzyme** and the whole functional enzyme-cofactor complex is termed the **holoenzyme**.

Catalysis by Enzymes

An important step in enzyme catalysis is substrate binding to the active sites.

Enzymes form **enzyme-substrate complexes** which reduce the activation energy for reactions which they catalyse.

Consider the reaction: $\text{SUBSTRATE (S)} \rightleftharpoons \text{PRODUCT (P)}$ which can be illustrated by a **reaction profile**.



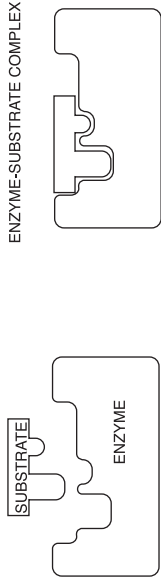
Effect of enzyme on activation energy

For a reaction $\text{S} \rightleftharpoons \text{P}$ the rate of the forward reaction depends on temperature and activation energy (difference in free energy between substrate and transition state, ΔG^\ddagger). The reaction rate is proportional to the number of molecules which have an energy $\geq \Delta G^\ddagger$. **Enzymes act as catalysts by providing alternative reaction pathways in which ΔG^\ddagger is lower than it otherwise would be.** Heat cannot be used by cells to increase rates of reaction because of possible denaturation.

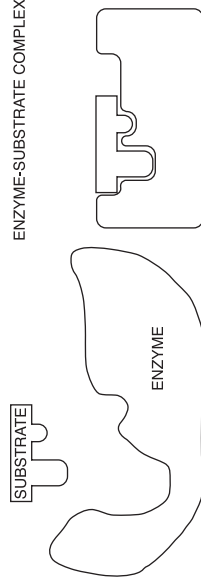


Stereospecificity: relationship of substrate(s) to active site

Emil Fischer's **lock and key hypothesis** suggested that the active site and the substrate were **exactly complementary**



but more recent work allowed **Koshland** to propose the **induced fit hypothesis** which suggests that active site and substrate are only fully complementary **after the substrate is bound**.



This latter process of **dynamic recognition** is now the more widely accepted hypothesis.

Cofactors are essential for enzyme activity

Some, such as Zn^{2+} or Mg^{2+} , or porphyrin groups such as the **haem** in catalase, may form part of the active site and cannot easily be separated from the enzyme protein: these are commonly called **prosthetic groups**.

Some, such as NAD (nicotinamide adenine dinucleotide), bind temporarily to the active site and actually take part in the reaction.



Such **coenzymes** shuttle between one enzyme system and another - most are formed from dietary components called **vitamins** (e.g., NAD is formed from niacin, one of the vitamin B complex).

Allosteric Enzymes

Allosteric enzymes have, in addition to an active site, another stereo-specific site to which an effector or modulator molecule can bind. When it does, the shape of the active site is altered so that it can or cannot bind substrate (allosteric stimulation or inhibition respectively). In this way the enzyme can be part of a fine control circuit, requiring the presence or absence of a substrate—in addition to substrate presence—before enzyme activity proceeds. Some allosteric enzymes respond to two or more such modulators, permitting still finer control over timing of enzymes activity.

Enzyme Inhibition

- Enzyme inhibition is the prevention of an enzyme process as a result of the interaction of some substrate with an enzyme so as to decrease the rate of the enzymic reaction. The substrate causing such an effect is termed '**inhibitor**'.
- Feedback inhibition of a biochemical pathway is often achieved by allosteric inhibition of the first enzyme in the sequence by the final product. The product binds non-covalently to the modulator site on the enzyme, closing the active site allosterically.
- In competitive inhibition, the binding is reversible. An important example of this is the most abundant enzyme, **ribulose biphosphate carboxylase**.
- The effect of a competitive inhibitor is to bind only free enzyme. Some enzymes are **constitutive**, being synthesized independently of substrate availability, while others are **inducible** (e.g., many liver enzymes), being synthesized only when substrate becomes available.

Classification and Nomenclature

- The first enzyme known was **diastase**.
- Previously it was suggested that enzymes be named by adding—'ase' to root, indicative of the nature of the substrate of enzyme. Although enzymes are now no longer named in such a simple manner.
- Now enzymes are usually classified and named according to the reaction they catalyse.
- An international code for enzymes recognizes six major categories of enzyme function, as follows :
 1. **Oxidoreductases**
- Oxidoreductases are enzymes which catalyse reaction involving electron transfer and play an important role in cellular respiration and energy production.
- Many respiratory enzymes are **dehydrogenases**.

2. Transferases

- Transferases catalyse the transfer of a group of atoms from one substrate to another, such as **transaminases** transfer amino groups.
- An important subclass of this group are the **Kinases**, which catalyse the phosphorylation of their substrate by transferring a phosphate group, usually from ATP, thereby activating the metabolically inert compound for further transformations.

3. Hydrolases

- Hydrolases catalyse hydrolysis reactions.
- Catalyse the hydrolysis of proteins (proteinases, peptidases), nucleic acids (nucleases), starch (amylases), fats (lipases), phosphate esters (phosphatases).
- Many hydrolases are secreted by stomach, pancreas, intestine and are responsible for the digestion of foods.
- For example—**Cholinesterase**, which catalyse the hydrolysis of acetylcholine, plays an important role in the transmission of nervous impulses.
- Hydrolases generally catalyse addition or removal of water molecule.

4. Lyases

- Lyases catalysing addition to double bonds and saturating them.
- Lyases catalyse the non-hydrolytic cleavage of their substrate with the formation of a double bond.
- Examples are decarboxylases, which remove carboxyl groups as carbon dioxide and dehydrases remove water molecule.

5. Isomerases

- Any enzyme converting a molecule to one of its isomers, commonly a structural isomer, is called isomerase enzyme.
- Isomerases catalyse the interconversion of isomeric compounds.
- For example—**Triose phosphate isomerase** catalyses D-Glyceraldehyde 3-phosphate into Dihydroxyacetone phosphate.

6. Ligases

- Ligases perform condensation reactions involving ATP cleavage.
- Ligases or synthetases are enzymes that catalyse endergonic synthesis, coupled with the exergonic hydrolysis of ATP.
- They allow the chemical energy stored in ATP.

OBJECTIVE QUESTIONS

1. Enzymes that catalyse endergonic synthesis coupled with exergonic hydrolysis of ATP, are—
 - (A) Lyases
 - (B) Ligases
 - (C) Isomerases
 - (D) Transferases
2. Which of the following functions as coenzyme ?
 - (A) Tocopherol
 - (B) Retinol
 - (C) Riboflavin
 - (D) All of these
3. Enzymes which catalyse reactions involving electron transfer, are called—
 - (A) Transferases
 - (B) Hydrolases

(Continued on Page 1264)

DISORDERS CAUSED BY PROTOZOANS

- Most of the disease affecting human beings are caused by living organisms, *i.e.*, Bacteria, Protozoans, Fungi, Viruses, Helminthes and Arthropods which are parasitic and pathogenic.
- The diseases occur as a result of the interaction between the pathogens and the organism under specific environmental conditions. This interaction is referred to as infection or the infectious process, the manifestation of which is always the infectious disease.
- Infectious disease is caused by the development of infectious process in which pathogenic parasites enter the human body's normal vital organs and cause damage.
- The pathogenic parasites are all obligatory parasites, *i.e.*, they depend for their existence upon their hosts.
- Parasites show host specificity, *i.e.*, they harbour selective host.
- They secrete toxic substances which cause the specific disease.
- They complete their life-cycle in one or more than one host.
- Disease causing species occur in all classes of protozoa.

Amoebiasis (Amoebic Dysentery or Enteritis)

- Amoebiasis is caused by *Entamoeba histolytica*. It inhabits the colon of large intestine of humans. Infection occurs by ingesting cysts with contaminated food and water. The cysts are quadrinucleated.
- Lamble discovered this species. Losch discovered its pathogenic nature.
- The parasites secrete a proteolytic enzyme **cytolysin** in the large intestine. In this disease the patient passes out blood and mucous with the stool.
- The parasites that invade intestinal mucous membrane may be carried by the blood stream to the liver, lungs and brain. In these organs, the parasites feed on cells and produce severe lesions and abscesses, establishing secondary infections.
- The life-cycle of *Entamoeba histolytica* is **monogenetic** (single host life-cycle).

Prophylaxis (Prevention)

- Prevention of infection involves personal health and hygiene. One must prevent his foodstuffs and utensils clean and well covered to avoid contamination by houseflies.

Therapy

- All patients must be given effective and regular treatment. Metronidazole and chloroquine and their derivatives are main compounds from which common drugs

for treatment of Amoebiasis are made. Drugs commonly available are abodogyl, enteroquinol, flagyl, metrogyl, tini, tridazole, TDF-Forte etc.

Diarrhoea

- Diarrhoea is mostly caused by flagellate protozoan-*Giardia intestinalis*.
- Giardia was discovered by Leeuwenhoek. It inhabits the upper parts (duodenum and jejunum) of the alimentary tract. It lives firmly attached to the intestinal mucous membrane by adhesive disc.
- Infection occurs by taking cysts with contaminated food and water. By covering the mucous membrane of the intestine, the parasites reduce the absorption of food, particularly fats.
- This causes diarrhoea or **giardiasis** (very loose and frequent stools). The infection of *Giardia* is more in children than in adults.
- Giardiasis is also known as **Back packer's disease**.

Prevention

- Properly washing hands, fruits and vegetables before eating and protecting food articles from dust, flies ants and cockroaches can check human infection.

Malaria

- Malaria or ague has been for thousand of years a very serious disease of the tropical and temperate regions.
- The name malaria was given by Mucculoch. Charles Laveran discovered that malaria is caused by the protozoan parasite *Plasmodium*. Sir Ronald Ross first discovered occysts of Plasmodium in female *Anopheles* mosquito and won the 1902 Nobel Prize for his work on malaria.
- Grassi fully described the life-cycle of *Plasmodium* and Garnham, shortt, Jeffrey and Bray had demonstrated pre-erythrocytic and exoerythrocytic stages of various Plasmodium species in humans.

Incubation Period

- The period between incubation of sporozoites of Plasmodium into human blood and first appearance of symptoms of malaria is called incubation period.
- On an average, it is 14 days in *P. vivax* and *P. ovale*, 12 days in *P. falciparum* and 30 days in *P. malariae*.

Symptoms and Phases of Malaria

- **Prodromal symptoms**—In a typical malarial infection, mild symptoms appear early, even during incubation period. These include nausea, loss of appetite, constipation and sometimes insomnia. Headache, muscular pain aches in joints develop and there may be mild sensation of chill.

- **Paroxysm**—It is the actual (clinical) attack of malaria which initially begins after a few earliest erythrocytic cycles but is then repeated after every cycle.
- Paroxysm results due to sufficient accumulation of **haemozoin** and other toxins in blood. It includes three stages :
 1. **Rigor stage**—In this, the patient experiences a terrible chill and shivering and rapid pulse.
 2. **Febrile stage**—Shivering subsides in about an hour or so and the body temperature rises.
 3. **Defervescent stage**—After few hours, profuse sweating starts, temperature of body steadily drops.

Transmission

- The malarial parasites are carried from the infected to the healthy persons by the female *Anopheles* mosquito. The mosquito picks up the parasites with the human blood when it bites an infected person, parasites (**sporozoites**) migrate into his saliva, which mosquitoes infect before sucking up the human blood to prevent blood clotting.

Species of Anopheles

- In India, the following five species of *Anopheles* are known to be transmitter of *Plasmodium* :
 1. *Anopheles culicifacies*
 2. *Anopheles fluviatilis*
 3. *Anopheles philippinensis*
 4. *Anopheles stephense*
 5. *Anopheles sundanicus*

Types of Malaria

- Three types of malaria are recognized on the basis of periodicity of paroxysms.
 1. **Tertian malaria or common ague**—It is caused by *P. vivax*, *P. ovale* and *P. falciparum*. Recurrence of fever is after every 48 hours.
- *P. vivax* and *P. ovale* cause 'Benign Tertian Malaria' with low death rate, because merozoites of *Plasmodium* generally invade and destroy old and mature RBCs. Often cause relapse malaria.
- *P. falciparum* causes 'Malignant or Subtertian or Aestivoautumnal or Pernicious or Cerebral or Tropical Malaria' with high death rate because infected RBCs usually clump together and block capillary blood circulation in organs like brain, lungs, heart, spleen etc.
 2. **Quartan malaria**—It is caused by *P. malariae*. Paroxysms occur at intervals of about 72 hours (every 4th day). It generally leads to secondary complications because of large-scale destruction of young RBCs.
 3. **Quotidian malaria**—In this paroxysms are irregular almost daily. It may result from secondary complications of malignant tertian or due to multiple or mixed infections by more than one species of *Plasmodium*.

Control of Malaria

- The control measures of malaria are offensive and defensive. The defensive measures can be taken against both the organism (mosquitoes and malarial parasites) involved in malaria.

- Mosquitoes can be destroyed by :
 1. Drain off all ditches and ponds so that mosquitoes may not find stagnant water to breed.
 2. Sprinkle kerosene oil on stagnant water so that the mosquito larvae and pupae may not get fresh air to breathe.
 3. Adding larvicidal fishes (*e.g.*, *Gambusia*), ducks.

Offensive Measures

- The malarial parasites can be killed by taking suitable medicines such as quinine derived from the Cinchona tree.

Defensive Measures

- This includes the protection of body from mosquito bite. Apply some mosquito oil or cream on exposed body and use mosquito nets.

Ciliary Dysentery

- Ciliary dysentery is caused by ciliate protozoans named *Balantidium coli*. It inhabits the human intestine. It feeds on tissue fragments, red blood corpuscles, bacteria and faecal matter. Infection occurs by ingesting cysts along with contaminated food and water.
- *Balantidium coli* causes ulcers and invade mucous membrane by secreting an enzyme **hyaluronidase**.

Trypanosomiasis

- Trypanosomiasis is caused by species of *Trypanosoma*, which are flagellate parasites.
- *Trypanosoma gambiense* and *Trypanosoma rhodesiense* are most dreadful of all pathogenic protozoans. These cause 'sleeping sickness' in Africa.
- The vector host is tse-tse fly (*Glossina palpalis*).
- Early symptoms of the disease include irregular fever and anaemia. The deadly sleeping sickness is caused only when the parasites leave the blood and invade cerebrospinal fluid and brain cells, causing extensive damage to the central nervous system.

Chaga's Disease

- It is caused by *Trypanosoma cruzi* in South and Central America. Mostly children are affected. Intermediate host are triatomid bugs.

Leishmaniasis

- *Leishmania donovani* causes **Kala-azar** disease. Parasites are primarily found in leishmania stage in the reticulo-endothelial cells of spleen, liver, intestinal mucosa, lymph glands and bone marrow.
- Kala-azar is characterized by enlargement of spleen, irregular fever and anaemia. Mortality is high in untreated cases. Treatment with antimony compounds prove useful.
- *Leishmania tropica* causes '**Oriental sore**' or cutaneous leishmaniasis.
- *Leishmania braziliensis* causes a disease called '**Espundia**', producing lesions upon skin and mucous membrane of nose, mouth, pharynx.

Trichomoniasis

- This disease is caused by *Trichomonas* species. The most common pathogenic species is *Trichomonas vaginalis* that inhabits the vagina of women and cause **Vaginitis** (Leucorrhoea).
- The transmission is always through sexual intercourse.

Toxoplasmosis

- This disease is caused by *Toxoplasma gondii*, a protozoan parasite. The parasites occupy the cells of the reticulo-endothelial and central nervous system.
- Symptoms of the disease include hydrocephalus and chorioretinitis. Infants infected before birth usually die.

OBJECTIVE QUESTIONS

1. Parasites which can live only as parasites and hence, die with the death of the host, are called—
(A) Pathogenic
(B) Obligatory
(C) Facultative
(D) None of these
2. The causative pathogen of Kala-azar is—
(A) *Leishmania tropica*
(B) *Leishmania donovani*
(C) *Leishmania braziliensis*
(D) None of these
3. Vector of *Trypanosoma gambiense* is—
(A) Housefly (B) Bedbug
(C) Tse-tse fly (D) Mosquito
4. Fish that feeds upon mosquito larvae in ponds, is—
(A) Rohu (B) Utricularia
(C) Scoliodon (D) Gambusia
5. The toxic substance released by malarial parasite in human blood is—
(A) Haematin (B) Heme
(C) Haemozoin (D) Globin
6. Charcot particles are found in faeces of man during infection of—
(A) *Entamoeba histolytica*
(B) *Trypanosoma gambiense*
(C) *Ascaris*
(D) None of these
7. Black-water fever is due to infection with—
(A) *Plasmodium falciparum*
(B) *Leishmania donovani*
(C) *Plasmodium ovale*
(D) *Plasmodium malariae*
8. Histolysin is produced by—
(A) Plasmodium
(B) Trypanosoma
(C) Entamoeba
(D) Leishmania
9. Pernicious malaria is—
(A) Vivax malaria
(B) Relapse malaria
(C) Tertian malaria
(D) Malignant malaria
10. Infective stage of Plasmodium is—
(A) Merozoites
(B) Ookinete
(C) Sporozoites
(D) All the above

ANSWERS

●●●

(Continued from Page 1227)

(Continued from Page 1261)

- (C) Ligases
(D) Oxidoreductases
4. Only free enzymes are binded by—
(A) Competitive inhibitor
(B) Non competitive inhibitor
(C) Both (A) and (B)
(D) None of these
5. Who first gave the term 'enzyme' ?
(A) Buchner (B) Sumner
(C) Kuhne (D) Louis Pasteur
6. Who first prepared the pure extract of Zymase enzyme ?
(A) Buchner (B) Kuhne
(C) Northrop (D) Emil Fischer
7. Enzymes are polymers of—
(A) Fatty acids
(B) Hexose sugar
(C) Amino acids
(D) Inorganic phosphate
8. Which of the following inactivates an enzyme by changing its shape ?
(A) Allosteric enzyme
(B) Competitive inhibitor
(C) Coenzyme
(D) All the above
9. Which of these functions at basic pH of 8 ?
(A) Pepsin (B) Trypsin
(C) Amylase (D) None of these
10. The phenomenon of change in an enzyme's shape following binding of substrate, is called—
(A) Active site
(B) Domains
(C) Induced fit
(D) Crystallography

ANSWERS

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NUTRITION

All living organisms need matter to build up the body and energy to operate the metabolic reactions that sustain life. The materials which provide these two primary requirements of life are called nutrients or food. The sum of the processes by which the living organisms obtain matter and energy is termed nutrition. All the processes involved in the taking in and utilization of food substances by which growth, repair and maintenance of activities in the body as a whole or in any of its parts are accomplished, are included in nutrition.

Evolution of Nutrition

Nutrients in the food an animal consumes provide the necessary chemicals for growth, maintenance and energy production. Overall, the nutritional requirements of an animal are inversely related to its ability to synthesize molecules essential for life : the fewer such biosynthetic abilities an animal has, the more kinds of nutrients it must obtain from its environment. Green plants and photosynthetic protists have the fewest such nutritional requirements because they can synthesize all their own complex molecules from simpler inorganic substances; they are called **Autotrophs**. Animals, fungi and bacteria that are called **heterotrophs**, cannot synthesize many of their own organic molecules and must obtain them by consuming other organisms or their products. Animals, such as rabbits, that subsist entirely on plant material are called **herbivores**. **Carnivores**, such as hawks, are animals that eat only meat. **Omnivores**, such as humans, eat both plant and animal matter.

Modes of Nutrition

Autotrophic or Holophytic Nutrition

All green plants and certain protists (*Euglena Viridis*) have evolved a mechanism to directly use the energy of sunlight for preparing organic food in their own body from simple inorganic materials. This process of making food is called photosynthesis and the organisms capable of it are termed **phototrophs**.

Some bacteria have developed a technique to capture energy released during oxidation of inorganic chemical substances and prepare organic food with its help. They are known as **chemotrophs** and the process as **Chemosynthesis**. Nitrifying bacteria, *Nitrosomonas* and *Nitrobacter* are chemotrophs.

Since, both phototrophs and chemotrophs do not take organic molecules produced by other organisms, they are called autotrophs. Their modes of feeding are together referred to as autotrophic nutrition. Since, it is characteristic of plants, it is also called holophytic nutrition.

Heterotrophic Nutrition

Animals, fungi, some protists (*Amoeba*) and many bacteria cannot utilize sun energy. They use chemical bond-energy of organic molecules synthesized by other

organisms in building their own organic molecules. Such a mode of feeding is termed heterotrophic nutrition and the organisms having it are called **heterotrophs**.

Heterotrophic Nutrition of three following types :

1. Saprotrophic Nutrition—Many organisms absorb fluid food through the body surface. This is called saprotrophic nutrition. Bacteria and fungi flourish on dead, decaying organic matter of both plant and animal origin. They secrete digestive enzymes onto this matter. The enzymes hydrolyze the organic matter into simple soluble products that are then absorbed. This method of taking up organic food is known as saprophytic nutrition. Some parasitic protists, such as *Trypanosoma* and a few invertebrates, such as tapeworms, live in a medium that contains simple organic compounds ready for absorption and straightway absorb them. This mode of taking up organic compounds is termed **saprozoic nutrition**.

2. Holotrophic Nutrition—Majority of invertebrates and all vertebrates take plant, animals or their products through the mouth and break up the large organic molecules into smaller ones in their own body with the help of digestive enzymes. The simple molecules are then absorbed into the cells and utilized. This mode of taking organic food is called **holotrophic nutrition**. Since, it is characteristic of animals, it is also called **holozoic nutrition**. The animals may take plants, or other animals, or both as food and are respectively called **herbivores** (rabbit, cow), **carnivores** (lion, tiger) and **omnivores** (sparrow, man).

3. Mixotrophic Nutrition—*Euglena* carries an autotrophic and saprotrophic nutrition at the same time. This is called mixotrophic nutrition.

The Metabolic fates of nutrients in Heterotrophs :

The nutrients ingested by a heterotroph can be divided into **macronutrients** and **micronutrients**. Macronutrients are needed in large quantities and include the carbohydrates, lipids and proteins. The **micronutrients** are needed in small quantities and include organic vitamins and inorganic minerals. Together, these nutrients make up the animal's dietary requirements. Besides these nutrients, animals require water.

Calories and Energy—The energy value of food is measured in terms of calories. A calorie is the amount of energy required to raise the temperature of 1 g of water 1°C. A calorie, with small 'c', is also called a gram calorie. A kilocalorie, also known as a **calorie** or kilogram calorie (k cal), is equal to 1000 calories [kilojoules (kJ = 4.1855 × k cal)].

A food's calorie content is determined by burning it in a bomb calorimeter, a chamber surrounded by water. When burning food is placed in the chamber, the energy released raises the water temperature and the energy is measured in kilocalories. Bomb calorimetry studies have

shown that 1 gram of carbohydrate yields 4.1 kilocalories, 1 gram of protein yields 4.3 kilocalories, 1 gram of fat yields 9.3 kilocalories. These values explain why a fatty diet may cause weight gain; fats supply more energy than most people can use.

The Average Caloric Values of Macronutrients

Macronutrient	Calories per gram
Carbohydrates	4.1
Lipids	9.3
Proteins	4.4

Macronutrients—With a few notable exceptions, heterotrophs require organic molecules, such as carbohydrates, lipids and proteins, in their diets. When these molecules are broken down by enzymes into their components, they can be used for energy production or as sources for the 'building blocks' of life.

The major dietary source of energy for heterotrophs is complex carbohydrates. Most carbohydrates originally come from plant sources. This dietary need can be met by various polysaccharides, disaccharides or any variety of simple sugars (monosaccharides). Carbohydrates also serve as a major carbon source for incorporation into important organic compounds. Many plants also supply cellulose, an indigestible polysaccharide, for humans and other animals (with the exception of herbivores). Cellulose is sometimes called dietary fibre.

Neutral lipids (fats) or triacylglycerols are contained in fats and oils, meat and dairy products, nuts and avocados. Lipids are the most concentrated source of food energy. They produce twice the energy available from an equal mass of carbohydrate or protein. Most heterotrophs have an absolute dietary requirement for lipids, sometimes for specific types. For example, unsaturated fatty acids (e.g., linoleic acid, linolenic acid and arachidonic acid) are required by a variety of animals. Their most obvious function is to act as precursor molecules for the synthesis of sterols, the most common of which is cholesterol. The sterols are required for the synthesis of steroid hormones and incorporated into cell membranes. Other lipids insulate the body of some vertebrates and help maintain a constant temperature.

The animal sources of protein include, for example, eggs, meat of animals and milk. The plant sources include, for example, beans, peas, and nuts. Proteins are needed for their amino acids, which heterotrophs use to build their own body proteins.

Micronutrients—Micronutrients are usually small ions, organic vitamins, inorganic minerals and molecules that are used over and over for enzymatic reactions or as parts of certain proteins (e.g., copper in haemocyanin and iron in haemoglobin). Even though they are needed in small amounts, animals cannot synthesize them rapidly, thus they must be obtained from the diet.

