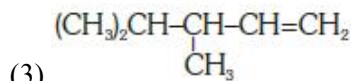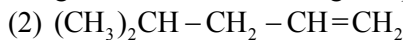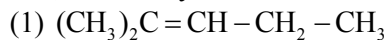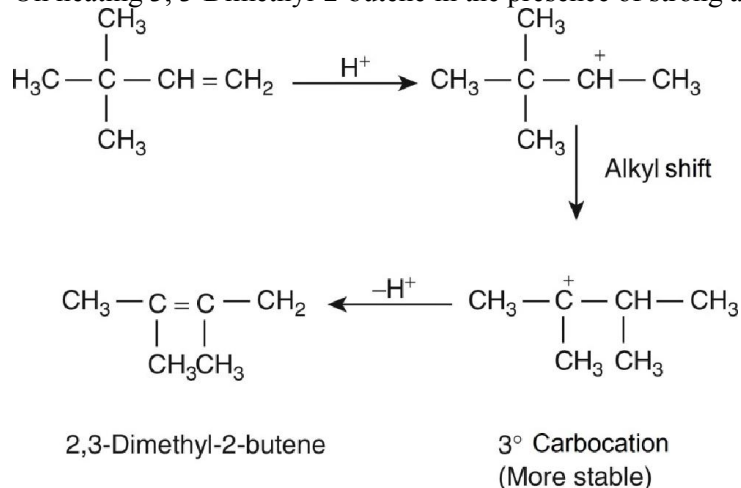# AIPMT 2015

<u>**Section A: Chemistry**</u>

1. 2,3–Dimethyl–2–butene can be prepared by heating which of the following compounds with a strong acid ?
(1) $(CH_3)_2C=CH-CH_2-CH_3$ (2) $(CH_3)_2CH-CH_2-CH=CH_2$

(3) (CH₃)₂CH–CH–CH=CH₂
           |
   CH₃   (4) $(CH_3)_3C-CH=CH_2$
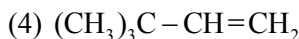
Solution:
On heating 3, 3-Dimethyl-2-butene in the presence of strong acid gives 2, 3-dimethyl-2-butene.

2,3-Dimethyl-2-butene   3° Carbocation (More stable)

Hence, the correct option is (4).

2. Gadolinium belongs to $4f$ series. It's atomic number is 64. Which of the following is the correct electronic configuration of gadolinium?
(1) $[Xe]4f^7 5d^1 6s^2$ (2) $[Xe]4f^6 5d^2 6s^2$
(3) $[Xe]4f^8 6d^2$ (4) $[Xe]4f^9 5s^1$
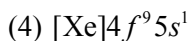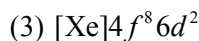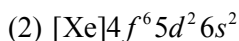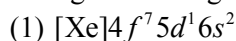
Solution:
The correct electronic configuration of
$_{64}Gd = _{54}[Xe]4f^7 5d^1 6s^2$
Hence, the correct option is (1).

3. The formation of the oxide ion, O^{2-} (g), from oxygen atom requires first an exothermic and then an endothermic step as shown below:
O (g) + e^- → O^- (g)   ; $\Delta_f H = -141$ kJ mol^{-1}
O^- (g) + e^- → O^{2-} (g)   ; $\Delta_f H = +780$ kJ mol^{-1}
Thus, process of formation of O^{2-} in gas phase is unfavorable even though O^{2-} is isoelectronic with neon. It is due to the fact that,
(1) Oxygen is more electronegative
(2) Addition of electron in oxygen results in larger size of the ion
(3) Electron repulsion outweighs the stability gained by achieving noble gas configuration
(4) O^- ion has comparatively smaller size than oxygen atom.
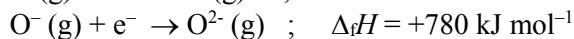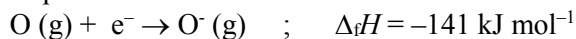
Solution:
Electron repulsion outweighs the stability gained by achieving noble gas configuration.

Hence, the correct option is (3).

4. The number of structural isomers possible from the molecular formula C_3H_9N is:
(1) 2   (2) 3
(3) 4   (4) 5

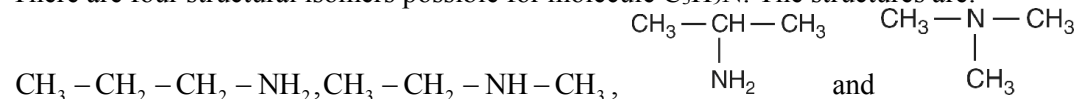**Solution:**
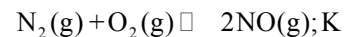There are four structural isomers possible for molecule C_3H_9N. The structures are:

$CH_3-CH_2-CH_2-NH_2, CH_3-CH_2-NH-CH_3$, $CH_3-CH-CH_3$ (with NH_2 below the CH) and CH_3-N-CH_3 (with CH_3 below the N)

Hence, the correct option is (3).

5. If the equilibrium constant for:
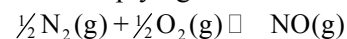$N_2(g)+O_2(g) \rightleftharpoons 2NO(g)$ is K, the equilibrium constant for $\frac{1}{2}N_2(g)+\frac{1}{2}O_2(g) \rightleftharpoons NO(g)$ will be:
(1) K   (2) K^2
(3) $K^{1/2}$ (4) ½K

Solution:
$N_2(g)+O_2(g) \rightleftharpoons 2NO(g); K$
On multiplying ½ both the sides of reaction, we get
$\frac{1}{2}N_2(g)+\frac{1}{2}O_2(g) \rightleftharpoons NO(g)$
Let the equilibrium constant for the above reaction be K'.
Then, $K' = (K)^{1/2}$
Hence, the correct option is (3).

6. Which one of the following pairs of solution is not an acidic buffer?
(1) H_2CO_3 and Na_2CO_3
(2) H_3PO_4 and Na_3PO_4
(3) $HClO_4$ and $NaClO_4$
(4) CH_3COOH and CH_3COONa

Solution:
The solution of $HClO_4$ and $NaClO_4$ can act as acidic buffer.
Hence, the correct option is (3).

7. Aqueous solution of which of the following compounds is the best conductor of electric current?
(1) Ammonia, NH_3 (2) Fructose, $C_6H_{12}O_6$
(3) Acetic acid, $C_2H_4O_2$ (4) Hydrochloric acid, HCl

Solution:
HCl is a strong acid. It dissociates completely into ions. Thus, the aqueous solution of HCl is a best conductor of electricity.
Hence, the correct option is (3).

8. Caprolactam is used for the manufacture of:
(1) Terylene   (2) Nylon - 6, 6
(3) Nylon - 6   (4) Teflon
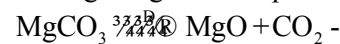
Solution:
Caprolactum is the monomer unit of Nylon-6.
Hence, the correct option is (3).

9. On heating which of the following releases CO_2 most easily?
(1) $MgCO_3$ (2) $CaCO_3$
(3) K_2CO_3 (4) Na_2CO_3

Solution:
Among the given compounds, magnesium carbonate is least stable hence it dissociates readily and releases CO_2.

$MgCO_3 \xrightarrow{\Delta} MgO + CO_2$ -

Hence, the correct option is (1).

10. Strong reducing behavior of H_3PO_2 is due to:
(1) High oxidation state of phosphorus
(2) Presence of two –OH groups and one P – H bond
(3) Presence of one –OH group and two P – H bonds
(4) High electron gain enthalpy of phosphorus

Solution: All oxy-acid of phosphorus which contain P – H bond act as reductant. H_3PO_2 as its structure suggests has one –OH group and two P – H bonds.

$$
\begin{array}{c}
O \\
\| \\
H\diagup P - OH \\
H
\end{array}
$$
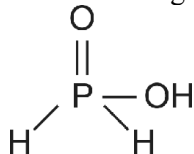
Hence, the correct option is (3).

11. Decreasing order of stability of O_2, O_2^-, O_2^+ and O_2^{2-} is:
(1) $O_2 > O_2^+ > O_2^{2-} > O_2^-$ (2) $O_2^- > O_2^{2-} > O_2^+ > O_2$
(3) $O_2^+ > O_2 > O_2^- > O_2^{2-}$ (4) $O_2^{2-} > O_2^- > O_2 > O_2^+$

Solution:
The stability of a given species is directly proportional to its bond order. Higher is the bond orders, greater is its stability. The bond order of O_2^+, O_2, O_2^- are 2.5, 2, 1.5 and 1 respectively. Thus, the stability order is

$O_2^+ > O_2 > O_2^- > O_2^{2-}$
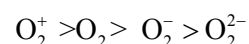
Hence, the correct option is (3).

12. The number of water molecules is maximum in:
(1) 18 gram of water   (2) 18 moles of water
(3) 18 molecules of water   (4) 1.8 gram of water

Solution:
1 mol of water contains 6.02×10^{23} molecules. Therefore, 18 mol water contains $= 18 \times 6.02 \times 10^{23}$ molecules
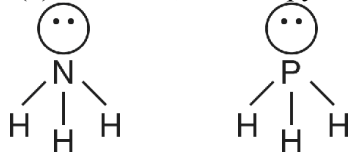**Hence, the correct option is (2).**

13. In which of the following pairs, both the species are not isostructural ?
(1) NH_3, PH_3 (2) XeF_4, XeO_4
(3) $SiCl_4$, PCl_4 (4) Diamond, silicon carbide
Solution:
 (1) Both NH_3, PH_3 are pyramidal in shape.

$$
\begin{array}{cc}
N & P \\
H\ H\ H & H\ H\ H
\end{array}
$$

(2) The structure of XeF_4 is square planar with hybridization sp^3d^2, while the structure of XeO_4 is tetrahedral with sp^3 hybridization.
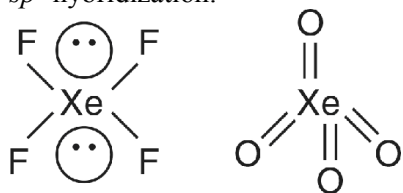
(3) Both $SiCl_4$, PCl_4^+ are tetrahedral in shape.
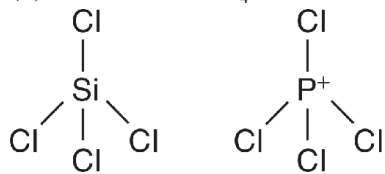
Hence, the correct option is (2).

14. In the reaction with HCl, an alkene reacts in accordance with the Markovnikov's rule, to give a product 1-chloro-1-methylcyclohexane. The possible alkene is:

(1) (A)   (2) (B)

(3) (A) and (B)   (4)
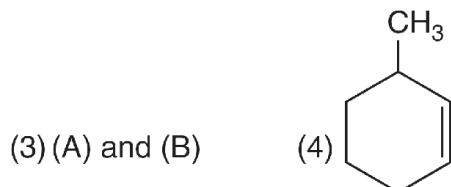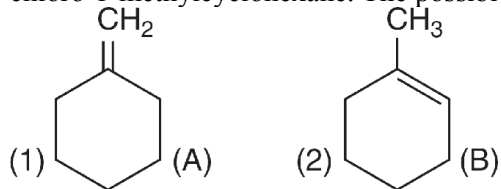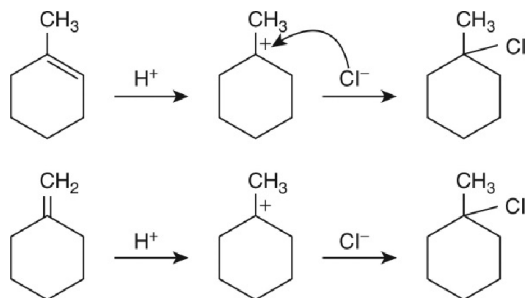
Solution:

Hence, the correct option is (3).

15. Assuming complete ionization, same moles of which of the following compounds will require the least amount of acidified $KMnO_4$ for complete oxidation?
(1) FeC_2O_4 (2) $Fe(NO_2)_2$
(3) $FeSO_4$ (4) $FeSO_3$

Solution:
$FeSO_4$ will require the least amount of acidified $KMnO_4$ for complete oxidation.
Hence, the correct option is (3).

16. Reaction of phenol with chloroform in presence of dilute sodium hydroxide finally introduces which one of the following functional group?

(1) $-CHCl_2$ (2) $-CHO$

(3) $-CH_2Cl$ (4) $-COOH$

Solution:
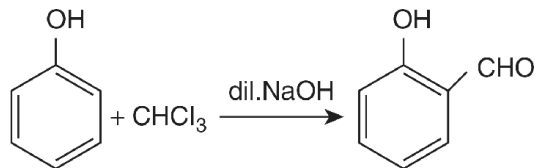
This is Reimer Tieman reaction.
Hence, the correct option is (2).

17. The vacant space in bcc lattice unit cell is:

(1) 23%   (2) 32%

(3) 26%   (4) 48%

Solution:
Packing efficiency in bcc lattice $= 68\%$
$\therefore$ vacant space in bcc lattice $= 100 - 68 = 32\%$
Hence, the correct option is (2).

18. Which of the statements given below is incorrect?

(1) ONF is isoelectronic with O_2N- (2) OF_2 is an oxide of fluorine

(3) Cl_2O_7 is an anhydride of perchloric acid   (4) O_3 molecule is bent

Solution:
(1) Both ONF and O_2N^- are isoelectronic to each other as both the species contain 24 electrons.
(2) The electron negativity of fluorine is more than that of oxygen. Hence, OF is a fluoride of oxygen.
(3) Cl_2O_7 is an anhydride of perchloric acid.
(4) Ozone (O_3) bent shape
Hence, the correct option is (2).

