

BIOLOGY

Q 1. What is the role of NAD⁺ in cellular respiration?

- Option A It is a nucleotide source for ATP synthesis.
- Option B It functions as an electron carrier.
- Option C It functions as an enzyme.
- Option D It is the final electron acceptor for anaerobic respiration.

Correct Option B

Solution: NAD⁺ molecule acts as a shuttle for electrons during cellular respiration.

Q 2. Oxygen is not produced during photosynthesis by

- Option A *Cycas*
- Option B *Nostoc*
- Option C Green sulphur bacteria
- Option D *Chara*

Correct Option C

Solution: Green sulphur bacteria utilise H₂S instead of H₂O and performs an oxygenic photosynthesis. So, they do not evolve oxygen.

Q 3. Double fertilisation is

- Option A Fusion of two male gametes with one egg
- Option B Fusion of one male gamete with two polar nuclei
- Option C Fusion of two male gametes of a pollen tube with two different eggs
- Option D Syngamy and triple fusion

Correct Option D

Solution: In angiosperms, double fertilisation refers to the fusion of one sperm cell with an egg (syngamy), and another sperm cell with the polar nuclei to yield a triploid endosperm (triple fusion).

Q 4. In which of the following forms is iron adsorbed by plants?

- Option A Free element
- Option B Ferrous
- Option C Ferric
- Option D Both ferric and ferrous

Correct Option C

Solution: Plants absorb iron mostly in the form of ferric (Fe³⁺) ions (*as per NCERT*). However, plants in the acidic soil can absorb iron in ferrous (Fe²⁺) as well as ferric (Fe³⁺) form. Iron is reversibly oxidised from Fe²⁺ to Fe³⁺ during electron transfer.

Q 5. Which of the following elements is responsible for maintaining turgor in cells?

- Option A Potassium
- Option B Sodium
- Option C Magnesium
- Option D Calcium

Correct Option A

Solution: Among the given elements, potassium (K^+) is responsible for maintaining turgor pressure in cells because it regulates the proton pumps involved in opening and closing of stomata. Magnesium (Mg^{2+}) is a constituent of chlorophyll pigment which helps in photosynthesis in green plants. Calcium (Ca^{2+}) provides selective permeability to the cell membrane. Sodium (Na^+) is involved in membrane permeability.

Q 6. Which one of the following plants shows a very close relationship with a species of moth, where none of the two can complete, its life cycle without the other?

- Option A Banana
- Option B *Yucca*
- Option C *Hydria*
- Option D *Viola*

Correct Option B

Solution: *Yucca gloriosa* has developed an obligate symbiotic relationship with pronuba moth. The female yucca moth is the sole pollinator of the yucca plant, and the yucca is the only caterpillar host plant of the yucca moth.

Q 7. Pollen grains can be stored for several years in liquid nitrogen having temperature of

- Option A $-196^{\circ}C$
- Option B $-80^{\circ}C$
- Option C $-120^{\circ}C$
- Option D $-160^{\circ}C$

Correct Option A

Solution: Pollen grains can be stored for several years in liquid nitrogen having temperature of $-196^{\circ}C$. This method is called cryopreservation. The low temperature allows storage for a longer period by reducing the growth rate of cells. The cry protective agents delay the aging of plants and protect the plants from the damages due to cold.

Q 8. What type of ecological pyramid would be obtained with the following data?

Secondary consumer: 120 g

Primary consumer: 60 g

Primary Producer: 10 g

- Option A Upright pyramid of numbers
- Option B Pyramid of energy
- Option C Inverted pyramid of biomass
- Option D Upright pyramid of biomass

Correct Option C

Solution: The given data depicts an inverted pyramid of biomass, usually found in an aquatic ecosystem. Upright pyramid of biomass and numbers are not possible since the data depicts that the biomass of primary producer is less than that of the primary consumer which again is less than the secondary consumers. Pyramid of energy is always upright.

Q 9. Natality refers to

- Option A Number of individuals leaving the habitat
- Option B Birth rate
- Option C Death rate
- Option D Number of individuals entering habitat

Correct Option B

Solution: Natality is the birth rate within a population. Natality when compared with mortality rate can be used to determine the growth or decrease in a population.

Q 10. World Ozone Day is celebrated on

- Option A 16th September
- Option B 21st April
- Option C 5th June
- Option D 22nd April

Correct Option A

Solution: World Ozone Day is celebrated on 16th September. 5th June is World Environment Day. 21st April is National Yellow Bat Day. 22nd April is National Earth Day.

Q 11. In stratosphere, which of the following elements acts as a catalyst in degradation of ozone and release of molecular oxygen?

- Option A Fe
- Option B Cl
- Option C Carbon
- Option D Oxygen

Correct Option B

Solution: CFCs and other halogenated ozone depleting substances are mainly responsible for man-made chemical ozone depletion. CFCs rise into the stratosphere where they are eventually broken down by UV rays from the Sun. This causes them to release free chlorine. The chlorine reacts with oxygen which leads to the chemical process of destroying ozone molecules.

Q 12. Niche is

- Option A The range of temperature that the organism needs to live.
- Option B The physical space where an organism live.
- Option c All the biological factors in the organism's environment.
- Option D The functional role played by the organism where it lives.

Correct Option D

Solution: Joseph Grinnell in 1917 coined the term niche which he used as largely equivalent to a species habitat. Niche refers to the functional role played by the organism where it lives.

Q 13. Which of the following is a secondary pollutant?

- Option A SO₂
- Option B CO₂
- Option C CO
- Option D O₃

Correct Option D

Solution: A primary pollutant is a pollutant emitted directly from a source. A secondary pollutant is not directly emitted from the source but gets formed when other primary pollutants react in the atmosphere. Ozone (O₃) is a secondary pollutant.

Q 14. Which of the following statement is correct?

- Option A Horsetails are gymnosperms.
- Option B *Selaginella* is heterosporous while *Salvinia* is homosporous.
- Option C Ovules are not enclosed by ovary wall in gymnosperms.
- Option D Stems are usually unbranched in both *Cycas* and *Cedrus*.

Correct option C

Solution: In gymnosperms, ovules are not enclosed by ovary wall. Seeds are not enclosed within the fruit. They are naked. Horsetail is the common name of *Equisetum*. Pteridophytes like *Selaginella* and *Salvinia* are heterosporous and possess two types of spores, i.e. microspores and megaspores. *Cycas* has an unbranched columnar stem while *Cedrus* possess branched stem.

Q 15. Pneumatophores occurs in

- Option A Carnivorous plants
- Option B Free-floating hydrophytes
- Option C Halophytes
- Option D Submerged hydrophytes

Correct Option C

Solution: Some lateral roots of mangroves become specialised as pneumatophores in saline mud flats. These are lateral roots that grow upward for varying distances and function as the site of oxygen intake for the submerged primary root system.

Q 16. Sweet potato is a modified

- Option A Tap root
- Option B Adventitious root
- Option C Stem
- Option D Rhizome

Correct Option B

Solution: Sweet potato is a modified adventitious root for the storage of food. Rhizomes are underground modified stem. Tap root is a primary root directly elongated from the radicle.

Q 17. Secondary xylem and phloem in dicot stem are produced by:

- Option A Phellogen
- Option B Vascular cambium
- Option C Apical meristems
- Option D Axillary meristems

Correct Option B

Solution: Secondary tissues are generated from the growth of cambium. Vascular cambium gives rise to secondary xylem on the inside, and secondary phloem on the outside.

Q 18. Select the wrong statement.

- Option A Pseudopodia are locomotory and feeding structures in protozoans.
- Option B Mushrooms belong to Basidiomycetes.
- Option C Cell wall is present in members of Fungi and Plantae.

Option D Mitochondria are the powerhouse of the cell in all kingdoms except Moneta.

Correct Option A

Solution: Sporozoans such as *Plasmodium* are end parasites. They lack Locomotors organelles like cilia, flagella and pseudopodia. Pseudopodia are found in amoeboid protozoans, e.g., *Amoeba* and *Entamoeba*.

Q 19. Casparian strips occur in

- Option A Cortex
- Option B Pericycle
- Option C Epidermis
- Option D Endodermis

Correct Option D

Solution: Casparian strip is a band of cell wall material deposited in the radial and transverse walls of the endodermis. Casparian strip is made of suberin and sometimes lignin.

Q 20. Plants having little or no secondary growth are

- Option A Conifers
- Option B Deciduous angiosperms
- Option C Grasses
- Option d Cycads

Correct Option C

Solution: Grasses are monocots and monocots usually do not exhibit secondary growth. Palm like monocots have anomalous secondary growth.

Q 21. A 'new' variety of rice was patented by a foreign company, though such varieties have been present in India for a long time. This is related to

- Option A Lerma Rojo
- Option B Sharbati Sonora
- Option C Co-667
- Option D Basmati

Correct Option D

Solution: In 1997, an American company got patent rights on Basmati rice through the US patent and trademark office. This variety was actually been derived from Indian farmer's varieties. Indian basmati was crossed with semi-dwarf varieties and claimed as an invention or a novelty. Sharbati Sonora and Lerma Rojo are varieties of wheat.

Q 22. Which of the following is commonly used as a vector for introducing a DNA fragment in human lymphocytes?

- Option A λ - phage
- Option B Ti plasmid
- Option C Retrovirus
- Option D pBR 322

Correct Option C

Solution: Retrovirus is commonly used as a vector for introducing a DNA fragment in human lymphocytes.

Q 23. Use of bioresources by multinational companies and organisation without authorisation from the concerned country and its people is called

- Option A Bio-degradation
- Option B Bio-piracy
- Option C Bio-infringement
- Option D Bio-exploitation

Correct Option B

Solution: Biopiracy refers to the use of bioresources by multinational companies and organisation without authorisation from the country and the people concerned with compensatory payment.

Q 24. Select the correct match:

- Option A T.H.Morgan - Transduction
- Option B $F_2 \times$ Recessive parent - Dihybrid cross
- Option C Ribozyme - Nucleic acid
- Option D G. Mendel - Transformation

Correct Option C

Solution: Ribozyme is a catalytic RNA which is a nucleic acid.

Q 25. The correct order of steps in Polymerase Chain Reaction (PCR) is

- Option A Denaturation, Extension, Annealing
- Option B Annealing, Extension, Denaturation
- Option C Extension, Denaturation, Annealing
- Option D Denaturation, Annealing, Extension

Correct option D

Solution: PCR involves three major steps in the synthesis of DNA – (a) denaturation of the template into single strands (b) annealing of primers to each original strand for the synthesis of new strand (c) extension of the new DNA strands from the primers.

Q 26. In India, the organisation responsible for assessing the safety of introducing genetically modified organisms for public use is

- Option A Research Committee on Genetic Manipulation (RCGM)
- Option B Council for Scientific and industrial Research (CSIR)
- Option C Indian Council of Medical Research (ICMR)
- Option D Genetic Engineering Appraisal Committee (GEAC)

Correct Option D

Solution: Indian Government has set up an organisation called Genetic Engineering Appraisal Committee (GEAC) which makes decisions regarding the validity of the GM research and safety of introducing GM organisms for public services.

Q 27. The stage during which separation of the paired homologous chromosomes begins is

- Option A Diakinesis
- Option B Diplotene
- Option C Pachytene
- Option D Zygotene

Correct Option B

Solution: During diplotene stage of meiosis, there is dissolution of synaptonemal complex and the recombined homologous chromosomes of the bivalents tend to separate.

Q 28. The Golgi complex participates in

- Option A Respiration bacteria
- Option B Formation of secretory vesicles
- Option C Fatty acid breakdown
- Option D Activation of amino acid

Correct Option B

Solution: Golgi complex after processing, packages the substances into vesicles and either stores them for later use or sends them out of the cell. It is also involved in the synthesis of lysosomes.

Q 29. Stomatal movement is not affected by

- Option A O₂ Concentration
- Option B Light
- Option C Temperature
- Option D CO₂ concentration

Correct Option A

Solution: Light, temperature and CO₂ concentration affect the opening and closing of stomata. O₂ concentration has not effect on this activity.

Q 30. Stomata in grass leaf are

- Option A Rectangular
- Option B Kidney shaped
- Option C Dumb-bell-shaped
- Option D Barrel shaped

Correct Option C

Solution: Grass being a monocot, has dumb-bell shaped stomata in its leaves.

Q 31. The two functional groups characteristic of sugars are

- Option A carbonyl and phosphate
- Option B carbonyl and methyl
- Option C hydroxyl and methyl
- Option D carbonyl and hydroxyl

Correct Option D

Solution: Sugar is a carbohydrate. Carbohydrates are polyhydroxy aldehydes, ketone or their derivatives. This implies that they have carbonyl and hydroxyl groups in their structure.

Q 32. Which of the following is not a product of light reaction of photosynthesis?

- Option A NADPH
- Option B NADH
- Option C ATP
- Option D Oxygen

Correct Option B

Solution: ATP, NADPH and oxygen are products of light reaction while NADH is a product of respiration.

Q 33. Which of the following is true for nucleolus?

- Option A It takes part in spindle formation.
Option B It is a membrane-bound structure.
Option c Larger nucleoli are present in dividing cells.
Option d It is a site for active ribosomal RNA synthesis.

Correct Option D

Solution: The nucleolus is a large, distinct, spherical sub-compartment of the nucleus in eukaryotic cells. It acts as the site for the synthesis of ribosomal RNA and assembly of ribosomal subunits.

Q 34. Which among the following is not a prokaryote?

- Option A *Nostoc*
Option B *Mycobacterium*
Option C *Saccharomyces*
Option D *Oscillatoria*

Correct Option C

Solution: *Saccharomyces* (yeast) is a unicellular fungi (eukaryote). *Mycobacterium* is a bacterium. *Oscillatoria* and *Nostoc* are cyanobacteria.

Q 35. Winged pollen grains are present in

- Option A Mango
Option B *Cycas*
Option C Mustard
Option D *Pinus*

Correct Option D

Solution: Winged pollen grains are present in *Pinus*. Each pollen grain has two wing-like structures which enable it to float in air as an adaptation for dispersal by wind.

Q 36. After karyogamy followed by meiosis, spores are produced exogenously in

- Option A *Agaricus*
Option B *Alternaria*
Option C *Neurospora*
Option D *Saccharomyces*

Correct Option A

Solution: In *Agaricus* (a genus of basidiomycetes), basidiospores or meiospores are produced exogenously. *Neurospora* (a genus of ascomycetes) produces ascospores as meiospores but endogenously inside the ascus. *Alternaria* (a genus of deuteromycetes) does not produce sexual spores. *Saccharomyces* (unicellular ascomycetes) produces ascospores, endogenously.

Q 37. Which one is wrongly matched?

- Option A Gemma cups - *Marchantia*
Option B Biflagellate zoospores - Brown algae
Option C Uniflagellate gametes - *Polysiphonia*
Option D Unicellular organism - *Chlorella*

Correct Option C

Solution: *Polysiphonia* is a genus of red algae where asexual spores and gametes are non-motile or non-flagellated.

Q 38. Match the items given in column I with those in column II and select the option given below:

Column I		Column II
a.	Herbarium	(i) It is a place having a collection of preserved plants and animals.
b.	Key	(ii) A list that enumerates methodically all the species found in an area with brief description aiding identification.
c.	Museum	(iii) Is a place where dried and pressed plant specimens mounted on sheets are kept.
d.	Catalogue	(iv) A booklet containing a list of characters and their alternate which are helpful in identification of various taxa.

	a	b	c	d
Option A	ii	iv	iii	i
Option B	iii	ii	i	iv
Option C	i	iv	iii	ii
Option D	iii	iv	i	ii

Correct Option D

Solution: Herbarium is a place where dried and pressed plant specimens mounted on sheets are kept. Key is a booklet containing a list of characters and their alternates which are helpful in identification of various taxa. Museum is a place having a collection of preserved plants and animals. Catalogue is a list that enumerates methodically all the species found in an area with brief description aiding identification.

