

## Questions with Solutions

Time: 3 Hours

Total Marks: 720

**General Instructions:**

1. The test is of 3 hours duration and Test Booklet contains 180 questions. Each question carries 4 marks. For each correct response, the candidate will get 4 marks. For each incorrect response, one mark will be deducted from the total scores. The maximum marks are 720.
2. Use Blue / Black Ball point Pen only for writing particulars on this page/markings responses.
3. Rough work is to be done on the space provided for this purpose in the Test Booklet only.
4. On completion of the test, the candidate must handover the Answer Sheet to the Invigilator before leaving the Room / Hall. The candidates are allowed to take away this Test Booklet with them.
5. The CODE for this Booklet is H1.
6. The candidates should ensure that the Answer Sheet is not folded. Do not make any stray marks on the Answer Sheet. Do not write your Roll No. anywhere else except in the specified space in the Test Booklet/Answer Sheet.
7. Each candidate must show on demand his/her Admission Card to the Invigilator.
8. No candidate, without special permission of the Superintendent or Invigilator, would leave his/her seat.
9. Use of Electronic/Manual Calculator is prohibited.
10. The candidates are governed by all Rules and Regulations of the examination with regard to their conduct in the Examination Hall. All cases of unfair means will be dealt with as per Rules and Regulations of this examination.
11. No part of the Test Booklet and Answer Sheet shall be detached under any circumstances.
12. The candidates will write the Correct Test Booklet Code as given in the Test Booklet / Answer Sheet in the Attendance Sheet.

**CHEMISTRY**

**Q 1. Following limiting molar conductivities are given as**

$$\lambda_m^\circ (\text{H}_2\text{SO}_4) = x \text{ S cm}^2\text{mol}^{-1}$$

$$\lambda_m^\circ (\text{K}_2\text{SO}_4) = y \text{ S cm}^2\text{mol}^{-1}$$

$$\lambda_m^\circ (\text{CH}_3\text{COOK}) = z \text{ S cm}^2\text{mol}^{-1}$$

$\lambda_m^\circ$  (in  $\text{S cm}^2\text{mol}^{-1}$ ) for  $\text{CH}_3\text{COOH}$  will be

Option A  $\frac{(x-y)}{2} + z$

Option B  $x - y + 2z$

Option C  $x + y + z$

Option D  $x - y + z$

**Correct Option A**

**Solution:**

Molar conductivity of AB is calculated as-

$$\lambda_m^\circ(AB) = \lambda_m^\circ(A^+) + \lambda_m^\circ(B^-)$$

$$\text{So, } \lambda_m^\circ(\text{CH}_3\text{COOH}) = \lambda_m^\circ(\text{CH}_3\text{COO}^-) + \lambda_m^\circ(\text{H}^+)$$

$$\text{So } \lambda_m^\circ(\text{CH}_3\text{COOH})$$

$$= \lambda_m^\circ(\text{CH}_3\text{COOK}) + \frac{1}{2} \lambda_m^\circ(\text{H}_2\text{SO}_4) - \frac{1}{2} \lambda_m^\circ(\text{K}_2\text{SO}_4)$$

$$= z + \frac{x}{2} - \frac{y}{2}$$

$$= z + \left(\frac{x-y}{2}\right)$$

**Q 2. A first order reaction has a rate constant of  $2.303 \times 10^{-3} \text{ s}^{-1}$ . The time required for 40 g of this reactant to reduce to 10 g will be [Given that  $\log_{10} 2 = 0.3010$ ]**

- Option A 602 s  
 Option B 230.3 s  
 Option C 301 s  
 Option D 2000 s

**Correct Option A**

**Solution:**

Half life for first order reaction is calculated by-

$$\begin{aligned} \text{Half life period, } t_{\frac{1}{2}} &= \frac{0.693}{k} = \frac{0.693}{2.303 \times 10^{-3}} \text{ s}^{-1} \\ &= 300.91 \text{ s} \end{aligned}$$