The Food

Major contents of food are carbohydrates, fats, proteins, water, mineral salts and vitamins. According to

their utility in the body, the various nutrients of food can be placed into the following three categories—

1. **Energy producers**—Oxidative combustion of these substances (mainly carbohydrates and fats) yield bioenergy required for performance of all biological activities.

2. **Body builders**—These (mainly proteins) are the major structural components of body and, hence, required for growth and repair.

3. **Metabolic regulators**—These substances (vitamins, water and mineral salts) control and regulate the internal environment of body and metabolism.

Carbohydrates

These are carbon 'hydrates' (polyhydroxy aldehydes and polyhydroxy ketones), *i.e.*, compounds of carbon, hydrogen and oxygen (1 : 2 : 1 ratio) with the ratio of hydrogen and oxygen being the same as in water (H₂O). Obviously their empirical formula is (CH₂O)_n. These occur in food as soluble sugars and insoluble starches. Chemically, these are of three main categories, *viz.*, monosaccharides, oligosaccharides and polysaccharides.

Monosaccharides—These are simplest, colourless, soluble and sweet carbohydrates. Their molecules may have three to seven carbon atoms. Monosaccharides having five or six (pentoses or hexoses) carbon atoms in their **glucose, fructose, galactose** and **mannose**. Glucose is the most common and most important hexose sugar. Animals mainly use it for energy production (main fuel substance). Of the pentose sugars, most important are ribose and deoxyribose, because these participate in the composition of DNA and RNA.

Oligosaccharides and Disaccharides—When two molecules of the same or different monosaccharides link by a '**glycosidic bond**', a disaccharide molecule is formed. Disaccharides are also sweet and soluble sugars. These are **maltose** (malt sugar) and **sucrose** (cane sugar) of plants and **lactose** (milk sugar) of animals. Maltose is formed from glucose monomers (α , 1-4 linkage), sucrose from combination of glucose and fructose (α , 1-2 linkage) and lactose from combination of glucose and galactose (β , 1-4 linkage). Amount of lactose is highest in the milk of human mothers. Linkages of a few (upto 10) monosaccharides are generally called oligosaccharides.

Polysaccharides—When several (more than 10) monosaccharide molecules link by glycosidic bonds, insoluble carbohydrate molecules, called polysaccharides are formed. These are the polymers (C₆H₁₀O₅)_n of monosaccharide units or monomers. **Starch** and **inulin** are common polysaccharides found in plants but cellulose of their cell wall is the most abundant structural polysaccharide of nature.

Glycogen is the common polysaccharide found in animals.

Chitin of arthropod exoskeleton is **nitrogenous polysaccharide**.

Uses of Carbohydrates—The carbohydrate of the food eaten, after being processed in the alimentary canal

and liver, are supplied to the tissues as glucose, often called **blood sugar**. The carbohydrates serve a variety of functions.

1. **As fuel**—Carbohydrates form the major fuel in the cells to provide energy for life processes. One gram of carbohydrates on complete combustion in a bomb calorimeter yields 4.1 kilocalories of energy. This is called caloric value of carbohydrates. One gram of food carbohydrate on oxidation in the cells produces 4 k cal of energy. This is known as the **physiological fuel value** of carbohydrates. Carbohydrate form a better fuel than proteins and fats because their molecules have relatively more oxygen and, therefore, need less molecular oxygen for oxidation than those of proteins and fats.

2. **Reserve food materials**—Carbohydrates form storage products. If in excess, glucose is converted into glycogen and stored in the liver and muscle cells. This conversion is called **glycogenesis**. It may be changed into fat and stored in liver, adipose tissue and mesenteries. This change is termed **lipogenesis**. In case the food provides inadequate glucose, reserve glycogen is converted into glucose for energy production work. This conversion is known as glycogenolysis.

3. **Components of cellular compounds and organelles**—Pentose sugar ribose is a component of ribonucleic acids (RNA) energy carriers, such as adenosine triphosphate (ATP) and certain coenzymes, such as **Nicotinamide Adenine Dinucleotide (NAD)**. Another pentose sugar deoxyribose is a component of deoxyribonucleic acid (DNA). The RNA and DNA are in turn components of ribosomes and chromosomes respectively.

4. **Formation of Amino Acids**—Amino acids may be formed from intermediates of carbohydrate metabolism.

5. **Heteropolysaccharides**—These consist of modified monosaccharide units. They form the following important substances :

Anticoagulant heparin; blood group substances, such as A, B and Rh antigens of erythrocytes. Lubricant hyaluronic acid present in the synovial fluid of the joints, cerebrospinal fluid and vitreous humor.

Protective coats, such as glycocalyx, that covers the intestinal epithelium and mucus which covers all mucous membranes.

Luteinizing hormone that causes ovulation, formation of corpus luteum and secretion of female sex hormone.

Cells can absorb only monosaccharides from tissue fluid. Therefore, all disaccharides and polysaccharides of food are broken down into their monomers in the gut before being absorbed in blood. This is their digestion. Since their synthesis is a condensation (= dehydration) process, their digestion is '**hydrolysis process**'.

Lipids

Three categories of lipids occur in animal food, *i.e.*, simple, compound and derived.

Simple lipids—These are neutral or true fats and compounds of carbon, hydrogen and oxygen but the ratio of H₂ and O₂ is never 2 : 1 unlike water. A molecule of fat

is formed by linking a molecule of **glycerol** with three molecules of **fatty acids** (aliphatic carboxylic acids) by an **ester-bond**. These fats are, therefore, also called **triglycerides**. This linkage is also a dehydration-condensation reaction, yielding three molecules of water. Ghee, oils, lard, butter etc. are common neutral fats. Waxes (such as beeswax) are also simple lipids. Most animal fats are saturated and hence, solidify at low temperatures. Most vegetable oils are unsaturated and, hence remain fluid. Oxidative breakdown of fats yields more than double the amount of energy yielded by glucose, because of their poor oxygen contents. These can be stored in an almost pure unhydrated form in large amounts in lesser space. Hence, fats serve as the best storage of spare energy in the form of 'reserve stored food'. These are stored in adipose tissues, which also serve for heat insulation.

Compound or Conjugated lipids—These lipids contain traces of nitrogen, phosphoric acid, or carbohydrates. Phosphoric acid containing **phospholipids** are components of membrane system of cells. Of these **lecithin** and **cephalin** are commonly found in liver, nervous tissue, yolk and muscles. Carbohydrate containing lipids called **glycolipids**, occur in cell-membranes of brain cells.

Derived fats—These are formed when neutral and conjugated fats are hydrolysed. Hence, these are fat-like alcohols, usually called **lipoids** or **steroids**. The most common steroids are **sterols**. Cholesterol is the main sterol found in blood plasma and cell membranes. Bile acids, sex hormones, vitamin D, ergosterol, hormones of adrenal cortex are examples of sterols.

Uses of fats—Fats serve a variety of functions :

1. Like carbohydrates, fats are also used as 'fuel substances'. Their caloric value is 9.4 k cal and physiological fuel value is 9 k cal.
2. There are important food—reserves and produce more energy on oxidation than glycogen.
3. Fat deposited in layers provides thermo-insulation and protection against pressure.
4. Conjugated lipids are components of membrane systems of cells, connective tissues and myelin of nerve fibres.

Man can synthesize most of the fatty acids in his body from the food taken. A few fatty acids are not synthesized in body and must be present in the diet. These are called **essential fatty acids**. They include **linoleic**, **linolenic** and **arachidonic acids**. They are present in unsaturated vegetable oils, such as groundnut oil, sunflower oil etc.

Proteins

Proteins account for about 14% part of living and 75% part of dead and dried animal body. These are the major components of the body and are more important for **anabolism** (architecture, growth and repair of body), than for **katabolism** (energy production).

There are compounds of C, H₂ and O₂ but in addition, these essentially contain about 16% nitrogen and may also contain traces of sulphur, phosphorus, iodine, iron etc.

Protein is polymer of very large or enormous molecular mass, composed of one or more polypeptide chains and whose monomers are amino acids, joined together (in condensation reactions) by peptide bonds. In addition, some have covalent 'sulphur bonds' formed by oxidation between two cysteine radicals in the polypeptide. Biological polypeptides are often several hundred amino acids long, so few of the possible polypeptides actually occur in organisms. Linking by peptide (= amide), amino acid molecules form dipeptide, tripeptide, oligopeptide and polypeptides. The latter then link with each other, forming first the peptones, then proteoses. Various proteins of biological system can be classified into three categories.

1. Simple proteins—These contain only amino acid monomers.

Globular proteins—In the molecules of these proteins, the polypeptide chains are folded into compact globular or spherical shapes. Hence, the length to breadth ratio of molecules is usually 1 : 3 or 4 (never more than 1 : 10). That is why, these proteins are noncontractile and soluble in aqueous systems, forming colloidal solutions and easily diffusible. All enzymes, many hormones (insulin, thyroxine, ACTH), the antibodies, albumins and globulins of blood plasma, globin of haemoglobin, myoglobin of muscles, histones of nucleoproteins, glutelins of cereals, prolamines of pulses are examples of globular proteins.

Fibrous proteins—In the molecules of these proteins the length to breadth ratio is always more than 1 : 10. Hence, these are insoluble structural proteins that make the body architecture. The collagen, elastin and reticulin of connective tissues, tendons, ligaments, cartilage and bones; the keratin of skin, horns, nails, feathers, hairs; the fibroin of silk; the actin and myosin of muscles, fibrinogen of blood plasma, tubulin of microtubules are examples of fibrous proteins. Collagen is the most abundant protein of the body.

2. Conjugated proteins—These are compounds of simple proteins conjugated with prosthetic groups.

Phosphoproteins—Compounds of simple proteins and phosphoric acid. Casein of milk and vitellin of egg-yolk are examples.

Nucleoproteins—These form chromatin of chromosomes in nuclei of cells.

Glycoproteins or Mucoproteins and Proteoglycans—Their example is the mucin found in connective tissues, cartilage, saliva etc.

Chromoproteins—Common examples are haemoglobin and haemocyanin of blood and cytochromes of mitochondria.

3. Derived proteins—Common examples are proteoses and peptones. These are smaller polypeptide chains formed as temporary by-products during protein digestion.

Proteins cannot, as such diffuse through cell membrane, only amino acids can diffuse. Of the twenty amino acids used by humans, only ten are obtained from food. The other ten are synthesized in the body cells themselves. Those obtained from food are called 'essential amino acids'. Food whose proteins yield all

essential amino acids on digestion is called **complete food**. Food proteins having all amino acids required for synthesis of all structural proteins are referred to as **adequate proteins**. Contrary to this, food proteins whose amino acid monomers can be used only for deamination and energy production are called **inadequate proteins**.

Water

Human body contains about 65% water. About 70% of this water is in the protoplasm and rest in the plasma of blood and lymph, tissue fluid of the intercellular spaces etc. Water does not yield energy but it is highly vital for the body. Water is universal solvent.

Minerals (Inorganic salts)

Minerals form about 4% of our body weight. Over a dozen elements are known to be essential as mineral salts in the diet. These include sodium (Na), potassium (K), calcium (Ca), magnesium (Mg), phosphorus (P), chlorine (Cl), copper (Cu), fluorine (F), manganese (Mn), cobalt (Co), zinc (Zn), iron (Fe), iodine (I), molybdenum (Mo) and selenium (Se). Of these, the first six are needed in relatively large amounts and are called **macrominerals**; others are required in very small amounts and are termed **microminerals**. The minerals have small molecules and do not require digestion. They are absorbed from the alimentary canal into the blood which supplies them to the tissues. Minerals must be taken as compounds, if taken as elements, they prove fatal.

Physiological Roles of the Essential Minerals (Macrominerals) Required in Large Amounts by Animals

Mineral	Major Physiological Roles
Calcium (Ca)	Component of bone and teeth, essential for normal blood clotting; needed for normal muscle, neuron and cell function.
Chlorine (Cl)	Principal negative ion in extracellular fluid; important in acid-base and fluid balance; needed to produce stomach HCl.
Magnesium (Mg)	Component of many coenzymes; needed for normal neuron and muscle function, as well as carbohydrate and protein metabolism.
Potassium (K)	Major constituent of bones, blood plasma; needed for energy metabolism.
Phosphorus (P)	Major positive ion in cells; influences muscle contraction and neuron excitability; part of DNA, RNA, ATP, energy metabolism.
Sodium (Na)	Principal positive ion in extracellular fluid; important in fluid balance; essential for conduction of action potentials, active transport.
Sulphur (S)	Protein structure; detoxification reactions and other metabolic activity.

Some Physiological Roles of Trace Minerals (Microminerals) in Animals

Mineral	Major Physiological Roles
Cobalt (Co)	Component of vitamin B ₁₂ ; essential for red blood cell production.
Copper (Cu)	Component of many enzymes, essential for melanin and hemoglobin synthesis; part of cytochromes.
Fluorine (F)	Component of bone and teeth; prevents tooth decay.
Iodine (I)	Component of thyroid hormones.
Iron (Fe)	Component of hemoglobin, myoglobin, enzymes and cytochromes.
Manganese (Mn)	Activates many enzymes; an enzyme essential for urea formation and parts of the Krebs cycle.
Molybdenum (Mo)	Constituent of some enzymes.
Selenium (Se)	Needed in fat metabolism.
Zinc (Zn)	Component of at least 70 enzymes; needed for wound healing and fertilization.

Vitamins

The vitamins are organic compounds regularly required in minute quantities in diet for normal metabolism, health and growth. Many enzymes of metabolic reactions are effective only when linked with nonprotein cofactors and the cofactors are mostly derived from vitamins. That is why, vitamins are commonly called 'growth factors'. Diseases caused by their deficiency are called 'deficiency diseases'.

The term 'Vitamin' was first used by Funk. Knowledge about vitamins was tremendously accelerated by the work of Hopkins and Funk.

Vitamins may be water soluble or fat soluble. Most water soluble vitamins, such as the B vitamins and vitamin C, are coenzymes needed in metabolism. The fat soluble vitamins have various functions.

The dietary need for vitamin C and fat soluble vitamins (A, D, E and K) tends to be limited to the vertebrates. Even in closely related groups, vitamin requirements vary. For example, among vertebrates, humans and guinea pigs require vitamin C but rabbits do not. Some birds require vitamin A; others do not.

Water-Soluble Vitamins

Vitamin	Characteristics	Functions	Sources
Thiamine (Vitamin B ₁)	Destroyed by heat and oxygen, especially in alkaline environment	Part of coenzyme needed for oxidation of carbohydrates and coenzyme needed in synthesis of ribose	Lean meats, liver, eggs, whole grain cereals, leafy green vegetables, legumes
Riboflavin (Vitamin B ₂)	Stable to heat, acids and oxidation; destroyed by alkalis and light	Part of enzymes and co-enzymes needed for oxidation of glucose and fatty acids and for cellular growth	Meats, dairy products, leafy green vegetables, whole-grain cereals
Niacin (Nicotinic acid)	Stable to heat, acids and alkalis; converted to niacinamide by cells; synthesized from tryptophan	Part of coenzymes needed for oxidation of glucose and synthesis of proteins, fats and nucleic acids	Liver, lean meats, poultry, peanuts, legumes
Vitamin B ₆	Group of three compounds; stable to heat and acids; destroyed by oxidation, alkalis and ultraviolet light	Coenzyme needed for synthesis of proteins and various amino acids, for conversion of tryptophan to niacin, for production of antibodies and for synthesis of nucleic acids	Liver, meat, fish, poultry, bananas, avocados, beans, peanuts, whole-grain cereals, egg yolk
Pantothenic acid	Destroyed by heat, acids and alkalis	Part of coenzyme needed for oxidation of carbohydrates and fats	Meats, fish, whole-grain cereals, legumes, milk, fruits, vegetables
Cyanocobalamin (Vitamin B ₁₂)	Complex, cobalt-containing compound; stable to heat; inactivated by light, strong acids and strong alkalis; absorption regulated by intrinsic factor from gastric glands; stored in liver	Part of coenzyme needed for synthesis of nucleic acids and for metabolism of carbohydrates; plays role in synthesis of myelin	Liver, meats, poultry, fish, milk, cheese, eggs
Folacin (Folic acid)	Occurs in several forms; destroyed by oxidation in acid environment or by heat in alkaline environment; stored in liver where it is converted into folinic acid	Coenzyme needed for metabolism of certain amino acids and for synthesis of DNA; promotes production of normal red blood cells	Liver, leafy green vegetables, whole-grain cereals, legumes
Biotin	Stable to heat, acids, and light destroyed by oxidation and alkalis	Coenzyme needed for metabolism of amino acids and fatty acids and for synthesis of nucleic acids	Liver, egg yolk, nuts, legumes, mushrooms
Ascorbic acid (Vitamin C)	Closely related to monosaccharides; stable in acids but destroyed by oxidation, heat, light and alkalis	Needed for production of collagen, conversion of folacin to folinic acid and metabolism of certain amino acids; promotes absorption of iron and synthesis of hormones from cholesterol	Citrus fruits, citrus juices, tomatoes, cabbage, potatoes, leafy green vegetables, fresh fruits

Fat-Soluble Vitamins

Vitamin	Characteristics	Functions	Sources
Vitamin A	Occurs in several forms; synthesized from carotenes; stored in liver, stable in heat, acids and alkalis; unstable in light	Necessary for synthesis of visual pigments, mucoproteins, and mucopolysaccharides; for normal development of bones and teeth; and for maintenance of epithelial cells	Liver, fish, whole milk, butter, eggs, leafy green vegetables and yellow and orange vegetables and fruits
Vitamin D	A group of sterols; resistant to heat, oxidation, acids and alkalis; stored in liver, skin, brain, spleen and bones	Promotes absorption of calcium and phosphorus; promotes development of teeth and bones	Produced in skin exposed to ultraviolet light; in milk, egg yolk, fish-liver oils, fortified foods
Vitamin E	A group of compounds; resistant to heat and visible light; unstable in presence of oxygen and ultraviolet light; stored in muscles and adipose tissue	An antioxidant; prevents oxidation of vitamin A and polyunsaturated fatty acids; may help maintain stability of cell membranes	Oils from cereal seeds, salad oils, margarine, shortenings, fruits, nuts and vegetables
Vitamin K	Occurs in several forms; resistant to heat but destroyed by acids, alkalis and light; stored in liver	Needed for synthesis of prothrombin; needed for blood clotting	Leafy green vegetables, egg yolk, pork liver, soy oil, tomatoes, cauliflower

Balanced Diet

Body requires carbohydrates, proteins and fats in the approximate proportions of 4 : 1 : 1. Adequate amount of water, mineral salts and vitamins are also necessary. No single food can supply all these substances. Hence, a mixed diet is needed. A diet which can provide materials for all the metabolic requirements of the body—energy, growth, replacement and physiological regulation is called a **Balanced diet**. Thus the proper quality and quantity of food is most significant basis of good health, proper growth, normal activity and vigour and longevity. It has been scientifically determined that a child of four to six years approximately requires 1500 k cal, thirteen to fifteen years child requires 2500 k cal and a youth of sixteen to eighteen years requires 3000 k cal of energy per day.

Average Indians have to obtain about 50% of their requirements of energy from carbohydrates, 35% from fats and 15% from proteins.

Nutritional Difference between Man and Rabbit

1. Man is omnivorous, while rabbit is herbivorous.
2. Gastric lipase is found in man but its presence in rabbit is doubtful.
3. In man caecum is very small having negligible function, while caecum helps in digestion of cellulose in rabbits.
4. In rabbit, the intestinal mucous membrane secretes only secretin hormone to stimulate liver and pancreas. In man both secretin and CCK are secreted by intestinal mucous membrane for stimulation of liver and pancreas.

Malnutrition

In India many people suffer from faulty or malnutrition due to unbalanced diet. Hence, these people suffer from malnutrition diseases.

Kwasiorkor—This disease is caused by continued deficiency of **proteins** in diet although energy intake may be adequate. Poor physical and mental growth of children, reduced vigour and increased sensitivity to infection are usual symptoms of this disease.

Marasmus—Liver of body stores glycogen to fulfil body's requirement of glucose for energy in between meals. This storage is recouped after every meal. If not recouped, it may last for perhaps half a day. If meal is delayed further, the body starts consuming its fat reserve and proteins. This condition is starvation. Prolonged starvation causes Marasmus. Marasmus is also a protein and energy deficiency disease.

Malnutrition also deprives persons of adequate supply of various vitamins. This leads to various deficiency diseases.

Flatus and foul odour of faeces—Flatus is accumulation of gases in gastrointestinal tract. Most gases in stomach are nitrogen and oxygen of air that we swallow with food. These are generally expelled by belching. In small intestine, only a small amount of gas is present. This includes the air passed from stomach or CO₂ formed in duodenum due to reactions between HCl of gastric juice and bicarbonates of pancreatic juice. In large intestine the colon bacteria generally ferment and putrefy the faeces. If faeces contain half digested nutrients, or even if intestinal absorption is inefficient, a large amount of CO₂, H₂, ammonia, methane, hydrogen sulphide and nitrogen gases are formed due to bacterial action, causing acute flatus.

Decarboxylation of certain unabsorbed amino acids, like tryptophan, by colon bacteria results in the formation of toxic amines like indole, skatole, mercaptans etc. The foul odour of flatus and faeces is due to the various gases of these amines.