Q 39. Which of the following flowers only once in its life-time?

- Option A Mango
- Option B Jackfruit
- Option C Bamboo species
- Option D Papaya

Correct option C

Solution: A monocarpic flowers and produces seeds only once before drying, e.g. bamboo. A polycarpic plant reproduces sexually more than once in its lifetime, e.g., jackfruit, mango and papaya.

Q 40. Which of the following pairs is wrongly matched?

- | | | | |
|----------|---------------------------|---|------------------|
| Option A | XO type sex determination | - | Grasshopper |
| Option B | ABO blood grouping | - | Co-dominance |
| Option C | Starch synthesis in pea | - | Multiple alleles |
| Option d | T.H. Morgan | - | Linkage |

Correct Option C

Solution: Starch synthesis in pea is controlled by pleiotropic gene. Pleiotropy occurs when one gene influences two or more seemingly unrelated phenotypic traits.

Q 41. Offsets are produced by

- | | |
|----------|-------------------|
| Option A | Parthenocarpy |
| Option B | Mitotic divisions |
| Option C | Meiotic divisions |
| Option D | Parthenogenesis |

Correct Option B

Solution: Offset is a vegetative part of the plant formed by mitosis.

Q 42. Which of the following has proved helpful in preserving pollen as fossils?

- | | |
|----------|-------------------|
| Option A | Oil content |
| Option B | Cellulosic intine |
| Option C | Pollenkitt |
| Option D | Sporopollenin |

Correct Option D

Solution: Sporopollenin cannot be degraded by enzymes, strong acids and alkalis. Therefore, it is helpful in preserving pollen as fossils.

Q 43. Select the correct statement:

- | | |
|----------|--|
| Option A | Spliceosomes take part in translation. |
| Option B | Punnett square was developed by a British scientist. |
| Option C | Franklin Stahl coined the term "linkage". |
| Option D | Transduction was discovered by S. Altman. |

Correct Option B

Solution: Punnett, a British scientist devised the 'Punnett Square' to depict the number and variety of genetic combinations. Franklin Stahl proved the semi-conservative mode of DNA replication. Transduction was discovered Zinder and Lederberg. Spliceosome formation is a part of the post-transcriptional change in eukaryotes.

Q 44. The experimental proof for semiconservative replication of DNA was first shown in a

- | | |
|----------|-----------|
| Option A | Plant |
| Option B | Bacterium |
| Option C | Fungus |
| Option D | Virus |

Correct Option B

Solution: Semiconservative replication of DNA was first shown in a bacterium, *Escherichia coli* by Matthew Meselson and Franklin Stahl.

Q 45. Select the correct match:

Option A	Matthew Meselson and F. Stahl	-	<i>Pisum sativum</i>
Option B	Alfred Hershey and Martha Chase	-	TMV
Option C	Alec Jeffreys	-	<i>Streptococcus pneumoniae</i>
Option D	Francois Jacob and Jacques Monod	-	Lac operon

Correct Option D

Solution: Francois Jacob and Jacques Monod proposed the model of gene regulation called operon model (lac operon). Alec Jeffreys gave the DNA fingerprinting technique. Matthew Meselson and F. Stahl gave the semiconservative DNA replication in *E.coli*. Alfred Hershey and Martha Chase proved DNA as the genetic material and not protein.

Q 46. Match the items given in Column I with those in Column II and select the correct option given below:

	Column I	Column II
a.	Tidal volume	i. 2500-3000 mL
b.	Inspiratory reserve volume	ii. 1100-1200 mL
c.	Expiratory reserve volume	iii. 500-550 mL
d.	Residual volume	iv. 1000-1100 mL

	a	b	c	d
Option A	i	iv	ii	iii
Option B	iii	i	iv	ii
Option C	iii	ii	i	iv
Option D	iv	iii	ii	i

Correct Option B

Solution: Tidal volume (TV) is the volume of air inspired or expired during normal respiration. It is approximately 500 mL. Inspiratory reserve volume (IRV) is additional volume of air a person can inspire by forceful inspiration. It is around 2500-3000 mL. Expiratory reserve volume (ERV) is additional volume of air a person can expire by forceful expiration. This averages 1000-1100 mL. Residual volume (RV) is volume of air remaining in lungs even after forceful expiration. This averages 1100-1200 mL.

Q 47. Which of the following options correctly represents the lung conditions in asthma and emphysema respectively?

Option A	Increased respiratory surface; Inflammation of bronchioles
Option B	Increased number of bronchioles; Increased respiratory surface
Option C	Inflammation of bronchioles; Decreased respiratory surface
Option D	Decreased respiratory surface; Inflammation a bronchioles

Correct Option C

Solution: Asthma is a long-term inflammatory disease of the airway of the lungs. It results in difficulty in breathing causing wheezing due to inflammation of bronchi and bronchioles. Emphysema is a chronic disorder in which alveolar walls are damaged due to which the respiratory surface is decreased. It is primarily caused by smoking.

Q 48. Match the items given in Column I with those in Column II and select the correct option given below:

Column I		Column II
a.	Tricuspid valve	i. Between left atrium and left ventricle
b.	Bicuspid valve	ii. Between right ventricle and pulmonary artery
c.	Semilunar valve	iii. Between right atrium and right ventricle

	a	b	c
Option A	i	ii	iii
Option B	i	iii	ii
Option C	iii	i	ii
Option D	ii	i	iii

Correct Option C

Solution: Tricuspid valves are AV valves present between the right atrium and right ventricle of the heart. Bicuspid valves are AV valves present between the left atrium and left ventricle. Semilunar valves are present at the openings of the aortic and pulmonary aorta.

Q 49. All of the following are part of an operon except

- Option A an enhancer
- Option B structural genes
- Option C an operator
- Option D a promoter

Correct Option A

Solution: Unlike eukaryotes, in prokaryotes, the genes are organized into an operon. An operon is made up of several structural genes arranged under a common promoter and regulated by a common operator.

Q 50. AGGTATCGCAT is a sequence from the coding strand of a gene. What will be the corresponding sequence of the transcribed mRNA?

- Option A ACCUAUGCGAU
- Option B UGGTUTCGCAT
- Option C AGGUAUCGCAU
- Option D UCCAUAAGCGUA

Correct Option C

Solution: Coding strand and mRNA have similar nucleotide sequence except, thymine (T) is replaced by uracil (U) in mRNA.

Q 51. According to Hugo de vries, the mechanism of evolution is

- Option a Phenotypic variation
- Option B Saltation
- Option C Multiple step mutations
- Option D Minor mutations

Correct Option B

Solution: As per the mutation theory given by Hugo de vries, evolution is a discontinuous phenomenon or saltatory phenomenon or saltation.

Q 52. Match the items given in column I with those in column II and select the correct option given below:

Column I	Column II
a. Proliferative phase	i. Breakdown of endometrial lining
b. Secretory phase	ii. Follicular Phase
c. Menstruation	iii. Luteal Phase

	a	b	c
Option A	ii	iii	i
Option B	i	iii	ii
Option C	iii	ii	i
Option D	iii	i	ii

Correct Option A

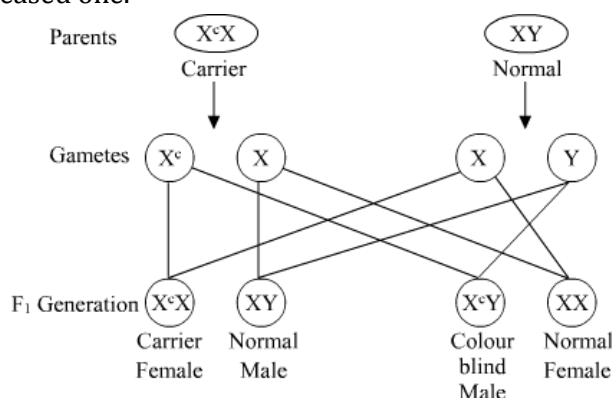
Solution: In proliferative phase, the follicles start developing. Hence, it is also called follicular phase. Secretory phase also called luteal phase is mainly controlled by progesterone secreted by corpus luteum. Menstruation involves breakdown of overgrown endometrial lining.

Q 53. A woman has X-linked condition on one of her X chromosomes. This chromosome can be inherited by

- Option A Only grandchildren
- Option B Only sons
- Option C Only daughters
- Option D Both sons and daughters

Correct Option D

Solution: Woman acts as a carrier. Both son and daughter inherit the X chromosome, although only the son would be the deceased one.



Q 54. Ciliates differ from all other protozoans in

- Option A Using pseudopodia for capturing prey
- Option B Having a contractile vacuole for removing excess water
- Option C Using flagella for locomotion
- Option D Having two types of nuclei

Correct Option D

Solution: Ciliates differ from other protozoans in having two types of nuclei. E.g. *Paramecium* has two types of nuclei, macronucleus and micronucleus.

Q 55. Identify the vertebrate group of animals characterized by crop and gizzard in their digestive system.

- Option A Aves
- Option B Reptilia
- Option C Amphibia
- Option D Osteichthyes

Correct Option A

Solution: The digestive tract of Aves has additional chambers called crop and gizzard. Crop is associated with the storage of foodgrains whereas gizzard is a masticatory organ in birds used to crush foodgrains.

Q 56. Which of the following organism are known as chief producers in the ocean?

- Option A Cyanobacteria
- Option B Diatoms
- Option C Dinoflagellates
- Option D Euglenoids

Correct Option B

Solution: Diatoms are the chief producers in some oceans and in some seasons as they are the primary producers of food and the food chain in marine ecosystem depends on them.

Q 57. Which of the following features is used to identify a male cockroach from a female cockroach?

- Option A Forewings with darker tegmina
- Option B Presence of caudal styles
- Option C Presence of a boat shaped sternum on the 9th abdominal segment
- Option D Presence of anal cerci

Correct Option B

Solution: Male cockroaches bear a pair of short, thread-like anal styles which are absent in females. Anal/caudal styles arise from the 9th abdominal segment in male cockroaches.

Q 58. Which of the following animals does not undergo metamorphosis?

- Option A Moth
- Option B Tunicate
- Option C Earthworm
- Option D Starfish

Correct Option C

Solution: Metamorphosis refers to the transformation of larva into an adult. Animals that undergo metamorphosis are said to have indirect development. Earthworms have a direct development which means no larval stage is formed. Hence, there is no metamorphosis in earthworms.

Q 59. Which one of these animals does not a homeotherm?

- Option A *Camelus*
- Option B *Chelone*
- Option C *Macropus*
- Option D *Psittacula*

Correct Option B

Solution: Homeotherms are organisms which have a body temperature that is relatively constant and independent of the environmental temperature. Most mammals including humans as well as birds are endothermic homeotherms. Most fishes, invertebrates, reptiles and amphibians are ectothermic poikilotherms. *Chelone* (turtle) belongs to class Reptilia. Hence, it is a poikilotherm or cold-blooded animal.

Q 60. The transparent lens in the human eye is held in its place by

- Option A Smooth muscles attached to the iris
- Option B Ligaments attached to the iris
- Option C Ligaments attached to the ciliary body
- Option D Smooth muscles attached to the ciliary body

Correct Option C

Solution: The muscles that move the eyeball are attached to the sclera. Suspensory ligament of lens- a series of fibres that connect the ciliary body of the eye with the lens holding it in place.

Q 61. Which of the following structure or regions is incorrectly paired with its function?

Option A	Hypothalamus	Production of releasing hormones and regulation of temperature, hunger and thirst
Option B	Limbic system	Consists of fibre tracts that interconnect different regions of brain; controls movement.
Option C	Medulla oblongata	Controls respiration and cardiovascular reflexes
Option D	Corpus callosum	Band of fibres connecting left and right cerebral hemispheres

Correct Option B

Solution: The limbic system is responsible for the experience and expression of emotion but not movement. It is located in the core of the brain and includes the amygdala, hippocampus and hypothalamus.

Q 62. Which of the following hormones can play a significant role in osteoporosis?

- Option A Estrogen and Parathyroid hormone
- Option B Progesterone and Aldosterone
- Option C Aldosterone and Prolactin
- Option D Parathyroid hormone and Prolactin

Correct Option A

Solution: Osteoporosis is mainly caused due to excess of parathyroid hormone, advanced age and lack of estrogen in older females. Estrogen promotes the activity of osteoblast and inhibits osteoclast. Parathormone promotes mobilisation of calcium from bone into blood. Excessive activity of parathormone causes demineralisation leading to osteoporosis.

Q 63. Which of the following is an amino acid derived hormone?

- Option A Estradiol
 Option B Ecdysone
 Option C Epinephrine
 Option D Estriol

Correct Option C

Solution: Epinephrine is derived from tyrosine by the removal of carboxyl group. It is a catecholamine.

Q 64. Match the items given in column I with those in Column II and select the correct option given below:

Column I	Column II
a. Glycosuria	i. Accumulation of uric acid in joints
b. Gout	ii. Mass of crystallised salts within the kidney
c. Renal calculi	iii. Inflammation in glomeruli
d. Glomerul nephritis	iv. Presence of glucose in urine

	a	b	c	d
Option A	ii	iii	i	iv
Option B	i	ii	iii	iv
Option C	iii	ii	iv	i
Option D	iv	i	ii	iii

Correct Option D

Solution: Glycosuria denotes presence of glucose in the urine. Gout is due to deposition of uric acid crystals in the joint. Renal calculi are precipitates of calcium phosphate produced in the pelvis of the kidney. Glomerular nephritis is the inflammatory condition of glomerulus characterised by proteinuria and haematuria.

Q 65. Match the items given in Column I with those in Column II and select the correct option given below

Column I	Column II
a. Ultrafiltration	i. Henle's loop
b. Concentration of urine	ii. Ureter
c. Transport of urine	iii. Urinary bladder
d. Storage of urine	iv. Malpighian corpuscle
	v. Proximal convoluted tubule

	a	b	c	d
Option A	V	iv	i	ii
Option B	iv	i	ii	iii
Option C	iv	V	ii	iii
Option D	v	iv	i	iii

Correct Option B

Solution: In renal physiology, ultrafiltration occurs at the barrier between the blood and the filtrate in the glomerular capsule in the kidneys. Concentration of urine refers to water absorption from glomerular filtrate created by counter-current mechanism in Henle's loop. Urine is carried from the kidney to bladder through ureter. Urinary bladder is for storage of urine.

Q 66. Which of the following gastric cells indirectly help in erythropoiesis?

- Option A Goblet cell
- Option B Mucous cell
- Option C Chief cells
- Option D Parietal cells

Correct Option D

Solution: Parietal or oxyntic cell is a source of HCl and intrinsic factor. HCl converts iron present in the diet from ferric to ferrous form so that it can be absorbed easily and used during erythropoiesis. Intrinsic factor is essential for the absorption of vitamin B₁₂ and its deficiency causes pernicious anaemia.

Q 67. Match the items given in Column I with those in Column II and select the correct option given below:

Column I	Column II
Fibrinogen	Osmotic balance
Globulin	Blood clotting
Albumin	Defence mechanism

- | | a | b | c |
|----------|----------|----------|----------|
| Option A | i | iii | ii |
| Option B | i | ii | iii |
| Option C | iii | ii | i |
| Option D | ii | iii | i |

Correct Option D

Solution: Fibrinogen forms fibrin strands during coagulation. These strands form a network, the meshes of which are occupied by blood cells. This structure finally forms a clot. Antibodies are derived from gamma-globulin fraction of plasma proteins which means globulins are involved in defence mechanisms. Albumin is a plasma protein mainly responsible for Blood Colloidal Osmotic Pressure (BCOP).

Q 68. Calcium is important in skeletal muscle contraction because it

- Option A Detaches the myosin head from the actin filament.
- Option B Activates the myosin ATPase by binding to it.
- Option C Binds to troponin to remove the masking of active site on actin for myosin.
- Option D Prevents the formation of bonds between the myosin cross bridges and the actin filament.