Now, 40g  $t_{1/2}$  20g  $t_{1/2}$  10g

So, 40 g substance requires 2 half-life periods to reduce upto 10 g

$$\begin{aligned} \text{Time taken in reduction} &= 2 \times 300.91 \text{ s} \\ &= 601.82 \\ &\approx 602 \text{ s} \end{aligned}$$

**Q 3. For a reaction, activation energy  $E_a = 0$  and the rate constant at 200 K is  $1.6 \times 10^6 \text{ s}^{-1}$ . The rate constant at 400 K will be [Given that gas constant,  $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ ]**

- Option A  $3.2 \times 10^6 \text{ s}^{-1}$   
 Option B  $3.2 \times 10^4 \text{ s}^{-1}$   
 Option C  $1.6 \times 10^6 \text{ s}^{-1}$   
 Option D  $1.6 \times 10^3 \text{ s}^{-1}$

**Correct Option C**

**Solution:** From Arrhenius equation,

$$\log \frac{k_{400}}{k_{200}} = \frac{E_a}{2.303R} \left[ \frac{T_2 - T_1}{T_1 T_2} \right]$$

Since, given that  $E_a = 0$

$$\therefore \log \frac{k_{400}}{k_{200}} = 0 \Rightarrow \frac{k_{400}}{k_{200}} = 1$$

$$\text{So, } k_{400} = k_{200}$$

So rate constant at 400  $k = 1.6 \times 10^6 \text{ s}^{-1}$

**Q 4. The correct option representing a Freundlich adsorption isotherm is**

Option A  $\frac{x}{m} = k p^{-1}$

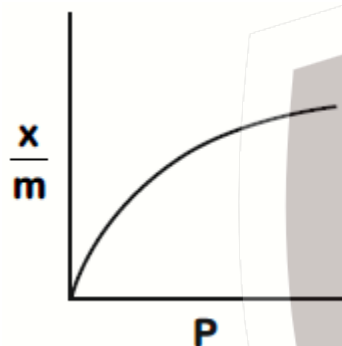
Option B  $\frac{x}{m} = k p^{0.3}$

Option C  $\frac{x}{m} = k p^{2.5}$

Option D  $\frac{x}{m} = k p^{-0.5}$

**Correct Option B**

**Solution:** According to Freundlich isotherm, graph between  $x/m$  and  $P$  is drawn as-



$$\frac{x}{m} = KP^{1/n}$$

( $n > 1$ )

So,  $\frac{x}{m} = KP^{0.3}$  as  $\frac{1}{n} = 0.3$

So, Answer is (B).

**Q 5. Which of the following is paramagnetic?**

Option A  $\text{O}_2$

Option B  $\text{N}_2$

Option C  $\text{H}_2$

Option D  $\text{Li}_2$

**Correct Option A**

**Solution:**

Total number of electrons in  $\text{O}_2$

$$8 + 8 = 16 \text{ electrons}$$

Distribution of electrons in MO(molecular orbitals) follows the order as

$$(\sigma 1s)^2, (\sigma^* 1s)^2, (\sigma 2s)^2, (\sigma^* 2s)^2, (\sigma 2p_z)^2,$$

$$(\pi 2p_x)^2 (\pi^* 2p_x)^1$$

$$(\pi 2p_y)^2 (2p_y)^1$$

So, in  $\text{O}_2$  molecule, there are two (2) unpaired electrons, so, it is a "paramagnetic" substance in nature.