OBJECTIVE QUESTIONS

1. a-1, 4 glycosidic bonds are broken when—
(A) Lipid is digested by lipase
(B) Protein is digested by pepsin
(C) Starch is digested by amylase
(D) None of the above
2. Conversion of glucose into glycogen in liver is called—
(A) Glycogenolysis
(B) Glycogenesis
(C) Glycolysis
(D) Gluconeogenesis
3. Vitamin D is also called—
(A) Calciferol (B) Ascorbic acid
(C) Retinol (D) Folic acid
4. Which of the following is a polysaccharide ?
(A) Glucose (B) Maltose
(C) Glycogen (D) Sucrose

5. Most important property of water for which it is needed in the body is—
 (A) It is a universal solvent
 (B) It is a liquid
 (C) Its O_2 is used in cellular metabolism
 (D) It cools the body
6. Which reserve a starving man first consumes ?
 (A) Fat (B) Protein
 (C) Glycogen (D) Vitamins
7. In hydrolysis, a small amount of energy is released as—
 (A) Kinetic energy
 (B) Potential energy
 (C) Light energy
 (D) None of the above
8. Amino acids not synthesized in body are called—
 (A) Non-essential (B) Essential
 (C) Active (D) Inactive
9. A man is said to be starving when—
 (A) Food is not meeting energy loss
 (B) Body begins storing reserve food
 (C) Stomach is not being filled by food
 (D) Diet is deficient in vitamins
10. In which part of the gut are proteins ultimately degraded to amino acids ?
 (A) Colon
 (B) Small intestine
 (C) Stomach
 (D) Caecum
11. Certain B vitamins act as—
 (A) Enzymes
 (B) Coenzymes
 (C) Hormones
 (D) None of the above
12. If a person lives exclusively on a diet of milk, eggs and bread, he is likely to suffer from—
 (A) Scurvy
 (B) Night-blindness
 (C) Rickets
 (D) Beri-beri
13. Proteins are stored in—
 (A) Blood
 (B) Liver
 (C) Muscles
 (D) None of the above
14. Digestion is accomplished by a chemical process called—
 (A) Condensation
 (B) Hydrolysis
 (C) Deamination
 (D) Transamination
15. The protein deficiency disease is known as—
 (A) Scurvy
 (B) Mycoses
 (C) Kwashiorkor
 (D) Osteomalacia
16. The anhydro-bonds of proteins are called—
 (A) Glycosidic (B) Peptide
 (C) Ester (D) Diester
17. The essential mineral for the formation of body protein is—
 (A) Sodium (B) Iron
 (C) Sulphur (D) Potassium
18. Vitamin which is destroyed on heating is—
 (A) A (B) C
 (C) D (D) K
19. Riboflavin is—
 (A) Vitamin B_1 (B) Vitamin B_2
 (C) Vitamin B_6 (D) Vitamin B_{12}
20. A vitamin which is generally excreted in human urine is—
 (A) C (B) K
 (C) D (D) A
21. Vitamins are—
 (A) Inorganic substances that cannot be synthesized by animals
 (B) Inorganic substances that can be synthesized by animals
 (C) Organic substances that can be synthesized by animals
 (D) Organic substances that cannot be synthesized by animals
22. The term vitamin was coined by—
 (A) Calvin (B) Funk
 (C) Kuhn (D) Starling
23. Person who is habitual alcoholic, is always short of vitamin ?
 (A) C (B) A
 (C) B_5 (D) D
24. Sterol are not fats but solid alcohols and included in lipids because they form—
 (A) Fats and fatty acids
 (B) Triglycerides
 (C) Cholesterol
 (D) Ester and fatty acids
25. How many odd calories are the requirement of a male hard labourer per day ?
 (A) 15000 k cal (B) 3000 k cal
 (C) 4000 k cal (D) 4500 k cal

ANSWERS

●●●

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ZOOLOGY

1. The sarcoplasmic reticulum of striated and cardiac muscle fibres—
(A) Release calcium ions
(B) Reabsorb calcium ions
(C) Conducts impulse inwards
(D) Both (A) and (B)
2. Hydra has a body cavity, called—
(A) Haemocoel
(B) Pseudocoel
(C) Coelenteron
(D) Coelom
3. Most deodorants contain which of these compounds to destroy the odoriferous bacteria of skin ?
(A) Zinc and Aluminium
(B) Zinc and Magnesium
(C) Zinc and Magphos
(D) Zinc and Copper
4. When a molecule is reduced, it always—
(A) Gains an electron
(B) Losses an electron
(C) Gains a proton
(D) Losses a proton
5. Which of the following nerve is purely motor nerve ?
(A) Abducens (B) Trigeminal
(C) Vagus (D) Facial
6. Which of the cellular organelle is related with autophagy ?
(A) Golgi complex
(B) Lysosome
(C) Rough endoplasmic reticulum
(D) Mitochondrion
7. In mammalian heart, the systemic circulation of blood is powered by—
(A) Left atrium
(B) Ventricle
(C) Both (A) and (B)
(D) None of these
8. Bone developing within a tendon of vertebrate, particularly where tendon operates over ridge of underlying bone, is called—
(A) Mentomeckelian bones
(B) Sesamoid bones
(C) Palatine bones
(D) Dentary bones
9. Vital capacity of lung is measured by—
(A) Spirometer
(B) Sphygmomanometer
(C) Stethometer
(D) Hypnometer
10. Xerophthalmia is caused due to lack of—
(A) Vitamin C (B) Vitamin D
(C) Vitamin A (D) Vitamin K
11. Which of the following only amino acid metabolized by brain ?
(A) Glutamic acid (B) Valine
(C) Leucine (D) Lysine
12. Hardening materials in bones are mainly—
(A) Carbonate and phosphate of lime
(B) Phosphates of sodium and magnesium
(C) Sulphates of calcium and magnesium
(D) All of the above
13. Lobo's disease is related with—
(A) Skin (B) Spleen
(C) Eyes (D) Liver
14. Which hormone is secreted at the time of emotional disturbances ?
(A) Thyroxine
(B) Oxytocin
(C) Vassopressin
(D) Adrenaline
15. Hensen's body is associated with—
(A) Retina of eye
(B) Organ of corti
(C) Liver
(D) Spleen
16. Closely related organisms with very different traits have experienced—
(A) Coevolution
(B) Convergent evolution
(C) Divergent evolution
(D) Parallel evolution
17. Wolffian body is known as—
(A) Pronephros
(B) Mesonephros
(C) Metanephros
(D) None of these
18. Which hormone acts on mammary gland to stimulate the release of milk ?
(A) Oxytocin (B) Glucagon
(C) Insulin (D) Progesterone
19. Boyer's bursa is associated with—
(A) Thyrohyoid membrane
(B) Tympanic membrane
(C) Endothelium
(D) None of these
20. Wharton's duct is related with—
(A) Submandibular salivary glands
(B) Mammary glands
(C) Perineal glands
(D) Gonads
21. Which of the following is found only urinary bladder ?
(A) Transitional epithelium
(B) Columnar epithelium
(C) Cuboidal epithelium
(D) Squamous epithelium
22. Gene Theory of Inheritance was given by—
(A) T. H. Morgan (B) Waldeyer
(C) Russow (D) Maegli
23. Which of the following is responsible for voluntary control of urine release ?
(A) Internal urethral sphincter
(B) External urethral sphincter
(C) Both (A) and (B)
(D) None of these
24. True coelom is not present in—
(A) Hirudinaria
(B) Earthworm
(C) Nereis
(D) All the above

25. Dapsone is the choice drug for the treatment of—
 (A) Influenza (B) Leprosy
 (C) Cancer (D) Leukemia
26. Which hormone is known as collip's hormone ?
 (A) Thyroxine
 (B) Parathormone
 (C) Aldosterone
 (D) Adrenocorticotrophic
27. Dohle's bodies are associated with—
 (A) Burns
 (B) Trauma
 (C) Neoplastic diseases
 (D) All the above
28. Scientific name of Cromagnon man is—
 (A) *Homo sapiens fossilis*
 (B) *Homo sapiens*
 (C) *Homo erectus*
 (D) *Homo habilis*
29. Chelicerate arthropods include—
 (A) Merostomata
 (B) Arachnida
 (C) Both (A) and (B)
 (D) None of these
30. Synthesis of plasma proteins takes place in—
 (A) Liver (B) Kidney
 (C) Spleen (D) Bone marrow
31. Peter Mitchell is associated with—
 (A) Chemiosmotic theory
 (B) Genetic code
 (C) Bacterial transduction
 (D) Virology
32. Function of erepsin is—
 (A) To hydrolyse all peptide bonds
 (B) To hydrolyse all carbohydrates
 (C) To hydrolyse all fats
 (D) To hydrolyse all nucleosides
33. Which enzyme is secreted by infants but not by adult humans ?
 (A) Lipase (B) Pepsinogen
 (C) Rennin (D) Renin
34. Which of the following is not excreted in the urine of normal individual ?
 (A) Urea (B) Creatine
 (C) H₂O (D) Glucose
35. Desmosomes are related with—
 (A) Cell excretion
 (B) Cell adherence
 (C) Cell division
 (D) Cytolysis
36. Which one controls the secretion of estrogen ?
 (A) HCG (B) Progesterone
 (C) LH (D) FSH
37. The rare disease progeria is related with—
 (A) Premature old age
 (B) Leukoplakia
 (C) Osteoporosis
 (D) Osteoarthritis
38. The 'thermostat' of a bird or mammal is in its—
 (A) Cerebral cortex
 (B) Spinal cord near the skull
 (C) Medulla oblongata
 (D) Hypothalamus
39. Camouflage in certain animals is associated with—
 (A) Chromomere
 (B) Chromoplast
 (C) Chromatophore
 (D) Chromosome
40. Life saving hormone is secreted by—
 (A) Pineal (B) Adrenals
 (C) Thymus (D) Thyroid
41. Which of the following secretes HCG hormone ?
 (A) Placenta
 (B) Ovary
 (C) Pituitary gland
 (D) Adrenal gland
42. Manas biosphere reserve is famous for—
 (A) Elephants (B) Lions
 (C) Rhino (D) Wild buffalo
43. Synovial fluid is found in—
 (A) Around the brain
 (B) Freely moveable joints
 (C) Intercellular spaces
 (D) Internal ear
44. The sound producing organ in singing bird is—
 (A) Larynx (B) Syrinx
 (C) Symsacrum (D) Pygostyle
45. Altmann's granule is also known as—
 (A) Mitochondria
 (B) Ribosome
 (C) Chloroplast
 (D) Endoplasmic reticulum
46. The largest corpuscle in mammalian blood are—
 (A) Basophils
 (B) Erythrocytes
 (C) Monocytes
 (D) Lymphocytes
47. Endotoxins are formed by—
 (A) Gram-negative bacteria
 (B) Gram-positive bacteria
 (C) Host cells
 (D) All the above
48. Rathke's pouch is associated with—
 (A) Thyroid gland
 (B) Pancreas
 (C) Pituitary gland
 (D) Thymus gland
49. Vertebrates with jaws are members of—
 (A) Agnatha
 (B) Gnathostomata
 (C) Cephalochordata
 (D) Urochordata
50. Which vitamin promotes wound healing ?
 (A) Vitamin B (B) Vitamin A
 (C) Vitamin D (D) Vitamin C

ANSWERS WITH HINTS

ZOOLOGY

- If thyroid gland is completely removed from a tadpole, it will—
(A) Die immediately
(B) Turn into a giant frog
(C) Turn into a dwarf frog
(D) Remain tadpole throughout its life
- 'Hashimoto' disease is caused, when—
(A) Adrenal gland is destroyed by autoimmunity
(B) Thyroid gland is destroyed by autoimmunity
(C) Kidney is destroyed
(D) Pancreas is destroyed
- In mammals which organ acts as blood-bank ?
(A) Heart (B) Lung
(C) Spleen (D) Liver
- The emergency hormone is—
(A) Thyroxine
(B) Adrenalin
(C) Insulin
(D) Progesterone
- Life-span of human R.B.C. is—
(A) 120 days (B) 90 days
(C) 2-3 days (D) 20 days
- Pharynx and middle ear are interconnected by—
(A) Tympanic canal
(B) Eustachian canal
(C) Cochlear canal
(D) Vestibular canal
- Specific cells found in liver are—
(A) Hepatic cells
(B) Beta cells
(C) Kupffer's cells
(D) Islets of Langerhans
- The following are needed for blood-clotting in mammals—
(A) Ca^{++} and Vitamin E
(B) Ca^{++} and Vitamin K
(C) Ca^{++} and Vitamin A
(D) K^+ and Vitamin K
- All arteries carry oxygenated blood, except—
(A) Hepatic artery
(B) Renal artery
(C) Pulmonary artery
(D) Cardiac artery
- In a sperm, the mitochondria occur—
(A) In tail
(B) In acrosome
(C) In middle piece
(D) In head
- Insulin is secreted by—
(A) Beta cells of Islets of Langerhans
(B) Alfa cells of Islets of Langerhans
(C) Kupffer cells
(D) Gall bladder
- In man removal of Parathyroid gland leads to—
(A) Acromegaly
(B) Tetany
(C) Polyuria
(D) Diabetes insipidus
- Atherosclerosis refers to the ailment of—
(A) Lungs (B) Heart
(C) Kidney (D) Liver
- In absence of ADH, the disease caused is—
(A) Diabetes mellitus
(B) Diabetes insipidus
(C) Oliguria
(D) Acromegaly
- Maximum power of division is found in the skin layer—
(A) Stratum granulosum
(B) Stratum malpighii
(C) Stratum spinosum
(D) Stratum corneum
- Only rods are present in the eyes of one of the following animals—
(A) Pigeon (B) Squirrel
(C) Fowl (D) Owl
- Haversian canals are found in the—
(A) Bones of birds
(B) Bones of mammals
(C) Bones of frog
(D) Cartilage
- Ligaments join—
(A) Muscle to muscle
(B) Muscle to bone
(C) Bone to bone
(D) Cartilage to bone
- From outer to inside the sequence of three bones present in the middle ear of mammals is—
(A) Incus, Malleus and Stapes
(B) Malleus, Incus and Stapes
(C) Malleus, Stapes and Incus
(D) Stapes, Malleus and Incus
- The main cause of paralysis is—
(A) Some defect in muscles
(B) Complete destruction of sensory nerves
(C) Complete destruction of motor nerves
(D) None of the above
- In human females at the time of birth there are two million ova; how many of them normally reach maturity in the course of normal reproductive life ?
(A) 500 (B) 1,000
(C) 2,000 (D) 5,000
- Orchidectomy is the surgical removal of—
(A) Liver (B) Kidney
(C) Ovary (D) Testes
- In mammals the estrogens are secreted by the Graafian follicle from its—
(A) External theca
(B) Internal theca
(C) Zona pellucida
(D) Corona radiata
- One hundred per cent literate state in India is—
(A) Goa (B) Punjab
(C) Rajasthan (D) Kerala
- If a curly haired man marries a straight haired woman, they have 8 children, what will be the proportion of curly hair and straight hair in them ?
(A) 1 : 6 (B) 3 : 5
(C) 5 : 3 (D) 3 : 1

26. Ratio of females to males in India is—
(A) 880–1000 (B) 830–1000
(C) 929–1000 (D) 980–1000
27. First census took place in India during—
(A) 1851 (B) 1891
(C) 1921 (D) 1951
28. The formula for the calculation of population density is $D = \frac{n/a}{t}$, in this formula 'a' represents—
(A) Whole world population
(B) Unit of time
(C) Population density
(D) Area of the land
29. If somatic cells of a human male contain single barrbody, the genetic composition of the person would be—
(A) XYY (B) XXY
(C) XO (D) XXXY
30. In which one of the following the birth rate is high and death rate is normal ?
(A) India and Morocco
(B) America and Spain
(C) Sweden
(D) Indonesia
31. To which population category India belongs ?
(A) High birth rate and high mortality rate
(B) Low birth rate and low mortality rate
(C) Low birth rate and high mortality rate
(D) High birth rate and low mortality rate
32. During ageing, collagen present in intercellular spaces becomes—
(A) Destroyed
(B) Impermeable and rigid
(C) More elastic
(D) All the above
33. If mother has blood group B, father has A group the offspring will be of—
(A) A group
(B) O group
(C) Any of the group
(D) AB group
34. Erythroblastosis foetalis occurs when—
(A) Husband is Rh⁻ and wife Rh⁻
(B) Wife is Rh⁺ and husband Rh⁻
(C) Wife is Rh⁺ and husband Rh⁺
(D) Wife is Rh⁻ and husband Rh⁺
35. The theory of ageing holds that ageing is due to—
(A) Random mutation in DNA of somatic cells
(B) Increased cross-linkage of collagen and other proteins
(C) Cumulative result of damage to tissues by free radicals
(D) All of these
36. The indigenous adult fish, which may be used most effectively for the biological control of mosquitoes is—
(A) *Aplocheilus* (B) *Gambusia*
(C) *Lebistes* (D) *Catla*
37. Lamarck's theory of organic evolution is known as—
(A) Natural selection
(B) Inheritance of acquired characters
(C) Ontogeny repeats phylogeny
(D) Artificial selection
38. Which one of the following sets of animals shows a close taxonomic relationship ?
(A) *Jelly fish*, *Cuttle fish*, *Cat fish*
(B) *Honey bee*, *Crayfish*, *Spider*
(C) *Alligator*, *Nautilus*, *Turtle*
(D) *Kangaroo*, *Octopus*, *Salamander*
39. To which of the following Phylum class Trematoda belongs ?
(A) Platyhelminthes
(B) Arthropoda
(C) Mollusca
(D) Annelida
40. Diapsid skull is found in the following—
(A) Crocodile, Turtle and Seymouria
(B) Sphenodon, Crocodile and Viper
(C) Natrix, Draco and Turtle
(D) Calotes, Cobra and Varanosauros
41. It is believed that the organisms first inhabited earth's surface were—
(A) Autotrophs
(B) Mixotrophs
(C) Chromatotrophs
(D) Heterotrophs
42. Which one of the following combination is generally recommended for composite fish farming in India ?
(A) *Catla*, *Cyprinus*, *Clarias*
(B) *Catla*, *Labeo*, *Cirrhinus*
(C) *Cirrhinus*, *Cyprinus*, *Channa*
(D) *Clarias*, *Chanos*, *Cyprinus*
43. Which of the following belongs to Phylum Arthropoda ?
(A) Star fish (B) Gold fish
(C) Silver fish (D) Cuttle fish
44. T-Lymphocytes originates from—
(A) Thymus (B) Bone marrow
(C) Liver (D) None of these
45. Sea cows are aquatic mammals included under—
(A) Lagomorpha (B) Pinnipedia
(C) Cetacea (D) Sirenia
46. The malarial parasite is introduced into the blood of man as a—
(A) Metacryptozoite
(B) Cryptozoite
(C) Schizont
(D) Sporozoite
47. The modification of second pair of wings into halteres or balancers is the characteristic of—
(A) Lepidoptera (B) Orthoptera
(C) Diptera (D) Hemiptera
48. Which of the following insects is vector for Bubonic plague ?
(A) *Xenopsylla*
(B) *Cimex*
(C) *Pediculus*
(D) *Phlebotomus*
49. Mode of nutrition in amoeba is—
(A) Saprozoic (B) Holophytic
(C) Coprozoic (D) Holozoic
50. In which one of the following groups all animals are hermaphrodite ?
(A) *Hydra*, *Ascaris*, *Pheretima*
(B) *Hydra*, *Homo sapiens*, *Leech*
(C) *Tapeworm*, *Toad*, *Starfish*
(D) *Hydra*, *Leech*, *Tapeworm*

ANSWERS WITH HINTS

SECONDARY GROWTH IN THICKNESS

—Kumar Pushkar

The continuous division in the apical meristems result in the formation of primary body. During this development fundamental parts of the plant body are formed and growth in length and to some extent in thickness take place. Such a primary growth is completed in a few weeks of the first year of growth of the plant.

In **Pteridophytes** and **monocotyledons** the primary structure remains as such through out the life of plants. It is structurally and functionally self sufficient. However in **gymnosperms** and **dicotyledons**, new tissues are formed entirely due to the activities of lateral meristems, *i.e.*, vascular cambium and phellogen or cork cambium. These tissues are known as secondary tissues which cause increase in the thickness of the plant body. This addition of secondary tissues is known as **secondary growth** (*i.e.*, secondary xylem and secondary phloem) and the periderm derived from vascular cambium and the cork cambium respectively.

Secondary growth continues for an indefinite period through numerous growing seasons. Hence, the diameter of main trunk, branches and the roots continue to increase throughout the life of a plant.

Secondary Growth in Dicot Root

- In dicot roots the arrangement of vascular bundles is radial and xylem is exarch. First of all parenchymatous cells below (towards pith) the phloem become meristematic, thus in a tetrach root four separate strips of cambia are formed. Later these strips become, continuous laterally as a result of tangential divisions of pericycle cells external to each protoxylem. Thus a continuous cambium ring is produced.

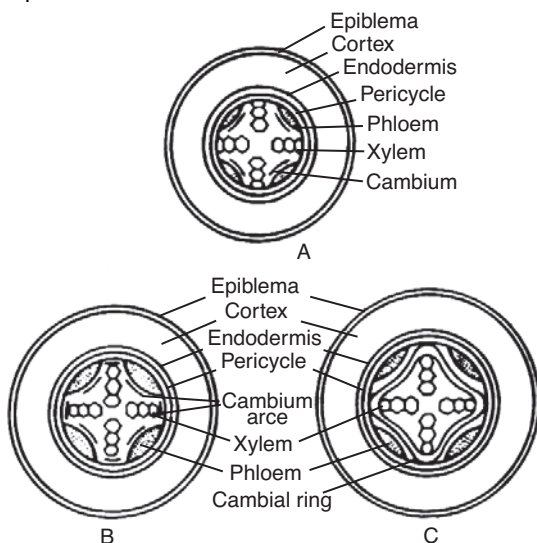


Fig. : Secondary growth in dicot root :
(A) Radial vascular bundles in root showing cambial groups just below the phloem
(B) Figure showing origin of cambial rings
(C) Formation of complete cambium ring

- This ring is present below the phloem, but above the protoxylem. This meristem is secondary meristem. First the strips of cambia below the phloem cut off secondary xylem towards the inner side. The cells cut off towards the outer face mature into secondary phloem. By this activity of these strips of cambium, the cambium become circular and cuts off secondary xylem internally at all places and secondary phloem at all places externally.
- Here and there some cambial cells, internally as well as externally cut off parenchymatous cells forming multiseriate medullary rays. These medullary rays are well developed as compared to stem.
- **Annual rings**—In perennial trees, shrubs and woody climbers the formation of secondary xylem and phloem continues year after year. In such cases the xylem elements differentiated in spring season are large and thin walled as compared to those differentiated in autumn.
- One spring wood and one autumn wood constitute one annual ring. Thus concentric annual rings are seen in a transverse section of root. The annual rings are poorly developed in roots due to uniform underground environment.
- **Cork cambium** arises as a result of the tangential division of the outer cells of pericycle. The cork cam-

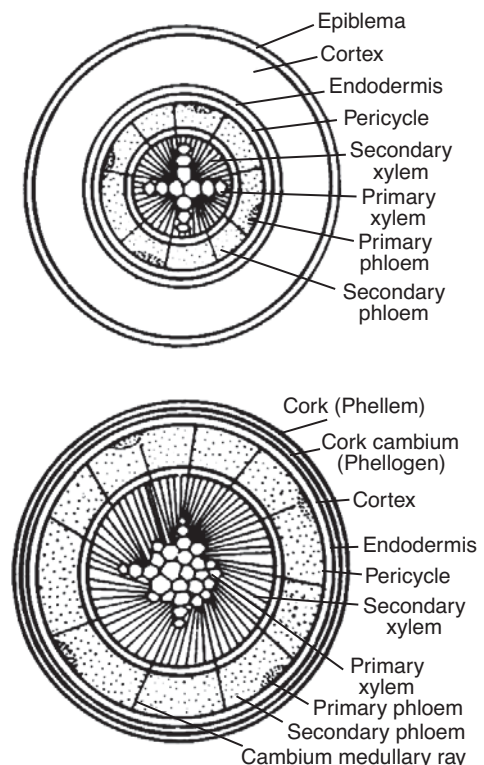


Fig. : Cambial ring producing secondary vascular tissue
Mature root showing secondary vascular tissue and periderms

bium instead of producing xylem and phloem produces cork cells on the outside and parenchyma on the innerside.

- The protoplast of cork cells secretes a fat like substance called **suberin** which is deposited in the walls. Due to further deposition of **suberin** these cells die.
- In some roots the cork cambium arises from **cortex**.

Secondary Growth in Dicot Stem

- The dicot stem have conjoint, collateral, open, vascular bundles the cambium is present in between xylem and phloem. It is called **fascicular** or **intrafascicular cambium**. Along with this cambium, some medullary ray cells also become active forming **interfascicular cambium**. **Interfascicular** and **intrafascicular** cambia together form a ring of cambium called **cambium ring**.

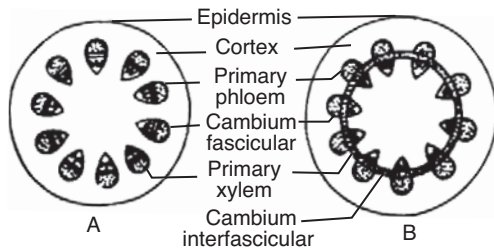


Fig. : Secondary growth in dicot stem :

- (A) Primary structure showing fascicular cambium
(B) Formation of cambial ring

(A) Formation of Secondary Tissues by Stellar Cambium

- Cambial cells are of two types **fusiform initials** and **ray initials**. Fusiform initials are elongated longitudinally, have wedge shaped ends and are wider tangentially than radially so that they appear rectangular in cross section.
- They form elements such as tracheids, vessels, fibres, sieve tubes, *i.e.*, vascular elements.
- **Ray initials** are much shorter than fusiform initials and appear as 'islands' of small cell when the cambium is viewed tangentially.

They give rise to parenchyma cells, all or most of which elongate in the horizontal direction forming vascular rays.

Consider and Understand

- In *Tamus* and *Cynodon asphodelus* monocot vascular bundles are arranged in an irregular rings. In such arrangement they resemble that of a dicot stem.
- Certain dicots show no normal peripheral rings of bundles. All bundles are scattered irregularly *e.g.*, *Anemone*, *Thalictrum Podophyllum*.
- Cortical vascular bundles are seen in *Casuarina*, *Centura*, *Lepidium* and *Nyctanthus*. In most of the cases the bundles are normally oriented but in *Nyctanthus* they are inversely oriented.
- Cambium cells continuously divide to form phloem on the outside (*i.e.*, secondary phloem) and xylem towards the inner side (*i.e.*, secondary xylem).

- Normally more secondary xylem cells are formed towards the centre due to which the cambium ring moves towards the periphery.

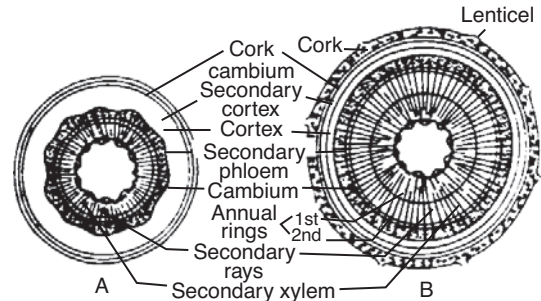


Fig. : Secondary growth in dicot stem (A-B) Stem showing formation of secondary xylem and secondary phloem

- Due to newly formed secondary xylem and secondary phloem the primary xylem and primary phloem which were near to one another earlier, get separated far apart.
- **Secondary phloem** is made up of sieve tubes, companion cells, phloem parenchyma and sometimes bast fibres. Primary phloem gets crushed.
- **Secondary xylem**, is made up of scalariform and pitted vessels, tracheids, and sclerenchymatous fibres (wood fibres) along with xylem parenchyma.
- With the formation of secondary xylem primary xylem is pushed towards pith.

Worth to Remember

- *Yucca*, *Draeaena*, *Aloe*, *Agave* etc. are monocot yet they show secondary growth due to presence of cambium.
- Medullary vascular bundles are found in the scars of *Boerhaavia*, *Mirabilis*, *Amaranthus* etc.
- Bark is a non-technical term and includes all tissues lying outside the vascular cambium.
- In some monocot *e.g.*, *Musa* rhizome and palms the thickening takes place by formation of primary thickening meristem, it contributes both to height and thickening.