Correct Option C

Solution: The sarcoplasmic reticulum releases calcium ions into the muscle interior where they bind to troponin, thus causing tropomyosin to shift from the face of the actin filament to which myosin heads need to bind to produce contraction.

Q 69. Which of the following is an occupational respiratory disorder?

- Option A Botulism
- Option B Silicosis
- Option C Anthracis
- Option D Emphysema

Correct Option B

Solution: Silicosis is an occupational disease caused due to excess inhalation of silica dust in the workers involved in grinding or stone breaking industries.

Q 70. Which of these statements is incorrect?

- Option A Glycolysis operates as long as it is supplied with NAD that can pick up hydrogen atoms.
- Option B Glycolysis occurs in cytosol.
- Option C Enzymes of TCA cycle are present mitochondrial matrix.
- Option D Oxidative phosphorylation takes place in the outer mitochondrial membrane.

Correct Option D

Solution: Oxidative phosphorylation takes place in the inner mitochondrial membrane.

Q 71. Nissl bodies are mainly composed of

- Option A Nuclei acids and SER
- Option B DNA and RNA
- Option C Proteins and lipids
- Option D Free ribosomes and RER

Correct Option D

Solution: Nissl bodies are present in the cell body of a neuron. When observed under an electron microscope, they appear to be composed of rough endoplasmic reticulum (RER) and free ribosomes and thus, help in protein synthesis.

Q 72. Select the incorrect match:

Option A	Sub-metacentric Chromosomes	-	L- shaped chromosomes
Option B	Allosomes	-	Sex chromosomes
Option C	Lampbrush chromosomes	-	Diplotene bivalents
Option D	Polytene chromosomes	-	Oocytes of amphibians

Correct Option D

Solution: Polytene chromosomes are found in the salivary glands of insects of order Diptera.

Q 73. Many ribosomes may associate with a single mRNA to form multiple copies of a polypeptide simultaneously. Such strings of ribosomes are termed as

- Option A Plastodome
- Option B Polyhedral bodies
- Option C Polysome
- Option D Nucleosome

Correct Option C

Solution: A polyribosome or polysome is a complex of an mRNA molecule and two or more ribosomes that act to translate the mRNA instructions into polypeptides.

Q 74. Which of the following events does not occur in rough endoplasmic reticulum?

- Option A Cleavage of signal peptide
- Option B Protein glycosylation
- Option C Protein folding
- Option D Phospholipid synthesis

Correct Option D

Solution: Phospholipid synthesis does not take place in rough endoplasmic reticulum (RER). Smooth endoplasmic reticulum (SER) is involved in lipid synthesis.

Q 75. Which of the following terms describe human dentition?

- Option A Pleurodont, Monophodont, Homodont
- Option B Thecodont, Diphyodont, Heterodont
- Option C Thecodont, Diphyodont, Homodont
- Option D Pleurodont, Diphyodont, Heterodont

Correct Option B

Solution: In thecodont dentition, teeth are present in the sockets of the jaw bone called alveoli. In diphyodont dentition, teeth erupt twice, temporary milk or deciduous teeth are replaced by a set of permanent or adult teeth. In heterodont dentition, it consists of different types of teeth namely incisors, canines, premolars and molars.

Q 76. In a growing population of a country

- Option A Reproductive and pre-reproductive individuals are equal in number
- Option B Reproductive individuals are less than the post-reproductive individuals
- Option C Pre-reproductive individuals are more than the reproductive individuals
- Option D Pre-reproductive, individuals are less than the reproductive individuals

Correct Option C

Solution: Whenever the pre-reproductive individuals or the younger population size is larger than the reproductive group, the population will be an increasing population.

Q 77. Match the items given in Column I with those in Column II and select the correct option given below:

Column I	Column II
a. Eutrophication	i. UV-B radiation
b. Sanitary landfill	ii. Deforestation
c. Snow blindness	iii. Nutrient enrichment
d. Jhum cultivation	iv. Waste disposal

	a	b	c	d
Option A	iii	iv	i	ii
Option B	i	iii	iv	ii
Option C	ii	i	iii	iv
Option D	i	ii	iv	iii

Correct Option A

Solution: Eutrophication is the nutrient enrichment of a water body. Sanitary landfill is a method of solid waste disposal. Snow blindness is characterised by the burning of the cornea by UV-B radiation. Jhum cultivation is the process of growing crops by first clearing the land of trees and vegetation and burning them thereafter.

Q 78. Which part of poppy plant is used to obtain the drug “Smack”?

- Option A Roots
- Option B Latex
- Option C Flowers
- Option D Leaves

Correct Option B

Solution: Smack also called brown sugar or heroin is formed by the acetylation of morphine. It is obtained from the latex of unripe capsule of Poppy plant (*Papaver somniferum*).

Q 79. Which one of the following population interactions is widely used in medical science for the production of antibiotics?

- Option A Parasitism
- Option B Mutualism
- Option C Commensalism
- Option D Amensalism

Correct Option D

Solution: Amensalism is an association between organisms of two different species in which one organism is inhibited or destroyed and the other is unaffected. Antibiotics are chemicals secreted by one microbial group (e.g. *Penicillium*) which harm the other microbes (e.g. *Staphylococcus*). They have no effect on *Penicillium* or the organism which produces them.

Q 80. All of the following are included in ‘ex-situ conservation’ except

- Option A Botanical gardens
- Option B Sacred groves
- Option C Wildlife safari parks
- Option D Seed banks

Correct Option B

Solution: In-situ conservation is the on-site conservation or the conservation of genetic resources in natural populations of plant or animal species, e.g. sacred groves.

Q 81. Hormones secreted by the placenta to maintain pregnancy are

- Option A hCG, hPL, progestogens, estrogens
- Option B hCG, hPL, estrogens, relaxin, oxytocin
- Option C hCG, hPL, progestogens, prolactin
- Option D hCG, progestogens, estrogens, glucocorticoids

Correct Option A

Solution: Placenta is an endocrine gland which is present only during pregnancy. It releases hCG, hPL, progestogens and estrogens. Human chorionic gonadotropic hormone (hCG) stimulates the corpus luteum during pregnancy to release estrogen and progesterone. Human placental lactogen (hPL) is involved in the growth of the body of mother and the breasts. Progesterone maintains pregnancy.

Q 82. The contraceptive "SAHELI"

- Option A is an IUD.
Option B increases the concentration of estrogen and prevent ovulation in females.
Option C blocks estrogen receptors in the uterus, preventing eggs from getting implanted.
Option D is a post-coital contraceptive.

Correct Option C

Solution: Saheli is world's first and the only oral, non-steroidal contraceptive pill which can be consumed once a week. It's functioning is based on selective estrogen receptor modulation and prevents the egg from getting implanted.

Q 83. The difference between spermiogenesis and spermiation is

- Option A In spermiogenesis spermatozoa from Sertoli cells are released into the cavity of seminiferous tubules, while in spermiation spermatozoa are formed.
Option B In spermiogenesis spermatozoa are formed, while in spermiation spermatids are formed.
Option C In spermiogenesis spermatids are formed, while in spermiation spermatozoa are formed.
Option D In spermiogenesis spermatozoa are formed, while in spermiation spermatozoa are released from Sertoli cells into the cavity of seminiferous tubule.

Correct Option D

Solution: Spermiogenesis is the conversion of spermatids into spermatozoa whereas spermiation is the release of the sperms from the Sertoli cells into the cavity of seminiferous tubule.

Q 84. The amnion of mammalian embryo is derived from

- Option A mesoderm and trophoblast
Option B endoderm and mesoderm
Option C ectoderm and mesoderm
Option D ectoderm and endoderm

Correct Option C

Solution: The extraembryonic membranes are amnion, chorion, allantois and yolk sac. Amnion is derived from mesoderm on the outer side and ectoderm on the inner side. Chorion is formed from trophoectoderm and mesoderm whereas allantois and yolk sac membrane have mesoderm on the outside and endoderm on inner side.

Q 85. The similarity of bone structure in the forelimbs of many vertebrates is an example of

- Option A Convergent evolution
Option B Analogy
Option C Homology
Option D Adaptive radiation

Correct Option C

Solution: The similarity of bone structure in the forelimbs of many vertebrates is an example of homology. The homologous organs have the same fundamental structure but are adapted to perform different functions, e.g. forelimbs of man, cheetah, whale and bat. Analogous organs show convergent evolution. These organs have similar functions but are different in their structural details and origin.

Q 86. In which disease does mosquito transmitted pathogen cause chronic inflammation of lymphatic vessels?

- Option A Ringworm disease
- Option B Ascariasis
- Option C Elephantiasis
- Option D Amoebiasis

Correct Option C

Solution: Lymphatic filariasis also known as elephantiasis is a human disease caused by parasitic filarial worms. It is caused by roundworm *Wuchereria bancrofti* and is transmitted by the *Culex* mosquito.

Q 87. Which of the following is not an autoimmune disease?

- Option A Alzheimer's disease
- Option B Rheumatoid arthritis
- Option C Psoriasis
- Option D Vitiligo

Correct Option A

Solution: Alzheimer's disease is a neurodegenerative disorder caused due to the deficiency of neurotransmitter acetylcholine. Rheumatoid arthritis is an autoimmune disorder in which antibodies are produced against the synovial membrane and cartilage. Vitiligo is also an autoimmune disorder which causes white patches on the skin. Psoriasis is an autoimmune skin disease which causes itchy or sore patches of thick red skin.

Q 88. Which of the following characteristics represent 'Inheritance of blood groups' in humans?

- a. Dominance
- b. Co-dominance
- c. Multiple allele
- d. Incomplete dominance
- e. Polygenic inheritance

- Option A b, d and e
- Option B a, b and c
- Option C b, c and e
- Option D a, c and e

Correct Option B

Solution: For blood groups in humans,

$I^A I^O$, $I^B I^O$ – Dominant-recessive relationship

$I^A I^B$ – Codominance

I^A , I^B , I^O – Three different allelic forms of a gene (multiple allelism)

Q 89. Among the following sets of examples for divergent evolution, select the incorrect option.

- Option A Brain of bat, man and cheetah
- Option B Heart of bat, man and cheetah
- Option C Forelimbs of man, bat and cheetah
- Option D Eye of octopus, bat and man

Correct Option D

Solution: Divergent evolution occurs when two separate species evolve differently from a common ancestor. Divergent evolution demonstrates how species can have common anatomical structures (homologous). Convergent evolution occurs when species have different ancestral origins but have developed similar features. Eye of octopus, bat and man are examples of analogous organs showing convergent evolution.

Q 90. Conversion of milk to curd improves its nutritional value by increasing the amount of

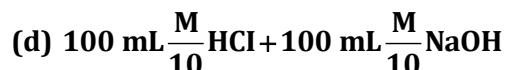
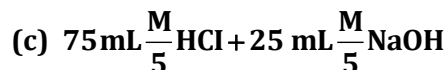
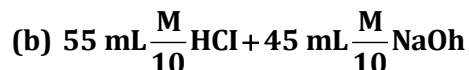
- Option A Vitamin B₁₂
- Option B Vitamin A
- Option C Vitamin D
- Option D Vitamin E

Correct Option A

Solution: Curd has increasing amount of vitamins specially vitamin B₁₂. This improves its nutritional value than milk.

CHEMISTRY

Q 1. Following solutions were prepared by mixing different volumes of NaOH and HCl of different concentration:



pH of which one of them will be equal to 1?

Option A d

Option B a

Option C b

Option D c

Correct Option D

Solution:

Total volume=

$$75 \text{ mL } \frac{M}{5} \text{ HCl} + 25 \text{ mL } \frac{M}{5} \text{ NaOH} = 100 \text{ mL}$$

$$25 \text{ mL } \frac{M}{5} \text{ NaOH will neutralise } 25 \text{ mL } \frac{M}{5} \text{ HCl}$$

$$\text{Remaining HCl} = 75 - 25 = 50 \text{ mL}$$

$$[\text{H}^+] = \frac{M}{10} \times \frac{50}{100}$$

$$= \frac{M}{10}$$

$$\therefore \text{pH} = -\log \frac{1}{10} = 1$$

Q 2. On which of the following properties does the coagulating power of an ion depend?

Option A Both magnitude and sign of the charge on the ion

Option B Size of the ion alone

Option C The magnitude of the charge on the ion alone

Option D The sign of charge on the ion alone

Correct Option C

Solution: Coagulating power of an ion depends on both magnitude and sign of the charge on the ion.

Q 3. The solubility of BaSO_4 in water is $2.42 \times 10^{-3} \text{ g L}^{-1}$ at 298 K. The value of its solubility product (Ksp) will be (Given molar mass of $\text{BaSO}_4 = 233 \text{ g mol}^{-1}$)

Option A $1.08 \times 10^{-14} \text{ mol}^2 \text{L}^{-2}$

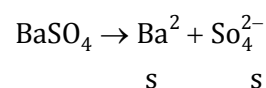
Option B $1.08 \times 10^{-12} \text{ mol}^2 \text{L}^{-2}$

Option C $1.08 \times 10^{-10} \text{ mol}^2 \text{L}^{-2}$

Option D $1.08 \times 10^{-8} \text{ mol}^2 \text{L}^{-2}$

Correct Option C

Solution:



$$K_{\text{sp}} = s^2$$

$$= \left(\frac{2.42 \times 10^{-3}}{233} \right)^2$$

$$= 1.08 \times 10^{-10} \text{ mol}^2 / \text{L}^2$$

Q 4. Given van der Waals constant for NH_3 , H_2 , O_2 and CO_2 are respectively 4.17, 0.244, 1.36 and 3.59, which one of the following gases is most easily liquefied?

Option A O_2

Option B H_2

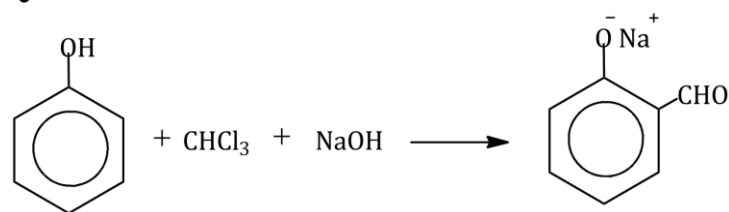
Option C NH_3

Option D CO_2

Correct Option C

Solution: Ease of liquification depends on van der Waal's constant 'a'. It depends on the intermolecular force of attraction.

Q 5. In the reaction



The electrophile involved is

Option A dichloromethyl anion

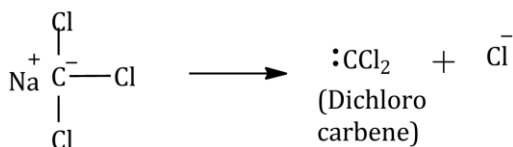
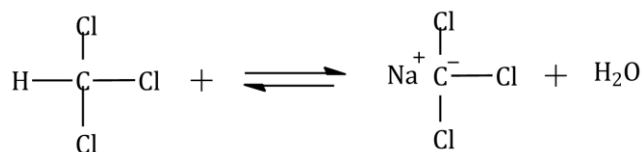
Option B formyl cation (CHO)

Option C dichloromethyl cation 2 (CHCl)

Option D dichlorocarbene ($:\text{CCl}_2$)

Correct Option D

Solution: The electrophile involved in the reaction is dichlorocarbene ($:\text{CCl}_2$)

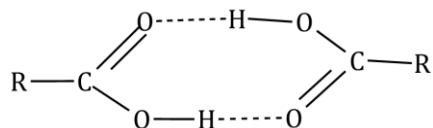


Q 6. Carboxylic acids have higher boiling points than aldehydes, ketones and even alcohols of comparable molecular mass. It is due to their

- Option A more extensive association of carboxylic acid via van der Waals force of attraction
 Option B formation of carboxylate ion
 Option C formation of intramolecular H-bonding
 Option D formation of intermolecular H-bonding

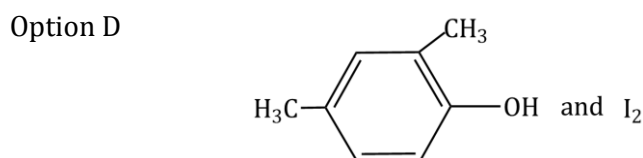
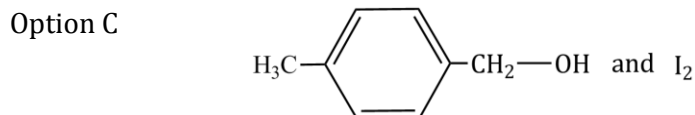
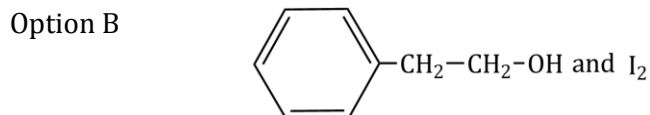
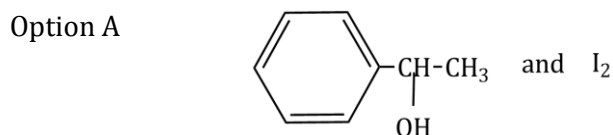
Correct Option D

Solution: Carboxylic acids have higher boiling points than aldehydes, ketones and even alcohols of comparable molecular mass. It is due to formation of intermolecular H-bonding.