19. The name of complex ion, $[Fe(CN)_6]^{3-}$ is:

(1) Tricyanoferrate (III) ion   (2) Hexacyanidoferrate (III) ion

(3) Hexacyanoiron (III) ion   (4) Hexacyanitoferrate (III) ion

Solution:
The name of the complexion is Hexacyanidoferrate (III) ion.
Hence, the correct option is (2).

20. If Avogadro number N_A, is changed from 6.022×10^{23} mol^{-1} to 6.022×10^{20} mol^{-1}, this would change:

(1) the ratio of chemical species to each other in a balanced equation.
(2) the ratio of elements to each other in a compound.
(3) the definition of mass in units of grams.
(4) the mass of one mole of carbon.

Solution:
12g of carbon $= 6.022 \times 10^{23}$ atoms (mass of 1 mol)

Mass of 1 mol of carbon $= \dfrac{12 \times 6.022 \times 10^{20}}{6.022 \times 10^{23}}$

$$= 12 \times 10^{-3} \text{g}$$

Hence, the correct option is (4).

21. Which of the following statements is not correct for a nucleophile?
(1) Nucleophiles attack low e^- density sites.   (2) Nucleophiles are not electron seeking.
(3) Nucleophile is a Lewis acid.   (4) Ammonia is a nucleophile.

Solution:
Nucleophiles are electron rich species this act as Lewis base. Lenis acids are electron-deficient species.
Hence, the correct option is (3).

22. A gas such as carbon monoxide would be most likely to obey the ideal gas law at:
(1) high temperatures and high pressures   (2) low temperatures and low pressures
(3) high temperatures and low pressures   (4) low temperatures and high pressures

Solution:
Carbon monoxide will show ideal gas behavior at high temperatures and low pressure.
Hence, the correct option is (3).

23. The hybridization involved in complex $[Ni(CN)_4]^{2-}$ is (At.no. of Ni = 28)
(1) d^2sp^2 (2) d^2sp^3
(3) dsp^2 (4) sp^3

Solution:
In $[Ni(CN)_4]^{2-}$, oxidation state of Ni is +2.
\ The electronic configuration of $Ni^{2+} = [Ar]^{18}3d^84s°$
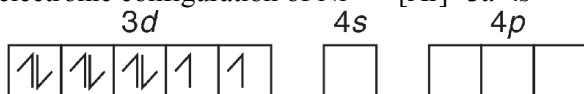
CN^- is a strong field ligand due which all the unpaired electrons are paired up.
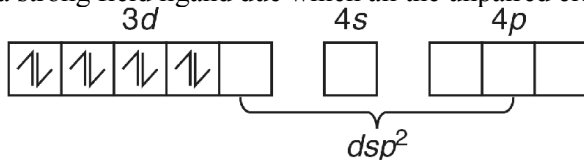
Hence, the correct option is (3).

24. The heat of combustion of carbon to CO_2 is -393.5 kJ/mol. The heat released upon formation of 35.2 g of CO_2 from carbon and oxygen gas is:
(1) -630 kJ   (2) -3.15 kJ
(3) -315 kJ   (4) $+315$ kJ
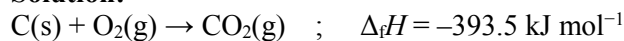
Solution:
$C(s) + O_2(g) \rightarrow CO_2(g)$; $\Delta_f H = -393.5$ kJ mol^{-1}
Heat released due to formation of 44g of $CO_2 = -393.5$ kJ mol^{-1}

Heat released due to formation of 35.2g of $CO_2 = \dfrac{-393.5}{44}$, $35.2 = -315$ kJ

Hence, the correct option is (3).

25. 20.0 g of a magnesium carbonate sample decomposes on heating to give carbon dioxide and 8.0g magnesium oxide. What will be the percentage purity of magnesium carbonate in the sample?
(1) 60   (2) 84

(3) 75   (4) 96

Solution:
The decomposition reaction is

$MgCO_3 \xrightarrow{\;\;\;} MgO + CO_2$

Number of notes of $MgCO_3 = \dfrac{20}{84} = 0.238$ mol

Since, 1 mol of $MgCO_3$ gives 1 mol of MgO
\ 0.238 mol of $MgCO_3$ will give 0.238 mol of MgO
$$= 0.238 \times 40g = 9.52g \; MgO$$

Yield obtained = 80g

$\% = \dfrac{\text{Experimental yield}}{\text{Theoretical yield}} \times 100$

$\quad = \dfrac{8}{9.523} \times 100 = 84\%$

Hence, the correct option is (2).

26. What is the mole fraction of the solute in a 1.00 m aqueous Solution?
(1) 0.0354   (2) 0.0177
(3) 0.177   (4) 1.770

Solution:

Number of moles of water $= \dfrac{1000}{8} = 55.5 \; mol/H_2O$

$X_{solute} = \dfrac{n_{solute}}{n_{solute} + n_{H_2O}} = \dfrac{1}{1 + 55.5} = 0.0177$

Hence, the correct option is (2).

27. The correct statement regarding defects in crystalline solids is:
(1) Frenkel defect is a dislocation defect
(2) Frenkel defect is found in hallides of alkaline metals
(3) Schottky defects have no effect on the density of crystalline solids
(4) Frenkel defects decrease the density of crystalline solids

Solution:
Frenkel defect is a dislocation defect.
Hence, the correct option is (1).

28. The stability of +1 oxidation state among Al, Ga, In and TI increases in the sequence:
(1) TI < In < Ga < Al   (2) In < TI < Ga < Al
(3) Ga < In < Al < TI   (4) Al < Ga < In < TI

Solution:
The stability of +1 oxidation state is
Al < Ga < In < Tl
Hence, the correct option is (4).

29. Two possible stereo-structures of $CH_3CHOH.COOH$, which are optically active, are called:
(1) Enantiomers   (2) Mesomers
(3) Diastereomers   (4) Atropisomers

Solution:
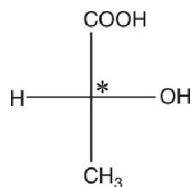
There is one chiral center in the molecule. Thus, two optically active enantiomers are possible.
Hence, the correct option is (1).

30. The following reaction:
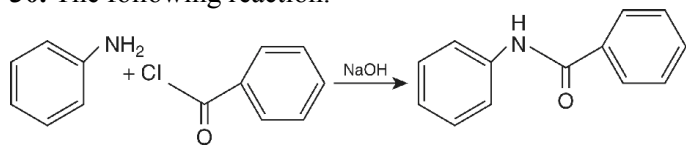
is known by the name :
(1) Acetylation reaction (2) Schotten-Baumen reaction
(3) Friedel Craft's reaction (4) Perkin's reaction

Solution:
The given reaction is an example of Schotten – Baumen reaction.
Hence, the correct option is (2).

31. The sum of coordination number and oxidation number of the metal M in the complex $[M(en)_2(C_2O_4)]Cl$
(where en is ethylenediamine) is:
(1) 7 (2) 8
(3) 9 (4) 6

Solution:
The oxidation state of M = 3
Coordination number = 6
\ Sum = 3 + 6 = 9
Hence, the correct option is (3).

32. Reaction of carbonyl compound with one of the following reagents involves nucleophilic addition followed by
elimination of water. The reagent is:
(1) hydrocyanic acid (2) sodium hydrogen sulphite
(3) a Grignard reagent (4) hydrazine in presence of feebly acidic solution

Solution:
Carbonyl compounds undergo nucleophilic addition elimination reaction with ammonia and its derivative.
Hence, the correct option is (4).

33. Which one of the following esters gets hydrolysed most easily under alkaline conditions?

(1)

(2)

(3)

(4)
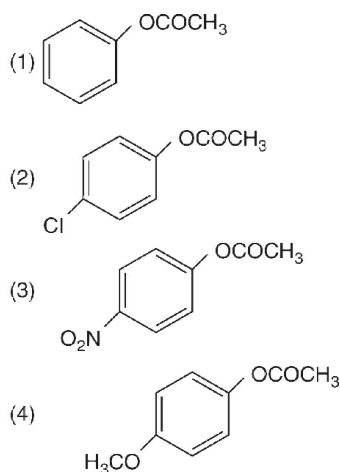
Solution:
(3) undergoes hydrolysis most easily due to the presence of electron withdrawing – NO_2 group.

O_2N ——⟨ ⟩—— $OCOCH_3$
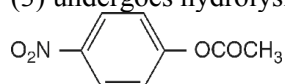
Hence, the correct option is (3).

34. In an S_N1 reaction on chiral centers, there is:
(1) 100% retention
(2) 100% inversion
(3) 100% racemization
(4) inversion more than retention leading to partial racemization

Solution:
S_N1 reaction is a two-step process. Carbocations formed undergo rearrangement also susceptible to attack by nucleophile from any side depending on steric factors. Thus, it leads to the formation of racemic mixture with some amount of the formation of isomer corresponds to inversion.
Hence, the correct option is (4).

35. The rate constant of the reaction A → B is 0.6×10^{-3} mole per second. If the concentration of A is 5 M, then concentration of B after 20 minutes is:
(1) 0.36 M
(2) 0.72 M
(3) 1.08 M
(4) 3.60 M

Solution:
For zero-order reaction
$c = kt$
where c is the concentration, k is rate constant and t is time.
$c = (0.6 \times 10^{-3} \text{ mol s}^{-1}) \times 20 \times 60\text{s}$
$= 0.72$ M
Hence, the correct option is (2).

36. What is the pH of the resulting Solution: when equal volumes of 0.1 M NaOH and 0.01 M HCl are mixed?
(1) 7.0
(2) 1.04
(3) 12.65
(4) 2.0

Solution:
$MV = M_1V_1 - M_2V_2$
$MX_2 = 0.1 \times 1 - 0.01 \times 1$
$[OH^-] = M = \dfrac{0.09}{2} = 0.045$ M

pOH = −log [OH⁻] = −log (0.045) = 1.35
∵ pH + pOH = 14
\ pH = 14 − 1.35 = 12.65
Hence, the correct option is (3).

37. Number of possible isomers for the complex [Co(en)₂Cl₂] Cl will be: (en = ethylenediamine)
(1) 3   (2) 4
(3) 2   (4) 1
Solution:
The total number of possible stereoisomers for the complex of type $[M(AA)_2a_2]$ is three.
Hence, the correct option is (1).

38. The variation of the boiling points of the hydrogen halides is in the order HF > HI > HBr > HCl. What explains the higher boiling point of hydrogen fluoride?
(1) The bond energy of HF molecules is greater than in other hydrogen halides.
(2) The effect of nuclear shielding is much reduced in fluorine which polarizes the HF molecule.
(3) The electronegativity of fluorine is much higher than for other elements in the group.
(4) There is strong hydrogen bonding between HF molecules.

Solution:
Hydrogen bonding is strongest in case of HF followed by HI, HBr and HCl.
Hence, the correct option is (4).

39. What is the mass of the precipitate formed when 50 mL of 16.9 % solution of AgNO₃ is mixed with 50 mL of 5.8% NaCl solution? (Ag = 107.8, N = 14, O = 16, Na = 23, Cl =35.5)
(1) 7 g   (2) 14 g
(3) 28 g   (4) 3.5 g

Solution:
16.9% solution of AgNO₃ implies that 8.45g of AgNO₃ is present in 50 mL solution.
Similarly, 5.8% of NaCl indicates 2.9g of NaCl is present in 50 mL solution.

No. of moles of AgNO₃ $= \dfrac{8.45\text{g}}{170\text{ g/mol}} = 0.049$ mol

No. of moles of NaCl $= \dfrac{2.9\text{ g}}{58.5\text{ g/mol}} = 0.049$ mol

The reaction is :	AgNO₃	+ NaCl	®	AgCl	+ NaNO₃
Initial amount	0.049	0.049		0	0
Final amount	0	0		0.049	0.049

\ Mass of AgCl precipitated = 0.049 mol × 143.5 g/mol
                                    = 7 g
Hence, the correct option is (1).

40. The oxidation of benzene by V₂O₅ in the presence of air produces:
(1) benzoic acid   (2) benzaldehyde
(3) benzoic anhydride   (4) maleic anhydride
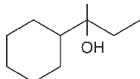
Solution:
The oxidation of benzene by V₂O₅ in the presence of air produces malic anhydride:
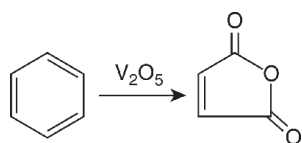
Hence, the correct option is (4).

41. Which of the following is not the product of dehydration of ?

(1)   (2)

(3)   (4)

Solution:

(Formation of 3° carbocation)

$-H^+$
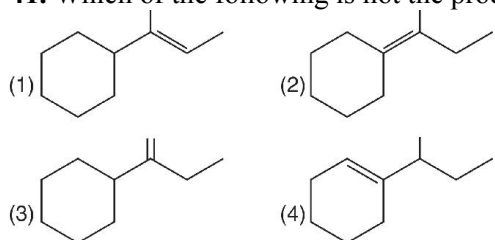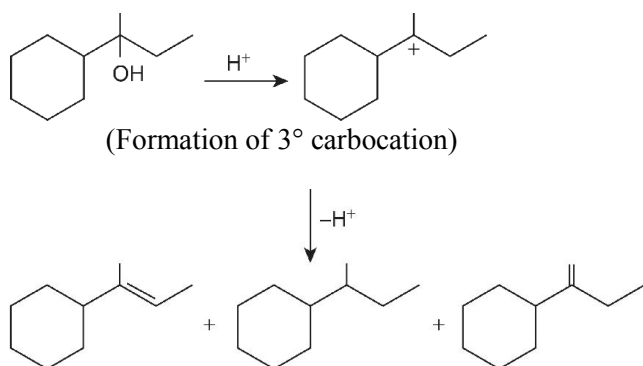
Hence, the correct option is (4).