- At some place the cambium does not form secondary xylem and secondary phloem but parenchymatous cells instead of xylem and phloem. Thus these cells form continuous strips from secondary xylem to secondary phloem and are called **secondary medullary rays**.

Annual Rings or Growth Rings

- The activity of cambium ring is markedly affected by variations in climate *e.g.*, in temperate regions where changes in climate in different seasons of the year are pronounced the xylem cells produced in spring season are with wider lumens.
- The secondary xylem formed during this period of pronounced activity is called **spring wood**.
- During autumn season the vessels produced are generally of smaller size and have narrow lumens. The secondary wood formed during this season is called **autumn wood**.
- One **spring wood** circle and one **autumn wood** circle constitute an annual ring.

- The number of annual rings in the oldest part of the tree corresponds to its age.

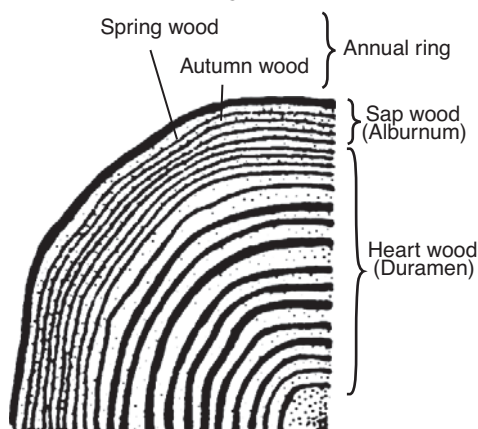


Fig. : Stem showing annual rings

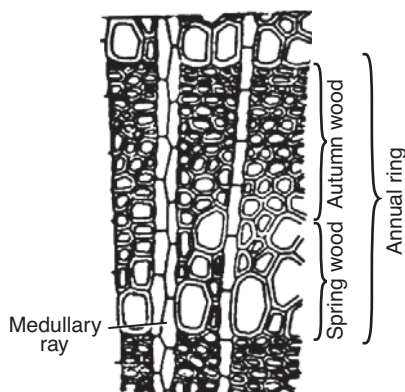


Fig. : A part of wood enlarged to show annual rings

(B) Formation of Secondary Tissues by Extrastelar Cambium

- In many woody plants further increase in girth takes place by formation of new tissue in extrastelar regions. These new tissues are called **periderm**. Periderm is made up of three tissue.

Overriding Facts

- Sap wood represent the outer and younger wood of the plant body.
- Heart wood represents the central and old secondary wood of the plant body.
- Autumn wood can be distinguished from spring wood by **narrow vessel** and **tracheids**.
- **Periderm** is made up of phellogen, phellem and phelloderm.

(a) **Phellogen**—It is secondary lateral meristem that may arise from permanent living cells of hypodermis or outer cortex. It is composed of a single layer of meristematic cells. In Transverse section its cells appear almost rectangular and radially flattened. These cells divide in a tangential plane cutting cells towards its inner as well as outer face.

(b) **Phellem or cork**—These cells are formed as a result of tangential and periclinal divisions of phellogen cells towards the outer face. These cells are compactly

arranged and have thin cellulose walls in the beginning.

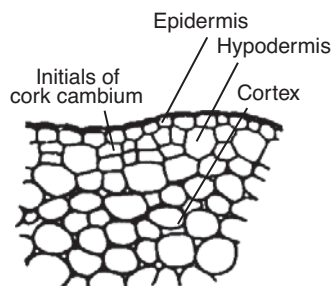


Fig. : Origin of cork cambium from hypodermis

- As they mature there is a gradual loss of living matter and cells get elongated radially, vertically or tangentially. The cell walls become thick because of development of fatty substance called **suberin**. Suberin is impervious to water.
- In *Quercus ruber* suberin yields bottle cork, the cavities of cork cells are filled with air which makes the cork light in weight.

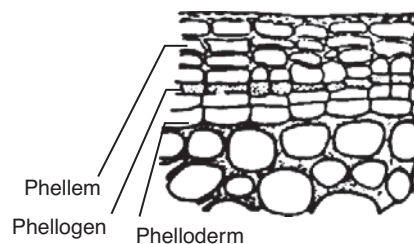


Fig. : Activity of cork cambium showing formation of Phellem and Phelloderm

(c) **Phelloderm**—Layers of thin walled cells cut off towards the inner side of the phellogen form phelloderm. The cells of this layer are living and possess cellulose cell wall. It is also called secondary cortex. In some species these cells may contain **chloroplasts** and **starch**.

- All tissues outside the vascular cambium constitute the **bark**. It includes periderm, primary cortex, pericycle, primary and secondary phloem.
- In case the layers of periderm of cork form complete cylinders the bark thus developed is called **ring bark** e.g., *Vitis* and *Clematis*.
- **Lenticel** is a small portion of periderm where the activity of phellogen is more than elsewhere and

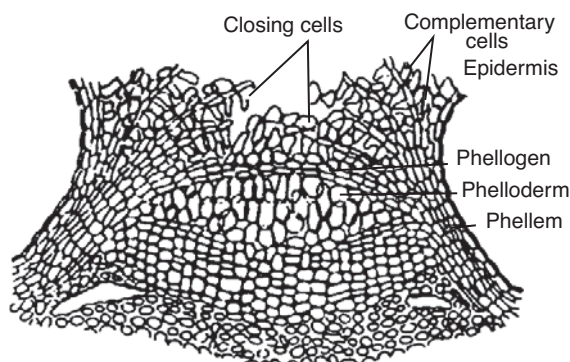


Fig. : A mature lenticels

produce loosely arranged, thin walled cells with numerous intercellular spaces, instead of thick walled suberized cork cells. These cells are called **complementary cells**.

- **Lenticels** serves for exchange of gases between the plant and atmosphere and also for loss of water vapour.

OBJECTIVE QUESTIONS

- Plants with little or no secondary growth are—
(A) Dicot (B) Herbaceous
(C) Deciduous (D) Evergreens
- The narrow band of meristematic tissue between the xylem and phloem is the—
(A) Pith meristem
(B) Cortex meristem
(C) Cork cambium
(D) Vascular cambium
- Wood is common name of—
(A) Cambium
(B) Vascular bundles
(C) Phloem
(D) Secondary xylem
- Growth rings are generally well marked in trees growing in—
(A) Nainital (B) Mumbai
(C) Chennai (D) New Delhi
- Derivatives of vascular cambium give rise to—
(A) Only xylem
(B) Only phloem
(C) Xylem and phloem
(D) Xylem, phloem and vascular rays
- Cork cambium in a dicot root is derived from—
(A) Hypodermis (B) Epidermis
(C) Pericycle (D) Cortex
- Intrafascicular cambium is situated—
(A) In between vascular bundles
(B) Inside vascular bundles
(C) Outside the vascular bundle
(D) In pith
- Secondary phloem is nearer to—
(A) Secondary xylem
(B) Cambium
(C) Cortex
(D) Pith
- Cambium causes growth in—
(A) Girth (B) Periphery
(C) Leaves (D) Length
- Age of plant can be calculated by—
(A) Measuring its height
(B) Counting lateral branches
(C) Counting annual rings
(D) All of these
- Which one of the tissue is present in periderm ?
(A) Xylem (B) Bast
(C) Phellum (D) Duramen
- Functional xylem in dicot stem is—
(A) Spring wood
(B) Autumn wood
(C) Heart wood
(D) Sap wood

(Continued on Page 1296)

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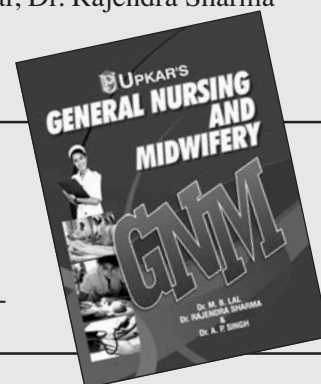
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MINERAL REQUIREMENTS OF PLANT

ABSTRACT

E. Epstein (1972) once opined that plant nutrition is of unique importance in the realm of life on earth and in the affairs of man. The nutritional needs of plants are often discussed under two headings : organic nutrition and inorganic nutrition. Among them inorganic nutrition is very much bound up with our interest in agriculture and crop improvement. In the field of plant nutrition some pioneering works was done by **N. T. de Saussure** (1767–1845). Till date, a total of 17 elements have been identified which have some specific nutritive roles on plants.

Living organisms require a supply of large number of substances from outside. This supply is called **nutrition**. The substances may be of inorganic or organic in nature. Inorganic plant requirements are obtained directly or indirectly from soil. As the sources of these inorganic requirements are minerals, the elements are known as **mineral nutrients** and the nutrition is called **mineral nutrition**. Nutrient elements that are required for the growth and development of plants are known as **essential elements**.

Criteria of Essentiality of Elements

About 30 elements can be detected by modern analytical techniques (either atomic absorption spectrometry or atomic emission spectrometry) in plants and as many as 60 have been reported in one or another tissue. Not all elements present in plant tissues are required for plant growth. Even though the mechanism of absorptions of molecules and ions by plant cells are selective and plant cells can accumulate some and exclude other, the discrimination process is not perfect.

In 1939, **Arnon** and **Stout** suggested the following criteria for demonstration of essentiality of elements—

(i) A deficiency of the element makes it impossible for the plant to complete the vegetative or reproductive stage of its life cycle.

(ii) Such deficiency is specific to the element and can be prevented or corrected only by supplying this element.

(iii) The element is directly involved in the nutrition of plants quite apart from its possible effects in correcting some unfavourable microbiological or chemical condition of the soil or other culture media.

Arnon and **Stout's** criteria of essentiality is quite controversial. Chlorine is listed as an essential element. But it has been shown (**Broyer et al.**, 1954) that bromine can substitute for it in some plants. Thus, we see that according to the second criterion, regarding complete specificity of an element, would mean that chlorine cannot be accepted as an essential element. In addition to satisfy **Arnon** and **Stout's** first criterion, if the element can be shown to have a role in plant metabolism, then it would appear justifiable to declare that the element is essential. Accepting this view **Wilson** and **Nicholas** (1967) established cobalt as an essential element in two species of higher plants. Another suggestion relating to the criteria of essentiality is that some elements might better be

called **functional** or **metabolic** elements rather than essential elements (**Bollard** and **Butler**, 1966). This designation indicates that an element is metabolically active; a functional or metabolic demand may or may not be essential.

Again according to **Epstein** (1972), an element is considered essential if (a) in its absence the plant is unable to complete a normal life cycle, or (b) that element is part of some essential plant constituent or metabolite. By the first criterion, if a plant is unable to produce viable seed when deprived of that element, the element is deemed essential. By the second criterion, an element such as magnesium would be considered essential because it is a constituent of the chlorophyll molecule and chlorophyll is essential for photosynthesis.

Essential Elements

At present 17 chemical elements are known to be essential for the growth of all higher plants. In the absence of each essential element, plants develop deficiency symptoms.

Essential nutrient elements of higher plants and their concentrations considered adequate for normal growth (Hopkins, 1995)

Elements	Chemical Symbol	Concentration in Dry matter (m mol/kg)
Macronutrients		
Hydrogen	H	60,000
Carbon	C	40,000
Oxygen	O	30,000
Nitrogen	N	1,000
Potassium	K	250
Calcium	Ca	125
Magnesium	Mg	80
Phosphorus	P	60
Sulphur	S	30
Micronutrients		
Chlorine	Cl	3.0
Boron	B	2.0
Iron	Fe	2.0
Manganese	Mn	1.0
Zinc	Zn	0.3
Copper	Cu	0.1
Nickel	Ni	0.05
Molybdenum	Mo	0.001

All (from the table) except carbon (available from CO₂), hydrogen (available from H₂O) and oxygen (available from O₂/CO₂) are mineral elements. Potassium, Calcium and Magnesium are present in the soil as cations (K⁺, Ca²⁺, Mg²⁺). Similarly, nitrogen, phosphorus and sulphur are normally present in soil as anions (NO₃⁻, H₂PO₄⁻, SO₄²⁻) [Under suitable conditions ammonium ions (NH₄⁺) may substitute for nitrate ions (NO₃⁻). These 9 elements (C, H, O, N, S, P, K, Ca, Mg) are called **macroelements**.

The **microelements** are chlorine, boron, iron, manganese, zinc, copper, nickel and molybdenum. Sometimes the microelements are called **minor** or **trace elements** because they are required by plants in only extremely small quantities. But these latter designations are quite unsatisfactory; there is nothing 'minor' about the essentiality of the microelements.

Physiological Role of Essential Elements

Each essential element performs a distinctive set of functions not duplicated completely by other essential elements. Generally an element is essential to the life of a higher green plant for one or more of the following four reasons—

- (1) It may perform a nutritive role by being a component of one or more of the major classes of plant constituents.
- (2) It may have a catalytic role either as an activator of an enzyme or as an integral component of an enzyme.
- (3) It may function as a non-catalytic 'metallo-biomolecule'.
- (4) It may function as a free ion.

The need of individual plants for any particular element is normally defined in terms of **critical concentration**. This is the concentration of that nutrient, measured in the tissue, just below the level which gives maximum growth (Epstein, 1972). In the absence of any essential element the plant will be expected to exhibit certain morphological and biochemical symptoms of that deficiency. In some cases the deficiency symptoms will clearly reflect the functional role of that element (Hopkins, 1995).

A summary of informations on the roles of most of the essential elements and their deficiency symptoms in higher plants is represented below :

Elements	Available Form	Roles	Deficiency Symptoms
1. Nitrogen	Nitrate ion (NO ₃ ⁻) or Ammonium ion (NH ₄ ⁺)	Constituents of amino acids, proteins, nucleotides, coenzymes, hormones (cytokinin, indole-3-acetic acid), chlorophylls.	Stunted growth, leaf fall, chlorosis (yellowing), anthocyanin formation, delayed flowering in agricultural crops.
2. Phosphorus	Phosphoric acid (H ₃ PO ₄), Primary orthophosphate (H ₂ PO ₄ ⁻) or secondary orthophosphate (HPO ₄ ²⁻)	Components of sugar phosphate, nucleic acids, coenzymes, phospholipids etc. It has key role in ATP involved reactions.	Premature leaf fall, anthocyanin formation, intense green colouration of leaves, necrotic spots and malformation of leaves; yield of fruits and seeds is markedly reduced; decrease in the rate of protein synthesis.
3. Sulphur	Sulphate (SO ₄ ²⁻)	Constituents of amino acids (cysteine, cystine, methionine), lipoic acid, coenzyme A, thiamin, biotin, etc.	Generalized chlorosis, extensive development of root system, hard woody stem.
4. Potassium	Potassium ion (K ⁺) or Potassium carbonate (K ₂ CO ₃)	Required as a cofactor for 40 or more enzymes; it has a role in stomatal movement; maintains electroneutrality in plant cells.	Stems become shortened and weakened, mottling or chlorosis of leaves; inhibition of starch and protein synthesis, carbohydrate metabolism, increase in the respiratory rate.
5. Calcium	Calcium ion (Ca ²⁺)	A constituent of the middle lamella of cell wall as calcium pectate; required as a cofactor by some enzymes involved in the hydrolysis of ATP and phospholipids; plays a role in the mitotic spindle formation.	Necrosis (dead tissue) of root and shoot tips, growth of meristematic regions inhibited.
6. Magnesium	Magnesium ion (Mg ²⁺)	A component of the chlorophyll molecules; an activator for RubisCo; required to stabilize ribosome structure; required non-specifically by large number of enzymes involved in phosphate transfer and oxidation reactions in Krebs cycle.	Leaf chlorosis in the interveinal regions, leaf tips turned up.
7. Chlorine	Chloride ion (Cl ⁻)	Required for photosynthetic reactions involved in oxygen evolutions, maintenance of electrical neutrality across membrane.	Reduced growth, wilting of leaf tips and a general chlorosis.

8. Boron	Borate (BO_3^{3-}) and $\text{B}_4\text{O}_7^{2-}$	Indirect evidence for involvement of boron in carbohydrate transport, borate forms complexes with certain carbohydrates; it has some role in the osmoregulation during the in vitro pollen germination.	Black necrosis of stem and root tips, twisted leaves, shortened internodes, inhibition of both cell division and elongation in primary and secondary roots.
9. Copper	Cupric ion (Cu^{2+})	An essential component of ascorbic acid oxidase, tyrosinase, laccase, monoamino oxidase, cytochrome oxidase, superoxide dismutase, polyphenol oxidases; component of plastocyanin.	Stunted growth, distortion of young leaves, wilting, 'dieback' disease (a loss of young leaves).
10. Iron	Ferrous ion (Fe^{2+}) or Ferric ion (Fe^{3+})	A constituent of cytochrome and enzymes like catalase peroxidase, dehydrogenase; a constituent of non-haeme iron proteins which are involved in photosynthesis, nitrogen fixation and respiration.	Chlorosis of young leaves; degeneration of chloroplast structure.
11. Manganese	Manganous ion (Mn^{2+})	Required for activities of some enzymes (dehydrogenases, decarboxylases, kinases, oxidases, peroxidases) and for photosynthetic oxygen evolution.	'Grey-speck' disease (appearance of greenish-grey, oval shaped spots on the basal portion of young leaves) of cereal; discolouration and deformities in legume seeds; reduction in photosynthesis and oxygen evolution.
12. Zinc	Zinc ion (Zn^{2+})	Essential constituents of alcohol dehydrogenase, carbonic anhydrase, glutamic dehydrogenase, lactic dehydrogenase and other enzymes.	Chlorosis, stunted leaves and internodes, distorted leaf margins; drop in auxin content in plants.
13. Nickel	Nickel ion (Ni^{2+})	Components of two enzymes urease and hydrogenase; probably involved in mobilization of nitrogen during seed germination.	Specifically not known.
14. Molybdenum	Molybdate (MoO_4^{2-})	Essential for nitrogen fixation; a constituent of nitrate reductase and dinitrogenase of fungi, bacteria and higher plants.	'Whiptail' syndrome (young leaves are twisted and deformed), necrosis, decrease in flower and seed production, seeds may fail to develop; particularly wide spread for maize, legumes and crucifers.

Beneficial Elements

In addition to the 17 essential element, some plants appear to have specific additional nutrient requirements. They are termed as **beneficial elements** instead of essential elements. In future, as the experimental methods will improve, one or more of these beneficial elements may be included under the heading of essential elements.

Sodium is an essential microelement to certain salt-marsh plant spp. (e.g., **Atriplex vesicaria**) in which CO_2 assimilation takes place by the C_4 pathway. Deficient condition shows reduced growth chlorosis and necrosis. **Cobalt** is an essential micro-element to legumes which are host to symbiotic nitrogen-fixing bacteria. **Silicon** is another microelement present in certain grass, maize and some other plants (e.g., **Equisetum arvense**) and is beneficial because it prevents fungal pathogens to infect the host and also provides mechanical support to host against heavy wind or rain. **Selenium**, although toxic to most plants, is also an essential micro-element in some plant spp. (e.g., **Astragalus**).

Several essential elements are the components of one or another of the constituents of living matter. The six major classes of constituents of living matter and their elemental compositions are listed in the table as the

evidences of the role of essential elements emphasizing carbon, hydrogen and oxygen.

Elemental composition of the six major classes of constituents of living matter

Plant Constituents	Elements present
1. Carbohydrates	Carbon, hydrogen, oxygen (nitrogen and/or phosphorus are also present in certain derivatives).
2. Amino acids	Carbon, hydrogen, oxygen, nitrogen (sulphur is also present in some amino acids).
3. Nucleotides	Carbon, hydrogen, oxygen, nitrogen and phosphorus.
4. Porphyrins	Carbon, hydrogen, oxygen, nitrogen (magnesium is present in chlorophylls and iron is present in cytochromes).
5. Lipids	Carbon, hydrogen, oxygen (phosphorus and/or sulphur are also present in some lipids).
6. Enzymes	Carbon, hydrogen, oxygen, nitrogen, phosphorus, sulphur.

(Continued on Page 1296)

FAMILY—BRASSICACEAE

Distribution

The members of family—Brassicaceae are cosmopolitan in distribution, but majority of them are abundantly distributed in north temperate regions with Mediterranean as the major centre. Some species are subarctic. As a whole this family includes about 375 genera and 3200 species. In India this family is represented by about 51 **genera** and 138 **species** chiefly in the temperate and alpine Himalayas, some in the plains of northern India and a few in the hills of south India. The important Indian species of this family are—*Brassica campestris*, *Iberis amara*, *Senebiera didyma*, *Brassica nigra* and *Brassica sativus*.

Habit

Plants of this family usually grow during winter season in India. Mostly the plants are annual, biennial, or perennial herbs, sometimes they are small shrubs. Majority of *Brassica* species are annuals, biennials and sometimes perennials. The *Raphanus* species may be annual or perennial herbs. However, the majority of plants are annuals having life cycle of only a few weeks. The biennials, *e.g.*, *Brassica rapa* (turnip) usually develop tap roots which store enough nourishment. Some plants are small branched undershrub, *e.g.*, *Fraseria*. Some plants are common weeds, *e.g.*, *Lepidium*, *Sisymbrium* and *Nasturtium*.

Vegetative Characters

Roots—Members of this family have usually tap root system. The tap root modification such as **napiform** root (*e.g.*, *Brassica rapa*) and **fusiform** root (*e.g.*, *Raphanus sativus*) are also found. Such roots become thick and swollen owing to enough nourishment in them. It should be noted in this connection that the underground swollen part of these types is not usually formed by the root alone but the hypocotyl is also incorporated within it.

Stem—The stem is usually herbaceous, solid, hairy and erect. Sometimes it becomes trailing as in *Coronopus*. In *Brassica oleraceae* (cabbage) the stem becomes corm like and very much thickened, which is eaten as vegetable. In radish (*Raphanus sativus*) fleshy roots and pods are used as vegetable.

Leaves—The leaves are simple, entire, alternate, or subopposite, exstipulate, having simple or branched hairs. They are usually radical, or cauline, sessile or subsessile, lyrate. When radical they form a rosette, *e.g.*, radish.

Floral Characters

Inflorescence—The inflorescence of this family is generally of racemose type and very often may be a raceme, corymb or corymbose.

Flowers—The flowers are generally actinomorphic, rarely zygomorphic (*e.g.*, *Iberis*), pedicellate, hypogynous, tetramerous, cruciform and complete.

Calyx—Calyx is composed of four sepals which are polysepalous. They are arranged in two whorls, each of two sepals. The outer two sepals are often large and pouched at the base, which serve as nectaries, and the inner two sepals are usually narrow. The aestivation is imbricate.

Corolla—The corolla consists of four petals, which are polypetalous, arranged alternately with sepals in cruciform manner. Each petal is usually differentiated into a broad expanded **limb** and a narrow **claw**. The flowers in *Iberis amara* become zygomorphic due to the enlargement of two outer petals. In certain species the petals are represented by four minute lobes, *e.g.*, *Senebiera*. In *coronopus*, they are altogether absent.

Androecium—Androecium usually consists of six stamens and termed as **tetradynamous**, *i.e.*, the two outer stamens are opposite the lateral sepals and the four inner stamens are opposite the petals which have longer filaments than the outer stamens. Some species of *Nasturtium* have four stamens and in *Coronopus didymus* there are only two lateral stamens. The filaments of two inner pairs of stamens are occasionally connate. Filaments also are winged or with tooth-like appendages, *e.g.*, *Alyssum*. The anthers are usually dithecous, basifixed and introse. A disc is often present at the base of the stamens which has usually four basal nectariferous glands opposite the sepals.

Gynoecium—Gynoecium is the female reproductive part of the flower of this family. It is bicarpellary, syncarpous, unilocular, sometimes becomes bilocular due to the formation of false septum, the **replum**, extending from placenta. The style is short with two lobed stigma. The placentation is **parietal**. Many ovules develop from this placenta.

Fruits and Seeds

Strictly, the ripened ovary and its contents are known as fruit. It is generally **siliqua** (*Brassica campestris*) or **silicula** (*Alyssum*, *Iberis*). This fruits provides a great variety regarding shape and size in different taxa and, hence, is very useful in the systematics of family Brassicaceae.

The **seeds** are small, nonendospermic (exalbuminous) and usually with a curved embryo.