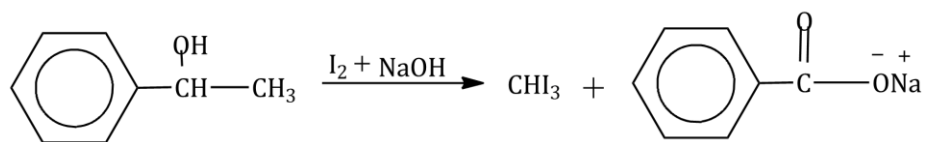
Q 7. Compound A, C₈ H₁₀ O, is found to react with NaOI (produced by reacting Y with NaOH) and yields a yellow precipitate with characteristic smell.

A and y are respectively



Correct Option A

Solution:



CHI_3 gives yellow precipitate and a characteristic medical smell.

Q 8. Magnesium react with an element (X) to form an ionic compound. If the ground state electronic configuration of (X) is $1s^2 2s^2 2p^3$, the simplest formula for this compound is

- Option A $\text{Mg}_2 \text{X}$
Option B MgX_2
Option C $\text{Mg}_2 \text{X}_3$
Option D $\text{Mg}_3 \text{X}_2$

Correct Option D

Solution:

Electronic configuration of (X) : $1s^2 2s^2 2p^3$

Valence of X = 3

Electronic configuration of (Mg) : $1s^2 2s^2 2p^6 3s^2$

Valence of Mg = 2

The formula of compound formed is Mg_3X_2

Q 9. Iron exhibits bcc structure at room temperature. Above 900°C , it transforms to fcc structure. The ratio for density of iron at room temperature to that at 900°C (assuming molar mass and atomic radii of iron remains constant with temperature) is

- Option A $\frac{3\sqrt{3}}{4\sqrt{2}}$
Option B $\frac{4\sqrt{3}}{3\sqrt{2}}$
Option C $\frac{\sqrt{3}}{\sqrt{2}}$
Option D $\frac{1}{2}$

Correct Option A

Solution:

For fcc lattice: $Z = 4$

$$a = \frac{4r}{\sqrt{3}}$$

For bcc lattice: $Z = 2$

$$a = 2\sqrt{2}r$$

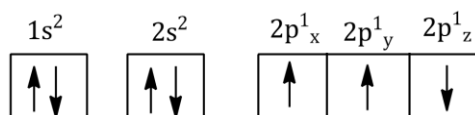
$$\frac{d_{\text{bcc}}}{d_{\text{fcc}}} = \frac{\left(\frac{ZM}{N_A} \times a^3 \right)_{\text{bcc}}}{\left(\frac{ZM}{N_A} \times a^3 \right)_{\text{fcc}}}$$

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

$$\frac{d_{\text{bcc}}}{d_{\text{fcc}}} = \frac{3\sqrt{3}}{4\sqrt{2}}$$

Q 10 .Which one is a wrong statement?

Option A The electronic configuration of N atom is



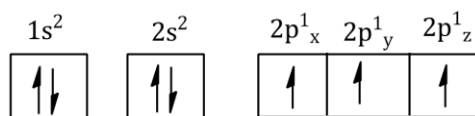
Option B An orbital is designated by three quantum numbers while an electron in an atom is designated by four quantum numbers.

Option C Total orbital angular momentum of electron in 's' orbital is equal to zero

Option D The value of m for d_{z^2} is zero

Correct Option A

Solution: The correct electronic configuration of N- atom is



Q 11. Consider the following species:

CN^+ , CN^- , NO and CN

Which one of these will have the highest bond order?

Option A CN^+

Option B CN^-

Option C NO

Option D CN

Correct Option B

Solution:In CN^-

$$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^2$$

$$\begin{aligned} \text{BO} &= \frac{\text{BMO} - \text{ABMO}}{2} \\ &= \frac{10 - 4}{2} \\ &= 3 \end{aligned}$$

In CN

$$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^1$$

$$\begin{aligned} \text{BO} &= \frac{\text{BMO} - \text{ABMO}}{2} \\ &= \frac{9 - 4}{2} \\ &= 2.5 \end{aligned}$$

In CN^+

$$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2$$

$$\begin{aligned} \text{BO} &= \frac{\text{BMO} - \text{ABMO}}{2} \\ &= \frac{8 - 4}{2} \\ &= 2 \end{aligned}$$

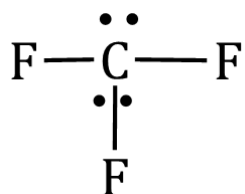
In NO

$$\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1 = \pi^* 2p_y^0$$

$$\begin{aligned} \text{BO} &= \frac{\text{BMO} - \text{ABMO}}{2} \\ &= \frac{10 - 5}{2} \\ &= 2.5 \end{aligned}$$

Q 12. In the structure of ClF_3 , the number of lone pairs of electrons on central atom 'Cl' is:

- Option A four
 Option B two
 Option C one
 Option D three

Correct Option B**Solution:**

Q 13. The correct order of atomic radii in group 13 elements is:

Option A B < Ga < Al < Tl < In

Option B B < Al < Ga < In < Tl

Option C B < Al < In < Ga < Tl

Option D B < Ga < Al < In < Tl

Correct Option D

Solution: B < Ga < Al < In < Tl

Ga, Tl, In have d- electrons, which are less efficient at shielding the nuclear charge than s and p electrons. Due to the poor shielding, the outer electron are firmly held by the nucleus. Therefore the size of atoms with d¹⁰ shell are smaller than expected.

Q 14. The correct order of N – compounds in its decreasing order of oxidation states is:

Option A HNO₃, NH₄Cl, NO, N₂

Option B HNO₃, NO, NH₄Cl, N₂

Option C HNO₃, NO, N₂, NH₄Cl

Option D NH₄Cl, N₂, NO, HNO₃

Correct Option C

Solution: The correct order of N – compounds in its decreasing order of oxidation states is

+5 +2 0 -3
HNO₃ > NO > N₂ > NH₄Cl

Q 15. Which one of the following elements is unable to form MF₆³⁻ ion?

Option A B

Option B Al

Option C Ga

Option D In

Correct Option A

Solution: B (5): 1s² 2s² 2p¹

Due to absence of vacant d-orbitals in boron it is unable to form MF₆³⁻ ion

Q 16. Which of the following statements is not true for halogens?

Option A All shows positive oxidation states

Option B All are oxidation agents

Option C All form monobasic oxyacids

Option D Chlorine has the highest electron-gain enthalpy

Correct Option A

Solution: Fluorine has high ionisation energy due small size. It forms oxyacid HOF. The oxidation number of F in HOF is +1.

Q 17. Considering Ellingham diagram, which of the following metals can be used to reduce alumina?

- Option A Mg
 Option B Zn
 Option C Fe
 Option D Cu

Correct Option A

Solution:

Metals with more negative ΔG value can reduce the metal oxides with low negative ΔG value.

MgO is in the lower part of the Ellingham diagram as it has more negative ΔG value than alumina.

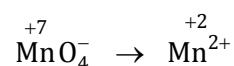
Q 18. For the redox reaction $\text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} + \text{H}^+ \rightarrow \text{Mn}^{2+} + \text{CO}_2 + \text{H}_2\text{O}$ the correct coefficients of the reactants for the balanced equation are:

	MnO_4^-	$\text{C}_2\text{O}_4^{2-}$	H^+
Option A	2	16	5
Option B	2	5	16
Option C	16	5	2
Option D	5	16	2

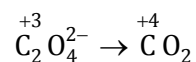
Correct Option B

Solution:

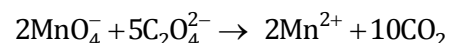
$5e^-$ gain



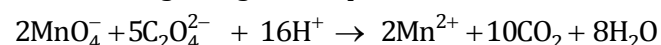
Loss of $2e^-$



Balanced equation is,



On balancing charge, the equation can be written as,



Q 19. Which one of the following conditions will favour maximum formation of the product in the reaction: $\text{A}_{2(g)} + \text{B}_2 \rightleftharpoons \text{X}_{2(g)} \quad \Delta_2\text{H} = -X \text{ kJ}$

- Option A High temperature and high pressure
 Option B Low temperature and low pressure
 Option C Low temperature and high pressure
 Option D High temperature and low pressure

Correct Option C

Solution: On Increasing pressure, reaction will shift in to the direction where number of moles decreases i.e. forward direction.

For exothermic reactions lower temperature favors product.

Q 20. The correction factor 'a' to the ideal gas equation corresponds to:

- Option A electric field present between the gas molecules
- Option B volume of the gas molecules
- Option C density of the gas molecules
- Option D forces of attraction between the gas molecules

Correct Option D

Solution: The correction factor, 'a' to the ideal gas equation corresponds to the force of attraction between the gas molecules.

Q 21. When initial concentration of the reactant is doubled, the half-life period of a zero order reaction:

- Option A is tripled
- Option B is doubled
- Option C is halved
- Option D remains unchanged

Correct Option B

Solution:

$$t_{1/2} = \frac{\text{Initial concentration}}{2k}$$

$$t_{1/2} \propto \text{Initial concentration}$$

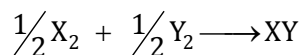
Therefore, the half-life period of a zero order reaction is will be doubled, when initial concentration of the reactant is doubled,

Q 22. The bond dissociation energies of X_2 , Y_2 and XY are in the ratio of 1:05:1. ΔH for the formation of XY is -200 kJ mol^{-1} . The bond dissociation energy of X_2 will be:

- Option A 800 kJ mol^{-1}
- Option B 100 kJ mol^{-1}
- Option C 200 kJ mol^{-1}
- Option D 400 kJ mol^{-1}

Correct Option A

Solution:



$$\Delta_r H = \sum B.E_{(\text{Reactants})} - \sum B.E_{(\text{Products})}$$

$$\begin{aligned} -200 &= \frac{1}{2}a + \frac{0.5}{2}a - a \\ &= \frac{1}{2}a + \frac{1}{4}a - a \\ &= \frac{3}{4}a - a \\ &= -\frac{1}{4}a \end{aligned}$$

$$a = 800 \text{ kJ/mol}$$

Q 23. Match the metal ions given in column I with the spin magnetic moments of the ions given in Column II and assign the correct code:

Column I	Column II
Co^{3+}	i. $\sqrt{8}$ B.M.
Cr^{3+}	ii. $\sqrt{35}$ B.M.
Fe^{3+}	iii. $\sqrt{3}$ B.M.
Ni^{2+}	iv. $\sqrt{24}$ B.M.
	v. $\sqrt{15}$ B.M.

	a	b	c	d
Option (A)	iv	i	ii	iii
Option (B)	i	ii	iii	iv
Option (C)	iv	v	ii	i
Option (D)	iii	v	i	ii

Correct Option C

Solution:

$$\text{Co}^{3+} - [\text{Ar}]3d^6, \text{unpaired } e^-(n)=4, \mu = \sqrt{n(n+2)}\text{BM} = \sqrt{24} \text{ BM}$$

$$\text{Cr}^{3+} - [\text{Ar}]3d^3, \text{unpaired } e^-(n)=3, \mu = \sqrt{n(n+2)}\text{BM} = \sqrt{15} \text{ BM}$$

$$\text{Fe}^{3+} - [\text{Ar}]3d^5, \text{unpaired } e^-(n)=5, \mu = \sqrt{n(n+2)}\text{BM} = \sqrt{35} \text{ BM}$$

$$\text{Ni}^{2+} - [\text{Ar}]3d^8, \text{unpaired } e^-(n)=2, \mu = \sqrt{n(n+2)}\text{BM} = \sqrt{8} \text{ BM}$$

Q 24. Which one of the following ions exhibits d-d transition and paramagnetism as well?

Option A MnO_4^-

Option B $\text{Cr}_2\text{O}_7^{2-}$

Option C CrO_4^{2-}

Option D MnO_4^{2-}

Correct Option D

Solution: MnO_4^{2-} Mn^{6+} $[\text{Ar}] d^1$

Unpaired electron = 1

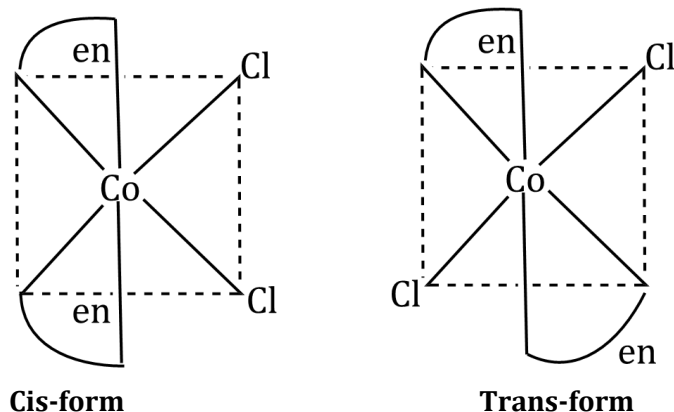
Therefore it is paramagnetic and it will show d-d transition.

Q 25. The type of isomerism shown by the complex $[\text{CoCl}_2 (\text{en})_2]$ is

- Option A Ionization isomerism
 Option B Coordination isomerism
 Option C Geometrical isomerism
 Option D Linkage isomerism

Correct Option C

Solution: The co-ordination number of Co is 6. The complex has octahedral geometry.



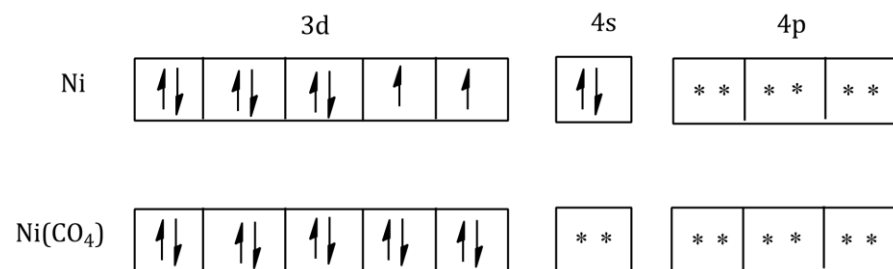
Q 26. The geometry and magnetic behaviour of the complex $[\text{Ni}(\text{CO})_4]$ are

- Option A square planar geometry and paramagnetic
 Option B tetrahedral geometry and diamagnetic
 Option C square planar geometry and diamagnetic
 Option D tetrahedral geometry and paramagnetic

Correct Option B

Solution:

$\text{Ni}(\text{CO})_4$ (28): $[\text{Ar}] 3d^8 4s^2$



The hybridization is sp^3 , so the geometry is tetrahedral and it is diamagnetic.