42. Method by which aniline cannot be prepared is:
(1) reduction of nitrobenzene with H_2/Pd in ethanol
(2) potassium salt of phthalimide treated with chlorobenzene followed by hydrolysis with aqueous NaOH solution
(3) hydrolysis of phenylisocyanide with acidic solution
(4) degradation of benzamide with bromine in alkaline solution

Solution:
The double bond character of C-Cl bond in chlorobenzene due to resonance would not lead to the formation of aniline.
Hence, the correct option is (2).

43. Which of the following reaction(s) can be used for the preparation of alkyl halides?
(I) $CH_3CH_2OH + HCl \xrightarrow{\text{anh. ZnCl}_2}$
(II) $CH_3CH_2OH + HCl \longrightarrow$
(III) $(CH_3)_3COH + HCl \longrightarrow$
(IV) $(CH_3)_2CHOH + HCl \xrightarrow{\text{anh. ZnCl}_2}$
(1) (IV) only   (2) (III) and (IV) only
(3) (I), (III) and (IV) only   (4) (I) and (II) only

Solution:

As (I) and (IV) involves the formation of more stable carbocation in the presence of anhydrous $ZnCl_2$. (III) gives alkyl halide due to formation of more stable carbocation.
Hence, the correct option is (3).

44. Which is the correct order of increasing energy of the listed orbitals in the atom of titanium? (At. no. of Z = 22)
(1) $3s$ $3p$ $3d$ $4s$ (2) $3s$ $3p$ $4s$ $3d$
(3) $3s$ $4s$ $3p$ $3d$ (4) $4s$ $3s$ $3p$ $3d$

Solution:
The electronic configuration of Ti is
$1s^2$ $2s^2$ $2p^6$ $3s^2$ $3p^6$ $4s^2$ $3d^2$
Therefore, the order of energy is $= 3s < 3p^2 < 4s < 4d$
Hence, the correct option is (2).
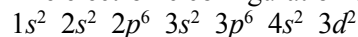
45. In the extraction of copper from its sulphide ore, the metal is finally obtained by the reduction of cuprous oxide with:
(1) copper(I) sulphide   (2) sulphur dioxide
(3) iron(II) sulphide   (4) carbon monoxide

Solution:
This is self-reduction.
$Cu_2S + 2Cu_2O \rightarrow 6Cu + SO_2 \uparrow$
Hence, the correct option is (3).
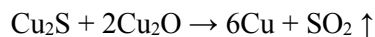
Section B: Biology

46. Root pressure develops due to:
(1) Increase in transpiration   (2) Active absorption
(3) Low osmotic potential in soil   (4) Passive absorption

Solution:
Root pressure is defined as the pressure that develops in xylem vessels as a result of active metabolic activities of roots.
Hence, the correct option is (2).

47. Which one is a wrong statement?
(1) Brown algae have chlorophyll a and c, and fucoxanthin.
(2) Archegonia are found in Bryophyta, Pteridophyta and Gymnosperms.
(3) *Mucor* has biflagellate zoospores.
(4) Haploid endosperm is typical feature of gymnosperms .

Solution:
Mucor and *Rhizopus* have non-motile sporangiospores are called aplanospores.
Hence, the correct option is (3).

48. Which of the following structures is not found in prokaryotic cells?
(1) Plasma membrane   (2) Nuclear envelope
(3) Ribosome   (4) Mesosome
Solution:
Prokaryotic cells lack nucleus and membrane bound organelles that distinguishes them from eukaryotic cells.
Hence, the correct option is (2).

49. Which one of the following animals has two separate circulatory pathways?
(1) Shark
(2) Frog
(3) Lizard
(4) Whale
Solution:
Whale is a mammal. Thus, a whale has four-chambered heart with two atria and two ventricles. The blood circulation to the lungs is separate from that to the rest of the body.
Hence, the correct option is (4).

50. Most animals that live in deep oceanic waters are:
(1) Detritivores
(2) Primary consumers
(3) Secondary consumers
(4) Tertiary consumers
Solution:
The deepest benthic zone of ocean consists of organic debris and mud. It consists of both micro and macroconsumers called detritrivores.
Hence, the correct option is (1).

51. An association of individuals of different species living in the same habitat and having functional interactions is:
(1) Population
(2) Ecological niche
(3) Biotic community
(4) Ecosystem
Solution:
A biotic community in a large area living in particular climatic condition constitutes a biome.
Hence, the correct option is (3).

52. The oxygen evolved during photosynthesis comes from water molecules. Which one of the following pairs of elements is involved in this reaction?
(1) Magnesium and Chlorine
(2) Manganese and Chlorine
(3) Manganese and Potassium
(4) Magnesium and Molybdenum
Solution:
Manganese along with chlorine is part of the oxygen-evolving complex associated with photosystem II, where it accumulates charges during the oxidation of water.
Hence, the correct option is (2).

53. Axile placentation is present in:
(1) *Argemone*
(2) *Dianthus*
(3) Lemon
(4) Pea
Solution:
In axile, the gynoecium is made up of two or more carpels, the ventral sutures of which meet at the center of the ovary making it multilocular. The ovules are borne on the placenta of the central axis. For example, lemon.
Hence, the correct option is (3).

54. In which of the following both pairs have correct combination:
(1)	Gaseous nutrient cycle	Sulphur and Phosphorous
	Sedimentary nutrient cycle	Carbon and Nitrogen
(2)	Gaseous nutrient cycle	Carbon and Nitrogen
	Sedimentary nutrient cycle	Sulphur and Phosphorous
(3)	Gaseous nutrient cycle	Carbon and Sulphur
	Sedimentary nutrient cycle	Nitrogen and phosphorous
(4)	Gaseous nutrient cycle	Nitrogen and Sulphur
	Sedimentary nutrient cycle	Carbon and phosphorous

Solution:
Gaseous cycle have their reservoirs in the atmosphere or hydrosphere (water), e.g., carbon and nitrogen. Sedimentary cycle have their reservoirs in the Earth's crust, e.g., sulphur and phosphorus.

Hence, the correct option is (2).

55. In mammalian eye, the 'fovea' is the center of the visual field, where:
(1) more rods than cones are found.
(2) high density of cones occur, but has no rods
(3) the optic nerve leaves the eye
(4) only rods are present

Solution:
The fovea centralis is a small depression in the center of the macula lutea. It contains only cones.
Hence, the correct option is (2).

56. Choose the wrong statement:
(1) Yeast is unicellular and useful in fermentation
(2) *Penicillium* is multicellular and produces antibiotics
(3) *Neurospora* is used in the study of biochemical genetics
(4) Morels and truffles are poisonous mushrooms
Solution:
Morels and truffles are not poisonous. They are edible sac mushroom.
Hence, the correct option is (4).

57. Which of the following are not membrane-bound?
(1) Mesosomes   (2) Vacuoles
(3) Ribosomes   (4) Lysosomes

Solution:
Infoldings of the cell membrane are called mesosomes. Vacuole is bound by membrane called tonoplast. Lysosomes enclose digestive enzymes within a membrane. Ribosomes are not membrane bound.
Hence, the correct option is (3).

58. In which of the following interactions both partners are adversely affected?
(1) Mutualism   (2) Competition
(3) Predation   (4) Parasitism

Solution:
Competition is a situation in which organisms that live near one another strive to obtain the same limited resources, thus compete with other.
Hence, the correct option is (2).

59. A colour blind man marries a woman with normal sight who has no history of colour blindness in her family. What is the probability of their grandson being colour blind?
(1) 0.25   (2) 0.5
(3) 1   (4) Nil
Solution:
Their grandson can be carrier of the diseases, but the probability of being colorblind is nil.
Hence, the correct option is (4).

60. Ectopic pregnancies are referred to as:
(1) Pregnancies terminated due to hormonal imbalance
(2) Pregnancies with genetic abnormality.
(3) Implantation of embryo at site other than uterus.
(4) Implantation of defective embryo in the uterus

Solution:

Ectopic pregnancy is the development of an embryo or foetus outside the uterine cavity.
Hence, the correct option is (3).

61. Cellular organelles with membranes are:
(1) Lysosomes, Golgi apparatus and mitochondria
(2) Nuclei, ribosomes and mitochondria
(3) Chromosomes, ribosomes and endoplasmic reticulum
(4) Endoplasmic reticulum, ribosomes and nuclei

Solution:
Lysosomes, Golgi apparatus and mitochondria are small, membrane-bound organelles found in eukaryotic cells.
Hence, the correct option is (1).

62. Cell wall is absent in:
(1) *Nostoc*   (2) *Aspergillus*
(3) *Funaria*   (4) *Mycoplasma*

Solution:
Mycoplasma are free-living prokaryotes, and thus do not have cell walls. They are also known as pleuropneumonia-like organisms (PPLO).
Hence, the correct option is (4).

63. The term "linkage" was coined by:
(1) W.Sutton   (2) T.H. Morgan
(3) T.Boveri   (4) G.Mendel

Solution:
Thomas Hunt Morgan coined the term linkage and explained the mechanism through his studies on the fruit fly *Drosophila melanogaster*.
Hence, the correct option is (2).

64. Which of the following biomolecules does have a phosphodiester bond?
(1) Nucleic acids in a nucleotide   (2) Fatty acids in a diglyceride
(3) Monosaccharides in a polysaccharide (4) Amino acids in a polypeptide
Solution:
In DNA or RNA, nucleotides are joined to each other via phosphodiester bond. The 5' end of one nucleotide is joined with the 3' end of the other.
Hence, the correct option is (1).

65. The primary dentition in human differs from permanent dentition in not having one of the following type of teeth:
(1) Incisors   (2) Canine
(3) Premolars   (4) Molars
Solution:
The deciduous molars are replaced by the first and second premolars (bicuspids), which have two cusps and one root (upper first premolars have two roots) and are used for crushing and grinding.
Hence, the correct option is (2).

66. A protoplast is a cell:
(1) without cell wall   (2) without plasma membrane
(3) without nucleus   (4) undergoing division

Solution:
A protoplast is a cell whose cell wall has been removed by enzymes.

Hence, the correct option is (1).

67. In which group of organisms the cells walls form two thin overlapping shells which fit together?
(1) Slime moulds   (2) Chrysophytes
(3) Euglenoids   (4) Dinoflagellates

Solution:
Chrysophytes, diatoms are unicellular and have two overlapping cell walls and look like fancy microscopic glass boxes of various shapes with shells composed of silica known as frustule.
Hence, the correct option is (2).

68. The DNA molecules to which the gene of interest is integrated for cloning is called:
(1) Carrier   (2) Transformer
(3) Vector   (4) Template
Solution:
A fragment of DNA, containing the desired gene to be cloned, is inserted into a circular DNA molecule called a vector, to produce a recombinant DNA molecule.
Hence, the correct option is (3).

69. Male gametophyte in angiosperms produces:
(1) Three sperms   (2) Two sperms and a vegetative cell
(3) Single sperm and a vegetative cell   (4) Single sperm and two vegetative cells

Solution:
Male gametophyte is derived from a pollen grain or microspore. It is three-celled when the pollen grain is shed. It contains two generative cells and one vegetative cell.
Hence, the correct option is (2).

70. Coconut water from a tender coconut is:
(1) Degenerated nucellus   (2) Immature embryo
(3) Free nuclear endosperm   (4) Innermost layers of the seed coat

Solution:
In coconut, the cell wall formation remains incomplete. Thus, coconut water is an example of free-nuclear endosperm.
Hence, the correct option is (3).

71. The species confined to a particular region and not found elsewhere is termed as:
(1) Rare   (2) Keystone
(3) Alien   (4) Endemic

Solution:
An 'Endemic Species' is defined as the one that is found only in a particular region and found nowhere other in the entire world.
Hence, the correct option is (4).

72. Metagenesis refers to:
(1) Presence of a segmented body and parthenogenetic mode of reproduction
(2) Presence of different morphic forms
(3) Alternation of generation between asexual and sexual phases of an organism
(4) Occurrence of a drastic change in form during post-embryonic development

Solution:

Metagenesis is also known as alternation of generations. In this phenomenon, one generation of a plant or animal reproduces asexually, followed by a sexual mode of reproduction.
Hence, the correct option is (3).

73. The enzymes that is not present in succus entericus is:
(1) lipase (2) maltase
(3) nucleases (4) nucleosidase
Solution:
The intestinal juice or succus entericus is formed by the secretions of goblet as well as brush border cells. It contains hormones, mucous, bicarbonate and enzymes for complete digestion of carbohydrates (maltase), fats (lipase) and nucleic acids (nucelosidase).
Hence, the correct option is (3).

74. Eutrophication of water bodies leading to killing of fishes is mainly due to non-availability of :
(1) oxygen (2) food
(3) light (4) essential minerals

Solution:
In eutrophication, enrichment of water with nutrients stimulates the growth of algae resulting in high BOD and decrease in oxygen content. Thus, the fish die due to lack of oxygen.
Hence, the correct option is (1).