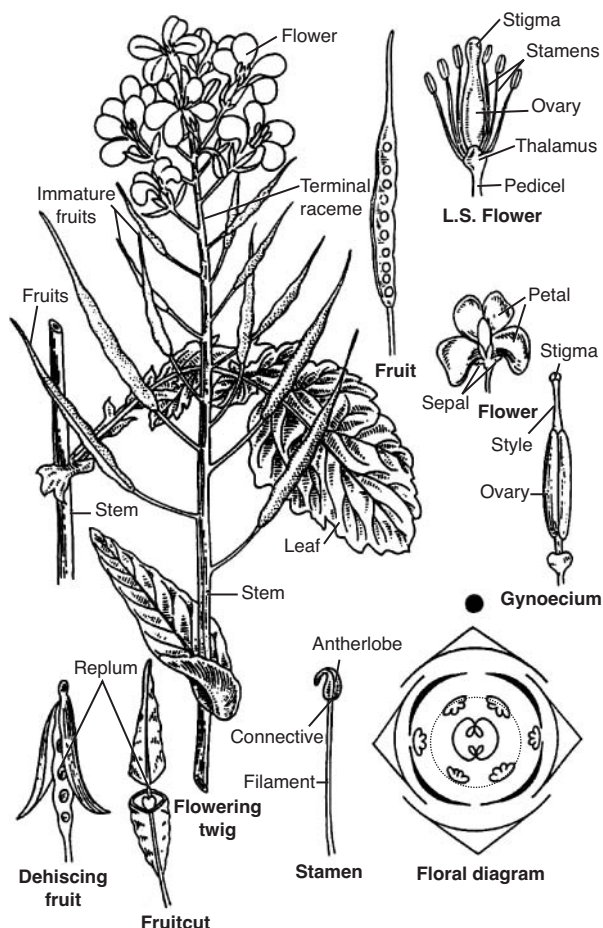


Fig. : Cruciferae (Brassicaceae), *Brassica campestris* Linn. Eng. Yellow mustard; Verna. Sarson

Pollination and Dispersal

The members of the family—Brassicaceae are both self- and insect-pollinated (entomophilous). The honey secreting nectaries found at the base of short stamens and anterior sepals are the chief centres of attractions for insects; the flowers arranged in corymbs also attract the insects and cross-pollination is effected. In such cases several flowers are pollinated by one insect at one time. The flowers are not very conspicuous and nectar is also not very easily accessible and hence they are visited by a small variety of insects.

The seeds are dispersed by cattles, birds, water or wind.

Floral Formulae

$$\text{Brassica} - \text{Ebr} \oplus \overset{\curvearrowright}{\underset{+}{\sigma}} K_{2+2} C_4 A_{2+4} \underline{G(2)}$$

$$\text{Iberis} - \text{Ebr} \% \overset{\curvearrowright}{\underset{+}{\sigma}} K_{2+2} C_{2+2} A_{2+4} \underline{G(2)}$$

Systematic Position

Bentham and Hooker	Engler and Prantl	Hutchinson
Phanerogams	Phanerogams	Angiospermae
Dicotyledones	Dicotyledoneae	Dicotyledones
Polypetalae	Archichlamydeae	Herbaceae
Thalamiflorae	Rhoadales	Cruciales (Brassicales)
Parietales		
Cruciferae (Brassicaceae)	Cruciferae (Brassicaceae)	Cruciferae (Brassicaceae)

Note : The new name of family Cruciferae is Brassicaceae.

Economic Importance

Brassicaceae is one of the most important families from economic point of view. The members of this family provide food, fruit, vegetables, oils, medicines and ornamental plants. The important members (plants) for such purposes are given below :

- Radish (*Raphanus sativus*), cabbage (*Brassica oleracea*), turnip (*B. rapa*) and brahmi sag (*Nasturtium officinale*) are eaten as vegetables.
- Oil is extracted from the seeds of mustard (*Brassica campestris*), black rai (*Brassica napus*), rai (*Brassica juncea*) and black mustard (*Brassica nigra*).
- The material left after the oil extraction from the seeds is highly nutritious and used as cattle feed.
- The seeds of wall flower (*Cherianthus cheiri*) are useful in fever and bronchitis, and flowers in the treatment of impotency and paralysis.
- The leaves and tender shoots of garden cress (*Lepidium sativum*) are used in bleeding piles and liver complaints, asthma and cough.
- The seeds of *Mathiola incana* mixed with wine or lemon juice are given as antidote to poisonous bites.
- The whole plant body of *Lobularia* is useful in the treatment of gonorrhoea.
- Candytuft (*Iberis amara*) is used in the treatment of gout and rheumatism.
- Various plants like basket of gold (*Alyssum*), chandani or candytuft (*Iberis amara*), rock cress (*Arabis*) wall flower (*Cherianthus cheiri*) are grown in gardens and parks as ornamentals for their beautiful flowers, fascination and fragrance.

OBJECTIVE QUESTIONS

- Which of the following is the floral formula of *Brassica campestris* ?
 (A) $\% \overset{\curvearrowright}{\underset{+}{\sigma}} K_4 C_4 A_{2+4} \underline{G(1)}$
 (B) $\% \overset{\curvearrowright}{\underset{+}{\sigma}} K_{2+2} C_{2+2} A_6 \underline{G(2)}$
 (C) $\oplus \overset{\curvearrowright}{\underset{+}{\sigma}} K_{2+2} C_4 A_{2+4} \underline{G(2)}$
 (D) $\% \overset{\curvearrowright}{\underset{+}{\sigma}} K_{3+3} C_{4+2} A_6 \underline{G(2)}$
- Brassica nigra* belongs to family —
 (A) Ranunculaceae
 (B) Chenopodiaceae
 (C) Papaveraceae
 (D) Brassicaceae
- Which of the following is/are correct regarding leaf characteristic of family Brassicaceae ?
 (A) Exstipulate
 (B) Sessile
 (C) Reticulate venation
 (D) All of these
- The botanical name of 'garden cress' is—
 (A) *Pisum sativum*
 (B) *Lepidium sativum*
 (C) *Iberis amara*
 (D) *Capsella bursa-pastoris*

(Continued on Page 1289)

BOTANY

1. Match **Column A** (Different fruits) with **Column B** (Different edible parts) then select the correct answer from the options given below—

Column A

- (a) Grape
- (b) Banana
- (c) Strawberry
- (d) Plum

Column B

- 1. Mesocarp and endocarp
- 2. Epicarp and mesocarp
- 3. Pericarp and placenta
- 4. Fleshy thalamus

	(a)	(b)	(c)	(d)
(A)	3	1	2	4
(B)	4	3	1	2
(C)	3	1	4	2
(D)	2	1	4	3

2. Oxygen gas released during photosynthesis is formed during—
- (A) Carbon fixation during the dark reaction
 - (B) Oxidative phosphorylation
 - (C) Non-cyclic photophosphorylation
 - (D) Cyclic photophosphorylation
3. Which one of the following bases of RNA replaces thymine (T) of DNA ?
- (A) Adenine (A)
 - (B) Uracil (U)
 - (C) Cytosine (C)
 - (D) Guanine (G)
4. Geothermal energy is—
- (A) Non-renewable, non-conventional
 - (B) Non-renewable, conventional
 - (C) Renewable non-conventional
 - (D) Non-renewable, conventional
5. The rusts are caused by—
- (A) Uredinales
 - (B) Ustilaginales
 - (C) Erysiphales
 - (D) Peronosporales

6. Genophore has—
- (A) ss DNA
 - (B) Histones and RNA
 - (C) Histones and nonhistones
 - (D) ds DNA
7. The two complete genome plus two different extra chromosomes ($2n + 1 + 1$) is called—
- (A) Monosomy
 - (B) Trisomy
 - (C) Double trisomy
 - (D) None of the above
8. A plant having two types of haploid structures in its life-cycle is termed as—
- (A) Haplobiontic
 - (B) Diplobiontic
 - (C) Haplodiplobiontic
 - (D) None of the above
9. The structure regulating the entrance and exit of molecules into and out of the cytoplasm is—
- (A) Nucleolus
 - (B) Cytosol
 - (C) Plasma membrane
 - (D) Vacuole
10. Branch of botany dealing with the internal organization of plant is—
- (A) Cytology
 - (B) Physiology
 - (C) Agronomy
 - (D) Anatomy
11. Genes are linearly arranged on—
- (A) mRNA
 - (B) tRNA
 - (C) Chromosome
 - (D) Nucleus
12. A sleep movement is nastic movement that occurs daily in response to—
- (A) Light
 - (B) Dark
 - (C) Both (A) and (B)
 - (D) None of the above
13. Depending on the moisture content, date fruits are—
- (A) Dry
 - (B) Semi-dry
 - (C) Soft
 - (D) All of the above

14. Deoxytosine monophosphate is a nucleotide of—
- (A) DNA
 - (B) RNA
 - (C) Both (A) and (B)
 - (D) None of the above
15. Aquatic ecosystems cover approximately how much of the earth's surface ?
- (A) 90%
 - (B) 75%
 - (C) 25%
 - (D) 10%
16. Energy capturing reaction in photosynthesis occurs in—
- (A) Thylakoids
 - (B) Stroma
 - (C) Outer wall of chloroplasts
 - (D) Mitochondria
17. The sporophyte of fern consists of—
- (A) Root
 - (B) Stem
 - (C) Leaf
 - (D) All of the above
18. Who among the following first of all used and defined the term 'molecular biology' in 1950 ?
- (A) W. T. Astbury
 - (B) Watson and Crick
 - (C) Temin and Baltimore
 - (D) H. Khorana
19. Proteins that are to be used outside the cell are synthesized—
- (A) On the free ribosomes
 - (B) On the rough endoplasmic reticulum
 - (C) On the smooth endoplasmic reticulum
 - (D) In the F_0-F_1 particles of mitochondria
20. Mass-flow hypothesis for phloem sap was first put forward and explained by—
- (A) Jolly and Dixon
 - (B) Stephan Hales
 - (C) F. F. Blackman
 - (D) Munch
21. The real control of flowering response is length of the night, so that short-day plants should be called—
- (A) Long night
 - (B) Short night
 - (C) Long day
 - (D) Day neutral

22. The continuity of cytoplasm from one cell to other cell is maintained by—
(A) Cell wall
(B) Plasma membrane
(C) Plasmodesmata
(D) Tracheids
23. The length of one turn of helix in B-DNA is approximately—
(A) 20 nm (B) 34 nm
(C) 2 nm (D) 3.4 nm
24. In RNA, apart from ribose sugar and phosphate, all are present except—
(A) Uracil (B) Thymine
(C) Adenine (D) Guanine
25. Which of the following is synthesized in the dark reaction of photosynthesis ?
(A) ATP
(B) O₂
(C) Both (A) and (B)
(D) Phosphoglyceric acid
26. Which of the following is an example of hornwort ?
(A) *Anthoceros*
(B) *Sphagnum*
(C) *Marchantia*
(D) *Funaria*
27. A resting stage enveloped by a protective capsule in the life cycle of certain organisms with a sac-like abnormal growth, is called—
(A) Cyst
(B) Pili
(C) Calyptrogen
(D) Plastid
28. Stomata having pores bounded by a single ring-shaped guard cell are found in—
(A) *Cycas*'s pinule
(B) *Funaria*'s capsule
(C) Fern's leaf
(D) All of the above
29. The cytokinins are a class of plant hormones that—
(A) Brings about the closure of stomata
(B) Promote cell division
(C) Stimulate leaf development and formation
(D) Stimulate photosynthesis
30. The natural source of energy which is thought to be most important is—
(A) Fossil fuels
(B) Biogas
(C) Atomic energy
(D) Sunlight
31. The ecology concerned with the interaction of organisms mediated by the chemicals they produce is known as—
(A) Autecology
(B) Synecology
(C) Hydrology
(D) Chemical ecology
32. Morphine is extracted from—
(A) *Papaver somniferum*
(B) *Claviceps purpurea*
(C) *Rauwolfia serpentina*
(D) *Argemone mexicana*
33. By growing close to the ground, a tundra plant—
(A) Attracts pollinators
(B) Avoids the wind
(C) Forms mutualistic relations with soil animals
(D) Avoids herbivores
34. If a plant is first exposed to light of 730 nm wavelength and then to 660 nm wavelength, then plant will—
(A) Die immediately
(B) Show inhibited growth
(C) Will not grow any more
(D) Resume normal growth
35. The branch of biology dealing with the mechanism of inheritance and maintenance of heredity characters constitute the science called—
(A) Physiology
(B) Molecular biology
(C) Genetics
(D) Internal morphology
36. The eyes of potato bear—
(A) Buds (B) Stems
(C) Roots (D) Flowers
37. Fibres are usually prominent in the leaves of—
(A) Dicotyledons
(B) Monocotyledons
(C) Gymnosperms
(D) None of the above
38. Histones of nucleosomes are—
(A) Glycoproteins
(B) Acidic proteins
(C) Both (A) and (B)
(D) None of the above
39. The osmotic pressure on the cell sap is more in—
(A) Mesophytes
(B) Hydrophytes
(C) Xerophytes
(D) Floating hydrophytes
40. Lignin is a component of the secondary cell wall of—
(A) Parenchyma
(B) Epidermis
(C) Collenchyma
(D) Sclerenchyma
41. Mulching means—
(A) Layer formed by stubble and grass
(B) Raising the plants against slope
(C) Planting of monocot plants in a row
(D) Shallow ploughing
42. How many molecules of oxygen gas (O₂) are used during the glycolysis of one glucose molecule ?
(A) 38 (B) 30
(C) Zero (D) 6
43. A pome fruit is said to be false because—
(A) Pericarp is inconspicuous
(B) Endocarp is cartilaginous
(C) Fruit is present in edible fleshy thalamus
(D) It is formed from inferior ovary
44. Coenzyme-A, which combines with acetyl group, is formed in part from—
(A) One of the vitamin-B complex
(B) Zinc
(C) Vitamin
(D) Iron
45. Among all the kingdoms the only taxon that exists in nature as a biologically cohesive unit is the—
(A) Kingdom (B) Species
(C) Phylum (D) Genus

46. A hormone that controls closure of stomata in response to water stress is—
 (A) IAA
 (B) GA₃
 (C) ABA
 (D) All of the above
47. Only phenotypic ratio 1 : 2 : 1 in the offspring explains the principle of—
 (A) Recessiveness
 (B) Incomplete dominance
 (C) Dominance
 (D) Independent assortment
48. The name protoplasm was given by—
 (A) Purkinje
 (B) Brown
 (C) Hook
 (D) Bose
49. Criss-cross inheritance in *Drosophila* was first shown by—
 (A) Morgan and Bridges
 (B) Bateson and Punnett
 (C) Watson and Crick
 (D) Wallace and Hedges
50. Hydrolysis reactions are responsible for the enzymatic depolarization of—
 (A) Proteins
 (B) Carbohydrates
 (C) Nucleic acids
 (D) All of the above

ANSWERS WITH HINTS

-
- (Continued from Page 1286)
5. Which type of fruit is found in *Brassica campestris* ?
 (A) Pome (B) Drupe
 (C) Siliqua (D) Carcerulus
6. Which of the plants is/are grown for beautification of gardens ?
 (A) *Arabis*
 (B) *Alyssum*
 (C) *Cherianthus*
 (D) All of the above
7. Which of the following members of family Brassicaceae give(s) oil ?
 (A) *Brassica nigra*
 (B) *Brassica napus*
 (C) *Brassica juncea*
 (D) All of the above
8. Mustard shows—
 (A) Epigeous germination of monocotyledonous seed
 (B) Epigeous germination of dicotyledonous exalbuminous seeds
 (C) Hypogeous germination of monocotyledonous seed
 (D) All of the above
9. The characteristic features of root of Brassicaceae includes—
 (A) Usually tap root system
 (B) Napiform root in *Brassicarapa*
 (C) Fusiform root in *Raphanus sativus*
 (D) All of the above
10. Silicula fruit is found in—
 (A) *Brassica campestris*
 (B) *Iberis*
 (C) *Alyssum*
 (D) Both (B) and (C)

ANSWERS



BOTANY

1. Match **Column A** (Different modification of roots) with **Column B** (Different examples of plants) then select the correct answer from the options given below :

Column A

- (a) Epiphytic root
- (b) Assimilatory root
- (c) Reproductive root
- (d) Mycorrhiza root

Column B

- 1. *Tinospora*
- 2. *Trichosanthes*
- 3. Certain aroids
- 4. *Monotropa*

	(a)	(b)	(c)	(d)
(A)	3	1	4	2
(B)	3	1	2	4
(C)	1	3	4	2
(D)	2	3	1	4

2. Which of the following is the sporulation method of asexual reproduction in Ascomycetes ?
- (A) Oidia
 - (B) Chlamydozoospores
 - (C) Conidia
 - (D) All of the above
3. Protein are diverse in nature because of—
- (A) Different molecular weight of amino acids
 - (B) Different arrangement of amino acids
 - (C) Complexity of amino acids
 - (D) Different molecular nature of amino acids
4. Which of the following properties makes plasmids suitable vectors for gene cloning ?
- (A) Plasmids are small circular DNA molecules with their own replication origin site
 - (B) Plasmids often carry antibiotic resistance genes
 - (C) Plasmids are small circular DNA molecules that can integrate with host chromosomal DNA

- (D) Plasmids can shuttle between prokaryotic and eukaryotic cells

5. Functional activities of the cell are chiefly controlled by—

- (A) Nucleoplasm
- (B) Nucleus
- (C) Mitochondria
- (D) Protoplasm

6. A taxonomic system based on all phenotypic similarities, equally weighted and without regard to evolutionary relationship, is called—

- (A) Phenetics
- (B) Phylogeny
- (C) Classical evolutionary taxonomy
- (D) All of the above

7. Cellular totipotency is related to—

- (A) Formation of new species
- (B) Cell capability to form whole organism
- (C) Synthesis of new plant cell
- (D) None of these

8. Which of the following chemicals or ray is **not** a mutagen ?

- (A) Nitrous acid
- (B) Gamma radiation
- (C) Acetic acid
- (D) 5-bromouracil

9. Each spikelet consists of a central stalk called—

- (A) Rachilla
- (B) Culm
- (C) Scutellum
- (D) Spur

10. RNA processing is—

- (A) Same as transcription
- (B) An event that occurs after RNA is transcribed
- (C) The rejection of old, wornout RNA
- (D) All of the above

11. Lactiferous vessels are found in—

- (A) Cortex
- (B) Phloem tissue
- (C) Xylem tissue
- (D) None of the above

12. Members of the Ascomycotina are popularly known as—

- (A) Sac fungi
- (B) Pin moulds
- (C) Puff balls
- (D) All of the above

13. Which of the following stains gives purple or violet colour to chromosome ?

- (A) Safranin
- (B) Acetocein
- (C) Acetocarmine
- (D) Feulgen

14. The longest fibres among these are obtained from—

- (A) Coir
- (B) Jute
- (C) Sunhemp
- (D) Cotton

15. Available form of nitrogen to plants is—

- (A) Nitrate (NO_3^-)
- (B) Ammonium (NH_4^+)
- (C) Both (A) and (B)
- (D) Atmospheric nitrogen

16. Special kinds of roots called pneumatophores are characteristics of plants growing in—

- (A) Saline soils
- (B) Sandy soils
- (C) Dryland regions
- (D) Marshy places and salt lakes

17. What is the causal organism of "soft rot of carrot" (*Daucus carota*) ?

- (A) *Synchytrium endobioticum*
- (B) *Rhizophora stolon*
- (C) *Erwinia caratovora*
- (D) *Claviceps purpurea*

18. Each molecule of fat is formed of—

- (A) 1 glycerol molecule and 3 fatty acid molecules
- (B) 3 glycerol molecules and 3 fatty acid molecules
- (C) 1 glycerol molecule and 1 fatty acid molecule
- (D) 3 glycerol molecules and 1 fatty acid molecule

19. Which of the following gives a possible sequence of organic chemicals prior to the protocell ?

- (A) Polypeptide, protein, inorganic gases

- (B) Water, salt, protein, oxygen
(C) Inorganic gases, nucleotides, nucleic acids, genes
(D) Both (B) and (C)
20. The taxonomy of fungi is chiefly based on—
(A) Type of cell wall
(B) Mode of nutrition
(C) Sexual reproduction structures
(D) Shape of the sporocarp
21. Coliphage ϕ 174 has—
(A) ss RNA (B) ds RNA
(C) ss DNA (D) ds DNA
22. Chromosome puffs are found in—
(A) Polytene chromosome
(B) B-chromosome
(C) Lampbrush chromosome
(D) Barr body
23. All alpha acids have one asymmetric carbon atom except—
(A) Asparagine
(B) Glycine
(C) Histidine
(D) Arginine
24. In fern, the sporophyte is—
(A) Diploid
(B) The source of haploid spore
(C) The dominant form
(D) All of the above
25. In which of the following plants archegonium is present ?
(A) *Rhizopus*
(B) *Spirogyra*
(C) *Funaria*
(D) All of the above
26. At each trophic level of a food chain (pyramid) the energy not used or passed along is given off as—
(A) Water (B) Heat
(C) Free energy (D) Matter
27. Elaters and pseudoelaters are meant for—
(A) Spore dispersal
(B) Nutritional absorption
(C) Mechanical strength
(D) Sap conduction
28. The DNA doubles and chromosomes replicate during which phase of the cell cycle ?
(A) G₁ phase (B) S phase
(C) G₂ phase (D) M phase
29. The surface layer of soil is known as—
(A) C-horizon (B) O-horizon
(C) A-horizon (D) B-horizon
30. Recent astronomical findings suggest that the earth's early atmosphere may have contained—
(A) CO
(B) CO₂
(C) Nitrogen
(D) All of the above
31. Reforestation will increase—
(A) Landslides (B) Soil erosion
(C) Cyclones (D) Rainfall
32. Cupule, a cup-shaped structure, is found in—
(A) Birch
(B) Carrot
(C) Bougainvillea
(D) All of the above
33. Dimorphism of chloroplast is found in—
(A) CAM plants
(B) C₃ plants
(C) C₄ plants
(D) All of the above
34. Which of the following taxonomic categories tops the hierarchy of categories ?
(A) Genus (B) Species
(C) Class (D) Order
35. The development of plant by the process of tissue culture is called—
(A) Sexual reproduction
(B) Binary fission
(C) Micropropagation
(D) Parthenocarp
36. Which one of the following produces GTP, CO₂, FADH₂ and NADH₂ ?
(A) Glycolysis
(B) Oxidative carboxylation
(C) Oxidative phosphorylation
(D) Citric acid cycle
37. In which of the following the whole portion of the leaf blade regenerate a new individual ?
(A) Money plant
(B) Mango
(C) Rose
(D) *Kalanchoe*
38. In DNA replication the Okazaki fragments on the lagging strands are joined together by—
(A) *Primase*
(B) *Helicase*
(C) *DNA ligase*
(D) *DNA polymerase*
39. A parenchyma cell which stores ergastic materials or waste substance is—
(A) Idioblast
(B) Phragmoblast
(C) Blastocyte
(D) Conidioblast
40. Eroded soils are—
(A) Devoid of plant nutrients
(B) Fit for agriculture
(C) Richer in plant nutrients
(D) All of the above are correct
41. Diatoms are—
(A) Protista
(B) Plantae
(C) Fungi
(D) None of the above
42. Which of the following are the only vascular plants that produce seeds in protective structure ?
(A) Angiosperms
(B) Conifers
(C) All gymnosperms
(D) None of the above
43. Which of the following is the function of coenzyme-A ?
(A) Isomerize pyruvic acid
(B) Facilitate oxidative phosphorylation
(C) Activate the acetyl group
(D) Isomerize NAD⁺
44. In older and woody stems, epidermis is replaced by—
(A) Stomata
(B) Cuticle
(C) Cork cells
(D) Epidermal hairs
45. Wilting of plants results from an excessive—
(A) Respiration
(B) Absorption
(C) Transpiration
(D) Poor osmosis and photosynthesis

46. In dicot roots, cells are fully differentiated in the—
 (A) Zone of cell division
 (B) Zone of maturation
 (C) Zone of elongation
 (D) All of the above
47. In an aquatic environment microscopic animals and plants are collectively known as—
 (A) Fauna and flora
 (B) Planktons
 (C) Zooplanktons
 (D) Ecosystem
48. The driving force for the ascent of sap of water in xylem is a negative pressure potential brought about by transpiration at the—
 (A) Leaves
 (B) Roots
 (C) Stems
 (D) All of the above
49. The flowering shoot that comes out of acaulescent annual plants with radical leaves is called—
 (A) Scape (B) Prophyll
 (C) Rachis (D) Peduncle
50. The archaebacterial cell walls are usually composed of—
 (A) Proteins
 (B) Glycoproteins
 (C) Polysaccharides
 (D) All of the above

ANSWERS WITH HINTS

●●●

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BOTANY

1. Match **Column-A** (Theories/Findings) with **Column-B** (Name of Scientist/Finders) then select the correct option as your answer.