Q 27. Iron carbonyl. $\text{Fe}(\text{CO})_5$ is

- Option A trinuclear
 Option B mononuclear
 Option C tetranuclear
 Option D dinuclear

Correct Option B

Solution: $\text{Fe}(\text{CO})_5$ is mononuclear as only one central metal atom is present.

Q 28. The correct difference between first and second-order reaction is that

- Option A A first-order reaction can be catalysed; a second-order reaction cannot be catalysed
Option B The half-life of a first-order reaction does not depend on $[A]_0$; the half-life of a second-order reaction does depend on $[A]_0$
Option C The rate of a first – order reaction does not depend on reaction concentrations; the rate of a second order reaction does depend on reactant concentrations
Option D The rate of a first-order reaction does depend on reactant concentration; the rate of a second-order reaction does not depend on reactant concentrations

Correct Option B

Solution:

For first order reaction:

$$t_{1/2} = \frac{0.693}{k}$$

(independent of Initial concentration)

For second order reaction:

$$t_{1/2} = \frac{1}{k \times \text{Initial concentration}}$$

(depends on initial concentration)

Q 29. Among CaH_2 , BeH_2 , BaH_2 , the order of ionic character is

- Option A $\text{BeH}_2 < \text{BaH}_2 < \text{CaH}_2$
Option B $\text{CaH}_2 < \text{BeH}_2 < \text{BaH}_2$
Option C $\text{BeH}_2 < \text{CaH}_2 < \text{BaH}_2$
Option D $\text{BaH}_2 < \text{BeH}_2 < \text{CaH}_2$

Correct Option C

Solution: $\xrightarrow[\text{Polarisation} \downarrow \text{Ionic character} \uparrow]{\text{BeH}_2 < \text{CaH}_2 < \text{BaH}_2}$

Q 30. Consider the change in oxidation state of Bromine corresponding to different emf values as shown in the diagram below:



Then the species undergoing disproportionation is

- Option A Br_2
Option B BrO_4^-
Option C BrO_3^-
Option D HBrO

Correct Option B

Solution:

As, BrO_4^- is present in its highest oxidation

State (+7), so it will not undergo disproportionation,

For, BrO_3^-

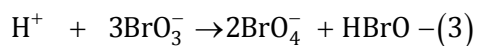
$$\therefore (1) + (2) = (3)$$



$$E_1^0 = -1.82$$



$$= 1.5\text{V}$$



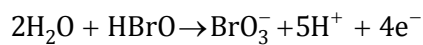
$$E_3^0 = \frac{-1.82 \times 4 + 1.5 \times 4}{4}$$

$$= -\text{ve}$$

Also for HBrO

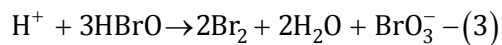


$$- (1), E_1^0 = 1.595$$



$$- (2), E_2^0 = -1.5 \text{ V}$$

$$(1) + (2) = 3$$



$$\therefore E_3^0 = \frac{1.595 \times 4 - 1.5 \times 4}{4}$$

$$= +\text{ve}$$

So, HBrO will disproportionate

Q 31. In which case is the number of molecules of water maximum?

Option A 0.00224 L of water vapours at 1 atm and 273 k

Option B 0.18 g of water

Option C 18 mL of water

Option D 10^{-3} mol of water

Correct Option C

Solution:

$$\begin{aligned}(1) \text{ No. of moles} &= \frac{0.00224}{22.4} \\ &= 10^{-4} \text{ mole}\end{aligned}$$

$$\text{No. of molecules} = 10^{-4} \times N_A$$

$$\begin{aligned}(2) \text{ No. of moles} &= \frac{0.18}{18} \\ &= 0.01 \text{ mole}\end{aligned}$$

$$\text{No. of molecules} = 10^{-2} \times N_A$$

$$\begin{aligned}(3) d_{\text{H}_2\text{O}} &= 1 \text{ gm/ml} \\ \therefore w &= 18 \text{ gm}\end{aligned}$$

$$\begin{aligned}\text{No. of moles} &= \frac{18}{18} \\ &= 1 \text{ mole}\end{aligned}$$

$$\text{No. of molecules} = 1 \times N_A$$

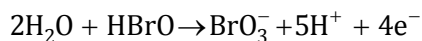
$$(4) 10^{-3} \text{ mole}$$

$$\text{No. of molecules} = 10^{-3} \times N_A$$

Also for HBrO

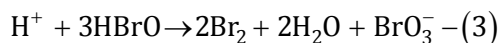


$$-(1), E_1^0 = 1.595$$



$$-(2), E_2^0 = -1.5 \text{ V}$$

$$(1) + (2) = 3$$



$$\therefore E_3^0 = \frac{1.595 \times 4 - 1.5 \times 4}{4}$$

$$= +ve$$

So, HBrO will disproportionate

Q 32. Which of the following molecules represents the order of hybridization sp^2 , sp^2 , sp , sp from left to right atoms?

Option A $\text{CH}_2=\text{CH}-\text{CH}=\text{CH}_2$

Option B $\text{CH}_2=\text{CH}-\text{C}\equiv\text{CH}$

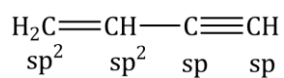
Option C $\text{HC}\equiv\text{C}-\text{C}\equiv\text{CH}$

Option D $\text{CH}_3-\text{CH}\equiv\text{CH}-\text{CH}_3$

Correct Option B

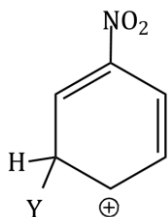
Solution: Carbon – carbon double bonds: sp^2 hybridised carbon atoms

Carbon – carbon triple bonds: sp hybridized carbon atoms

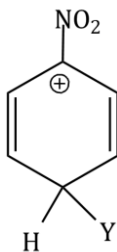


Q 33. Which of the following carbocations is expected to be most stable?

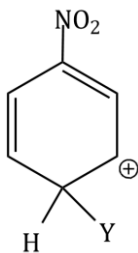
Option A



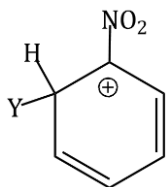
Option B



Option C

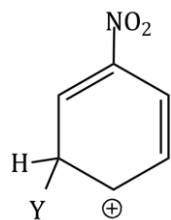


Option D



Correct Option A

Solution:



is more stable as more number of resonating structures due less electron withdrawing group -NO_2 .

Q 34. Which of the following is correct with respect to $-\text{I}$ effect of the substituents? ($\text{R}=\text{alkyl}$)

Option A $-\text{NH}_2 > -\text{OR} > -\text{F}$

Option B $-\text{NR}_2 < -\text{F} < -\text{OR}$

Option C $-\text{NH}_2 < -\text{OR} < -\text{F}$

Option D $-\text{NR}_2 > -\text{OR} > -\text{F}$

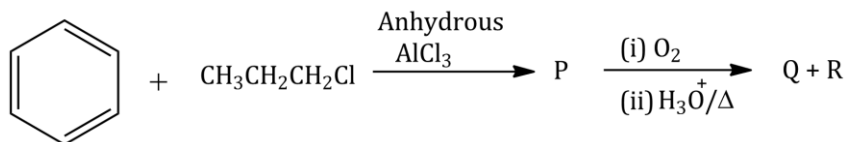
Correct Option C

Solution: The correct with respect to $-\text{I}$ effect is $-\text{NH}_2 < \text{OR} < -\text{F}$

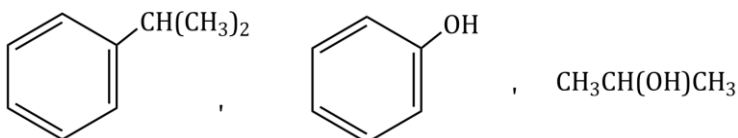
As the electronegativity increases $-\text{I}$ effect also increases.

$-\text{NR}_2 < -\text{OR} < -\text{F}$ is also correct order.

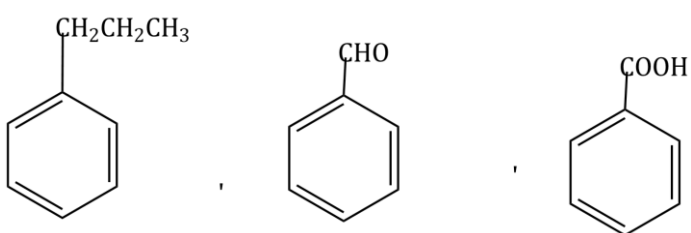
Q 35. Identify the major products P, Q and R in this following sequence of reactions:



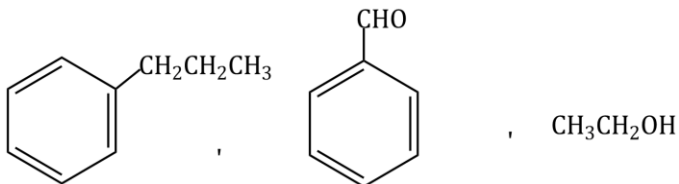
Option A



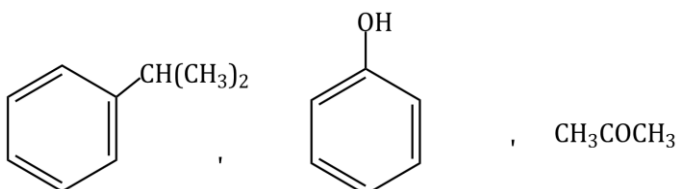
Option B



Option C

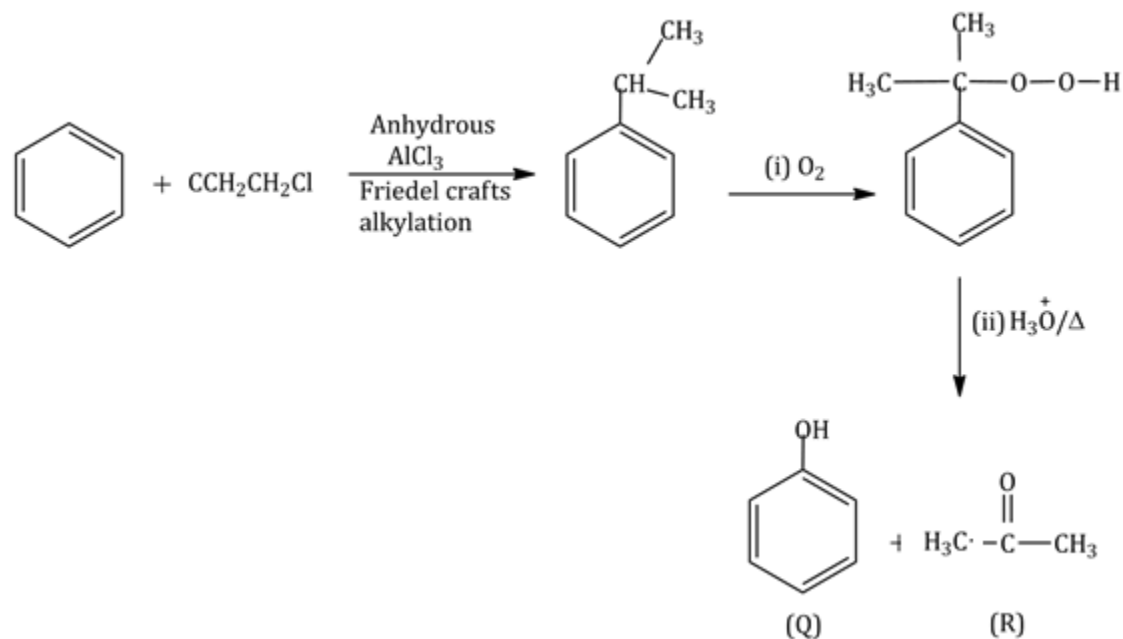


Option D



Correct Option D

Solution:

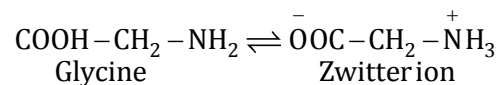


Q 36. Which of the following compounds can form a zwitterion?

- Option A Benzoic acid
- Option B Acetanilide
- Option C Aniline
- Option D Glycine

Correct Option D

Solution:

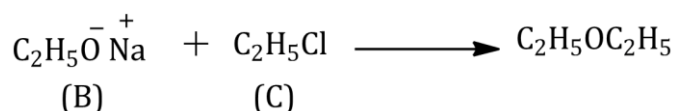
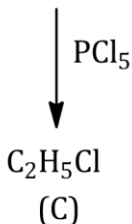
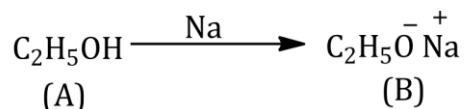


Q 37. The compound A on treatment with Na gives B, and with PCl_5 gives C. B and C react together to give diethyl ether. A, B and C are in the order:

- Option A $\text{C}_2\text{H}_5\text{Cl}$, C_2H_6 , $\text{C}_2\text{H}_5\text{OH}$
- Option B $\text{C}_2\text{H}_5\text{OH}$, $\text{C}_2\text{H}_5\text{Cl}$, $\text{C}_2\text{H}_5\text{ONa}$
- Option C $\text{C}_2\text{H}_5\text{OH}$, C_2H_6 , $\text{C}_2\text{H}_5\text{Cl}$
- Option D $\text{C}_2\text{H}_5\text{OH}$, $\text{C}_2\text{H}_5\text{ONa}$, $\text{C}_2\text{H}_5\text{Cl}$

Correct Option D

Solution:



Q 38. Hydrocarbon (A) react with bromine by substitution to form an alkyl bromide which by Wurtz reaction is converted to gaseous hydrocarbon containing less than four carbon atoms (A) is:

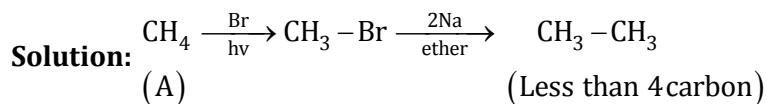
Option A $\text{CH}_3 - \text{CH}_3$

Option B $\text{CH}_2 = \text{CH}_2$

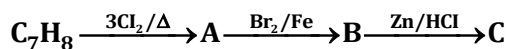
Option C $\text{CH} \equiv \text{CH}$

Option D CH_4

Correct Option D



Q 39. The compound C_7H_8 undergoes the following reactions:



The product 'C' is:

Option A 3-bromo-2, 4, 6-trichlorotoluene

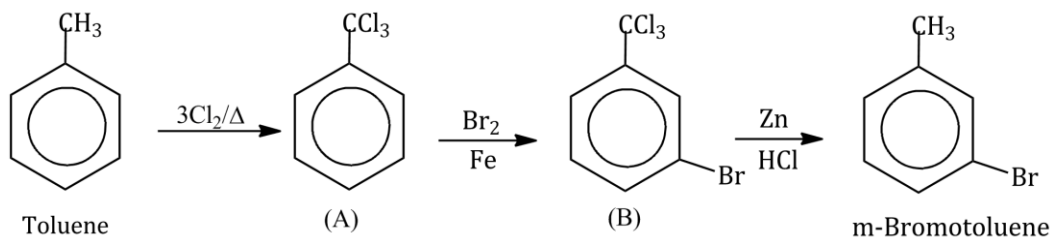
Option B o-bromotoluene

Option C m-bromotoluene

Option D p-bromotoluene

Correct Option C

Solution:



Q 40. Which oxide of nitrogen is not a common pollutant introduced into the atmosphere both due to natural and human activity?

- Option A N_2O
Option B NO_2
Option C N_2O_5
Option D NO

Correct Option C

Solution: N_2O_5

NO_2 and NO are formed during the fuel combustion in automobile engines.

N_2O occurs naturally in the atmosphere.

Q 41. Regarding cross-linked or network polymers, which of the following statements is incorrect?