75. The function of the gap junction is to :
(1) stop substance from leaking across a tissue
(2) performing cementing to keep neighbouring cells together
(3) Facilitate communication between adjoining cells by connecting the cytoplasm for rapid transfer of ions, small molecules and some large molecules
(4) separate two cells from each othe

Solution:
Gap junctions allow the cells in a tissue to communicate with one another. Through the junctions, ions, small molecules and few big molecules can diffuse from the cytosol of one cell to another.
Hence, the correct option is (3).

76. Match the following list of microbes and their importance:
(a) *Saccharomyces cerevisiae* (i) Production of immunosuppressive drug
(b) *Moanscus purpureus* (ii) Ripening of Swiss cheese
(c) *Trichoderma polysporum* (iii) Commercial production of ethanol
(d) *Propionibacterium sharmanii* (iv) Production of blood cholesterol lowering agents

	(a)	(b)	(c)	(d)
(1)	(iii)	(i)	(iv)	(ii)
(2)	(iii)	(iv)	(i)	(ii)
(3)	(iv)	(iii)	(ii)	(i)
(4)	(iv)	(ii)	(i)	(iii)

Solution:
Saccahromyces cerevisiae is used for production of ethanol. *Monascus purpureus* is used for the production of agent used in lowering of blood cholesterol. *Trichoderma polysporum* is used for the production of immunosuppressive drug. *Propionibacterium sharmanii* is used for ripening of Swiss cheese.

Hence, the correct option is (2).

77. Arrange the following events of meiosis in correct sequence:
(a) Crossing over   (b) Synapsis
(c) Terminalisation of chaismata   (d) Disappearance of nucleolus

(1) (b), (c), (d), (a)   (2) (b), (a), (d), (c)
(3) (b), (a), (c), (d)   (4) (a), (b), (c), (d)

Solution:
The important characteristics of each phase of prophase I of meiosis are (a) leptotene—chromosomal compaction, (b) zygotene—chromosome pairing or synapsis and formation of synaptonemal complex (SC), (c) pachytene—recombination nodules and crossing over between non-sister chromatids of the homologous chromosomes, (d) diplotene—chiasmata formation, separation of homologous chromosomes and (e) diakinesis—terminalization of chiasmata, assembly of the meiotic spindle, recompaction of the chromosomes, breakdown of the nuclear envelope and the movement of the tetrads to the metaphase plate.
Hence, the correct option is (3).

78. The cutting of DNA at specific locations became possible with the discovery of:
(1) Ligases   (2) Restriction enzymes
(3) Probes   (4) Selectable markers

Solution:
The restriction enzymes belong to a class of enzymes called nucleases. They recognize and cut DNA at a specific sequence. They were first identified by H.O. Smith, K.W. Wilcox and T.J. Kelly.
Hence, the correct option is (2).

79. During biological nitrogen fixation, inactivation of nitrogenase by oxygen poisoning prevented by:
(1) Cytochrome   (2) Leghaemoglobin
(3) Xanthophyll   (4) Carotene

Solution:
Leghemoglobin protects nitrogenase (nitrogen fixing enzyme) from oxygen by combining very rapidly with oxygen, and thus acting as a very efficient oxygen scavenger.
Hence, the correct option is (2).

80. Grafted kidney may be rejected in a patient due to:
(1) Innate immune response   (2) Humoral immune response
(3) Cell-mediated immune response   (4) Passive immune response
Solution:
The organs cannot be taken from just anybody because usually, the immune system recognizes the proteins in the transplanted organ as foreign and mounts both cell-mediated and antibody mediated immune responses against them. This phenomenon is known as graft rejection.
Hence, the correct option is (2).

81. The body cells in cockroach discharge their nitrogenous waste in the haemolymph mainly in the form of:
(1) Calcium carbonate   (2) Ammonia
(3) Potassium urate   (4) Urea
Solution:
In cockroaches, the nitrogenous wastes such as urates of sodium and potassium formed in the tissues enter the haemolymph and enter the lumen of the distal end of the Malpighian tubule, where uric acid is formed and is excreted with the faeces from the hindgut.
Hence, the correct option is (3).

82. Filiform apparatus is characteristic feature of:
(1) Synergids
(2) Generative cell
(3) Nucellar embryo
(4) Aleurone cell
Solution:
The synergids have a filiform apparatus (finger-like cellular thickenings at the micropylar tip) attached to their upper wall that functions to attract and guide the pollen tube into the synergid.
Hence, the correct option is (1).

83. Acid rain is caused by increase in the atmospheric concentration of:
(1) O_3 and dust
(2) SO_2 and NO_2
(3) SO_3 and CO
(4) CO_2 and CO

Solution:
Acid rain is a mixture of wet and dry acidic depositions from the atmosphere containing higher than normal amounts of nitric and sulphuric acid.
Hence, the correct option is (2).

84. The wheat grain has an embryo with one large, shield-shaped cotyledon known as:
(1) Coleoptile
(2) Epiblast
(3) Coleorrhiza
(4) Scutellum

Solution:
Monocots have a single cotyledon which is known as scutellum. It is situated on one side of the embryonal axis.
Hence, the correct option is (4).

85. Among china rose, mustard, brinjal, potato, guava, cucumber, onion and tulip, how many plants have superior ovary?
(1) Four
(2) Five
(3) Six
(4) Three

Solution:
When the gynoecium occupies the top most position above other floral whorls, the ovary is called superior. For example, in china rose, brinjal, mustard, Citrus, potato, onion and tulip. Cucumber and guava have inferior ovary.
Hence, the correct option is (3).

86. Which of the following is not a function of the skeletal system?
(1) Locomotion
(2) Production of erythrocytes
(3) Storage of minerals
(4) Production of body heat

Solution:
The skeletal system provides support, protection to the body, assist in movement, bones store and release minerals, storage triglycerides and produce blood cells.
Hence, the correct option is (4).

87. Golden rice is a genetically modified crop plant where the incorporated gene is meant for biosynthesis of :
(1) Vitamin A
(2) Vitamin B
(3) Vitamin C
(4) Omega 3

Solution:
Golden rice, is a transgenic variety of rice (*Oryza sativa*) that is so named because of its yellow color grains due the presence of large quantities of β-carotene (provitamin A).
Hence, the correct option is (1).

88. Chromatophores take part in:

(1) Respiration
(2) Photosynthesis
(3) Growth
(4) Movement

Solution:
Cyanobacteria have structures called chromatophores. These contain the pigments used for photosynthesis.
Hence, the correct option is (2).

89. Select the wrong statement:
(1) Mosaic disease in tobacco and AIDS in human being are caused by viruses
(2) The viroids were discovered by D.J. Ivanowski
(3) W.M. Stanley showed that viruses could be crystallized
(4) The term 'contagium vivum fluidum' was coined by M.W. Beijerinek

Solution:
Viroids were discovered by T.O. Diener.
Hence, the correct option is (2).

90. A pleiotropic gene:
(1) controls multiple traits in an individual
(2) is expressed only in primitive plants
(3) is a gene evolved during Pliocene
(4) controls a trait only in combination with another gene

Solution:
When a gene controls multiple phenotypes that are mostly unrelated, it is said to exhibit pleiotropy.
Hence, the correct option is (1).

91. Human urine is usually acidic because:
(1) hydrogen ions are actively secreted into the filtrate.
(2) the sodium transporter exchanges one hydrogen ion for each sodium ion, in peritubular capillaries.
(3) excreted plasma proteins are acidic
(4) potassium and sodium exchange generates acidity

Solution:
The pH of urine ranges between 4.6 and 8.0; average 6.0 (slightly acidic). It varies considerably with diet. High-protein diets increase acidity. Tubular secretion involves the removal of urea uric acid, hippuric acid, creatinine, K^+, H^+, etc.
Hence, the correct option is (1).

92. Auxin can be bioassayed by:
(1) Lettuce hypocotyl elongation
(2) Avena coleoptile curvature
(3) Hydroponics
(4) Potometer

Solution:
In Went's Avena curvature test, a small cube of agar containing auxin is placed on the cut surface of a shoot tip. The auxin diffuses into the plant tissue, stimulating growth of the cells below the agar cube. The differential growth causes the shoot tip to curve away from the block. This curvature is plotted against auxin concentration to obtain a linear curve.
Hence, the correct option is (1).

93. Which of the following events is not associated with ovulation in human female?
(1) LH surge
(2) Decrease in estradiol

(3) Full development of Graafian follicle   (4) Release of secondary oocyte

Solution:
Ovulation is the rupture of a mature ovarian (Graafian) follicle with discharge of a secondary oocyte into the pelvic cavity. It is controlled by luteinizing hormone.
Hence, the correct option is (2).

94. Body having meshwork of cells, internal cavities lined with food filtering flagellated cells and indirect developments are the characteristics of phylum:
(1) Protozoa   (2) Coelenterata
(3) Porifera   (4) Mollusca

Solution:
The inner cavity of the sponge is lined by specialized, flagellated cells called collar cells or choanocytes.
Hence, the correct option is (3).

95. Which one of the following hormones is not involved in sugar metabolism?
(1) Glucagon   (2) Cortisone
(3) Aldosterone   (4) Insulin

Solution:
Aldosterone regulates homeostasis of sodium and potassium ions. Rest all the hormones are involved in the metabolism of sugar.
Hence, the correct option is (3).

96. Which of the following diseases is caused by a protozoan?
(1) Blastomycosis   (2) Syphilis
(3) Influenza   (4) Babesiosis

Solution:
Babesiosis is a malaria sort of parasitic disease. It is caused due to the infection by *Babesia*, a protozoal.
Hence, the correct option is (4).

97. Outbreeding is an important strategy of animal husbandry because it :
(1) exposes harmful recessive genes that are eliminated by selection
(2) helps in accumulation of superior genes.
(3) is useful in producing purelines of animals.
(4) is useful in overcoming inbreeding depression

Solution:
Inbreeding depression can be overcome by mating the selected animals of the breeding population with unrelated superior animals of the same breed that is through outbreeding.
Hence, the correct option is (4).

98. A childless couple can be assisted to have a child through a technique called GIFT. The full form of this technique is:
(1) Germ cell internal fallopian transfer   (2) Gamete inseminated fallopian transfer
(3) Gamete intra fallopian transfer   (4) Gamete internal fertilization and transfer

Solution:
If a woman cannot produce ova, but can provide a suitable environment for fertilization and further development, then Gamete Intra Fallopian Transfer (GIFT) is used.
Hence, the correct option is (3).

99. A jawless fish which lays eggs in fresh water and whose ammocoetes larvae after metamorphosis return to the ocean is:
(1) Petromyzon (2) Eptatretus
(3) Myxine (4) Neomyxine

Solution:
In Petromyzon (Lamprey), fertilization takes place externally and the fertilized eggs develop into larvae. The larvae take a few years to mature and metamorphose (change) into parasitic adults. Their round ventral jawless mouth is like a suction-cup that can attach to the prey.
Hence, the correct option is (1).

100. The structures that help some bacteria to attach to rocks and/or host tissues are :
(1) Holdfast (2) Rhizoids
(3) Fimbriae (4) Mesosomes

Solution:
Attachment pilli also called fimbriae are short and helps bacterium to adhere to surfaces. It helps bacteria in forming colonies.
Hence, the correct option is (3).

101. If you suspect major deficiency of antibodies in a person, to which of the following would you look for confirmatory evidence?
(1) Serum globulins (2) Fibrinogin in plasma
(3) Serum albumins (4) Haemocytes

Solution:
The straw-colored liquid, called serum, is simply blood plasma minus the clotting proteins. This blood plasma contains antibodies called agglutinins. Thus, it can be used to test the level of antibodies in the body.
Hence, the correct option is (3).

102. In human females, meiosis-II is not completed until?
(1) birth (2) puberty
(3) fertilization (4) uterine implantation

Solution:
If fertilization occurs, then meiosis II resumes. The sperms are present in the fallopian tube and one of them penetrates the secondary oocyte, which then splits into two haploid cells, again of unequal size. The larger cell is the ovum, or mature egg; the smaller one is the second polar body.
Hence, the correct option is (3).

103. Which of the following layers in an antral follicle is acellular?
(1) Zona pellucida (2) Granulosa
(3) Theca interna (4) Stroma

Solution:
The zona pellucida is a clear glycoprotein layer between the corona radiata and the oocyte's plasma membrane.
Hence, the correct option is (3).

104. In his classic experiments on pea plants, Mendel did not use:
(1) Flower position (2) Seed colour
(3) Pod length (4) Seed shape

Solution:

Mendel used seven characters of pea plants: plant height, color and position of flower, shape and color of pod and shape and color of seed.
Hence, the correct option is (3).

105. Which one of the following fruits is parthenocarpic?
(1) Banana   (2) Brinjal
(3) Apple   (4) Jackfruit

Solution:
Parthenocarpic fruits are those that develop without fertilization. For example, banana, pineapple, grapes, orange etc.
Hence, the correct option is (3).

106. In angiosperms, microsporogenesis and megasporogenesis :
(1) occur in ovule   (2) occur in anther
(3) form gametes without furthers divisions   (4) involve meiosis

Solution:
In the angiospermic plants, the sporophytic and the gametophytic generation is extremely reduced. Formation of spores is the first phase of gametogenesis while formation of gametophyte containing the gametes is the second phase. Thus, both microsporogenesis and megasporogenesis involve meiosis.
Hence, the correct option is (3).