Column A

(Theories/Findings)

- Apical cell theory
- Histogen theory
- Tunica-Corpus theory
- Quicent centre in maize

Column B

(Name of Scientists/Finders)

- Schmidt
- Clowes
- Nageli
- Hanstein

	a	b	c	d
(A)	3	1	4	2
(B)	3	4	1	2
(C)	2	4	3	1
(D)	2	3	4	1

- Important types of mutualistic union are made by fungi namely—
(A) Lichens
(B) Mycorrhizas
(C) Both (A) and (B)
(D) Bacteria
- Fixation of one molecule of CO_2 through Calvin cycle requires—
(A) 1 ATP and 2 NADPH_2
(B) 2 ATP and 1 NADPH_2
(C) 3 ATP and 3 NADPH_2
(D) 3 ATP and 2 NADPH_2
- A molecule of ADP differs from a molecule of ATP in that it has—
(A) More phosphate bond
(B) Less electrical
(C) Diamine instead of thymine
(D) Fewer phosphate groups
- Two species of pines *Pinus radiata* and *Pinus muricata*, occur sympatrically in two different states of India are capable of forming hybrids. However, they do not interbreed because one releases pollen in February and the other in April. They are

an example of prezygotic isolation by—

- Gametic isolation
- Geographic isolation
- Ecological isolation
- Temporal isolation

- In a eukaryotic cell, glycolysis takes place—

- In the cytoplasm but outside the organelles
- Within the mitochondria
- Within the nucleus
- None of the above

- A plant in Tracheophyta has a sporophyte with—

- Root, stem and leaf
- Isogametes
- No independent life
- Vessels that transport fluid

- A new mutation spreads from one population to another by means of—

- Crossovers
- Removed bottle necks
- Emigrants and immigrants
- Mutation pressures

- Which of the following RNA along with proteins, makes up the ribosomes, where proteins are synthesized ?

- m-RNA
- r-RNA
- t-RNA
- All of the above

- The reaction in which glucose and fructose combine to form sucrose and water is—

- Endergonic
- Exergonic
- Both (A) and (B)
- None of the above

- In angiosperm, phloem is generally made up of—

- Phloem tubes and companion cells
- Phloem parenchyma, albuminous cells and sieve tubes

- Phloem parenchyma, sieve tubes and companion cells

- None of the above

- Interferon suppresses the pathogenic activity of—

- Viruses
- Bacteria
- Protozoa
- All of the above

- In *Oxalis*, the flowers open in the morning and close during evening because of—

- Phototaxis
- Photonasty
- Phototropism
- Nyctinasty

- In the conversion of pyruvate to Acetyl CoA, the pyruvate is—

- Reduced
- Oxidized
- Isomerized
- Broken into one carbon fragment

- Meiosis in *Dryopteris* occurs at the time of—

- Spore formation
- Gamete formation
- Sex organs formation
- All of the above

- Formation of sporophyte from vegetative part of prothallus is called—

- Apogamy
- Parthenocarpy
- Apospory
- Parthenogenesis

- Which of the following methanogenic bacteria is **not** a Gram-positive ?

- Methanobacterium*
- Methanomicrobium*
- Methanogenium*
- Methanospirillum*

- A pollinium consists of—

- A cluster of pollen grains belonging to a chamber of microsporangium
- Two pollen tetrads attached by a small stalk
- A group of four pollen grains derived from a single mother cell
- A bag of pollen grain formed in a microsporangium

19. The spore of fungi—
 - (A) Is always windblown
 - (B) Germinates directly into an organism
 - (C) Both (A) and (B) are correct
 - (D) Contains embryonic organism
20. When an end of product of a metabolic pathway activates the repressor of the operon that produces enzymes for the pathway, it is called a/an—
 - (A) Operator
 - (B) Suppressor
 - (C) Corepressor
 - (D) Promotor
21. Cyanobacteria can use H₂O as an electron donor for—
 - (A) N₂ fixation
 - (B) CO₂ fixation
 - (C) O₂ fixation
 - (D) All of the above
22. Staminode condition is found in—
 - (A) *Canna*
 - (B) *Cassia*
 - (C) Both (A) and (B)
 - (D) None of the above
23. Auxin can—
 - (A) Inhibit growth in lateral buds
 - (B) Inhibit growth in stems
 - (C) Induce the formation of adventitious roots
 - (D) All of the above
24. Bryophytes acquire most of their water through—
 - (A) Above ground structures
 - (B) Mycorrhizae
 - (C) True roots
 - (D) Underground cup-like structures called gemmae
25. The centromere, or the primary constriction of the chromosome, contains rings of protein that are intimately associated with a spindle fibre. These rings are called—
 - (A) Kinetochores
 - (B) Secondary constrictions
 - (C) Somites
 - (D) Centrioles
26. Phylogenetic classification is based on—
 - (A) Overall similarity
 - (B) Utilitarian system
 - (C) Habits
 - (D) Common evolutionary descent
27. The greatest number of plants currently in existence are found within—
 - (A) Ferns
 - (B) Club mosses
 - (C) Gymnosperms
 - (D) Angiosperms
28. The concept that “population tends to increase geometrically while food supply increases arithmetically” was put forward by—
 - (A) T. Malthus
 - (B) C. Darwin
 - (C) S. Mill
 - (D) A. Smith
29. Mendel did not deal with—
 - (A) Incomplete dominance
 - (B) Linkage
 - (C) Both (A) and (B)
 - (D) Segregation
30. Which of the following is **not** a member of Caesalpiniaceae family ?
 - (A) *Bauhinia variegata*
 - (B) *Tamarindus indica*
 - (C) *Parkinsonia aculeata*
 - (D) *Glycine max*
31. Most biologists believe that the earliest organisms were—
 - (A) Autotrophs
 - (B) Heterotrophs
 - (C) Eukaryotes
 - (D) None of the above
32. Removal of pollen grains or anthers from the hermaphrodite flower is termed—
 - (A) Sterilization
 - (B) Hybridization
 - (C) Emasculation
 - (D) Mass selection
33. When the filament of the anther is firmly fixed to some position on back of the anther is termed as—
 - (A) Basifixed
 - (B) Dorsifixed
 - (C) Versatile
 - (D) All of the above
34. Special kind of roots called pneumatophores are characteristic of plants growing in—
 - (A) Sandy soils
 - (B) Dryland soils
 - (C) Saline soils
 - (D) Marshy places and salt lakes
35. Which of the following is mismatched ?
 - (A) Solar energy
— Green house effect
 - (B) Fossil fuel burning
— CO₂ given off
 - (C) Biomass burning
— CO₂ given off
 - (D) Nuclear power
— Radioactive wastes
36. A virus consists of—
 - (A) Lipid coat (capsid), genes and ribosomes
 - (B) Cell membrane and chromosome
 - (C) Protein coat genes and mitochondria
 - (D) Protein coat and nucleic acid molecules
37. ‘Central dogma’ of molecular biology regarding protein synthesis was proposed by—
 - (A) Waldeyer
 - (B) McClintock
 - (C) Johanssen
 - (D) Crick
38. Which of the following enzymes is responsible for the reduction of molecular nitrogen to the level of ammonia in the root nodule of leguminous plants ?
 - (A) Nitrogenase
 - (B) Nitrate reductase
 - (C) Nitrite reductase
 - (D) All of the above
39. Barbara McClintock was awarded Nobel Prize for the discovery of—
 - (A) DNA ligase
 - (B) Intron
 - (C) Recon
 - (D) Transposons
40. The pyramid of energy in grassland ecosystem is—
 - (A) Inverted
 - (B) Upward
 - (C) Both (A) and (B)
 - (D) Not clearly determined due to zig-zag elaboration
41. Chilgoza is a fruit obtained from—
 - (A) Angiosperm

- (B) Gymnosperm
(C) Pteridophytes
(D) None of the above
42. Meselson and Stahl tested the—
(A) Watson and Crick's model of DNA replication
(B) Watson and Crick model of DNA
(C) Chargaff's rule
(D) Ringing experiment
43. Fossil fuels include—
(A) Natural gas
(B) Coal derivatives
(C) Petroleum
(D) All of the above
44. Bark of plant is—
(A) Vascular cambium, cortex and phloem
(B) Hypodermis and cortex
(C) Cortex, phloem and cork cambium
(D) Xylem, phloem and cambium
45. Which of the following ground tissues makes the cell wall tough and hard ?
(A) Parenchyma
(B) Collenchyma
(C) Sclerenchyma
(D) None of the above
46. Secondary nucleus formed by the fusion of 2 polar nuclei is called—
(A) Tube nucleus
(B) Coenocyte
(C) Vegetative nucleus
(D) Definitive nucleus
47. Pressure potential that increases due to the process of osmosis is often called—
(A) Osmotic pressure
(B) Exosmosis
(C) Endosmosis
(D) Turgor pressure
48. 'Red rot' of sugarcane is caused by—
(A) *Colletotrichum falcatum*
(B) *Synchytrium endobioticum*
(C) *Claviceps purpurea*
(D) *Rhizopus stolonifer*
49. Which of the following branches is concerned with the organisms and geological environment of the past ?
(A) Paleoeecology
(B) Synecology
(C) Production ecology
(D) Cytecology
50. If a parent cell has 12 chromosomes, then the daughter cells following meiosis will have—
(A) 24 chromosomes
(B) 12 chromosomes
(C) 6 chromosomes
(D) 48 chromosomes

ANSWERS WITH HINTS

●●●

(Continued from Page 1281)

13. In which of the following trees there is no differentiation of bark, sapwood and heartwood ?
(A) Ashok (B) Neem
(C) Mango (D) Date palm
14. In old tissues gaseous exchange takes place through—
(A) Stomata (B) Aerenchyma
(C) Lenticels (D) Hydathodes
15. Abnormal secondary growth is found in—
(A) *Triticum*
(B) *Cucurbita*
(C) *Dracaena* and *Yucca*
(D) *Helianthus*
5. In addition to the essential elements some plants appear to have specific additional nutrient requirements. They are termed as—
(A) Non essential elements
(B) Macronutrients
(C) Micronutrients
(D) Beneficial elements
6. 'Whip tail' disease is caused by the deficiency of—
(A) Manganese (B) Zinc
(C) Nickel (D) Molybdenum
7. 'Grey-Speck' disease is caused by the deficiency of—
(A) Molybdenum (B) Zinc
(C) Manganese (D) Boron
8. The need of individual plants for any particular element is normally defined in terms of—
(A) Critical period
(B) Critical condition
(C) Critical concentration
(D) None of the above
9. Available form of nitrogen to plants is—
(A) Nitrate (NO_3^-)
(B) Ammonium (NH_4^+)
(C) Both (A) and (B)
(D) None of the above
10. Black necrosis of stem and root tip is caused by the deficiency of—
(A) Magnesium (B) Chlorine
(C) Copper (D) Boron

ANSWERS

●●●

(Continued from Page 1284)

OBJECTIVE QUESTIONS

1. How many elements are thought to be essential for the healthy growth and development in plant ?
(A) 10 (B) 17
(C) 2 (D) More than 100
2. Which element is essential for IAA synthesis ?
(A) Sodium (B) Zinc
(C) Iron (D) Calcium
3. Which one of the following is a micronutrient ?
(A) Calcium (B) Magnesium
(C) Oxygen (D) Molybdenum
4. Which of the following element is required for the activity of nitrate reductase ?
(A) Copper (B) Iron
(C) Zinc (D) Molybdenum

ANSWERS

●●●

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BIOLOGY

1. The interferons are—
(A) Antibacterial drugs
(B) Antiviral drugs
(C) Antibiotic drugs
(D) Anticoagulant drugs
2. Magic bullets are the—
(A) Recombinant vaccines
(B) Monoclonal antibodies
(C) Chemotherapy drugs for cancer
(D) Anabolic steroids
3. Which of the following causes prostate cancer ?
(A) Chromium
(B) Cadmium oxide
(C) Vinyl chloride
(D) Aflatoxins
4. The tests that are used in the diagnosis of AIDS are—
(A) ELISA and immunoblot
(B) Northern blot and ELISA
(C) ELISA and Southern blot
(D) Western blot and ELISA
5. Cyclosporin and endosporins are the drugs that are used as—
(A) Anti-retroviral drugs
(B) Immuno suppressants
(C) Immuno modulators
(D) Immuno vaccines
6. Amphetamines are the drugs of—
(A) Narcotics
(B) Sedatives
(C) Stimulants
(D) Hallucinogens
7. Which of the following movements in plants is related to the changes in the auxin level ?
(A) Movement of shoot towards the source of light
(B) Nyctinasty
(C) Movement of sunflower towards the sun
(D) All the three
8. The gene which controls many characters is called—
(A) Codominant gene
(B) Poly gene
(C) Pleiotropic gene
(D) Multiple gene
9. Simple or rarely compound leaves exstipulate and net venation leaves and racemose or capitulum inflorescence are the characteristics of—
(A) *Poaceae* (B) *Liliaceae*
(C) *Asteraceae* (D) *Fabaceae*
10. *Tobacco* and *Petunia* belong to the family—
(A) *Poaceae*
(B) *Fabaceae*
(C) *Solanaceae*
(D) *Brassicaceae*
11. The order of opening of flower parts from the periphery towards the centre is called—
(A) Acropetal (B) Centripetal
(C) Centrifugal (D) Basipetal
12. The bladder serving as floats and for trapping insects is found in—
(A) *Zizypus* (B) *Utricularia*
(C) *Nepenthes* (D) *Acacia*
13. Which one is **not** a non-sense codon ?
(A) UAA (B) UGA
(C) UCA (D) UAG
14. In cellular respiration, the final acceptor of electron is—
(A) NAD (B) FAD
(C) NADP (D) Oxygen
15. TCA cycle's enzymes are present in—
(A) Cytoplasm
(B) Intermembrane space of mitochondria
(C) Mitochondrial matrix
(D) Inner membrane of mitochondria
16. Long flattened, usually unbranched units arranged in parallel stacks in endoplasmic reticulum is called—
(A) Cisternae (B) Cristae
(C) Vesicles (D) Tubules
17. The fusion of male and female gametes in humans is called—
(A) Fertilization
(B) Conjugation
(C) Amphimixis
(D) Panmixis
18. The assemblage of all the populations of different species that function as an integrated unit through coevolved metabolic transformation in a specific area is called—
(A) Biome
(B) Biotic community
(C) Population
(D) Ecosystem
19. Chlorophyll 'a' and 'b' differ in having—
(A) Chlorophyll 'a' has a methyl group and chlorophyll 'b' has aldehyde group in position X
(B) Chlorophyll 'a' has a aldehyde group and chlorophyll 'b' has methyl group in position X
(C) Chlorophyll 'a' has a carboxyl group and chlorophyll 'b' has aldehyde group in position X
(D) Chlorophyll 'a' has an ethyl group and chlorophyll 'b' has aldehyde group in position X
20. Which one does **not** occur in cyclic photophosphorylation ?
(A) Oxygen is not given off
(B) Water is not consumed
(C) Only photosystem-I is involved
(D) NADPH₂ formation
21. Which one is true about guttation ?
(A) It occurs through specialised pores called hydathodes
(B) It occurs in herbaceous plants when root pressure is low and transpiration is high
(C) It only occurs during the day time
(D) It occurs in plants growing under conditions of low soil moisture and high humidity
22. Molybdenum is the essential constituent of—
(A) *Nitrogenase* enzyme
(B) Respiratory chain
(C) Growth regulators
(D) Chlorophyll

23. Which one is **not true** about vitamins ?
 (A) Vitamins are organic catalysts
 (B) Vitamins are indispensable for life
 (C) Vitamins act as source of energy
 (D) Tocopherol is anti-sterility vitamin
24. The protein deficiency disease in man is—
 (A) Cri du chat syndrome
 (B) Klinefelter syndrome
 (C) Pot belly syndrome
 (D) Kwashiorkor
25. Haversian canals are series of tubes around narrow channels formed by—
 (A) Hyaline cartilage
 (B) Fibrous cartilage
 (C) Lamellae
 (D) Myelin sheath
26. The snake eating snake is—
 (A) Black Cobra
 (B) King Cobra
 (C) Black rattle snake
 (D) Anaconda
27. The layer of cells forming tissue that appears to be multilayered but actually some of the cells or cilia emerge at the top of each cell, is called—
 (A) Simple columnar epithelium
 (B) Pseudostratified ciliated columnar epithelium
 (C) Stratified columnar epithelium
 (D) Stratified cuboidal epithelium
28. The largest aquatic mammalian vertebrate is—
 (A) Blue Whale
 (B) Whale Shark
 (C) Sea Elephant
 (D) Dugongs
29. Cohesion and adhesion theory is otherwise called—
 (A) Relay pump theory
 (B) Pulsation theory
 (C) Root pressure theory
 (D) Transpiration pull theory
30. Path of Ascent of Sap in plants was demonstrated by—
 (A) Ringing experiment
 (B) Ganong's experiment
 (C) Went experiment
 (D) Lever auxanometer
31. Which of the following statement is correct regarding turgor pressure developing in epiblema cells of root—
 (A) Osmotic diffusion of water into pericycle through passage cells
 (B) High water potential of cortical cells and epidermis
 (C) Entry of water into root hairs and increase in volume of cell sap
 (D) In root hairs large vacuole fills up with cell sap
32. Plasmolysis is the result of—
 (A) Exosmosis
 (B) Endosmosis
 (C) Reverse osmosis
 (D) Diffusion
33. Flocculation is a—
 (A) Interchangeability between sol and gel states
 (B) The ability to scatter the beam of light
 (C) The erratic zig-zag movement of protoplasmic particles
 (D) Process of contact and adhesion whereby the particles of a dispersion form larger-size clusters
34. Which one of the following inhibits seed germination for a particular period ?
 (A) Light
 (B) Water
 (C) Carbon dioxide
 (D) Dormancy
35. The species that has a disproportionate effect on its environment relative to its abundance, is called—
 (A) Edge species
 (B) Key stone species
 (C) Pioneer species
 (D) Seral species
36. In plant succession when climax community is reached, the net productivity—
 (A) Continuous to increase
 (B) Becomes zero
 (C) Becomes reduced
 (D) Becomes stable
37. CO₂, CH₄, N₂O and CFC are called Green House gases because they absorb—
 (A) UV rays (B) Infra-red light
 (C) X-rays (D) Gamma rays
38. Which one is the edaphic factor in biosphere ?
 (A) Light (B) Temperature
 (C) Water (D) Soil
39. Genetically adapted population to a particular habitat is called—
 (A) Ecotone (B) Ecotype
 (C) Biome (D) Niche
40. Sudden and rapid increase of population is called—
 (A) Natural increase
 (B) Population growth
 (C) Population explosion
 (D) None of the above
41. The chronological order of human evolution from early to the recent is—
 (A) Ramapithecus—Australopithecus—Homohabilis—Homoerectus
 (B) Australopithecus—Ramapithecus—Homohabilis—Homoerectus
 (C) Pithecentropus pekinensis—Homohabilis—Homoerectus
 (D) Australopithecus—Ramapithecus—Pithecentropus pekinensis—Homoerectus
42. Which one of the following was **not** explained by the Darwinism ?
 (A) Natural selection
 (B) Struggle for existence
 (C) Arrival of the fittest
 (D) Origin of species
43. "Ontogeny recapitulates phylogeny" is narrated in which of the evidences for organic evolution ?
 (A) Palaeontological evidence
 (B) Physiological evidence
 (C) Embryological evidence
 (D) Anatomical evidence
44. Among the following which one is the mutagenic agent ?
 (A) UV light
 (B) Alpha particles
 (C) Gamma rays
 (D) All of these

45. Urey-Miller's experiment mixture had the following except—
(A) Methane
(B) CO₂
(C) Hydrogen
(D) Water vapour
46. The photosynthetic or assimilatory roots are observed in—
(A) *Banyan* (B) *Vanda*
(C) *Cuscuta* (D) *Tinospora*
47. The Periyar sanctuary is located in—
(A) Kerala
(B) Tamil Nadu
(C) Karnataka
(D) Andhra Pradesh
48. The term bacteria was coined by—
(A) Leeuwenhoek
(B) Louis Pasteur
(C) Robert Koch
(D) Ehrenberg
49. The non-living characteristic of viruses is—
(A) Ability to multiply only inside the host
(B) Ability to cause diseases in the host
(C) Ability to undergo mutation
(D) Ability to be crystallised
50. The kingdom of prokaryotes is—
(A) Protista (B) Monera
(C) Fungi (D) Plantae
51. Systematic Botany means—
(A) System analysis
(B) Systematic arrangement of organs of plants
(C) Systematic study of organelles and tissues
(D) Methodical study of plants, dealing with identification, naming and classification
52. Which one is the **correct** hierarchical order in Taxonomy ?
(A) Genus < Species < Class < Order
(B) Genus < Class < Order < Family
(C) Species < Order < Class < Phylum
(D) Genus < Class < Division < Order
53. When the stimulus reaches the end of one neuron it is conducted to the adjacent neuron through the secretions of—
(A) Acetaldehyde
(B) Acetylcholine
(C) Acetylcholine esterase
(D) Acetyl CoA
54. The hormones oxytocin and vasopressin are secreted by—
(A) Neurohypophysis
(B) Adenohypophysis
(C) Hypothalamus
(D) Adrenal medulla
55. The total number of lobes and alveoli present in both the lungs of man is about—
(A) 17 and 30 million respectively
(B) 300 and 500 million respectively
(C) 19 and 300 million respectively
(D) 18 and 300 lakhs respectively
56. Nitrogenous waste is excreted mainly as—
(A) Urea in tadpole, ammonia in frog
(B) Urea in both frog and tadpole
(C) Urea in frog, ammonia in tadpole
(D) Uric acid in frog, urea in tadpole
57. The process of resynthesis of food materials from simpler food molecules is called—
(A) Biosynthesis
(B) Catabolism
(C) Absorption
(D) Assimilation
58. Limbless amphibians are called—
(A) Paddle worms
(B) Glow worms
(C) Caecilian worms
(D) Pin worms
59. The second largest number of species containing phylum in the animal kingdom is—
(A) Annelida (B) Arthropoda
(C) Mollusca (D) Protozoa
60. Siphonophora is the order in—
(A) Protozoa (B) Cnidaria
(C) Porifera (D) Annelida
61. Choanocytes form the lining of paragastral cavity in—
(A) Jelly fish
(B) Sponges
(C) Helminthes
(D) Echinoderms
62. Which one is **not** the renewable energy of natural resources ?
(A) Tidal energy
(B) Wind energy
(C) Fossil fuel
(D) Solar energy
63. Ratio between mortality and natality is called—
(A) Population ratio
(B) Vital index
(C) Density coefficient
(D) Census ratio
64. Which one does **not** conform to the theory of 'Biogenesis' ?
(A) Francois Redi's experiment
(B) Spallanzani's experiment
(C) Louis Pasteur's experiment
(D) Von Helmont's experiment
65. Which one is regarded as molecular scissors in Biotechnology ?
(A) Reverse transcriptase
(B) Restriction endonuclease
(C) Taq polymerase
(D) Topo isomerase
66. The phenotypic ratio in the F₂ generation of dihybrid cross is—
(A) 9 : 3 : 3 : 1
(B) 1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1
(C) 7 : 1 : 1 : 7
(D) 12 : 3 : 4
67. In microbial genetics which one is referred to as 'Griffith effect' ?
(A) Conjugation
(B) Transduction
(C) Transformation
(D) Sexduction
68. The autonomously independent self replicating extra nuclear DNA imparting certain factors to some bacterium is called—
(A) Plastid (B) Plasmid
(C) Phagemid (D) Cosmid
69. Which one is referred to as soluble RNA ?
(A) *m*RNA (B) *t*RNA
(C) *r*RNA (D) *ss*RNA

70. Abscissic acid is primarily synthesized in—
 (A) Lysosomes
 (B) Golgi complex
 (C) Chloroplast
 (D) Ribosomes
71. Micropyle is useful for the entry off—
 (A) Pollen grain
 (B) Pollen tube
 (C) Water
 (D) Male gamete
72. The scientist who performed some experiments with oat coleoptiles for the presence of a substance which could diffuse into agar blocks is—
 (A) Ganong
 (B) Went
 (C) Boysen-Jensen
 (D) Fujikura
73. Vivipary is observed in—
 (A) *Banyan* (B) *Bryophyllum*
 (C) *Ipomea* (D) *Rhizophora*
74. Double fertilization is also called—
 (A) Triple fusion
 (B) True fertilisation
 (C) Syngamy
 (D) Generative fertilisation
75. Embryo developed from the somatic cells are called—
 (A) Cybrids (B) Embryoids
 (C) Callus (D) Hybrids

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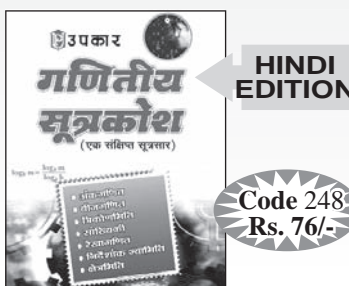
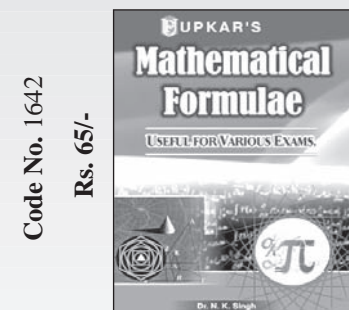
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ASSERTION AND REASON TYPE QUESTIONS

In each of the following questions, a statement of Assertion (A) is given and a corresponding statement of Reason (R) is given just below it. Of the statements, mark the correct answer as —

- (A) If both A and R are true and R is the correct explanation of A
- (B) If both A and R are true but R is not the correct explanation of A
- (C) If A is true but R is false
- (D) If both A and R are false
- (E) If A is false but R is true

PHYSICS

1. **Assertion (A)** : Raman spectrum of a liquid contains lines whose wavelengths are larger and shorter than the incident radiation.