- Option A examples are bakelite and melamine.
Option B They are formed from bi- and tri- functional monomers.
Option C They contain covalent bonds between various linear polymer chains.
Option D They contain strong covalent bonds in their polymer chain.

Correct Option D

Solution: Cross-linked or network polymers contain strong covalent bonds in their polymer chains. They are formed from bi-functional and tri-functional monomers.

Q 42. Which of the following oxides is most acidic in nature?

- Option A BaO
Option B BeO
Option C MgO
Option D CaO

Correct Option B

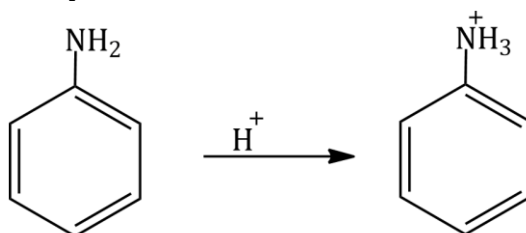
Solution: On moving down the group the atomic size increases and ionization energy decreases and elements become more basic. So the acidic strength decreases moving down the group.

Q 43. Nitration of aniline in strong acidic medium also gives m-nitro aniline because:

- Option A In absence of substituents nitro group always goes to m-position.
Option B In electrophilic substitution reactions amino group is Meta directive.
Option C In spite of substituents nitro group always goes to only m-position.
Option D In acidic (strong) medium aniline is present as anilinium ion.

Correct Option D

Solution: In acidic medium, aniline is protonated to form anilinium ion, which is Meta directing.



Therefore Meta product is formed. Aniline

Anilinium ion

Q 44. A mixture of 2.3 g formic acid 4.5 g oxalic acid is treated with conc. H_2SO_4 . The evolved gaseous mixture is passed through KOH pellets. Weight (in g) of the remaining product at STP will be:

Option A 2.8

Option B 3.0

Option C 1.4

Option D 4.4

Correct Option A

Solution:

No. of moles of HCOOH are:

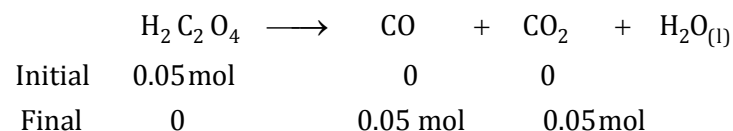
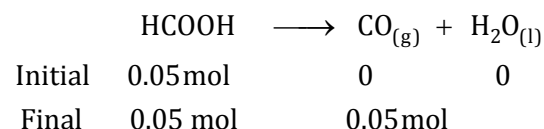
$$n = \frac{2.3}{46}$$

$$n = 0.05 \text{ moles}$$

No. of moles of $\text{H}_2\text{C}_2\text{O}_4$ are:

$$n = \frac{4.5}{90}$$

$$n = 0.05 \text{ moles}$$



CO_2 is absorbed by KOH and the remaining product is CO.

Therefore total no. of moles of CO formed in both the reactions is,

$$0.05 + 0.05 = 0.1 \text{ mole}$$

$$\text{Mass of CO formed} = 0.1 \times 28$$

$$= 2.8 \text{ gm}$$

Q 45. The difference between amylose and amylopectin is;

Option A Amylopectin have $1 \rightarrow 4 \alpha$ linkage and $1 \rightarrow 6 \beta$ -linkage

Option B Amylose have $1 \rightarrow 4 \alpha$ - linkage and $1 \rightarrow 6 \beta$ -linkage

Option C Amylopectin have $1 \rightarrow 4 \alpha$ - linkage and $1 \rightarrow 6 \alpha$ -linkage

Option D Amylose is made up of glucose and galactose

Correct Option C

Solution: Amylose and amylopectin are polymers of α - D glucose.

Amylose have linear $1 \rightarrow 4 \alpha$ - linkage and amylopectin is branched and have $1 \rightarrow 4 \alpha$ - linkage and

$1 \rightarrow 6 \alpha$ -linkage

NEET - 2018
Questions with Solutions

Time: 3 Hours

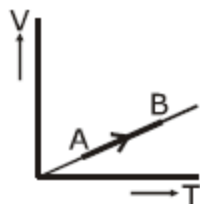
Total Marks: 720

General Instructions:

1. The test is of **3 hours** duration.
2. The Test Paper contains **180** questions. There are **three** parts in the question paper consisting of **Physics and Chemistry** having **45** questions each and **Biology** with **90** questions.
3. Each question carries **4 marks**. For each correct response, the candidate will get **4 marks**. For each incorrect response, **1 mark** will be deducted from the total scores. The maximum marks are **720**.
4. Out of the four options given for each question, only one option is the correct answer. If more than one response is marked in any question, it will be treated as wrong response and marked up for wrong response will be deducted.
5. No deduction from the total score will be made if no response is indicated for an item in the answer box.
6. Use of Electronic/Manual Calculator is prohibited.

PHYSICS

Q 1. The volume (V) of a monatomic gas varies with its temperature (T), as shown in the graph. The ratio of work done by the gas, to the heat absorbed by it, when it undergoes a change from state A to state B, is



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

Correct Option C

Solution:

From the graph is clear that this is an isobaric process.

$P = \text{constant}$

At constant pressure

$$W = nR\Delta T \quad \dots (1)$$

$$\Delta Q = nC_p\Delta T \text{ (for constant pressure)}$$

$$\Delta Q = n\left(\frac{5}{2}R\right)\Delta T \quad \dots(1)$$

Equation (1)/(2)

$$\Rightarrow \frac{nR\Delta T}{n\left(\frac{5}{2}R\right)\Delta T} \Rightarrow \frac{2}{5}$$

Q 2. The fundamental frequency in an open organ pipe is equal to the third harmonic of a closed organ pipe if the length of the closed organ pipe is 20 cm, the length of the open organ pipe is

Option A 12.5 cm

Option B 8 cm

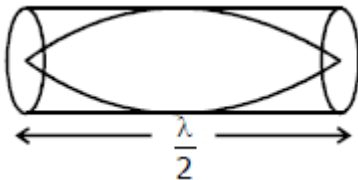
Option C 13.2 cm

Option D 16 cm

Correct Option C

Solution:

For open organ pipe



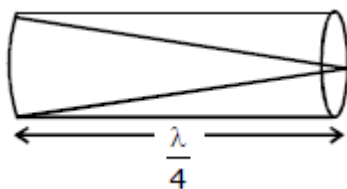
$$\ell = \frac{\lambda}{2}$$

$$\Rightarrow \lambda = 2\ell$$

$$\text{General formula } f = \frac{nv}{2l}$$

$$f_{\text{open}} = \frac{v}{\lambda} = \frac{v}{2\ell}$$

For pipe closed at one end



$$\text{General formula } f = \frac{nv}{4l}$$

$$\text{Fundamental } f = \frac{v}{4}$$

As given:

$$\frac{3v}{4l_1} = \frac{v}{2l_2} = \frac{3}{4 \times 20} = \frac{1}{2l_2}$$

$$= 13.2$$

Q 3. The efficiency of an ideal heat engine working between the freezing point and boiling point of water, is

Option A 6.25%

Option B 20%

Option C 26.8%

Option D 12.5%

Correct Option C

Solution: Efficiency of heat engine

$$Q_1 = W + Q_2$$

$$\text{Efficiency} = \frac{\text{work done}}{\text{Energy available}}$$

$$\eta = \frac{Q_1 - Q_2}{Q_1}$$

$$h = 1 - \frac{T_2}{T_1}$$

$$= 1 - \frac{273}{373}$$

$$= 1 - 0.731$$

$$26.8\%$$

Q 4. At what temperature will the rms speed of oxygen molecules become just sufficient for escape from the Earth's atmosphere? (Given: Mass of oxygen molecule (m) = $2.76 \times 10^{-26} \text{ kg}$)

Option A $5.016 \times 10^4 \text{ K}$

Option B $8.360 \times 10^4 \text{ K}$

Option C $2.508 \times 10^4 \text{ K}$

Option D $1.254 \times 10^4 \text{ K}$

Correct Option B

Solution:

$$\text{Escape velocity} = 11.2 \text{ km/s} = 11200 \text{ m/s}$$

$$V_{rms} = \sqrt{\frac{3RT}{M_0}}$$

$$\sqrt{\frac{30 \times 1.38 \times 10^{-23} \times T}{2.76 \times 10^{-26}}} = (11.2 \times 10^{-3})^2$$

$$T = 8.360 \times 10^4$$

Q 5. Unpolarised light is incident from air on a plane surface of a material of refractive index ' μ '. At a particular angle of incidence ' i ', it is found that the reflected and refracted rays are perpendicular to each other, which of the following options is correct for this situation?

Option A $i = \sin^{-1} \left(\frac{1}{\mu} \right)$

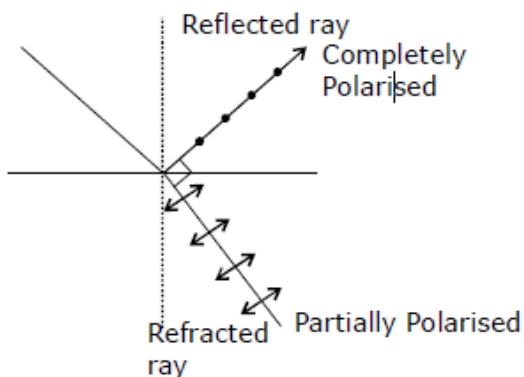
Option B Reflected light is polarised with its electric vector perpendicular to the plane of incidence

Option C Reflected light is polarised with its electric vector parallel to the plane of incidence

Option D $i = \tan^{-1} \left(\frac{1}{\mu} \right)$

Correct Option B

Solution:



This is the condition of polarisation in which light is incident on an interface at Brewster's angle.

Thus reflected light is polarised with its \vec{E} perpendicular to the plane of incidence.

Q 6. In Young's double slit experiment the separation d between the slits is 2mm, the wavelength λ of the light used is 5896 \AA and distance D between the screen and slits is 100 cm. It is found that the angular width of the fringes is 0.20° . To increase the fringe angular width to 0.21° (with same λ and D) the separation between the slits needs to be changed to

Option A 2.1 mm

Option B 1.9 mm

Option C 1.8 mm

Option D 1.7 mm

Correct Option B

Solution:

Angular width $\omega = \frac{\lambda}{d}$

$\omega = \frac{\lambda}{d}$

For new separation

$\omega' = \frac{\lambda}{d'}$

$$\begin{aligned}\therefore \frac{0.20}{0.21} &= \frac{d'}{d} \\ \Rightarrow \frac{0.20}{0.21} &= \frac{d'}{2} \\ \Rightarrow d' &= 1.904\end{aligned}$$

Q 7. An astronomical refracting telescope will have large angular magnification and high angular resolution, when it has an objective lens of

- Option A large focal length and large diameter
- Option B large focal length and small diameter
- Option C small focal length and large diameter
- Option D small focal length and small diameter

Correct Option A

Solution:

R. $P \propto d$

$$\text{angular magnification} = \frac{f_o}{f_e}$$

And

$$\text{Resolving power} = \frac{\text{Aperture of objective}}{\text{wavelength}}$$

\therefore Greater the focal length of the objective, more is the magnification.

Also for a telescope to have high resolution the aperture of objective lens should be large.

Q 8. The kinetic energies of a planet in an elliptical orbit about the Sun, at positions A, B and C are K_A , K_B and K_C , respectively. AC is the major axis and SB is perpendicular to AC at the position of the Sun S as shown in the figure. Then



- Option A $K_B < K_A < K_C$
- Option B $K_A > K_B > K_C$
- Option C $K_A < K_B < K_C$
- Option D $K_B > K_A > K_C$

Correct Option B

Solution: We know that angular momentum remains conserved In motion of a planet around the sun $m(\vec{r} \times \vec{v}) = \text{constant}$

The nearest point in perigee which is point A. Next nearest is B and then C

Therefore

$$V_A > V_B > V_C$$

$$\Rightarrow K_A > K_B > K_C$$

Q 9. A solid sphere is in rolling motion. In rolling motion a body possesses translational kinetic energy (K_t) as well as rotational kinetic energy (K_r) simultaneously. The ratio K_t : ($K_t + K_r$) for the sphere is

Option A 10:7

Option B 5:7

Option C 7:10

Option D 2:5

Correct Option B

Solution:

moment of inertia for solid sphere

$$I_{\text{solid sphere}} = \frac{2}{5}MR^2$$

$$KE_T = \frac{1}{2}m(r\omega)^2 = \frac{1}{2}mr^2\omega^2$$

$$KE_{(R+T)} = \frac{1}{2}\frac{2}{5}mR^2\omega^2 + \frac{1}{2}m(r\omega)^2$$

$$KE_R + KE_T = \frac{1}{5}mR^2\omega^2 + \frac{1}{2}mR^2\omega^2$$

$$= \frac{7}{10}mR^2\omega^2$$

$$\frac{K_T}{K_T + K_R} = \frac{\frac{1}{2}mr^2\omega^2}{\frac{7}{10}mR^2\omega^2}$$

$$= \frac{5}{7}$$

Q 10. If the mass of the Sun were ten times smaller and the universal gravitational constant were ten times larger in magnitude, which of the following is not correct?

Option A Time period of a simple pendulum on the Earth would decrease.

Option B Walking on the ground would become more difficult.

Option C Raindrops will fall faster.

Option D 'g' on the Earth will not change.

Correct Option D

Solution:

$$g = \frac{GM_e}{R_e^2}$$

$$g_{\text{new}} = \frac{10GM_e}{R_e^2} = 10g$$

$\therefore g$ changes

Therefore option d is not correct

Q 11. A solid sphere is rotating freely about its symmetry axis in free space. The radius of the sphere is increased keeping its mass same. Which of the following physical quantities would remain constant for the sphere?

- Option A Rotational kinetic energy
- Option B Moment of inertia
- Option C Angular velocity
- Option D Angular momentum

Correct Option D

Solution: As we see that the torque acting on the body is zero, thus we can say that angular momentum is conserved.

$$\tau_{ext} = 0$$

$$\frac{d\vec{L}}{dt} = \text{constant}$$

Q 12. A metallic rod of mass per unit length 0.5 kg m^{-1} is lying horizontally on a smooth inclined plane which makes an angle of 30° with the horizontal. The rod is not allowed to slide down by flowing a current through it when a magnetic field of induction 0.25 T is acting on it in the vertical direction. The current flowing in the rod to keep it stationary is

- Option A 14.76 A
- Option B 5.98 A
- Option C 7.14 A
- Option D 11.32 A

Correct Option D

Solution: $ilB \cos 30^\circ = mg \sin 30^\circ$

$$i = \frac{mg \tan 30^\circ}{lB}$$

$$i = \frac{0.5 \times 9.8}{0.25 \times \sqrt{3}}$$

$$i = 11.32 \text{ A}$$

Q 13. An inductor 20 mH , capacitor $100 \text{ }\mu\text{F}$ and a resistor $50 \text{ }\Omega$ are connected in series across a source of emf, $V = 10 \sin 314 t$. The power loss in the circuit is

- Option A 2.74 W
- Option B 0.43 W
- Option C 0.79 W
- Option D 1.13 W

Correct Option C

Solution: $\omega = 314$

$$= 100 \Omega$$

Inductive reactance

$$X_L = \omega L$$

$$= 100 \pi \times 20 \times 10^{-3}$$

$$X_L = 2 \pi$$

$$\text{Capacitive reactance } X_c = \frac{1}{\omega C}$$

$$= \frac{1}{100\pi \times 100 \times 10^{-6}}$$

$$= \frac{100}{\pi}$$

$$= \sqrt{R^2 + (X_L - X_c)^2}$$

$$= \sqrt{(50)^2 + \left(2\pi - \frac{100}{\pi}\right)^2}$$

$$= \sqrt{(50)^2 + (25.56)^2}$$

$$= \sqrt{3153.31}$$

$$p = V_{\text{rms}} I_{\text{rms}} \cos \phi$$

$$= \frac{V_{\text{rms}}^2 R}{Z^2}$$

$$= \left(\frac{10}{\sqrt{2}}\right)^2 \times 50$$

$$p = \frac{\left(\frac{10}{\sqrt{2}}\right)^2 \times 50}{3153.31}$$

$$p = 0.79 \text{ watt}$$

Q 14. A thin diamagnetic rod is placed vertically between the poles of an electromagnet. When the current in the electromagnet is switched on, the diamagnetic rod is pushed up, out of the horizontal magnetic field. Hence the rod gains gravitational potential energy. The work required to do this comes from

- Option A the lattice structure of the material of the rod
- Option B the magnetic field
- Option C the current source
- Option D the induced electric field due to the changing magnetic field

Correct Option C

Solution:

Energy due to current source is responsible.