107. A gene showing codominance has:
(1) both alleles independently expressed in the heterozygote
(2) one allele dominant on the other
(3) alleles tightly linked on the same chromosome
(4) alleles that are recessive to each other
 Solution:
Codominance is the condition in which there is independence of function of two alleles. This implies that neither allele is dominant, or even partially dominant, over the other.
Hence, the correct option is (3).

108. The chitinous exoskeleton of arthropods is formed by the polymerisation of:
(1) lipoglycans   (2) keratin sulphate and chondroitin sulphate
(3) D-glucosamine   (4) N-acetyl glucosamine
Solution:
The exoskeleton of arthropods is composed of protein and flexible chitin. Chitin is a polymer of N acetylglucosamine, a derivative of glucose.
Hence, the correct option is (3).

109. The imperfect fungi which are decomposers of litter and help in mineral cycling belong to :
(1) Ascomycetes   (2) Deuteromycetes
(3) Basidiomycetes   (4) Phycomycetes

Solution:
The Fungi Imperfecti, or Deuteromycota, are called imperfect since no sexual stage has been observed in their life cycles.
Hence, the correct option is (2).

110. The wings of a bird and the wings of an insect are :
(1) homologous structures and represent convergent evolution
(2) homologous structures and represent divergent evolution
(3) analogous structures and represent convergent evolution

(4) phylogenetic structures and represent divergent evolution

Solution:
The wings of birds and insects are analogous structures though they perform similar function, but they do not have same embryological origin or similar anatomy.
Hence, the correct option is (3).

111. Flowers are unisexual in:
(1) Onion   (2) Pea
(3) Cucumber   (4) China rose

Solution:
Unisexual flowers are those in which only one reproductive whorl is present either androecium or gynoecium., for example, cucumber.
Hence, the correct option is (3).

112. Increase in concentration of the toxicant at successive trophic levels is known as :
(1) Biogeochemical cycling   (2) Biomagnification
(3) Biodeterioration   (4) Biotransformation

Solution:
Biomagnification is the accumulation or increase in the concentration of a substance in living tissue as it moves through a food web (also known as bioaccumulation).
Hence, the correct option is (2).

113. Destruction of the anterior horn cells of the spinal cord would result in loss of :
(1) Integrating impulses   (2) Sensory impulses
(3) voluntary motor impulses   (4) Commissural impulses

Solution:
The grey matter on each side of the spinal cord is subdivided into regions called horns. The anterior (ventral) grey horns contain somatic motor nuclei, which are clusters of cell bodies of somatic motor neurons that provide nerve impulses for contraction of skeletal muscles.
Hence, the correct option is (3).

114. Roots play insignificant role in absorption of water in:
(1) Wheat   (2) Sunflower
(3) *Pistia*   (4) Pea

Solution:
Roots of *Pistia* are covered by several root pockets instead of root cap. These pockets help the plant in in balancing.
Hence, the correct option is (3).

115. Match the columns and identify the correct option:

Column-I	Column-II
(a) Thylakoids	(i) Disc-shaped sacs in Golgi apparatus
(b) Cristae	(ii) Condensed structure of DNA
(c) Cisternae	(iii) Flat membranous sacs in stroma
(d) Chromatin	(iv) Infoldings in mitochondria

(a)   (b)   (c)   (d)

(1)	(iii)	(iv)	(ii)	(i)
(2)	(iv)	(iii)	(i)	(ii)
(3)	(iii)	(iv)	(i)	(ii)
(4)	(iii)	(i)	(iv)	(ii)

Solution:
The flattened membranous sacs in chloroplast are called thylakoids. Cristae are deep in-folds characteristic of the inner mitochondrial membrane. Cisternae are disc-shaped sacs in Golgi apparatus. Chromatin is the condensed structure of DNA.
Hence, the correct option is (3).

116. Identify the correct order of organisation of genetic material from largest to smallest:
(1) Chromosome, genome, nucleotide, gene
(2) Chromosome, gene, genome, nucleotide
(3) Genome, chromosomes, nucleotide, gene
(4) Genome, chromosome, gene, nucleotide

Solution:
Nucleotides combine to code for a gene. A sequence of gene forms a chromosome. All the chromosomes are collectively called as genome.
Hence, the correct option is (4).

117. Which one of the following hormones though synthesised elsewhere, is stored and released by the master gland?
(1) Melanocyte stimulating hormone   (2) Antidiuretic hormone
(3) Luteinizing hormone   (4) Prolactin
Solution:
After the production of antidiuretic hormone in the cell bodies of neurosecretory cells, it is packaged into secretory vesicles, which move by fast axonal transport to the axon terminals in the posterior pituitary, where they are stored until nerve impulses trigger release of the hormone.
Hence, the correct option is (2).

118. Read the different components from (a) to (d) in the list given below and tell the correct order of the components with reference to their arrangement from outer side to inner side in a woody dicot stem:
(a) Secondary cortex   (b) Wood
(c) Secondary phloem   (d) Phellem

The correct order is:
(1) (d), (c), (a), (b)   (2) (c), (d), (b), (a)
(3) (a), (b), (d), (c)   (4) (d), (a), (c), (b)

Solution:
In a dicot stem, the correct order from outer side to inner side is Phellem, followed by secondary cortex and secondary phloem and then wood.
Hence, the correct option is (4).

119. Which of the following joints would allow no movement?
(1) Ball and Socket joint   (2) Fibrous joint
(3) Cartilaginous joint   (4) Synovial joint

Solution:
Fibrous joints lack a synovial cavity, and the articulating bones are held very closely together. They permit little or no movement.
Hence, the correct option is (3).

120. Which one of the following is not applicable to RNA?
(1) Chargaff's rule
(2) Complementary base pairing
(3) 5' phosphoryl and 3' hydroxyl ends
(4) Heterocyclic nitrogenous bases

Solution:
Chargaff rules are applicable only on double stranded DNA.
Hence, the correct option is (1).

121. Doctors use stethoscope to hear the sound; produced during each cardiac cycle. The second sound is heard when:
(1) AV node receives signal from SA node
(2) AV valves open up
(3) Ventricular walls vibrate due to gushing of blood from atria
(4) Semilunar valves close down after the blood flows into vessels from ventricles

Solution:
The second sound is shorter and high-pitched, is called dub sound. S2 is caused by blood turbulence associated with closure of the SL valves at the beginning of ventricular diastole.
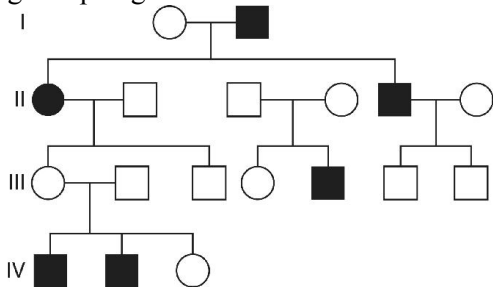**Hence, the correct option is (4).**

122. During ecological succession:
(1) the changes lead to a community that is in near equilibrium with the environment and is called pioneer community
(2) the gradual and predictable change in species composition occurs in a given area
(3) the establishment of a new biotic community is very fast in its primary phase
(4) the number and types of animals remain constant

Solution:
The process of development of an ecological community or ecosystem over a system of stages; early, middle, late and mature (or climax) is called ecological succession. The change in species is gradual and can be predicted.
Hence, the correct option is (2).

123. In the following human pedigree, the filled symbols represent the affected individuals. Identify the type of given pedigree

(1) X-linked dominant
(2) Autosomal dominant
(3) X-linked recessive
(4) Autosomal recessive
Solution:
Autosomal recessive mutations could be detected in an unlikely event of bringing two mutant alleles together in a homozygote.
Hence, the correct option is (4).

124. Balbiani rings are sites of:
(1) RNA and protein synthesis
(2) Lipid synthesis
(3) Nucleotide synthesis
(4) Polysaccharide synthesis

Solution:
A Balbiani ring is a large chromosome puff, a site for the transcription of RNA.
Hence, the correct option is (1).

125. Name the pulmonary disease in which alveolar surface area involved in gas exchange is drastically reduced due to damage in the alveolar walls:
(1) Asthma   (2) Pleurisy
(3) Emphysema   (4) Pneumonia

Solution:
Emphysema is a disorder characterized by destruction of the walls of the alveoli, producing abnormally large air spaces that remain filled with air during exhalation.
Hence, the correct option is (3).

126. Which the following are most suitable indicator of SO_2 pollution in the environment?
(1) Fungi   (2) Lichens
(3) Conifers   (4) Algae

Solution:
Lichens obtain their nutrition from the atmosphere rather than soil, thus they act as bioindicators for air pollution, mainly for sulfur dioxide pollution.
Hence, the correct option is (2).

127. Satellite DNA is important because it:
(1) Codes for enzymes needed for DNA replication
(2) Codes for proteins needed in cell cycle
(3) Shows high degree of polymorphism in population and also the same degree of polymorphism in an individual, which is heritable from parents to children
(4) Does not code for proteins and is same in all members of the population

Solution:
The satellite DNAs in eukaryotes has long repetitive sequences. They do not code for any proteins but exhibit polymorphism on which DNA fingerprinting is based.
Hence, the correct option is (3).

128. Industrial melanism is an example of:
(1) Neo Lamarckism   (2) Neo Darwinism
(3) Natural selection   (4) Mutation

Solution:
In industrial melanism, the dark-winged moths were naturally selected over the white-winged moths and have almost replaced white-winged moth.
Hence, the correct option is (3).

129. A column of water within xylem vessels of tall trees does not break under its weight because of :
(1) Positive root pressure   (2) Dissolved sugars in water
(3) Tensile strength of water   (4) Lignification of xylem vessels

Solution:
Force of gravity acts on the water column and allows the absorption of water till the adhesive and cohesive forces are balanced by the force of gravity. As a result of adhesion, cohesion and surface tension, water has high tensile strength which provides it the ability to resist the pull.

Hence, the correct option is (3).

130. The introduction of t-DNA into plants involves:
(1) Allowing the plant roots to stand in water
(2) Infection of the plant by *Agrobacterium tumefaciens*
(3) Altering the pH of the soil, then heat shocking the plants
(4) Exposing the plants to cold for a brief period

Solution:
Nematode-specific genes are introduced into the plant using the vector *Agrobacterium tumefaciens*.
Hence, the correct option is (2).

131. Pick up the wrong statement:
(1) Nuclear membrane is present in Monera
(2) Cell wall is absent in Animalia
(3) Protista has photosynthetic and heterotrophic modes of nutrition
(4) Some fungi are edible

Solution:
All monerans are unicellular; they lack true nuclei and generally lack membrane-enclosed organelles.
Hence, the correct option is (1).

132. In photosynthesis, the light-independent reactions take place at :
(1) Stromal matrix   (2) Thylakoid lumen
(3) Photosystem – I   (4) Photosystem-II

Solution:
Light-independent reactions also known as dark reactions take place in the stromal matrix of chloroplast. They are dependent on the products of light reactions.
Hence, the correct option is (1).

133. Which of the following immunoglobulins does constitute the largest percentage in human milk?
(1) IgG   (2) IgD
(3) IgM   (4) IgA

Solution:
IgA is present in tears, nasal mucus, breast milk and intestinal secretions.
Hence, the correct option is (4).

134. Which of the following pairs is not correctly matched?

	Mode of reproduction	Example
(1)	Conidia	*Penicillium*
(2)	Offset	Water hyacinth
(3)	Rhizome	Banana
(4)	Binary fission	*Sargassum*

Solution:
Sargassum reproduces by fragmentation and not binary fission.
Hence, the correct option is (4).

135. The UN conference of Parties on climate change in the year 2012 was held at:
(1) Warsaw   (2) Durban
(3) Doha   (4) Lima

Solution:
The 18th session of the United Nations Conference of the Parties on climate change in the year 2012 held in Doha, Qatar.
Hence, the correct option is (3).

Section C: Physics

136. In the spectrum of hydrogen, the ratio of the longest wavelength in the Lyman series to the longest wavelength in the Balmer series is:

(1) $\dfrac{5}{27}$

(2) $\dfrac{4}{9}$

(3) $\dfrac{9}{4}$

(4) $\dfrac{27}{5}$

Solution:
For Lyman Series:
$$\left(\frac{1}{\lambda_{max}}\right)_L = R(1)^2\left[\frac{1}{(1)^2} - \frac{1}{(2)^2}\right]$$
$$(\lambda_{max})_L = \frac{4}{3R}$$
For Balmer Series:
$$\left(\frac{1}{\lambda_{max}}\right)_B = R(1)^2\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right]$$
$$(\lambda_{max})_L = \frac{36}{5R}$$
$$\frac{(\lambda_{max})_L}{(\lambda_{max})_B} = \frac{4}{3R} \times \frac{5R}{36} = \frac{5}{27}$$
Hence, the correct option is (1).

137. The energy of the em waves is of the order of 15 keV. To which part of the spectrum does it belong?
(1) γ-rays
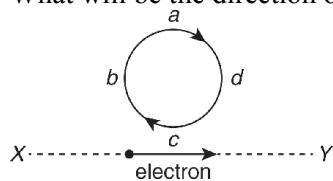(2) X-rays
(3) Infra-red rays
(4) Ultraviolet rays

Solution:
Wavelength of the ray
$$\lambda = \frac{hc}{E} = 0.826 \overset{0}{A}$$
Since, $\lambda < 100 \overset{0}{A}$, hence is a X-ray.
Hence, the correct option is (2).