Reason (R) : If a photon strikes an atom or a molecule in a liquid which is in the excited state, the photon gains energy.

(A) (B) (C) (D) (E)

2. **Assertion (A)** : A voltmeter must be connected in parallel in a circuit and it should have a high resistance.

Reason (R) : The introduction of the voltmeter in the circuit must not affect the potential difference it is to measure.

(A) (B) (C) (D) (E)

3. **Assertion (A)** : Mass and energy are not conserved separately but are conserved as a single entity called 'mass-energy'.

Reason (R) : This is because one can be obtained at the cost of the other as per Einstein's equation $E = mc^2$.

(A) (B) (C) (D) (E)

4. **Assertion (A)** : An emf is induced in a circuit whenever there is a change in the magnetic flux linked with the circuit and the magnitude of emf is equal to the rate of change of flux.

Reason (R) : The direction of the induced emf is such as to oppose the very cause to which it is due

(A) (B) (C) (D) (E)

5. **Assertion (A)** : For making permanent magnets, steel is preferred over soft iron.

Reason (R) : Retentivity of steel is smaller.

(A) (B) (C) (D) (E)

6. **Assertion (A)** : Water is taken for heating purpose in a hot water bottle.

Reason (R) : Specific heat of water is less than that of other liquids.

(A) (B) (C) (D) (E)

7. **Assertion (A)** : When a charged particle is fired in a magnetic field, the centripetal force on it is independent of the mass of the particle.

Reason (R) : The centripetal force on a particle with charge q moving with velocity \vec{v} in a magnetic

field \vec{B} is $\vec{F}_m = q \vec{v} \times \vec{B}$

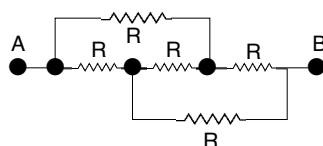
(A) (B) (C) (D) (E)

8. **Assertion (A)** : The density of ice is less than that of water and the ice floats on water.

Reason (R) : When water freezes to form ice, its volume increases.

(A) (B) (C) (D) (E)

9. **Assertion (A)** : In the following circuit the net resistance between A and B is $R/5$.



Reason (R) : All the resistances are in parallel to each other.

(A) (B) (C) (D) (E)

10. **Assertion (A)** : Diffraction effects are not observable in sound waves.

Reason (R) : For diffraction the size of the obstacle should be of the order of the wavelength.

(A) (B) (C) (D) (E)

CHEMISTRY

11. **Assertion (A)** : Both basicity and nucleophilicity of CH_3O^- , OH^- and CH_3COO^- follow the trend as $\text{CH}_3\text{O}^- > \text{OH}^- > \text{CH}_3\text{COO}^-$

Reason (R) : When the nucleophilic and basic sites are same in the species, the nucleophilicity parallels basicity.

(A) (B) (C) (D) (E)

12. **Assertion (A)** : Hydrogen molecule (H_2) is more stable than HeH^+ ion.

Reason (R) : The antibonding electrons present in the molecule or ion, destabilize it.

(A) (B) (C) (D) (E)

13. **Assertion (A)** : Carbon-carbon bond break rather than C-H bond when alkanes are pyrolysed, i.e., heated at higher temperature in absence of O_2 .

Reason (R) : Carbon-carbon bond in alkanes has a higher bond energy than does C-H bond.

(A) (B) (C) (D) (E)

14. **Assertion (A)** : The explosion takes place when concentrated H_2SO_4 is added to KMnO_4 .

Reason (R) : An explosive peroxosulphuric acid is formed when KMnO_4 reacts with conc. H_2SO_4 .

(A) (B) (C) (D) (E)

15. **Assertion (A)** : When hydrogen peroxide (H_2O_2) is added to alkaline potassium ferricyanide, the potassium ferrocyanide is formed.

Reason (R) : Hydrogen peroxide, when reacts with strong oxidising agents, it behaves as reducing agent.

(A) (B) (C) (D) (E)

16. **Assertion (A)** : Copper sulphate solution on reacting with excess of potassium cyanide solution gives $\text{K}_3[\text{Cu}(\text{CN})_4]$.

Reason (R) : Cupric state of copper is more stable than Cuprous state in the complex.

(A) (B) (C) (D) (E)

17. **Assertion (A)** : In the blast furnace iron metal is obtained by auto-reduction process.

Reason (R) : In blast furnace haematite ore is reduced by coke and carbon mono-oxide in different zones.

(A) (B) (C) (D) (E)

18. **Assertion (A)** : Nitration of aniline can only be done by protecting —NH_2 group by acetylation.

Reason (R) : Acetylation of aniline results in the increase of electron density at benzene ring.

(A) (B) (C) (D) (E)

19. **Assertion (A)** : $(\text{CH}_3)_3\text{N}$ has higher melting point as compared to NH_3 .

Reason (R) : The molecular mass of $(\text{CH}_3)_3\text{N}$ is much higher as compared to NH_3 molecule.

(A) (B) (C) (D) (E)

20. **Assertion (A)** : Methyl chloride can give methane as well as ethane separately in single steps.

Reason (R) : Wurtz reaction proceeds through free radical mechanism.

(A) (B) (C) (D) (E)

ZOOLOGY

21. **Assertion (A)** : Today, the theory of evolution is one of the great unifying theories of biology.

Reason (R) : Because it has been supported by so many different lines of evidence.

(A) (B) (C) (D) (E)

22. **Assertion (A)** : A threshold stimulus is the minimum stimulus needed to stimulate a muscle cell to contract.

Reason (R) : The all-or-none law states that a muscle cell contracts maximally or not at all.

(A) (B) (C) (D) (E)

23. **Assertion (A)** : The body plan of phylum Chordata is bilaterally symmetrical and segmented coelomates.

Reason (R) : Chordata is a very large and diverse phylum which has been studied extensively, mainly because it includes the vertebrates.

(A) (B) (C) (D) (E)

24. **Assertion (A)** : Long periods of close-up work such as reading can cause eyestrain.

Reason (R) : The eye-lens shape is changed by contraction of muscles in the ciliary body and prolonged contraction fatigues the ciliary muscle cells.

(A) (B) (C) (D) (E)

25. **Assertion (A)** : The adrenal medulla releases glucocorticoids and mineralo corticoids.

Reason (R) : The adrenal cortex releases the hormones nor-epinephrine and epinephrine when stimulated by ANS.

(A) (B) (C) (D) (E)

26. **Assertion (A)** : Frequent use or repetition of information facilitates consolidation, as does associating information in short-term memory with items that are already in long-term storage.

Reason (R) : Students needing long-term memory of technical terms and data frequently associate the information with nonsense rhymes. These and other memory tricks are called mnemonic devices.

(A) (B) (C) (D) (E)

27. **Assertion (A)** : The microtubule that brings about chromosomal movement during cell division is termed as centromere.

Reason (R) : As the cell cycle progresses, a protein combines with and activates the kinases that act to promote the events of cell cycle.

(A) (B) (C) (D) (E)

28. **Assertion (A)** : Clonal selection occurs when an antigen binds to a receptor on a lymphocyte which forms a clone of reactive cells.

Reason (R) : If a specific antigen invades the body, the lymphocyte with the correct specific receptor can bind to it and begin the immune response. During binding process, it selects a lymphocyte and serves as a signal for that lymphocyte to proliferate, producing a clone.

(A) (B) (C) (D) (E)

29. **Assertion (A)** : Eukaryotes evolved about 20 billion years ago.

Reason (R) : Phospholipids readily form spherical liposomes, and perhaps this was the origin of the plasma membrane.

(A) (B) (C) (D) (E)

30. **Assertion (A)** : In a metabolic reaction with a negative ΔG , the products contain less free energy than the reactants, energy is released and entropy increases.

Reason (R) : Such negative ΔG reaction is spontaneous because it occurs without an input of energy.

(A) (B) (C) (D) (E)

BOTANY

31. **Assertion (A)** : Lysosomes are membrane bounded vesicles that contain specific enzymes.

Reason (R) : Lysosomes are produced by Golgi apparatus, and their hydrolytic enzymes digest macromolecules from various sources.

(A) (B) (C) (D) (E)

32. **Assertion (A)** : Many species of *Selaginella* are herbaceous perennials.

Reason (R) : Some dorsiventral species are caulescent with erect stems from creeping rhizomes.

(A) (B) (C) (D) (E)

33. **Assertion (A)** : Transport of carbohydrates and other substances from one place to another through sieve tubes is called translocation.

Reason (R) : Thaine reported that cyclosis does not occur in mature sieve tubes.

(A) (B) (C) (D) (E)

34. **Assertion (A)** : The passive absorption of a substance occurs across a protoplasmic membrane from its lower to higher chemical potentials.

Reason (R) : Active absorption occurs across a protoplasmic membrane from its lower to higher chemical potential *i.e.*, against the concentration gradient.

(A) (B) (C) (D) (E)

35. **Assertion (A)** : Fruits and seeds of different kinds should be of light-weight for wind dispersal.

Reason (R) : So that the buoyancy of seeds and fruits help them to a long distance.

(A) (B) (C) (D) (E)

36. **Assertion (A) :** *Aquaspirilla* are helical or vibrioid organisms without flagella.

Reason (R) : Because in this organisms growth occurs in the presence of 3% NaCl.

(A) (B) (C) (D) (E)

37. **Assertion (A) :** Diffuse porous woods are characteristic of plants growing in alpine zone.

Reason (R) : Photorespiration is insignificant or rather absent in plants which have very low CO₂ compensation point.

(A) (B) (C) (D) (E)

38. **Assertion (A) :** Traits are expressed in different ways because a gene can exists in alternate forms, or alleles.

Reason (R) : An individual who has two identical alleles for a gene is homozygous for that gene. An individual with two different alleles is heterozygous.

(A) (B) (C) (D) (E)

39. **Assertion (A) :** The point of contact where crossing-over occurs is called mutation.

Reason (R) : The RNA polymerase does not bind to specific sequences in the DNA.

(A) (B) (C) (D) (E)

40. **Assertion (A) :** Yeasts are multicellular but most of the ascomycetes are composed of aseptate hyphae.

Reason (R) : The ascospores in ascomycetes are produced in thin-walled sac-like, spore producing units called asci.

(A) (B) (C) (D) (E)

ANSWERS WITH HINTS

TRUE OR FALSE

Physics

1. A square frame of side ' l ' carrying a current i produces a field ' B ' at its centre. The same current is passed through a circular coil having the same perimeter as the square. The field at the centre of circular coil is B' .

The ratio of $\left(\frac{B'}{B}\right)$ is $\frac{\pi^2}{8\sqrt{2}}$.

— T/F

2. We have the following arrangement in the order of descending wavelengths :

X-rays, ultraviolet light, visible light, radiowaves

— T/F

3. The (S.I.) unit of magnetic dipole moment is ampere- m^2 .

— T/F

4. The coefficient of expansion of copper is less than that of iron.

— T/F

5. A capacitor only is connected to an a.c. source. The current flowing in the circuit and the potential difference between the plates of the capacitor will be in phase.

— T/F

6. The unit ampere/weber is also known as henry.

— T/F

7. Cathode rays enter a magnetic field making an oblique angle with the lines of induction, then their path in magnetic field is parabola.

— T/F

8. The half life of a radioactive element depends upon its atomic number.

— T/F

9. The surface of some material is radiated in turn by waves of $\lambda = 3.5 \times 10^{-7}$ and $\lambda = 5.4 \times 10^{-7}$ m respectively. The ratio of the stopping potential in the two cases is 2 : 1. The work function of the metal is 1.05 eV.

— T/F

10. When potential difference across an X-ray tube is increased, intensity changes and minimum wavelength increases.

— T/F

11. If the elements with principal quantum number $n > 4$ were not allowed in nature, then the number of possible elements would be 64.

— T/F

12. Two light sources are said to be coherent if they emit waves of same wavelength having a constant phase difference.

— T/F

13. A radioactive element of half life 1.5 years completely disintegrates in four and a half years.

— T/F

14. The velocity of sound in liquids is less than that in gases.

— T/F

15. The binding energy of hydrogen atom is 13.6 eV. The binding energy of singly ionised helium atom is 54.4 eV.

— T/F

Chemistry

16. Inability of two liquids to dissolve in one another is known as immiscibility.

— T/F

17. Valence bond theory of chemical bonding was developed by **Linus Pauling** and molecular orbital theory by **Robert Mulliken**.

— T/F

18. Two or more than two substances having the same or similar crystalline form are known as **isomers**.

— T/F

19. If the density of an unknown gas is 1.429 g/L at STP, the molar mass of the gas is 14.29.

— T/F

20. Some elements exhibit two or more possible arrangements of particles in the same physical state, the phenomenon is known as **isomorphism**.

— T/F

21. An aliphatic ketone undergoes nucleophilic addition more easily than corresponding aliphatic aldehyde.

— T/F

22. A drying agent, such as silica gel, conc. H_2SO_4 , anhydrous calcium chloride, are known as desiccants.

— T/F

23. $Ni(CO)_4$ molecule is tetrahedral and diamagnetic.

— T/F

24. A temperature below which a gas cannot be changed into a liquid no matter how much pressure is applied, is known as critical temperature.

— T/F

25. Benzaldehyde is different from aliphatic aldehydes in its reaction towards Fehling solution.

— T/F

26. In sodium hydride, the hydrogen is present as an anion.

—T/F

27. At isoelectric point, an α -amino acid has the minimum solubility.

—T/F

28. Some gases bypass the liquid state and condense directly into solids. This is known as gas to solid condensation.

—T/F

29. Tertiary amines are always more basic than secondary amines.

—T/F

30. All orbitals in a subshell have the same energy and similar shape.

—T/F

Zoology

31. Gingiva is the gum tissue that surrounds the neck of the teeth and covers the alveolar processes of the maxilla and mandible.

—T/F

32. Cyclic AMP is a second messenger within cells.

—T/F

33. Natural parabiosis occurs in Siamese twins.

—T/F

34. Planarians are free-living Turbellarians.

—T/F

35. Perissodactyla is the order of mammals that contains even-toed ungulates.

—T/F

36. Prosimian is a group of primates that include apes and humans.

—T/F

37. Plasmagene is contained in a self-replicating cytoplasmic particle and inheritance of the characters controlled by such genes is Mendelian.

—T/F

38. The occurrence of different morphological stages during the life of an organism is called pleiomorphism.

—T/F

39. Intestinal micro-organisms are capable of synthesizing considerable amounts of phylloquinone and menaquinone vitamins.

—T/F

40. Some developmental structures or processes, such as gill pouches in mammalian embryos are regarded as phyletic.

—T/F

41. Planula is solid free-swimming ciliated larva of most cnidaria and a few of the ctenophores.

—T/F

42. Pentose phosphate pathway is an alternative to glycolysis.

—T/F

43. A conserved DNA sequence of 180 base pairs encodes a protein domain in many proteins.

—T/F

44. The rate of oxygen consumption of an organism or tissue is called oxygen quotient.

—T/F

45. Epitope is antibody determinant.

—T/F

Botany

46. A fertilized ovule is called fruit and an ovary containing fruit is called seed.

—T/F

47. The monomeric unit nucleotide in RNA is termed as ribotide.

—T/F

48. Stomata permit gaseous exchange between the plant and the environment and also control the rate of water loss.

—T/F

49. The enzyme which combines with non-protein part to form a functional enzyme is called holoenzyme.

—T/F

50. The flower colour in *Lathyrus odoratus* is determined by one recessive genes.

—T/F

51. Mycoplasma bears a rigid cell wall but no nucleic acid.

—T/F

52. Amino acid is activated by the reaction with ATP in the presence of **aminoacyl synthetase** enzyme and Mg^{2+} .

—T/F

53. The sclerotia of *Claviceps* are called ergot.

—T/F

54. Temperate deciduous woody perennials do not lose their leaves in autumn.

—T/F

55. Transpiration has been described as a necessary evil but potentially not harmful.

—T/F

56. Parthenogenesis involves well developed as well as fertilized egg for better development.

—T/F

57. DNA is associated with highly basic proteins called histones.

—T/F

58. Plants and plant communities grow in the same configurations and result in definite variety of heat balance.

—T/F

59. In clematis petiole is modified into a tendril.

—T/F

60. Seed coat develops from the integument of the ovule.

—T/F

Do You Know ?

Physics

Q. What are the important properties of electric charge ?

- ☞ (i) Electric charge is scalar.
- (ii) Electric charge is additive.
- (iii) There exist two kinds of electric charges.
- (iv) Like charges repel but unlike charges attract.
- (v) Electric charge is quantized.

Q. Define the gravitational constant G.

☞ It is defined as the force between two unit masses which are placed a unit distance apart.

$$F = \frac{Gm_1m_2}{d^2}$$

$$\therefore F = G$$

if $m_1 = m_2 = 1$ and $d = 1$

Q. What is a voltaic cell ? Name the scientist who designed it ?

☞ It is an arrangement for getting a continuous supply of electricity from the metals. It consists of copper and zinc plates dipped in an electrolyte (dil H_2SO_4). Sir Alessandro Volta first designed a voltaic cell.

Q. What does a solar system comprise ?

☞ The main constituents of the universe are the solar system, stars and galaxies. The solar system consists of the sun at the centre with nine planets (including the earth) revolving around it, and 32 natural satellites that revolve around the planets. In addition, there are many asteroids and hundreds of comets.

Q. What are the three uses of polaroids ?

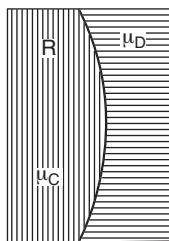
- ☞ (1) They are used as sun-glasses to avoid glare.
- (2) They are used in wind screens and head lights of automobiles to avoid glare.
- (3) Polaroids are used as window screens to regulate the amount of light entering the room.

Q. Why the light of a motor car becomes slightly dim when the car is started ?

☞ Initially, the starter draws a high current from the battery. This causes a large voltage drop across the internal resistance of the battery. Consequently, the potential difference across the terminals of the battery is reduced, thereby making lights dim.

Q. A plane glass plate is constructed by combining a plano-convex lens and a plano-concave lens of different materials as shown in figure. Will it act as a lens ? If so what will be its focal length and nature ?

☞ As μ_C and μ_D are refractive indices of convergent and divergent lens respectively and R the radius of curvature of common interface, by lens makers formula



$$\frac{1}{f_C} = (\mu_C - 1) \left[\frac{1}{\infty} - \frac{1}{-R} \right] = \frac{(\mu_C - 1)}{R} \quad \dots(1)$$

$$\text{and } \frac{1}{f_D} = (\mu_D - 1) \left[\frac{1}{-R} - \frac{1}{\infty} \right] = \frac{-(\mu_D - 1)}{R} \quad \dots(2)$$

Now as the lenses are in contact

$$\frac{1}{F} = \frac{1}{f_C} + \frac{1}{f_D} = \frac{(\mu_C - \mu_D)}{R}$$

$$\text{i.e., } F = \frac{R}{(\mu_C - \mu_D)}$$

As $\mu_C \neq \mu_D$, the system will act as a lens. The system will behave as convergent lens if $\mu_C > \mu_D$ (as its focal length will be positive) and as divergent lens if $\mu_C < \mu_D$ (as F will be negative).

Q. Why is the element of a heater very hot while the wires carrying the same current are not ? Explain.

☞ As element of heater is in series with the current carrying wires, current is same for both. Now as :

$$P = I^2 R$$

$$\text{i.e., } P \propto R \quad [\text{as } I \text{ is same}]$$

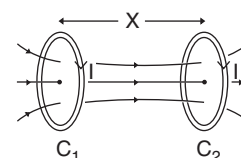
And as $R_H \gg R_W$, $P_H \gg P_W$ i.e., heater will dissipate more power than wires and so will be much hotter.

Q. Two identical co-axial circular loops carry equal currents circulating in the same direction. What will happen to the current in each loop if the loop's approach each other.

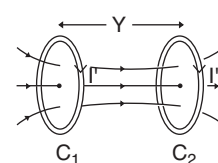
☞ As the field at an axial point due to a current carrying coil is given by

$$B = \frac{\mu_0}{4\pi} \frac{2\pi N I R^2}{(R^2 + x^2)^{3/2}}$$

So the coil approach each other the flux linked with each coil increases. So in accordance with Lenz's law a current will be induced in each coil which will try to decrease the flux, i.e., the induced current in each coils will be opposite to initial current. So, the current in each coil will decrease as the coil approach each other.



(A)



(B)

Q. What are the special characteristics of a heating wire and fuse wire ?

☞ The heating wire must have high resistance and high melting point while a fuse wire must have low resistance and low melting point.

Q. What is 'Thomson effect' ?

☞ The absorption or evolution of heat along the length of a conductor

when current is passed through it whose one end is hot and the other is cold is known as 'Thomson effect'. Thomson effect for lead is zero and it is positive for the metals below lead and negative for metals above lead in Seebeck series. The amount of heat energy absorbed or evolved per second between two points of a conductor having a unit temperature difference when a unit current is passed is known as Thomson coefficient for the material of the conductor. This is denoted by σ .

$$\sigma = \frac{\text{Heat energy evolved or absorbed}}{(\text{Charge flowing}) (\text{Temp. difference})}$$

Q. What is the principle of spin-dry cycle in an automatic washing machine ?

☞ In spin-dry cycle, the wet cloth is made to revolve rapidly about an axis and the water particles fly-off the cloth tangentially. This causes quick drying.

Q. What is 'Photon flux' ?

☞ The number of photons crossing unit area normally per sec is called photon-flux and is given by

$$\begin{aligned}\text{Photon flux} &= \frac{\text{Energy-flux}}{\text{Photon-energy}} \\ &= \frac{I}{E}\end{aligned}$$

Q. What is 'Electrostatic pressure' ?

☞ Force per unit area on the surface of a conductor due to its own charge is called 'Mechanical force or Electrostatic pressure'.

$$\frac{dF}{dS} = \frac{\sigma^2}{2\epsilon_0} = \frac{1}{2} \epsilon_0 \cdot E^2$$

Chemistry

Q. What is the difference between precision and accuracy of results in science ?

☞ Different measured values may vary slightly from one another. The term **precision** refers for closeness of the set of values obtained from identical measurements of a quantity. **Accuracy**, a related term, refers to the closeness of a single measurement to its true value.

Q. Why do jet aeroplanes flying at high altitude need pressurization of cabins ?

☞ The air pressure decreases with increase in altitude. This is why jet aeroplane flying at high altitude need pressurization of cabins so that the partial pressure of oxygen is sufficient for normal breathing. It is for the same reason that mountaineers have to carry oxygen cylinders when climbing to high ranges.

Q. What are the CFRP and CFRC ?

☞ These are two varieties of carbon fibres. Carbon fibre reinforced in a light weight matrix, generally an epoxy resin, polyester resin or polyamide are called **carbon fibre reinforced plastics** (CFRP). When the carbon fibres are reinforced in a carbon matrix, they are known as carbon fibre reinforced carbon (CFRC), commonly known as carbon-carbon composites.

Q. Which family of ceramics has been found to be superconductor with high critical temperature ?

☞ One such material is yttrium barium copper oxide which has critical temperature of 92 K. New superconducting ceramics reported to have even higher critical temperature have been recently developed.

Material	Critical Temperature (T_c)
$\text{Bi}_2\text{Cr}_2\text{Ca}_2\text{Cu}_3\text{O}_{10}$	110 K
$\text{Tl}_2\text{Ba}_2\text{Ca}_2\text{Cu}_3\text{O}_{10}$	125 K
$\text{HgBa}_2\text{Ca}_2\text{Cu}_2\text{O}_8$	153 K

Q. Which inorganic compounds are generally used as antacids ?

☞ Acid gastritis is the common ailment associated with digestion. It is caused by excess hydrochloric acid in the gastric juice. Magnesium hydroxide, magnesium carbonate, magnesium trisilicate, aluminium hydroxide gel, sodium bicarbonate and aluminium phosphate are commonly used as antacids.

Q. Cellulose is digested by ruminant mammals and not by human beings, why ?

☞ Large population of cellulolytic bacteria present in stomach (rumen) of ruminant mammals, breaks down cellulose with the help of enzyme cellulase. It is then digested and converted into glucose. Human stomach does not have enzyme capable of breaking cellulose molecules.

Q. What is the difference between Daltonide and Bertholide compounds ?

☞ The *stoichiometric* compounds, where the number of different types of atoms or ions are present exactly in the ratio indicated by their chemical formula are called **Daltonide** compounds. The *non-stoichiometric* compounds where the chemical composition of a compound is variable or not constant, are known as Bertholide compound.