Q 15. Current sensitivity of a moving coil galvanometer is 5 div/mA and its voltage sensitivity (angular deflection per unit voltage applied) is 20 div/V. The resistance of the galvanometer is

- Option A 250Ω
- Option B 25Ω
- Option C 40Ω
- Option D 500Ω

Correct Option A

Solution:

5 div \rightarrow 1 mA

20 div \rightarrow 4 mA

$V = iR$

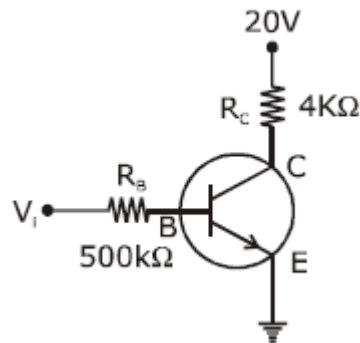
$I = 4 \times 10^{-3} \times R$

$$R = \frac{1}{4 \times 10^{-3}}$$

$$= \frac{1000}{4}$$

$$= 250 \Omega$$

Q 16. In the circuit shown in the figure, the input voltage V_i is 20 V, $V_{BE} = 0$ and $V_{CE} = 0$. The values of I_B , I_C and β are given by



Option A $I_B = 20 \mu A$, $I_C = 5 mA$, $\beta = 250$

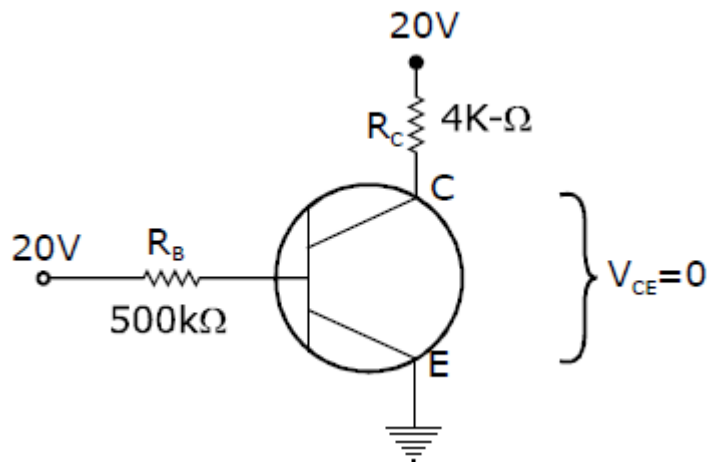
Option B $I_B = 25 \mu A$, $I_C = 5 mA$, $\beta = 200$

Option C $I_B = 40 \mu A$, $I_C = 10 mA$, $\beta = 250$

Option D $I_B = 40 \mu A$, $I_C = 5 mA$, $\beta = 125$

Correct Option D

Solution:



$$I_B = \frac{20}{500 \times 10^3} = \frac{20}{5 \times 10^4}$$

$$= 4 \times 10^{-5}$$

$$= 40 \mu A$$

$$I_c = \frac{20}{4 \times 10^3} = 5 \text{ mA}$$

$$\therefore \beta = 125$$

Q 17. In a p-n junction diode, change in temperature due to heating

- Option A does not affect resistance of p-n junction
- Option B affects only forward resistance
- Option C affects only reverse resistance
- Option D affects the overall V - I characteristics of p-n junction.

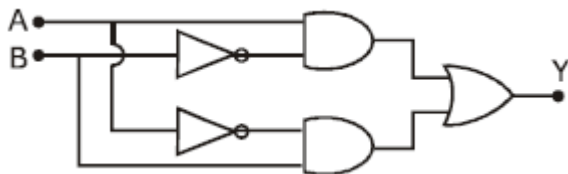
Correct Option D

Solution: on increasing the temperature

The resistances falls.

Current increases in both cases. The overall V-I characteristics of a p-n junction changes.

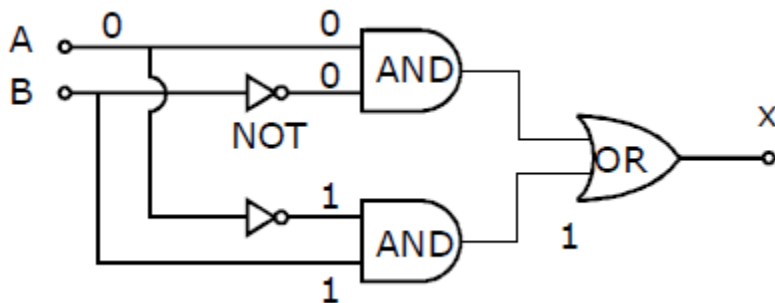
Q 18. In the combination of the following gates the output Y can be written in terms of inputs A and B as



- Option A $\overline{A.B} + A.B$
- Option B $A.\overline{B} + \overline{A}.B$
- Option C $\overline{A.B}$
- Option D $\overline{A+B}$

Correct Option B

Solution:



A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

X - OR gate

Q 19. A carbon resistor of $(47 \pm 4.7)\text{k}\Omega$ is to be marked with rings of different colours for its identification. The colour code sequence will be

- Option A Yellow-Green - Violet-Gold
- Option B Yellow-Violet-Orange-Silver
- Option C Violet-Yellow-Orange-Silver
- Option D Green-Orange -Violet -Gold

Correct Option B

Solution:

$$\begin{aligned}
 R &= (47 \pm 4.7) \text{ K}\Omega \\
 &= 47 \times 10^3 \pm 4700 \\
 R &= 47 \times 10^3 \pm 10\% \\
 \text{B B R O Y G B V G W G S} \\
 0 \ 1 \ 2 \ 3 \ 4 \ 5 \ 6 \ 7 \ 8 \ 9
 \end{aligned}$$

Q 20. A set of 'n' equal resistors, of value 'R' each, are connected in series to a battery of emf 'E' and internal resistance 'R'. The current drawn is I. Now, the 'n' resistors are connected in parallel to the same battery. Then the current drawn from battery becomes 10 I. The value of 'n' is

- Option A 20
- Option B 11
- Option C 10
- Option D 9

Correct Option C

Solution:

$$I = \frac{E}{E + nR}$$

Where parallel combination current 10 I is given by

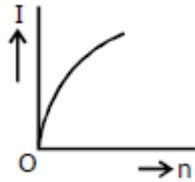
$$\begin{aligned}
 \frac{E}{R} + \frac{R}{n} &= 10 I \\
 \frac{E}{R} + \frac{R}{n} &= 10 \left(\frac{E}{R} + nR \right)
 \end{aligned}$$

How according to problem

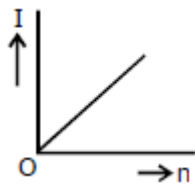
$$\begin{aligned}
 1 + n/1 + 1/n &= 10 \\
 10 &= (1 + n/n + 1) n \\
 n &= 10
 \end{aligned}$$

Q 21. A battery consists of a variable number ' n ' of identical cells (having internal resistance ' r ' each) which are connected in series. The terminals of the battery are short-circuited and the current I is measured. Which of the graphs shows the correct relationship between I and n ?

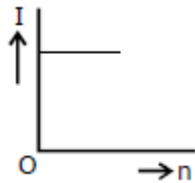
Option A



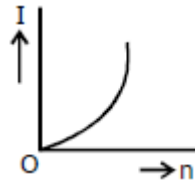
Option B



Option C

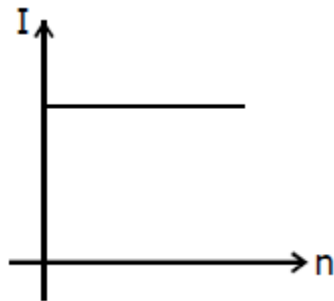


Option D



Correct Option C

Solution: I is independent of the no. of batteries as the terminals of the battery are short circuited.



Q 22. A body initially at rest and sliding along a frictionless track from a height h (as shown in the figure) just completes a vertical circle of diameter $AB = D$. The height h is equal to

Option A $\frac{7}{5}D$

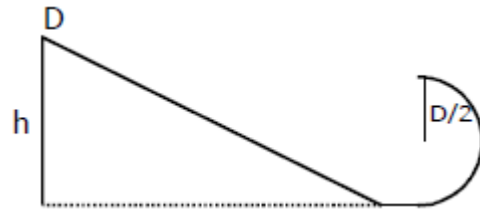
Option B D

Option C $\frac{3}{2}D$

Option D $\frac{5}{4}D$

Correct Option D

Solution:



$$\frac{1}{2}mv^2 = mgh$$

$$v = \sqrt{2gh}$$

$$\frac{1}{2}m(\sqrt{2gh})^2 = \frac{1}{2}mg\frac{D}{2} + MgD$$

$$h = \frac{D}{4} + D$$

$$h = \frac{5D}{4}$$

Q 23. Three objects, A: (a solid sphere), B: (a thin circular disk) and C: (a circular ring), each have the same mass M and radius R . They all spin with the same angular speed ω about their own symmetry axes. The amounts of work (W) required to bring them to rest, would satisfy the relation.

Option A $W_B > W_A > W_C$

Option B $W_A > W_B > W_C$

Option C $W_C > W_B > W_A$

Option D $W_A > W_C > W_B$

Correct Option C

Solution:

A - Solid sphere

B - Thin circular disc

C - Circular ring

As all are rotating about their own symmetry axis, they have rotational KE

$$I_{ss} = \frac{2}{5}MR^2$$

$$I_{dis} = \frac{MR^2}{2}$$

$$I_{ring} = MR^2 \quad \mathbf{s}$$

$$\therefore I_R > I_{Dis} > I_{ss}$$

$$W_C > W_B > W_A$$

Q 24. Which one of the following statements is incorrect?

- Option A Friction force opposes the relative motion
 Option B Limiting value of static friction is directly proportional to normal reaction
 Option C Rolling friction is smaller than sliding friction.
 Option D Coefficient of sliding friction has dimensions of length.

Correct Option D

Solution: Coefficient of sliding friction has dimensions of length.

Q 25. A moving block having mass m , collides with another stationary block having mass $4m$. The lighter block comes to rest after collision. When the initial velocity of the lighter block is v , then the value of coefficient of restitution (e) will be

- Option A 0.8
 Option B 0.25
 Option C 0.5
 Option D 0.4

Correct Option B

Solution:

Before:



After:



$$P_i = P_f$$

$$mv + 4m \times 0 = 4mv' + m \times 0$$

$$\Rightarrow mv = 4mv'$$

$$\Rightarrow v' = \frac{v}{4}$$

$$e = \frac{v_2 - v_1}{u_1 - u_2} \Rightarrow ev = \frac{v}{4}$$

$$\Rightarrow e = \frac{1}{4} = 0.25$$

Q 26. A tuning fork is used to produce resonance in a glass tube. The length of the air column in this tube can be adjusted by a variable piston. At room temperature of 27°C two successive resonances are produced at 20 cm and 73 cm of column length. If the frequency of the tuning fork is 320 Hz, the velocity of sound in air at 27°C is

Option A 350 m/s

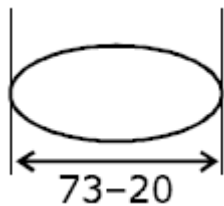
Option B 339 m/s

Option C 330 m/s

Option D 300 m/s

Correct Option B

Solution:



$$53 = \lambda / 2$$

$$f = \frac{v}{\lambda}$$

$$320 = \frac{v}{106 \times 10^{-2}}$$

$$v = 339 \text{ m/s}$$

Q 27. The electrostatic force between the metal plates of an isolated parallel plate capacitor C having a charge Q and area A is

Option A proportional to the square root of the distance between the plates.

Option B linearly proportional to the distance between the plates.

Option C independent of the distance between the plates.

Option D inversely proportional to the distance between the plates.

Correct Option C

Solution:

$$F = \frac{Q^2}{2A\epsilon_0}$$

\therefore the force F is independent of the distance between the plates.

Q 28. A pendulum is hung from the roof of a sufficiently high building and is moving freely to and fro like a simple harmonic oscillator. The acceleration of the bob of the pendulum is 20 m/s² at a distance of 5 m from the mean position. The time period of oscillation is

Option A 2 s

Option B π s

Option C 2π s

Option D 1 s

Correct Option B

Solution:

$$a = -\omega^2 x$$

taking magnitude only

$$20 = \omega^2 5$$

$$\omega = 2 \text{ rad / sec}$$

time period of oscillation

$$T = \frac{2\pi}{\omega} = \frac{2\pi}{2} = \pi \text{ sec}$$

Q 29. An electron falls from rest through a vertical distance h in a uniform and vertically upward directed electric field E. The direction of electric field is now reversed, keeping its magnitude the same. A proton is allowed to fall from rest in it through the same vertical distance h. The time of fall of the electron, in comparison to the time of fall of the proton is.

Option A 10 times greater

Option B 5 times greater

Option C Smaller

Option D equal

Correct Option C

Solution:

$$S = ut + \frac{1}{2} at^2$$

$$h = \frac{eE}{2m_e} t^2$$

As a result

$$t \propto \frac{1}{\sqrt{m}} \sqrt{h}$$

But the $m_e < m_p$

Therefore

$$t_e < t_p$$

Q 30. An electron of mass m with an initial velocity $\vec{V} = V_0 \hat{i}$ ($V_0 > 0$) enters an electric field $\vec{E} = -E_0 \hat{i}$ ($E_0 = \text{constant}$ $t > 0$) at $t = 0$. If λ_0 its de-Broglie wavelength initially, then de-Broglie wavelength initially, then de-Broglie wavelength at time is

Option A $\lambda_0 t$

Option B $\lambda_0 \left(1 + \frac{eE_0}{mV_0} t \right)$

Option C $\frac{\lambda_0}{\left(1 + \frac{eE_0}{mV_0} t \right)}$

Option D λ_0

Correct Option C

Solution:

$$\vec{v} = v_0 \hat{i}, \vec{E} = -E_0 \hat{j}$$

$$v = v_0 + \frac{E_0 e t}{m}$$

$$\lambda = \frac{h}{mv}$$

$$\lambda = \frac{h}{m \left(v_0 + \frac{E_0 e t}{m} \right)}$$

$$\lambda = \frac{h}{m v_0 \left(1 + \frac{E_0 e t}{m v_0} \right)}$$

$$\lambda = \frac{\lambda_0}{1 + \left(\frac{e E_0}{m v_0} \right) t} \quad \left(\lambda_0 = \frac{h}{m v_0} \right)$$

Q 31. For a radioactive material, half -life 10 minutes. If initially there are 600 number nuclei, the time taken (in minutes) for the disintegration of 450 nuclei is

Option A 30

Option B 10

Option C 20

Option D 15

Correct Option C

Solution:

$$N_0 = 600$$

$$N_0 \xrightarrow{\frac{T_1}{2}} \frac{N_0}{2} \xrightarrow{\frac{T_1}{2}} \frac{N_0}{4}$$

$$600 \rightarrow 300 \rightarrow 150$$

450 nuclei disintegration in $2 t_{1/2}$ life

$$N = \frac{N_0}{2^n}$$

$$150 = \frac{600}{2^n}$$

$$2^n = 4$$

$$n = 2$$

$$\frac{T}{t_{1/2}} = 2$$

$$T = 2 \times 10 = 20 \text{ min}$$

Q 32. When the light of frequency $2\nu_0$ (where ν_0 threshold frequency), is incident on a metal plate, the maximum velocity of electrons emitted is v_1 . When the frequency of the incident radiation is increased to $5\nu_0$, the maximum velocity of electrons emitted from the same plate is v_2 . The ratio of v_1 to v_2 is

Option A 4 : 1

Option B 1 : 4

Option C 1 : 2

Option D 2 : 1

Correct Option C

Solution:

$KE_{\max} = E \text{ energy} - \text{Work function}$

$$\frac{1}{2}mv_1^2 = h(2\nu_0 - \nu_0)$$

$$\frac{1}{2}mv_1^2 = h\nu_0 \quad \dots(1)$$

$$\frac{1}{2}mv_2^2 = h(5\nu_0 - \nu_0)$$

$$\frac{1}{2}mv_2^2 = 4h\nu_0 \quad \dots(2)$$

Dividing (1) by (2)

$$\frac{\frac{1}{2}mv_1^2}{\frac{1}{2}mv_2^2} = \frac{h\nu_0}{4h\nu_0}$$

$$\frac{v_1^2}{v_2^2} = \frac{1}{4} \Rightarrow \frac{V_1}{V_2} = \sqrt{\frac{1}{4}}$$

$$\frac{V_1}{V_2} = \frac{1}{2}$$

Q 33. The ratio of kinetic energy to the total energy an electron in a Bohr orbit of the hydrogen atomic is

Option A 2: -1

Option B 1: -1

Option C 1: 1

Option D 1:-2

Correct Option B

Solution:

$$\text{Kinetic Energy} = \frac{13.6z^2}{n^2}$$

$$\text{Total Energy} = -13.6 \frac{z^2}{n^2}$$

$$TE = -KE$$

$$\therefore \frac{KE}{TE} = 1:-1$$

Q 34. An em wave is propagating in a medium with a velocity $\vec{V} = V\hat{i}$. The instantaneous oscillating electric field of this em wave is along +y axis. Then the direction of oscillating magnetic field of the em wave will be along.