138. An electron moves on a straight line path *XY* as shown. The *abcd* is a coil adjacent to the path of electron. What will be the direction of current, if any, induced in the coil?

(1) No current induced
(2) *abcd*
(3) *adcb*
(4) The current will reverse its direction as the electron goes past the coil

Solution:
When e– comes towards the loop, the magnetic flux of one type starts increasing and when it goes away from the loop, the same magnetic flux starts decreasing, thus induced current will be opposite to each other.
Hence, the correct option is (4).

139. The cylindrical tube of a spray pump has radius R, one end of which has n fine holes, each of radius r. If the speed of the liquid in the tube is v, the speed of the ejection of the liquid through the holes is:

(1) $\dfrac{v^2 R}{nr}$

(2) $\dfrac{vR^2}{n^2 r^2}$

(3) $\dfrac{vR^2}{nr^2}$

(4) $\dfrac{vR^2}{n^3 r^2}$

Solution:
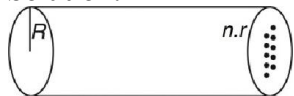
$A_1 V_1 = A_2 V_2$

$\Rightarrow V_2 = \dfrac{A_1 V_1}{A_2} = \dfrac{\pi R^2 \times v}{n(\pi r^2)} = \dfrac{R^2 \times v}{nr^2}$

Hence, the correct option is (3).

140. The Young's modulus of steel is twice that of brass. Two wires of same lenght and of same area of cross section, one of steel and another of brass are suspended from the same roof. If we want the lower ends of the wires to be at the same level, then the weights added to the steel and brass wires must be in the ratio of:

(1) 1 : 1

(2) 1 : 2

(3) 2 : 1

(4) 4 : 1

Solution:

$Y = \dfrac{F}{A} \cdot \dfrac{l}{\Delta l}$

$\Rightarrow \Delta l = \dfrac{F}{A} \cdot \dfrac{l}{Y}$

$(\Delta l)_{\text{steel}} = (\Delta l)_{\text{brass}}$

$\therefore \dfrac{W_s}{A} \cdot \dfrac{l}{Y_s} = \dfrac{W_b}{A} \cdot \dfrac{l}{Y_s}$

$\Rightarrow \dfrac{W_s}{W_b} = \dfrac{Y_s}{Y_b} = 2 : 1$

Hence, the correct option is (3).

141. A potentiometer wire of length L and a resistance r are connected in series with a battery of e.m.f. E_0 and a resistance r_1. An unknown e.m.f. E is balanced at a length l of the potentiometer wire. The e.m.f. E will be given by:

(1) $\dfrac{LE_0 r}{(r + r_1)l}$

(2) $\dfrac{LE_0 r}{lr_2}$

(3) $\dfrac{E_0 r}{(r + r_1)} \cdot \dfrac{l}{L}$

(4) $\dfrac{E_0 l}{L}$

Solution:

$$\text{Current}, i = \frac{E_0}{(r_1 + r)}$$

$$\text{Potentiometer gradient}, x = \frac{ir}{L} = \frac{E_0}{(r_1 + r)} \frac{r}{L}$$

$$\therefore \text{e.m.f. } E = xl = \frac{E_0 r}{(r_1 + r)} \frac{l}{L}$$

Hence, the correct option is (3).

142. A particle is executing a simple harmonic motion. Its maximum acceleration is a and maximum velocity is b. Then, its time period of vibration will be:

(1) $\dfrac{2\pi\beta}{\alpha}$

(2) $\dfrac{\beta^2}{\alpha^2}$

(3) $\dfrac{\alpha}{\beta}$

(4) $\dfrac{\beta^2}{\alpha}$

Solution:
For Simple Harmonic Motion:
Maximum acceleration $= \omega^2 A = \alpha$
Maximum velocity $= \omega A = \beta$

$$\Rightarrow \omega = \frac{\alpha}{\beta} \Rightarrow \frac{2\pi}{T} = \frac{\alpha}{\beta}$$

$$\therefore T = \frac{2\pi\beta}{\alpha}$$

Hence, the correct option is (1).

143. If vectors $\vec{A} = \cos\omega t \, \hat{i} + \sin\omega t \, \hat{j}$ and $\vec{B} = \cos\dfrac{\omega t}{2} \, \hat{i} + \sin\dfrac{\omega t}{2} \, \hat{j}$ are functions of time, then the value of t at which they are orthogonal to each other is:

(1) $t = 0$

(2) $t = \dfrac{\pi}{4\omega}$

(3) $t = \dfrac{\pi}{2\omega}$

(4) $t = \dfrac{\pi}{\omega}$

Solution:
For perpendicular vectors,
$$\vec{A}.\vec{B} = 0$$

$$\left[\cos\omega t\ \hat{i}\ +\ \sin\omega t\ \hat{j}\right]\left[\cos\frac{\omega t}{2}\ \hat{i}\ +\ \sin\frac{\omega t}{2}\ \hat{j}\right]=0$$

$$\cos\omega t\cos\frac{\omega t}{2}+\sin\omega t\sin\frac{\omega t}{2}=0$$

$$\Rightarrow\cos\left(\omega t-\frac{\omega t}{2}\right)=0$$

$$\Rightarrow\cos\left(\frac{\omega t}{2}\right)=0$$

$$\Rightarrow\frac{\omega t}{2}=\frac{\pi}{2}$$

$$\Rightarrow t=\frac{\pi}{\omega}$$

Hence, the correct option is (4).

144. A source of sound S emitting waves of frequency 100 Hz and an observer O are located at some distance from each other. The source is moving with a speed of 19.4 ms^{-1} at an angle of 60° with the source observer line as shown in the figure. The observer is at rest. The apparent frequency observed by the observer (velocity of sound in air 330 ms^{-1}) is:
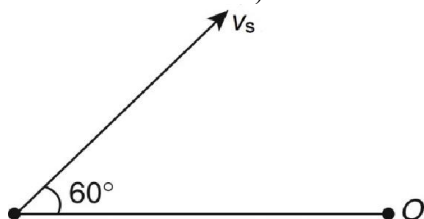
(1) 97 Hz　　　　　　　　　　　　　　(2) 100 Hz
(3) 103 Hz　　　　　　　　　　　　　　(4) 106 Hz

Solution:

$$f'=f\left(\frac{v}{v-v_s\cos 60°}\right)$$

$$f'=100\left(\frac{330}{330-19.4\times\frac{1}{2}}\right)=100\left(\frac{330}{330-9.7}\right)=100\left(\frac{330}{320.3}\right)=103.02\text{Hz}$$

Hence, the correct option is (3).

145. An automobile moves on a road with a speed of 54 kmh^{-1}. The radius of its wheels is 0.45 m and the moment of inertia of the wheel about its axis of rotation is 3 kgm^2. If the vehicle is brought to rest in 15s, the magnitude of average torque transmitted by its brakes to wheel is:
(1) 2.86 kg m^{2}s^{-2}　　　　　　　　　(2) 6.66 kg m^{2}s^{-2}
(3) 8.58 kg m^{2}s^{-2}　　　　　　　　　(4) 10.86 kg m^{2}s^{-2}

Solution:

Velocity of automobile, $v=54\times\dfrac{5}{18}=15\text{ms}^{-1}$

$\omega_0=\dfrac{v}{R}=\dfrac{15}{0.45}=\dfrac{100}{3}\text{rad s}^{-1}$, $\omega=0$

As,

$$\omega = \omega_0 + \alpha t$$

$$0 = \frac{100}{3} + \alpha(15)$$

Thus, angular acceleration

$$\alpha = \frac{100}{45} \text{rad s}^{-2}$$

Torque, $\tau = I\alpha = 3 \times \dfrac{100}{45} = 6.66 \text{kg m}^2\text{s}^{-2}$

Hence, the correct option is (2).

146. A rectangular coil of length 0.12m and width 0.1m having 50 turns of wire is suspended vertically in a uniform magnetic field of strength 0.2 Weber/m². The coil carries a current of 2 A. If the plane of the coil is inclined at an angle of 30° with the direction of the field, the torque required to keep the coil in stable equilibrium will be:
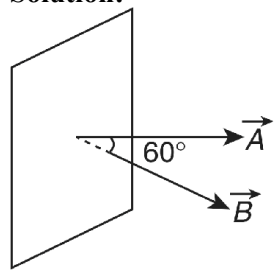
(1) 0.12 Nm (2) 0.15 Nm
(3) 0.20 Nm (4) 0.24 Nm

Solution:

$$\vec{\tau} = \vec{M} \times \vec{B}$$

$$\left|\vec{\tau}\right| = MB\sin\theta = nIAB\sin\theta = 50 \times 0.012 \times 2 \times 0.2 \times \sin 60^{\circ} = 0.20 \,\text{Nm}$$

Hence, the correct option is (3).

147. A parallel plate air capacitor has capacity 'C' distance of separation between plates is 'd' and potential difference 'V' is applied between the plates force of attraction between the plates of the parallel plate air capacitor is:

(1) $\dfrac{C^2V^2}{2d^2}$ (2) $\dfrac{C^2V^2}{2d}$

(3) $\dfrac{CV^2}{2d}$ (4) $\dfrac{CV^2}{d}$

Solution:
Force between plates of capacitor,

$$F = qE = q\left(\frac{q}{2\varepsilon_0 A}\right)$$

$$\because q = CV \text{ and } C = \frac{\varepsilon_0 A}{d}$$

$$\therefore F = \frac{C^2V^2}{2\varepsilon_0 A} = \frac{\left(\dfrac{\varepsilon_0 A}{d}\right)CV^2}{2\varepsilon_0 A} = \frac{CV^2}{d}$$

Hence, the correct option is (3).

148. Two vessels separately contain two ideal gases A and B at the same temperature, the pressure of A being twice that of B. Under such conditions, the density of A is found to be 1.5 times the density of B. The ratio of molecular weight of A and B is:

(1) $\dfrac{1}{2}$

(2) $\dfrac{2}{3}$

(3) $\dfrac{3}{4}$

(4) 2

Solution:
Ideal gas equation

$$P = \frac{\rho RT}{M} \Rightarrow M = \frac{\rho RT}{P}$$

$$\frac{M_A}{M_B} = \frac{\rho_A RT_A}{P_A} \cdot \frac{P_B}{\rho_B RT_B} = \frac{\rho_A}{\rho_B} \cdot \frac{P_B}{P_A} = (1.5)\left(\frac{1}{2}\right) = \frac{3}{4}$$

Hence, the correct option is (3).

149. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth. Then,
(1) the acceleration of S is always directed towards the centre of the earth.
(2) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant.
(3) the total mechanical energy of S varies periodically with time.
(4) the linear momentum of S remains constant in magnitude.

Solution:
Satellite is experiencing only the gravitational force, which will always be towards the centre of the earth.
Hence, the correct option is (1).

150. In the given figure, a diode D is connected to an external resistance $R = 100$ W and an e.m.f of 3.5V. If the barrier potential developed across the diode is 0.5 V, the current in the circuit will be:
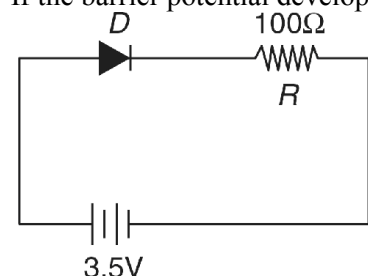
(1) 35 mA
(2) 30 mA
(3) 40 mA
(4) 20 mA

Solution:

$$I = \frac{V_{net}}{R_{net}} = \frac{3.5 - 0.5}{100} = 0.03\,\text{A} = 30\,\text{mA}$$

Hence, the correct option is (2).

151. A remote-sensing satellite of earth revolves in a circular orbit at a height of 0.25×10^6 m above the surface of earth. If earth's radius is 6.38×10^6 m and $g = 9.8$ ms^{-2}, then the orbital speed of the satellite is:
(1) 6.67 km s^{-1}
(2) 7.76 km s^{-1}
(3) 8.56 km s^{-1}
(4) 9.13 km s^{-1}

Solution:
Velocity of satellite revolving around earth,

$$v_s = \sqrt{\frac{GM_e}{R_e\left(1+\dfrac{h}{R_e}\right)}} = \sqrt{\frac{gR_e}{1+\dfrac{h}{R_e}}}$$

Substituting the values,

$$v_0 = \sqrt{60\times10^6} = 7.76\times10^3\,\mathrm{ms^{-1}} = 7.76\,\mathrm{kms^{-1}}$$

Hence, the correct option is (2).

152. The position vector of a particle $\vec{R}$ as a function of time is given by:
$$\vec{R} = 4\sin(2\pi t)\hat{i} + 4\cos(2\pi t)\hat{j}$$

Where R is in meters, t is in seconds and $\hat{i}$ and $\hat{j}$ denote unit vectors along x and y-directions, respectively. Which one of the following statements is wrong for the motion of particle?
(1) Path of the particle is a circle of radius 4 meter.
(2) Acceleration vector is along $-\vec{R}$.
(3) Magnitude of acceleration vector is v^2/R where v is the velocity of particle.
(4) Magnitude of the velocity of particle is 8 meter/second.

Solution:
$$\vec{R} = 4\sin(2\pi t)\hat{i} + 4\cos(2\pi t)\hat{j}$$
$$x = 4\sin 2\pi t$$
$$y = 4\cos 2\pi t$$
$$\vec{v} = \frac{d\vec{R}}{dt}$$
$$v_x = +4(\cos 2\pi t)(2\pi)$$
$$v_y = -4(\sin 2\pi t)(2\pi)$$
$$v = \sqrt{v_x + v_y} = \sqrt{(8\pi)^2(\cos^2 2\pi t + \sin^2 2\pi t)} = 8\pi$$

Hence, the correct option is (4).