Q. What is isoelectronic principle ?

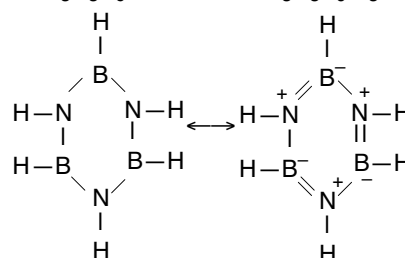
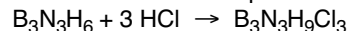
☞ Isoelectronic species are those which have same number of electrons. Such species have similar structure. This may be extended to species with the same number of **valence electrons**. Thus BF_4^- , CH_4 , NH_4^+ are all tetrahedral, CO_3^{2-} , NO_3^- and SO_3 are all planar triangular and CO_2 , N_3^- and NO_2^+ are all linear.

Q. Why a catalyst is generally needed when an organic compound is reduced with hydrogen ?

☞ The lack of reactivity of hydrogen is related to the strength of H—H bond. An essential step in H_2 reacting with another compound is breaking of H—H bond to produce atoms of hydrogen. This requires $435.9 \text{ kJ mol}^{-1}$, and there is high activation energy to such reactions. Hence most of reactions of hydrogen involve heterogeneous catalysis where catalyst first react with H_2 and either breaks or weakens the H—H bond and thus lowers the activation energy.

Q. What is inorganic benzene ?

☞ Borazine, $\text{B}_3\text{N}_3\text{H}_6$ is called **inorganic benzene** because its structure shows some formal similarities with benzene, with delocalized electrons and aromatic nature. The physical properties are also almost similar. Borazine is comparatively more reactive than benzene and addition reactions occur quite readily



Borazine

Q. Why carbon disulphide (CS₂) is stored in dark coloured bottles ?

☞ CS₂ is a colourless liquid, b.p. 46°C. It has a very low flash point (30°C). Sunlight changes CS₂ to CS and that is why it is stored in dark coloured bottles. CS is, unlike CO very reactive even at the liquid air temperature.

Q. What are the uses of soluble glass ?

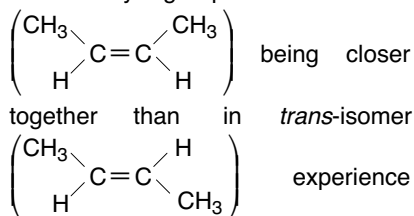
☞ Sodium or potassium silicates [Na₄SiO₄, (Na₂SiO₃)_n etc.] are called soluble silicates as these are soluble in water. They are used in liquid detergents to keep the pH high, so that grease and fat can be dissolved by forming a soap. Sodium silicate is also used as an adhesive, in asbestos roof tiles, in fireproof paint and putty and in making silica gel.

Q. Which salts are responsible for blue baby syndrome ?

☞ There is a grave and growing concern that nitrates are harmful in drinking water. They cause a disease in babies called *methaemoglobinemia*, which reduces the amount of oxygen in the baby's blood. In extreme forms this causes the blue baby syndrome. There is also concern that nitrates could be linked with stomach cancer.

Q. *trans*-2-butene is more stable than *cis*-2-butene which in turn is more stable than 1-butene, why ?

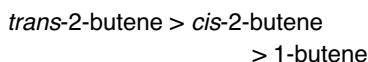
☞ This order of stability can be explained in terms of *steric effect* and *hyperconjugation*. In 1-butene (CH₃—CH₂—CH=CH₂) the steric repulsion is practically absent. In 2-butenes, the two methyl groups in *cis*-isomer



greater repulsion and consequently the *cis*-form is under greater strain than *trans* form. The steric effect destabilises a molecule. This *trans*-2-butene is more stable than *cis*-2-butene.

On the other hand hyperconjugation stabilises the molecule and is

smallest in 1-butene but much larger in 2-butenes. Since hyperconjugation has greater stabilising effect than steric destabilising effect, 1-butene is the least stable. The order of stability is as :



Zoology

Q. How many types chromatophores are found in vertebrates ?

☞ Skin cells lying superficially with permanent radiating processes containing pigment that can be concentrated or dispersed within the cell under nervous and/or hormonal stimulation, effecting colour changes are known as chromatophores. When dispersed, the pigment group of such cells are noticeable. When condensed in centre of cells, the region may appear pale. Three common types occur in vertebrates, i.e., **melanophores**, containing the dark brown pigment melanin; **lipophores**, with red-yellow carotenoid pigments; **guanophores**, containing guanine crystals whose light reflection may lighten the region when other chromatophores have their pigments condensed. Melanocyte-stimulating hormone disperses melanin, while melatonin and adrenaline concentrate it.

Q. What is population ?

☞ Population is a group of individuals of the same species inhabiting the same area. The members of the population are capable of interbreeding among themselves. A population is characterised by parameters like density, natality, mortality, age distribution, biotic potential, growth form etc. under favourable conditions, the population size tends to increase. Broadly speaking, two patterns of growth form occur, the J-shaped and S-shaped. The population size is determined by the balance between number of individuals added (by natality and immigration) and individuals removed (by mortality and emigration). The maximum size of the population that can be supported in a given habitat is called its carrying capacity.

Q. What are the functions of Pineal gland hormones ?

☞ The endocrine gland attached to the roof of third ventricle in the rear

portion of brain, is known as the pineal gland. It has no direct connection with central nervous system. It is richly vascularised and secretes several hormones, including melatonin. Pineal gland functions as a biological clock and a neurosecretory transducer, converting neural information. More melatonin is produced during darkness. Its formation is interrupted when light enters the eyes and stimulates the retinal neurons. They transmit impulses to the hypothalamus, and finally to the pineal gland. The result is inhibition of melatonin secretion. In this way, the release of melatonin is governed by the diurnal dark-light cycle.

Q. How bone grows ?

☞ Bones elongate by appositional growth at the epiphyseal plates under hormonal control (e.g., growth hormone). New cartilage cells are generated on the epiphyseal side of the plate and the older cartilage cells are destroyed and replaced by bone on the shaft side of the plate (thus plate has a constant thickness but the length of the shaft increases). Growth in diameter occurs when osteoblasts from the periosteum add new bone to the outer surface of the bone while osteoclasts erode bone material inside the shaft and so enlarge the marrow cavity.

Q. What is Mosaic Evolution ?

☞ A species might be thought of a mosaic of different molecules and structures that have evolved at different rates. Some molecules or structures are conserved in evolution, while others change more rapidly. The basic design of a bird provides a simple example. All birds are easily recognizable as because of highly conserved structures, such as feathers, bills and a certain body form. Particular parts of birds, however, are less conservative and have a higher rate of change. Wings have been modified for hovering, soaring and swimming. Similarly, legs have been modified for wading, swimming and perching. These are examples of mosaic evolution.

Q. What is muscle sliding filament model ?

☞ When a striped muscle contracts, the filament (which do not change length) slide past each other. In each sarcomere, the many globular

myosin heads which project laterally along each end of the heavy myosin filament attach to the actin filament and change conformation. The myosin pulls at the actin filaments adjacent to it. The myosin heads have been energetically charged, adopting a conformation in which they can bind to actin. This binding elicits the conformational change that provides the force for filament sliding and exposes an ATP-binding site. ATP binding causes an allosteric (shape) change that promotes detachment of the head from actin. Dephosphorylation of ATP provides the energy to re-establish the actin binding; thus the process is repeated many times (each using one ATP molecule) and the myosin pulls along the actin filament in a ratchet fashion. Since the ends of each myosin filament pull in opposite directions, towards the sarcomere centre, the myosin pulls the two actin regions closer and with them the Z lines, thus whole muscle contracts.

Botany

Q. What do you mean by cryptobiosis ?

☞ Cryptobiosis is a state of life in which the metabolic rate of an organism is reduced to an imperceptible level. The several kinds of cryptobiosis include **anhydrobiosis** (life without water), **cryobiosis (life at low temperatures)** and **amoxybiosis (life without oxygen)**.

States of anhydrobiosis occur in early developmental stages of various organisms, including seeds of plants, spores of bacteria and fungi, cysts of certain crustaceans and larvae of certain insects; they occur in both developmental and adult stages of certain soil-dwelling micrometazoans, certain ferns, mosses and lichens.

Q. What do you mean by association of protein subunits ?

☞ Proteins are a polymeric compound made up of various amino acids as the monomeric units. Many proteins with molecular weights of more than 50,000 occur in aqueous solutions as complexes—dimers, tetramers and higher polymers—i.e., as chains of two, four or more repeating basic structural units.

Proteins generally contain from 50 to 1000 amino acid residues per polypeptide chain. The subunits, which are called monomers or protomers, usually are present as even number. Less than 10% of the polymers have been found to have an odd number of monomers. The arrangement of the subunits is thought to be regular and may be cyclic, cubic or tetrahedral. Some of the small proteins also contain subunits. For example, insulin with a molecular weight of about 6000 consists of two peptide chains linked to each other by disulphide bridges (—S—S—). In certain other proteins hydrogen bonds and hydrophobic bonds (resulting from the interaction between amino acid side chains of leucine, isoleucine, valine and phenylalanine) cause the formation of aggregates of the subunits. The long polypeptide chains of fibrous proteins are held together in a rather well-defined configuration.

Q. What is virus interference ? How does it act ?

☞ Virus interference is a phenomenon which may be defined as protection of host cells against one virus, conferred as a result of prior infection with a different virus. Interference between viruses has been observed in humans, in laboratory animals and in tissue culture systems.

Interference is believed to act in one of two ways :

(i) The first virus may inactivate surface receptors of the cell and so make them unavailable to the second virus; or

(ii) The cell materials or enzymes necessary for the growth of the second virus may be taken over by or directed by the first virus.

Q. What do you mean by protogyny ?

☞ Protogyny is a condition in hermaphrodite or dioecious animals and plants in which the female reproductive structures mature before the male structures. It is of rare occurrence. Botanically, protogyny occurs in some plant species in which the female part stigma develops, withers and dies before male part anthers mature.

Q. What do you mean by primary vascular system of plant ?

☞ The arrangement of conducting elements which serve for two-way transportation of substances between different parts of a plant is known as

primary vascular system. The conducting elements are of two principal types : **xylem** and **phloem**.

Xylem is mainly responsible for the conduction of water together with dissolved inorganic substances upward from the roots to the other organs. Phloem is mainly responsible for the conduction of food materials (assimilates), a flow which may take place in either direction. In the shoot region of the plant, xylem and phloem are usually associated into vascular bundles. In the root, however, they usually alternate with one another on different radii.

Q. What do you mean by meristems based on plane of division ?

☞ Meristematic tissue, commonly called meristem, is composed of cells which are immature, not fully differentiated ones, and which possess the power of cell division.

Meristems on the basis of planes of divisions are of three types : mass meristem, rib meristem and plate meristem.

Mass meristem grows by dividing in all planes, so that the bodies formed are either isodiametric or have no definite shape. The **rib meristem** divides anticlinally to the long axis and gives rise to the longitudinal files or rows of cells. The **plate meristem** divides chiefly anticlinally into two planes, so that new cells are formed out number of layers does not increase.



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Correct Solution and Prize Winners of CSV Quiz No. 136

According to the rules of the CSV Quiz, all entry forms were examined. As a result, the following participants have qualified for various prizes. CSV sends them greetings and good wishes for their bright future. It also places on record its appreciation for their inquisitive nature and expresses obligation for their co-operation.

PRIZE WINNERS

First Prize


Ravi Jaiswal
C/o Gaurav Jaiswal
Room No. 88, A. N. Jha Hostel,
University of Allahabad, Allahabad
U.P.-211 002

Second Prize

1. Gagandeep Singh
C/o Dayaram Verma
L-971, Shastri Nagar, Meerut
U.P.-250 004
2. Romesh Nongmeikapam
Koirou Thongju Part-2
Imphal East
P.O.-Canchipur
Manipur-795 003

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C S V QUIZ CONTEST

- A ball is thrown vertically upward, reaches the roof of a house 100 metre high. At the moment this ball is thrown vertically upward another ball is dropped from rest vertically downward from the roof of the house. At which height do the balls pass each other and after what time ?
 (A) $20 \text{ m}, \frac{80}{\sqrt{1960}} \text{ s}$
 (B) $75 \text{ m}, \frac{75}{\sqrt{1960}} \text{ s}$
 (C) $75 \text{ m}, \frac{100}{\sqrt{1960}} \text{ s}$
 (D) None of these
- Find the area of the triangle having vertices at P (1, 3, 2), Q (2, -1, 1) and R (-1, 2, 3).
 (A) $\sqrt{107}$ (B) $\sqrt{\frac{107}{2}}$
 (C) $\frac{701}{\sqrt{2}}$ (D) $\frac{\sqrt{107}}{2}$
- Two equal drops of water are falling through air with a steady velocity of 10 cm/sec. If the balls recombine to form a single drop, what would be their terminal velocity ?
 (A) $\frac{10}{\sqrt{3}} \text{ cm/sec}$
 (B) $10 \times 2^{2/3} \text{ cm/sec}$
 (C) 10 cm/sec
 (D) $10 \times \sqrt{3} \text{ cm/sec}$
- In hydrogen atom, the electron moves in orbit of radius $5.0 \times 10^{-11} \text{ m}$ with a speed of $2.2 \times 10^6 \text{ m/s}$. Find the equivalent current—
 (A) 1.12 mA (B) 1.12 μA
 (C) 1.12 A (D) None of these
- A beam of protons enters a uniform magnetic field of 0.3 tesla with a velocity of $4 \times 10^5 \text{ m/s}$ at an angle of 60° to the field. Find the radius of the helical path taken by the beam as well as the pitch of the helix—
 (A) $r = 4.45 \times 10^{-3} \text{ m}$,
 $p = 1.226 \times 10^{-2} \text{ m}$
 (B) $r = 4.45 \times 10^{-2} \text{ m}$,
 $p = 1.226 \times 10^{-3} \text{ m}$
 (C) $r = 1.226 \times 10^{-2} \text{ m}$,
 $p = 4.45 \times 10^{-3} \text{ m}$
 (D) None of these
- During electrolysis of solution of AgNO_3 (silver nitrate), 9650 coulomb of charge passed through the electroplating bath, the mass of silver deposited on the cathode will be—
 (A) 10.8 g (B) 1.08 g
 (C) 108 g (D) 0.108 g
- Permittable pH range of drinking water should be between—
 (A) 5.5 and 6 (B) 5.5 and 9.5
 (C) 10 and 12 (D) 4 and 5
- The raisin pudding model of the atom was propounded by—
 (A) Belling
 (B) Mendeleev
 (C) Thomson
 (D) Ramakrishnan
- The electron pair geometry and molecular geometry of ICl_2^- ion is—
 (A) Tetrahedral, linear
 (B) Trigonal bipyramidal, bent
 (C) Tetrahedral, angular
 (D) Trigonal bipyramidal, linear
- The electronegativity of the following elements increases in the order—
 (A) $\text{C} < \text{Si} < \text{N} < \text{P}$
 (B) $\text{C} < \text{N} < \text{Si} < \text{P}$
 (C) $\text{N} < \text{C} < \text{P} < \text{Si}$
 (D) $\text{Si} < \text{P} < \text{C} < \text{N}$
- Which of the following is/are the member(s) of seed genera of Lyginopteridaceae ?
 (A) *Geminitheca*
 (B) *Hydrasperma*
 (C) *Eosperma*
 (D) All of the above
- Who among the following suggested that "the two pairs of genes under study were present on the same pair of homologous chromosomes" ?
 (A) T. H. Morgan
 (B) Bateson and Punnett
 (C) E. Chargaff
 (D) J. Belling
- Internal mechanism that maintains a biological rhythm in the absence of environmental stimulus is called—
 (A) Coevolution
 (B) Parallel evolution
 (C) Photoperiodism
 (D) Biological clock
- A dioecious plant has—
 (A) Two X-chromosomes
 (B) Two separate sexes in separate individuals
 (C) Both sexes in the same individual
 (D) Both X- and Y-chromosomes
- Red algae differ from green algae and brown algae in having—
 (A) No chlorophyll-a
 (B) No differentiated cells
 (C) Leghaemoglobin within their cells
 (D) No differentiated stages in their life cycle
- Metabolism is a highly coordinated and directed cell activity in which multienzyme systems co-operate to—
 (A) Polymerize monomeric precursors
 (B) Obtain chemical energy
 (C) Convert nutrient molecules
 (D) All of the above
- Lining of human intestine is—
 (A) Brush border
 (B) Ciliated
 (C) Keratinized
 (D) Dry and keratinized
- Which of the following muscles help urinary bladder to expel urine forcefully ?
 (A) Hamstring muscle
 (B) Detrusor muscle
 (C) Latissimus muscle
 (D) Erector muscle
- Certain behaviour patterns require an interaction of instinctive and learned components for efficient performance. In some instances, an animal may inherit a disposition to—
 (A) Learn unspecific behaviour
 (B) Learn specific behaviour
 (C) Learn Idiocy
 (D) Avoid specific behaviour
- Skates and rays are specialized for life—
 (A) In the air
 (B) In the desert
 (C) On the ocean floor
 (D) In the black soil

Rules for taking part in Quiz Contest of Competition Science Vision





1. All students or those appearing in competitive examinations can take part in this contest.
2. Candidates taking part in quiz contest will necessarily have to send their entries by a fixed date. Entries are to be sent by ordinary post. Please mark your envelope '**Quiz-Competition Science Vision**' on the top left hand side.
3. Answers given only on the form of the magazine will be admissible.
4. In the form there are four squares against each question number. Contestants should put a cross (x) in the square for the answer they think is correct. Giving more than one answer to a question will disqualify it.
5. Contestants should essentially write the number of questions they have solved.
6. Marks will be deducted for wrong answers.
7. The candidate sending the maximum number of correct answers will be given Rs. 600 as first prize. Next two candidates after that will get Rs. 400 and Rs. 300 as second and third prize respectively. If there are more than one candidate eligible for a prize, the amount will be equally distributed among them.
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Solution to Quiz No. 139 Competition Science Vision

Last date for sending 28th December, 2009

Name Mr./Miss/Mrs.

Full Address

State Pin Code No.

Age..... Academic Qualification.....

Competition examination for which preparing

I have read and understood the rules of quiz contest of Competition Science Vision issued by Pratiyogita Darpan and agree to abide by them.

(Signature)

RESULT

No. of questions attempted.....

No. of correct answers.....

No. of wrong answers.....

Marks obtained.....

ANSWER FORM

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3.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	13.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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8.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	18.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	19.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
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GENERAL AWARENESS

1. Tera Tali is the folk dance of—
(A) Kerala
(B) Rajasthan
(C) Madhya Pradesh
(D) Tamil Nadu
2. The Upanishads were translated by Dara Shikoh in Persian under the title of—
(A) Al-Fihrist
(B) Kitabul Bayan
(C) Mayma-ul-Bahrain
(D) Sirr-i-Akbar
3. The first joint meeting of both Houses of Indian Parliament as provided under Article 108 was held in connection with—
(A) Dowry Abolition Bill
(B) Hindu Code Bill
(C) Bank Nationalisation Bill
(D) Gold Control Bill
4. Which one of the following is the most urbanised state of India ?
(A) Maharashtra
(B) Mizoram
(C) Goa
(D) Tamil Nadu
5. The smallest bone of our body is found in—
(A) Our ear (B) Our nose
(C) Our eye (D) Our toe
6. UNO has fixed the target for Education for all till the year—
(A) 2012 (B) 2015
(C) 2018 (D) 2020
7. That an accused of an offence cannot be compelled to be a witness against himself is provided in—
(A) Article 20 (B) Article 21
(C) Article 22 (D) Article 74
8. The largest item of expenditure in the current account of Central Government budget is—
(A) Defence Expenditure
(B) Subsidies
(C) Interest Payments
(D) Expenditure on Social Services
9. Which one of the following is **not** an element of Human Development Index ?
(A) Life Expectancy at birth
(B) Infant Mortality Rate
(C) Adult Literacy Rate
(D) Number of people below poverty line
10. Hydrocarbon Vision 2025 is associated with—
(A) Storage of Petroleum Products
(B) Euro I and Euro II Vehicles
(C) Green House Effect
(D) None of the above
11. The largest producer of rubber in India is—
(A) Assam (B) Karnataka
(C) Kerala (D) Maharashtra
12. The beneficiary states of Sardar Sarovar Project are—
(A) Gujarat, Maharashtra, Madhya Pradesh and Rajasthan
(B) Andhra Pradesh, Madhya Pradesh, Gujarat and Maharashtra
(C) Orissa, Madhya Pradesh, Gujarat and Maharashtra
(D) Madhya Pradesh, Gujarat, Karnataka and Maharashtra
13. The source of the energy of the sun is—
(A) Nuclear fission
(B) Nuclear fusion
(C) Collision of atoms
(D) Chemical reactions
14. The speed of revolution of earth is—
(A) 28 km/min (B) 31 km/min
(C) 25 km/min (D) 39.5 km/min
15. Who discovered the nucleus ?
(A) James Chadwick
(B) J. J. Thomson
(C) Henry Rutherford
(D) Bohr
16. Under Charter Act 1833 which of the following provisions was **not** provided ?
(A) Governor-General of Bengal was the Governor-General of India
(B) The Government of Bombay and Madras were deprived of their legislative powers
(C) The activities of East India Company as a commercial body ended
(D) The portfolio system was given statutory recognition
17. Which of the following Government of India Acts contained the provision of bicameralism in provinces ?
(A) Government of India Act 1858
(B) Government of India Act 1919
(C) Government of India Act 1935
(D) None of the above
18. The Constituent Assembly formed in 1946 was assigned which of the following major functions ?
(A) Constituent functions
(B) Legislative functions
(C) Both (A) and (B)
(D) Neither (A) nor (B)
19. In context of evolution of Civil Service, which of the following is **not** correctly matched ?

Committee/Commission	Formation Year
(A) Macaulay Committee	1854
(B) Aitchison Committee	1886
(C) Islington Commission	1918
(D) Lee Commission	1920
20. Daroga System in India was introduced by Lord Cornwallis in—
(A) 1780 (B) 1792
(C) 1785 (D) 1770
21. First Municipal Corporation was set up in 1687 in—
(A) Bombay (B) Allahabad
(C) Madras (D) Calcutta
22. In 1921, which of the following important committees was created ?
(A) Committee on Public Undertakings
(B) Estimates Committee

- (C) Public Accounts Committee
(D) None of the above
23. How many stages does the General Budget of India go through during the process of enactment ?
(A) Five stages
(B) Six stages
(C) Seven stages
(D) Four stages
24. Which of the following Articles contains the provision that no money Bill imposing tax shall be introduced in Parliament except on the recommendation of the President ?
(A) Article 114
(B) Article 115
(C) Article 117
(D) None of the above
25. In total how many days are allotted for voting of demands contained in the Budget ?
(A) 30 days (B) 27 days
(C) 26 days (D) 20 days
26. The instrument which converts thermal energy into mechanical energy is called—
(A) Thermostat
(B) Dynamo
(C) Space System
(D) Thermal Engine
27. Which of the following causes disease of syphilis ?
(A) Bacteria (B) Fungus
(C) Protozoan (D) Virus
28. The substance used to bring down body temperature in high fever is—
(A) Tranquilisers
(B) Antipyretics
(C) Analgesics
(D) Antibiotics
29. Which one of the following elements is **not** naturally found in human body ?
(A) Copper (B) Zinc
(C) Iodine (D) Lead
30. Which one of the following is **not** a vitamin ?
(A) Folic acid
(B) Oleic acid
(C) Pantothenic acid
(D) Ascorbic acid

31. The winner of prestigious Abel Prize this year was—
(A) Mikhail Gromov
(B) Mahashweta Devi
(C) H. Sudarshan
(D) Martin Chalfie
32. Which among the following was **not** the winner of Nobel Prize winners 2008 in Chemistry ?
(A) Francoise Barre Sinoussi
(B) Osamu Shimomura
(C) Martin Chalfie
(D) Roger Y. Tsien
33. Peter Zumthor winner of Pritzker Prize—an equal to the Nobel Prize in architecture belongs to—
(A) France (B) Switzerland
(C) England (D) U.S.A.
34. National Science Day is observed on—
(A) February 28
(B) January 28
(C) March 28
(D) April 28
35. The first person to travel twice to space is—
(A) Suman Sharma
(B) Charles Simonyi
(C) David Kellermann
(D) None of the above
36. Which of the following cricketers was named as the leading cricketer 2008 in the World by 'Wisden magazine' ?
(A) R. T. Ponting
(B) Virendra Sehwag
(C) Sachin Tendulkar
(D) M. S. Dhoni
37. Warren Hastings appointed the Amini Commission in 1776 to—
(A) Gather information about the Indian Judicial System
(B) To work out the modalities of setting up judicial structure suitable to new colony
(C) Work out the administrative structure suitable to govern Indian territories
(D) Gather systematic information about the Indian agrarian system
38. With reference to Indian freedom struggle, which of the following was the lady representative of

India at the Second Round Table Conference ?

- (A) Aruna Asaf Ali
(B) Sarojini Naidu
(C) Sucheta Kripalani
(D) Vijayalakshmi Pandit

ANSWERS WITH HINTS