Option A -y direction

Option B +z direction

Option C -z direction

Option D -x direction

Correct Option B

Solution:

$$\vec{S} = \vec{E} \times \vec{B}$$

The direction of propagation of EM wave is towards positive x-axis (\hat{i}) and \hat{E} is given in positive direction of y axis direction (\hat{j}). So by using right hand thumb rule we can say that the direction of B is along positive direction of Z- axis .

Q 35. The refractive index of the material of a prism is $\sqrt{2}$ and the angle of the prism is 30° . One of the two refracting surfaces of the prism is made a mirror inwards, by silver coating. A beam of monochromatic light entering the prism from the other face will retrace its path (after reflection from the silvered surface) if its angle of incidence on the prism is -

Option A 30°

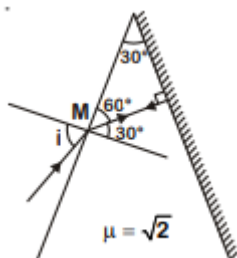
Option B 45°

Option C 60°

Option D zero

Correct Option B

Solution:



To retrace its path the ray should incident normally on the silvered surface.

$$r_2 = 0$$

$$r_1 = A$$

On applying snell's law

$$1 \times \sin i = n \sin A$$

$$\sin i = \sqrt{2} \sin 30^\circ$$

$$i = 45^\circ$$

Here $e = 0$

(No emergence)

Q 36. The magnetic potential energy stored in a certain inductor is 25 mJ, when the current in the inductor is 60 mA. This inductor is of inductance

Option A 1.389 H

Option B 138.88 H

Option C 0.138 H

Option D 13.89 H

Correct Option D

Solution:

$$\frac{1}{2}LI^2 = 25 \times 10^{-3}$$

$$L = \frac{2 \times 25 \times 10^{-3}}{(60 \times 10^{-3})^2}$$

$$= \frac{50 \times 10^{-3}}{36 \times 10^{-4}}$$

$$= 1.389 \times 10$$

$$= 13.89 \text{ H}$$

Q 37. An object is placed at a distance of 40 cm from a concave mirror of focal length 15 cm. If the object is displaced through a distance of 20 cm towards the mirror, the displacement of the image will be

Option A 30 cm towards the mirror

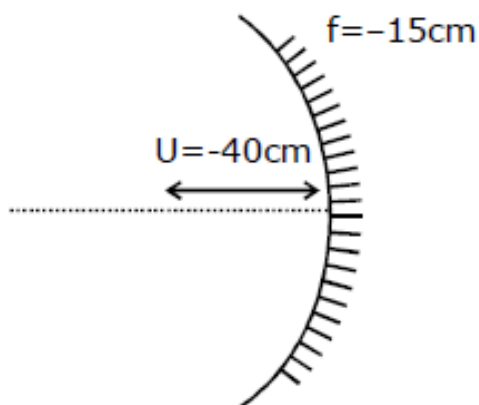
Option B 36 cm away from the mirror

Option C 30 cm away from the mirror

Option D 36 cm towards the mirror

Correct Option B

Solution:



Initial position of the image

$$\frac{1}{v_1} + \frac{1}{u} = \frac{1}{f} \Rightarrow \frac{1}{v_1} - \frac{1}{40} = -\frac{1}{15}$$

$$\frac{1}{v_1} = \frac{1}{40} - \frac{1}{15}$$

$$\frac{1}{v_1} = \frac{15-40}{600}$$

$$v_1 = -\frac{600}{25} \Rightarrow -24 \text{ cm}$$

Final position of the image after the object is displaced by 20cm towards the mirror.

$$\frac{1}{v_2} + \frac{1}{u} = \frac{1}{f}$$

$$\Rightarrow \frac{1}{v_2} - \frac{1}{20} = -\frac{1}{15}$$

$$\frac{1}{v_2} = \frac{1}{20} - \frac{1}{15}$$

$$\frac{1}{v_2} = \frac{15-20}{300}$$

$$v_2 = \frac{300}{-5} \Rightarrow -60 \text{ cm}$$

Displacement of image = 60 - 24
= 36 cm

Q 38. A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field \vec{E} . Due to the force $q\vec{E}$, its velocity increases from 0 to 6 m/s in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively

Option A 1 m/s, 3.5 m/s

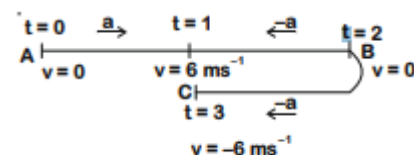
Option B 1 m/s, 3 m/s

Option C 2 m/s, 4 m/s

Option D 1.5 m/s, 3 m/s

Correct Option B

Solution:



$t = 0, v = 0$ and $t = 1, v = 6$

$$6 = 0 + at$$

$$a = 6$$

Displacement for 1st second

$$x = \frac{1}{2} \times 6(1)^2$$

$$= 3$$

Displacement for 2nd second

$$S = 6 \times 1 - \frac{1}{2} \times 6 \times 1^2 = 3$$

After 2 second the car will stop and starts moving backward

$$V = u + at$$

$$0 = 6 - 6t$$

$$t = 1 \text{ second}$$

Displacement for 3rd second

$$S = 0 - \frac{1}{2} \times 6 \times 1^2 = -3$$

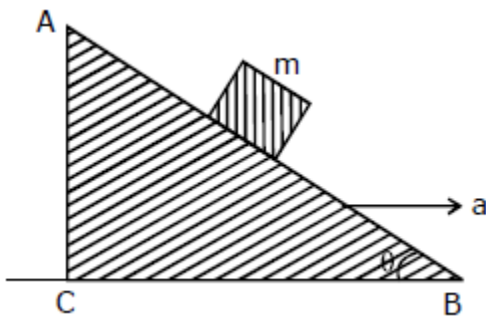
$$\text{Total displacement} = 3 + 3 - 3 = 3 \text{ m}$$

$$\text{Total distance} = 3 + 3 + 3 = 9 \text{ m}$$

$$|\vec{v}_{\text{avg}}| = \frac{3}{3} = 1 \text{ m/s}$$

$$V_{\text{avg}} = \frac{9}{3} = 3 \text{ m/s}$$

Q 39. A block of mass m is placed on a smooth inclined wedge ABC of inclination θ as shown in the figure. The wedge is given an acceleration ' a ' towards the right. The relation between a and θ for the block to remain stationary on the wedge is –



Option A $a = g \cos \theta$

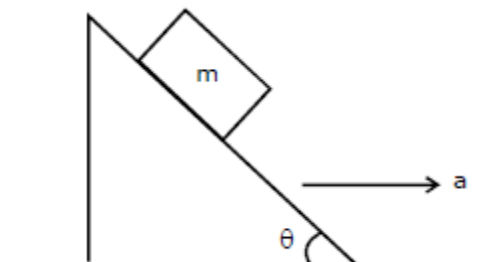
Option B $a = \frac{g}{\sin \theta}$

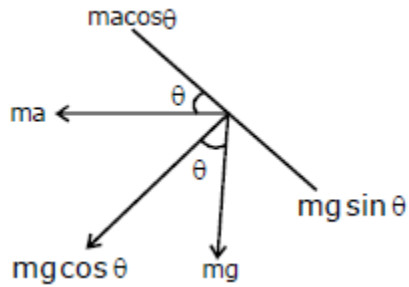
Option C $a = \frac{g}{\operatorname{cosec} \theta}$

Option D $a = g \tan \theta$

Correct Option D

Solution:





The component of forces along the inclined plane should be balanced

$$\therefore ma \cos \theta = mg \sin \theta$$

$$\Rightarrow \boxed{a = g \tan \theta}$$

Q 40. A student measured the diameter of a small steel ball using a screw gauge of least count 0.001 cm. The main scale reading is 5 mm and 0 of circular scale division coincides with 25 divisions above the reference level. If screw gauge has a zero error of -0.004 cm, the correct diameter of the ball is -

Option A 0.053 cm

Option B 0.525 cm

Option C 0.521

Option D 0.529 cm

Correct Option D

Solution:

LC = 0.001 cm

Main scale reading = 5 mm

Zero error = -0.004

CSR (least count) = 0.025 cm

$$D = 0.5 + 0.025 + 0.004$$

$$= 0.529 \text{ cm}$$

Q 41. The moment of the force $\vec{F} = 4\hat{i} + 5\hat{j} - 6\hat{k}$ at (2, 0, -3), about the point (2, -2, -2), is given by

Option A $-7\hat{i} - 8\hat{j} - 4\hat{k}$

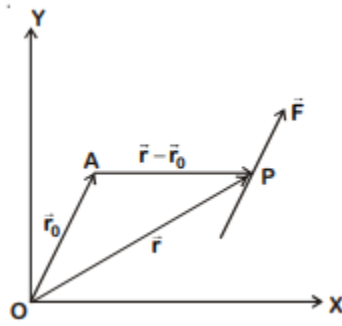
Option B $-4\hat{i} - \hat{j} - 8\hat{k}$

Option C $-8\hat{i} - 4\hat{j} - 7\hat{k}$

Option D $-7\hat{i} - 4\hat{j} - 8\hat{k}$

Correct Option D

Solution:



$$\tau = \vec{r} \times \vec{F}$$

$$\vec{r} = \vec{r} - \vec{r}_0$$

$$\vec{r} = (2\hat{i} + 0\hat{j} - 3\hat{k}) - (2\hat{i} - 2\hat{j} - 2\hat{k})$$

$$\vec{r} = 2\hat{j} - \hat{k}$$

$$= \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 2 & -1 \\ 4 & 5 & -6 \end{vmatrix}$$

$$\hat{i}(-12+5) - \hat{j}(+4) + \hat{k}(8)$$

$$\Delta \vec{r} = (2-2)\hat{i} + (0+2)\hat{j} + (-3+2)\hat{k}$$

$$= -7\hat{i} - 4\hat{j} - 8\hat{k}$$

Q 42. The power radiated by a black body is P and it radiates maximum energy at wavelength λ_0 . If the temperature of the black body is now changed so that it radiates maximum energy at wavelength $\frac{3}{4}\lambda_0$, the power radiated by it becomes nP . The value of n is

-

Option A $\frac{256}{81}$

Option B $\frac{4}{3}$

Option C $\frac{3}{4}$

Option D $\frac{81}{256}$

Correct Option A

Solution:

$$P = eA\sigma T^4$$

$$P \propto T^4$$

According to Wien's displacement law

$$\lambda_M \times T = \text{constant}$$

$$\lambda_1 \times T_1 = \lambda_2 \times T_2$$

$$\frac{T_1}{T_2} = \frac{\lambda_2}{\lambda_1}$$

$$P \propto \frac{1}{\lambda^4} \Rightarrow \frac{P_1}{P_2} = \left(\frac{\lambda_2}{\lambda_1} \right)^4$$

$$P_2 = P_1 \times \left(\frac{\lambda_1}{\lambda_2} \right)^4$$

$$= P_1 \left(\frac{\lambda_0}{3\lambda_0} \times 4 \right)^4$$

$$P_2 = P_1 \times \frac{256}{81}$$

Q 43. Two wires are made of the same material and have the same volume. The first wire has cross-sectional area A and the second wire has cross-sectional area 3A. If the length of the first wire is increased by Δl on applying a force F, how much force is needed to stretch the second wire by the same amount?

Option A 4 F

Option B 6 F

Option C 9 F

Option D 5 F

Correct Option C

Solution:

$$\gamma = \frac{\text{stress}}{\text{strain}}$$

$$\gamma = \frac{F \times L}{A \Delta L}$$

$$\therefore \frac{FL}{A} = (\gamma \Delta L) = \text{constant}$$

$$\frac{F_1 L_1}{A_1} = \frac{F_2 L_2}{A_2}$$

$$F_2 = \frac{A_2 F_1 L_1}{A_1 L_2}$$

As the volume is same for both

$$A L_1 = 3 A L_2$$

$$L_2 = \frac{L_1}{3}$$

$$= \frac{F_1 \times L_1 \times 3A}{A \times \frac{L_1}{3}} = 9F_1$$

Q 44. A sample of 0.1 g of water at 100°C and normal pressure ($1.013 \times 10^5 \text{ Nm}^{-2}$) requires 54 cal of heat energy to convert to steam at 100°C. If the volume of the steam produced is 167.1 CC, the change in internal energy of the sample, is -

Option A 42.4 J

Option B 208.7 J

Option C 104.3 J

Option D 84.5 J

Correct Option B

Solution:

According to first law of thermodynamics

$$\Delta Q = \Delta U + \Delta W$$

$$\Delta U = \Delta Q - \Delta W$$

$$\Delta U = 54 \times 4.2 - P (\Delta V)$$

$$\Rightarrow 54 \times 4.2 - (1.013 \times 10^5 \times 167.1 \times 10^{-6})$$

$$\Rightarrow 208.7 \text{ Joule}$$

Q 45. A small sphere of radius 'r' falls from rest in a viscous liquid. As a result, heat is produced due to viscous force. The rate of production of heat when the sphere attains its terminal velocity, is proportional to -

Option A r^5

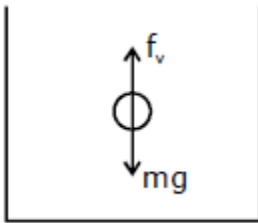
Option B r^2

Option C r^3

Option D r^4

Correct Option A

Solution:



When terminal velocity is attained all the forces are balanced

Viscous force= Weight

$$6\eta r v = \rho \left(\frac{4}{3} \pi r^3 \right) g$$

$$v \propto r^2$$

Rate of heat generated

$$\text{Power} = Fv$$

$$\text{Power} \propto (mg) v$$

$$\text{Power} \propto \rho \frac{4}{3} \pi r^3 g v$$

$$\text{Power} \propto r^5$$