153. A string is stretched between fixed points separated by 75.0 cm. It is observed to have resonant frequencies of 420 Hz and 315 Hz. There are no other resonant frequencies between these two. The lowest resonant frequency for this string is:
(1) 105 Hz   (2) 155 Hz
(3) 205 Hz   (4) 10.5 Hz

Solution:
For a string fixed at both ends, two consecutive resonant frequencies will be:
$$f_3 = \frac{nv}{2l} \text{ and } f_4 = \frac{(n+1)v}{2l}$$
$$f_4 - f_3 = \frac{(n+1)v}{2l} - \frac{nv}{2l} = 420 - 315$$
$$\therefore \frac{v}{2l} = 105\,\mathrm{Hz}$$

Hence, the correct option is (1).

154. Point masses m_1 and m_2 are placed at the opposite ends of a rigid rod of length L, and negligible mass. The rod is to be set rotating about an axis perpendicular to it. The position of point P on this rod through which the axis should pass so that the work required to set the rod rotating with angular velocity ω_0 is minimum, is given by:
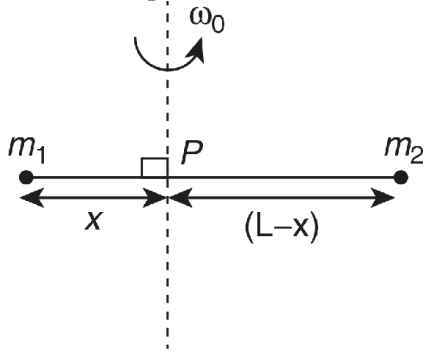
(1) $x = \dfrac{m_2 L}{m_1 + m_2}$

(2) $x = \dfrac{m_1 L}{m_1 + m_2}$

(3) $x = \dfrac{m_1}{m_2} L$

(4) $x = \dfrac{m_2}{m_1} L$

Solution:

The position of point P on rotating rod should be such that the work required to set the rod rotating with minimum angular velocity ω_0 is the centre of mass.

$I = m_1 x^2 + m_2 (L - x)^2$

$I = m_1 x^2 + m_2 L^2 + m_2 x^2 - 2m_2 Lx$

$\dfrac{dI}{dx} = 2m_1 x + 0 + 2xm_2 - 2m_2 L = 0$

$x(2m_1 + 2m_2) = 2m_2 L$

$x = \dfrac{m_2 L}{m_1 + m_2}$

Hence, the correct option is (1).

155. At the first minimum adjacent to the central maximum of a single-slit diffraction pattern the phase difference between the Huygen's wavelet from the edge of the slit and the wavelet from the mid-point of the slit is:
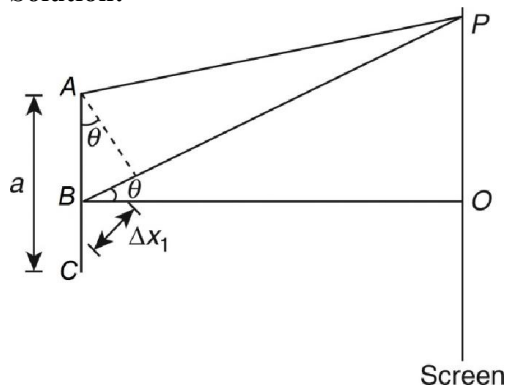
(1) $\dfrac{\pi}{8}$ radian

(2) $\dfrac{\pi}{4}$ radian

(3) $\dfrac{\pi}{2}$ radian

(4) π radian

Solution:

The first minima path difference between A and C is λ so path difference between A and B should be λ/2.

Thus, phase difference , $\Delta\phi_1 = \dfrac{\lambda}{2\lambda} \times 2\pi = \pi$ radian

Hence, the correct option is (4).

156. A force $\vec{F} = \alpha\hat{i} + 3\hat{j} + 6\hat{k}$ is acting at a point $\vec{r} = 2\hat{i} - 6\hat{j} - 12\hat{k}$ .The value of α for which angular momentum about origin is conserved is:

(1) 1   (2) −1

(3) 2   (4) zero

Solution:

For conservation of angular momentum:

$\sum \vec{\tau}_{net} = 0$

$\Rightarrow \vec{r} \times \vec{F} = 0$

$$\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -6 & -12 \\ \alpha & 3 & 6 \end{vmatrix} = 0$$

On solving it we get:

$\alpha = -1$

Hence, the correct option is (2).

157. Two particles A and B, move with constant velocities $\vec{v}_1$ and $\vec{v}_2$. At the initial moment their position vectors are $\vec{r}_1$ and $\vec{r}_2$ respectively. The condition for particle A and B for their collision is:

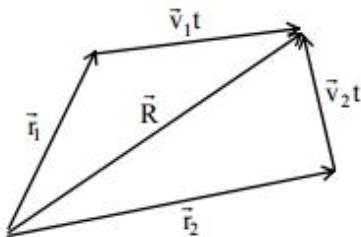(1) $\vec{r}_1 - \vec{r}_2 = \vec{v}_1 - \vec{v}_2$ (2) $\dfrac{\vec{r}_1 - \vec{r}_2}{\left|\vec{r}_1 - \vec{r}_2\right|} = \dfrac{\vec{v}_2 - \vec{v}_1}{\left|\vec{v}_2 - \vec{v}_1\right|}$

(3) $\vec{r}_1 . \vec{v}_1 = \vec{r}_2 . \vec{v}_2$ (4) $\vec{r}_1 \times \vec{v}_1 = \vec{r}_2 \times \vec{v}_2$

Solution:

For two particles to collide with each other, the direction of the relative velocity of one with respect to other should be directed towards the relative position of the other particle.

Thus, direction of relation position of 1 with respect to 2 $= \dfrac{\vec{r}_1 - \vec{r}_2}{\left|\vec{r}_1 - \vec{r}_2\right|}$

And, direction of relation velocity of 1 with respect to 2 $= \dfrac{\vec{v}_2 - \vec{v}_1}{\left|\vec{v}_2 - \vec{v}_1\right|}$

So, for collision to take place:

$\dfrac{\vec{r}_1 - \vec{r}_2}{\left|\vec{r}_1 - \vec{r}_2\right|} = \dfrac{\vec{v}_2 - \vec{v}_1}{\left|\vec{v}_2 - \vec{v}_1\right|}$

Hence, the correct option is (2).

158. A nucleus of uranium decays at rest into nuclei of thorium and helium. Then:

(1) The helium nucleus has less kinetic energy than the thorium nucleus

(2) The helium has more kinetic energy than the thorium nucleus.

(3) The helium nucleus has less momentum than the thorium nucleus.

(4) The helium nucleus has more momentum than the thorium nucleus.

Solution:

By law of conservation of momentum

$p_{Th} = p_{He} = p$

As, Kinetic energy $= \dfrac{p^2}{2m}$

Thus, Kinetic energy is inversely proportional to mass of elements.

$\because m_{He} < m_{Th}$
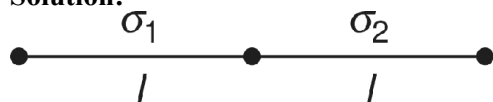
$\therefore$ Kinetic Energy of He> Kinetic Energy of Th

Hence, the correct option is (2).

159. Two metal wires of identical dimensions are connected in series. If σ_1 and σ_1 are the conductivities of the metal wires respectively, the effective conductivity of the combination is:

(1) $\dfrac{\sigma_1 \sigma_2}{\sigma_1 + \sigma_2}$

(2) $\dfrac{2\sigma_1 \sigma_2}{\sigma_1 + \sigma_2}$

(3) $\dfrac{\sigma_1 + \sigma_2}{2\sigma_1 \sigma_2}$

(4) $\dfrac{\sigma_1 + \sigma_2}{\sigma_1 \sigma_2}$

Solution:

$R_{eq} = R_1 + R_2$

$\rho_{eq} \dfrac{2L}{A} = \rho_1 \dfrac{L}{A} + \rho_2 \dfrac{L}{A}$

$2\rho_{eq} = \rho_1 + \rho_2$

$\dfrac{2}{\sigma_{eq}} = \dfrac{1}{\sigma_1} + \dfrac{1}{\sigma_2}$

$\dfrac{2}{\sigma_{eq}} = \dfrac{\sigma_1 + \sigma_2}{\sigma_1 \sigma_2}$

$\sigma_{eq} = \dfrac{2\sigma_1 \sigma_2}{\sigma_1 + \sigma_2}$

Hence, the correct option is (2).

160. Light of wavelength 500 nm is incident on a metal with work function 2.28 eV. The de Broglie wavelength of the emitted electron is:

(1) $\leq 2.8 \times 10^{-12}\,\text{m}$

(2) $< 2.8 \times 10^{-10}\,\text{m}$

(3) $< 2.8 \times 10^{-9}\,\text{m}$

(4) $\geq 2.8 \times 10^{-9}\,\text{m}$

Solution:

Energy of Photon $= \dfrac{12400}{5000} = 2.48\,\text{eV}$

According to Einstein Equation:

$E = \phi_0 + (K.E.)_{max}$

$(K.E.)_{max} = 2.48 - 2.28 = 0.2\,\text{eV}$

For an electron, $\lambda = \dfrac{h}{\sqrt{(K.E.)_{max}}} = \dfrac{12.27}{\sqrt{0.2}} = 2.7 \times 10^{-9}\,\text{m}$

Thus, $\lambda \geq 2.8 \times 10^{-9}\,\text{m}$

Hence, the correct option is (4).

161. 4.0 g of a gas occupies 22.4 litres at NTP. The specific heat capacity of the gas at constant volume is 5.0 JK^{-1} mol^{-1}. If the speed of sound in this gas at NTP is 952 ms^{-1}, then the heat capacity at constant pressure is: (Take gas constant R = 8.3 JK^{-1} mol^{-1})

(1) 8.5 JK^{-1} mol^{-1} (2) 8.0 JK^{-1} mol^{-1}

(3) 7.5 JK^{-1} mol^{-1} (4) 7.0 JK^{-1} mol^{-1}

Solution:

$v = \sqrt{\dfrac{\gamma RT}{M}} \Rightarrow \gamma = \dfrac{Mv^2}{RT} = 1.6$

As, $C_P = \gamma C_V = 1.6 \times 5.0 = 8.0\,\text{JK}^{-1}\text{mol}^{-1}$

Hence, the correct option is (2).

162. A series R-C circuit is connected to an alternating voltage source. Consider two situations:

(a) When capacitor is air filled.

(b) When capacitor is mica filled.

Current through resistor is i and voltage across capacitor is V then:

(1) $V_a = V_b$ (2) $V_a < V_b$

(3) $V_a > V_b$ (4) $i_a > i_b$

Solution:

As, $X_C = \dfrac{1}{2\pi f C}$

Thus, when capacitor is filled with mica and its capacitance C increases, X_C decreases. Therefore, in case (b) X_C decreases and so does the voltage across capacitor.

So, $V_a > V_b$.

Hence, the correct option is (3).

163. A plank with a box on it at one end is gradually raised about the other end. As the angle of inclination with the horizontal reaches 30°, the box starts to slip and slides 4.0 m down the plank in 4.0s. The coefficients of static and kinetic friction between the box and the plank will be, respectively:
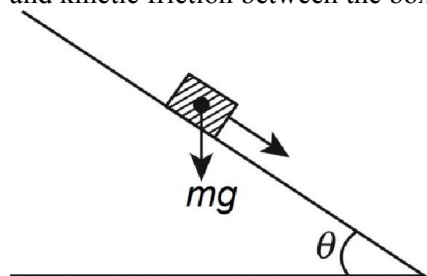
(1) 0.4 and 0.3   (2) 0.6 and 0.6

(3) 0.6 and 0.5   (4) 0.5 and 0.6

Solution:

Coefficient of static friction, $\mu_s = \tan 30^\circ = \dfrac{1}{\sqrt{3}} = 0.6$

$s = v_0 t + \dfrac{1}{2} at^2$

$$4 = 0 + \frac{1}{2}(g \sin 30° - \mu_k g \cos 30°)(4)^2$$

$$\frac{4}{8} = 10 \times \frac{1}{2} - \mu_k \frac{\sqrt{3}}{2}$$

$$\mu_k = 0.5$$

Hence, the correct option is (3).

164. Two stones of masses *m* and 2 *m* are whirled in horizontal circles, the heavier one in a radius *r*/2 and the lighter one in radius *r*. The tangential speed of lighter stone is *n* times that of the value of heavier stone when they experience same centripetal forces. The value of *n* is:
(1) 1   (2) 2
(3) 3   (4) 4

Solution:
$$(F_C)_{heavier} = (F_C)_{lighter}$$

$$\frac{2mv_1^2}{(r/2)} = \frac{mv_2^2}{r}$$

$$\Rightarrow v_1^2 = 4v_2^2 \Rightarrow v_1 = 2v_2$$

Hence, the correct option is (2).

165. The coefficient of performance of a refrigerator is 5. If the temperature inside freezer is –20°C, the temperature of the surroundings to which it rejects heat is:
(1) 21°C   (2) 31°C
(3) 41°C   (4) 11°C

Solution:
Coefficient of performance of refrigerator, $\alpha = 5$
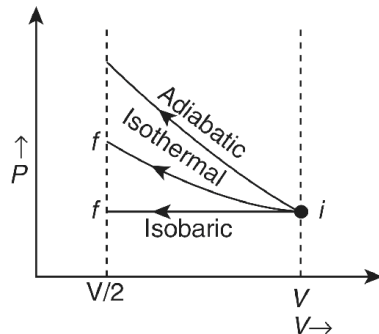
$$\alpha = 31\frac{T_L}{T_H - T_L} = 5$$

$$\Rightarrow T_H = \frac{6}{5}T_L = \frac{6}{5}(253) = 303.6K = 30.6 \,^{\circ}C \,\square\, 31^{\circ}C$$

Hence, the correct option is (2).

166. An ideal gas is compressed to half its initial volume by means of several processes. Which of the process results in the maximum work done on the gas?
(1) Isothermal   (2) Adiabatic
(3) Isobaric   (4) Isochoric

Solution:

Work done on the gas = Area under curve

$W_{isochoric} = 0$

$W_{adiabatic} > W_{isothermal} > W_{isobaric}$

Hence, the correct option is (2).

167. A ball is thrown vertically downwards from a height of 20 m with an initial velocity v_0. It collides with the ground, loses 50 percent of its energy in collision and rebounds to the same height. The initial velocity v_0 is: (Take $g = 10$ ms^{-2})

(1) 10 ms^{-1} (2) 14 ms^{-1}

(3) 20 ms^{-1} (4) 28 ms^{-1}

Solution:

Let ball rebounds with speed v so

$$0.5\left(mgh + \frac{1}{2}mv^2 \right) = mgh$$

$$0.25mv^2 = 0.5mgh$$

$$v = \sqrt{2gh} = \sqrt{2 \times 10 \times 20} = \sqrt{400} = 20 \text{ ms}^{-1}$$

Hence, the correct option is (3).

168. On a frictionless surface, a block of mass, M moving at speed v collides elastically with another block of same mass M which is initially at rest. After collision the first block moves at an angle θ to its initial direction and has a speed $v/3$. The second block's speed after the collision is:

(1) $\frac{\sqrt{3}}{2}v$ (2) $\frac{2\sqrt{2}}{3}v$

(3) $\frac{3}{4}v$ (4) $\frac{3}{\sqrt{2}}v$

Solution:

According to law of conservation of energy, in elastic collision

$(K.E.)_{before\,collision} = (K.E.)_{after\,collision}$

Let speed of block after collision be v'

$$\frac{1}{2}mv^2 + 0 = \frac{1}{2}m\left(\frac{v}{3}\right)^2 + \frac{1}{2}m(v')^2$$

$$v^2 = \frac{v^2}{9} + v'^2 \Rightarrow v'^2 = \frac{8v^2}{9}$$

$$\Rightarrow v' = \frac{2\sqrt{2}}{3}v$$

Hence, the correct option is (2).

169. If potential (in volts) in a region is expressed as $V(x,y,z) = 6xy - y + 2yz$, the electric field (in N/C) at point (1,1,0) is:

(1) $-(6\hat{i} + 9\hat{j} + \hat{k})$ (2) $-(3\hat{i} + 5\hat{j} + 3\hat{k})$

(3) $-(6\hat{i} + 5\hat{j} + 2\hat{k})$ (4) $-(2\hat{i} + 3\hat{j} + \hat{k})$

Solution:

$V = 6xy - y + 2yz$

$$\vec{E} = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$$

$$\vec{E} = -6y\hat{i} - (6x - 1 + 2z)\hat{j} - 2y\hat{k}$$

At (1, 1, 0)

$$E = -6\hat{i} - 5\hat{j} - 2\hat{k}$$

$$= -\left(6\hat{i} + 5\hat{j} + 2\hat{k}\right)$$

Hence, the correct option is (2).

170. Two slits in Young's experiment have widths in the ratio 1 : 25. The ratio of intensity at the maxima and minima in the interference pattern, $\dfrac{I_{max}}{I_{min}}$ is:

(1) $\dfrac{4}{9}$

(2) $\dfrac{9}{4}$

(3) $\dfrac{121}{49}$

(4) $\dfrac{49}{121}$

Solution:

$$\frac{I_1}{I_2} = \frac{W_1}{W_2} = \frac{1}{25} \Rightarrow \frac{I_2}{I_1} = \frac{25}{1}$$

$$\frac{I_{max}}{I_{min}} = \frac{\left(\sqrt{I_2} + \sqrt{I_1}\right)^2}{\left(\sqrt{I_2} - \sqrt{I_1}\right)^2} = \frac{\left(\sqrt{\dfrac{I_2}{I_1}} + 1\right)^2}{\left(\sqrt{\dfrac{I_2}{I_1}} - 1\right)^2}$$

$$= \left(\frac{5+1}{5-1}\right)^2 = \left(\frac{6}{4}\right)^2 = \frac{9}{4}$$

Hence, the correct option is (2).

171. The heart of a man pumps 5 litres of blood through the arteries per minute at a pressure of 150 mm of mercury. If the density of mercury be 13.6×10^3 kg/m^3 and $g = 10$m/s^2 , then the power of heart in watt is:

(1) 1.50

(2) 1.70

(3) 2.35

(4) 3.0

Solution:

$$P = \frac{W}{t} = \frac{mgh}{t} = \frac{V}{t}\rho gh$$

$$= \frac{5 \times 10^{-3}}{60} \times 13.6 \times 10^3 \times 10 \times 150 \times 10^{-3}$$

$$= \frac{5 \times 13.6 \times 150}{6} \times 10^{-3} = 1700 \times 10^{-3} = 1.7 \text{ Watt}$$

Hence, the correct option is (2).

172. A proton and an alpha particle both enter a region of uniform magnetic field, B, moving at right angles to the field B. If the radius of circular orbits for both the particles is equal and the kinetic energy acquired by proton is 1 MeV, the energy acquired by the alpha particle will be:

(1) 1 MeV

(2) 4 MeV

(3) 0.5 MeV

(4) 1.5 MeV

Solution:

Radius in magnetic field, $R = \dfrac{mv}{qB} = \dfrac{\sqrt{2mE}}{qB}$

$E = \dfrac{q^2 B^2 R^2}{2m}$

For proton,

$E_1 = \dfrac{e^2 B^2 R^2}{2m_p}$

For α-particles,

$E_2 = \dfrac{(2e)^2 B^2 R^2}{2 \times 4m_p}$

Therefore, $E_1 = E_2$.

Hence, the correct option is (1).

173. The input signal given to a CE amplifier having a voltage gain of 150 is $Vi = 2 \cos\left(15t + \dfrac{\pi}{3}\right)$. The corresponding output signal will be:

(1) $300 \cos\left(15t + \dfrac{4\pi}{3}\right)$

(2) $300 \cos\left(15t + \dfrac{\pi}{3}\right)$

(3) $75 \cos\left(15t + \dfrac{2\pi}{3}\right)$

(4) $2 \cos\left(15t + \dfrac{5\pi}{6}\right)$

Solution:

$V_i = 2 \cos(15t + \pi/3)$

$A_v = \dfrac{V_0}{V_{in}} \Rightarrow V_0 = A_v \times V_{in} \Rightarrow V_0 = 150 \times 2 \cos\left(15t + \dfrac{\pi}{3} + \pi\right)$

$V_0 = 300 \cos\left(15t + \dfrac{4\pi}{3}\right)$

Hence, the correct option is (2).

174. In dimension of critical velocity v_c, of liquid following through a tube are expressed as $(\eta^x \rho^y r^z)$, where η, ρ and r are the coefficient of viscosity of liquid, density of liquid and radius of the tube respectively, then the values of x, y and z are given by:

(1) 1, 1, 1

(2) 1, −1, −1

(3) −1, −1, 1

(4) −1, −1, −1

Solution:

$v_c = \eta^x \rho^y r^z$

$M^0 L^1 T^{-1} = (M^1 L^{-1} T^{-1})^x (M^1 L^{-3})^y (L^1)^z$

$M^0 L^1 T^{-1} = M^{x+y+z} \ L^{-x-3y+z} \ T^{-x}$

On comparing x, y and z on both the sides, we get

$x = 1$

$x + y = 0 \Rightarrow y = -x = -1$

$-x - 3y + z = 1$
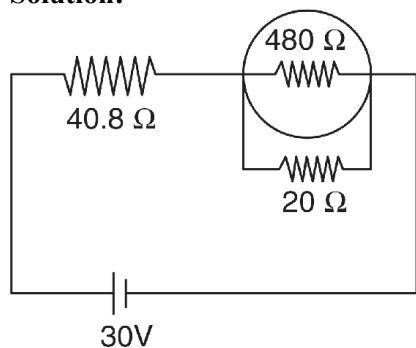
$-1 - 3(-1) + z = 1$

$z = -1$

Hence, the correct option is (2).

175. A circuit contains an ammeter, a battery of 30 V and a resistance 40.8 ohm all connected in series. If the ammeter has a coil of resistance 480 ohm and a shunt of 20 ohm, the reading in the ammeter will be:

(1) 1 A (2) 0.5 A
(3) 0.25 A (4) 2 A

Solution:

$$R_{eq} = 40.8 + \frac{480 \times 20}{480 + 20} = 40.8 + 19.2 = 60 \ \Omega$$

$$I = \frac{V_{eq}}{R_{eq}} = \frac{30}{60} = 0.5 \, A$$

Hence, the correct option is (2).

176. Water rises to height 'h' in capillary tube. If the length of capillary tube above the surface of water is made less than 'h', then :

(1) water does not rise at all.
(2) water rises upto the tip of capillary tube and then starts overflowing like a fountain.
(3) water rises upto the top of capillary tube and stays there without overflowing.
(4) water rises upto a point a little below the top and stays there.

Solution:
Height of water column > length of tube ⇒ so liquid will be stay there
Hence, the correct option is (3).

177. In an astronomical telescope in normal adjustment a straight black line of length L is drawn on inside part of objective lens. The eye-piece forms a real image of this line. The length of this image is I. The magnification of the telescope is:

(1) $\dfrac{L}{I}$ (2) $\dfrac{L}{I} + 1$

(3) $\dfrac{L}{I} - 1$ (4) $\dfrac{L+I}{L-I}$

Solution:
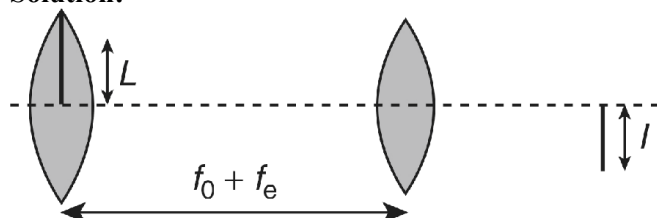
For eye-piece lens

$$m = \frac{f}{f+u} = \frac{h_1}{h_o} \Rightarrow \frac{f_e}{f_e + [-(f_0 + f_e)]} = \frac{I}{L}$$

$$\Rightarrow -\frac{f_e}{f_0} = \frac{I}{L}$$

$$\Rightarrow M = \frac{L}{I}$$

Hence, the correct option is (1).

178. The value of coefficient of volume expansion of glycerin is 5×10^{-4} K^{-1}. The fractional change in the density of glycerin for a rise of 40°C in its temperature is:
(1) 0.010   (2) 0.015
(3) 0.020   (4) 0.025

Solution:
$$\rho = \rho_0(1 + Y\Delta T)$$
$$\rho - \rho_0 = \rho_0 Y\Delta T$$
Fractional change
$$\frac{\rho - \rho_0}{\rho_0} = Y\Delta T = 5 \times 10^{-4} \times 40$$
$$= 200 \times 10^{-4} = 0.020$$

Hence, the correct option is (3).

179. A photoelectric surface is illuminated successively by monochromatic light of wavelength λ and $\frac{\lambda}{2}$.

If the maximum kinetic energy of the emitted photoelectrons in the second case is 3 times that in the first case, the work function of the surface of the material is:
(h = Plank's constant, c = speed of light)

(1) $\dfrac{hc}{3\lambda}$ (2) $\dfrac{hc}{2\lambda}$

(3) $\dfrac{hc}{\lambda}$ (4) $\dfrac{2hc}{\lambda}$

Solution:
$$KE_1 = \frac{hc}{\lambda} - \phi \qquad (1)$$

$$KE_2 = \frac{hc}{\lambda/2} - \phi = \frac{2hc}{\lambda} - \phi \qquad (2)$$

Since, $KE_2 = 3KE_1$, therefore, using Eq. (1) and (2), we get
$$\frac{2hc}{\lambda} - \phi = 3\left(\frac{hc}{\lambda} - \phi\right)$$

$$\Rightarrow 2\phi = \frac{hc}{\lambda}$$

$$\Rightarrow \phi = \frac{hc}{2\lambda}$$

Hence, the correct option is (2).

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

The prism will:

(1) separate the red colour part from the green and blue colours.

(2) separate the blue colour part from the red and green colours.

(3) separate all the three colours from one another.

(4) not separate the three colours at all.

Solution:

$$\mu = \frac{1}{\sin i_c} = \frac{1}{\sin 45^\circ} = \sqrt{2} = 1.414$$

$$\because (\mu_{red} = 1.39) < \mu; \mu_{violet} > \mu \text{ and } \mu_{green} > \mu$$

Therefore, green and blue colour will not emerge out and will suffer total internal reflection.

Hence, the correct option is (1).