**Q 6. Which of the following is the correct order of dipole moment?**

Option A  $\text{H}_2\text{O} < \text{NF}_3 < \text{NH}_3 < \text{BF}_3$

Option B  $\text{NH}_3 < \text{BF}_3 < \text{NF}_3 < \text{H}_2\text{O}$

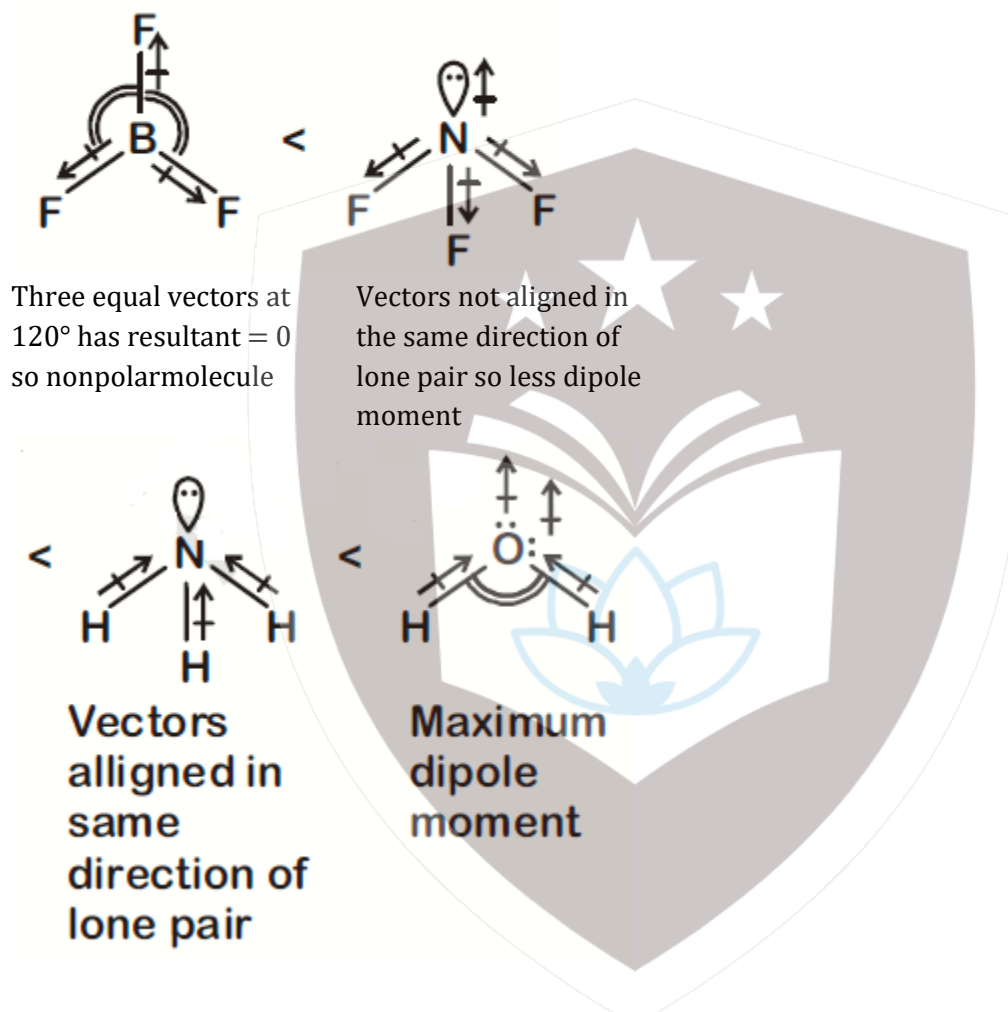
Option C  $\text{BF}_3 < \text{NF}_3 < \text{NH}_3 < \text{H}_2\text{O}$

Option D  $\text{BF}_3 < \text{NH}_3 < \text{NF}_3 < \text{H}_2\text{O}$

**Correct Option A**

**Solution:**

Dipole moment of a molecule is the vector sum of dipoles of bonds. So based on molecular geometry of following molecules,



**Q 7. Crude sodium chloride obtained by crystallisation of brine solution does not contain**

Option A  $\text{CaSO}_4$

Option B  $\text{MgSO}_4$

Option C  $\text{Na}_2\text{SO}_4$

Option D  $\text{MgCl}_2$

**Correct Option B**

**Solution:**

Crude sodium chloride generally obtained by crystallisation of brine solution contains  $\text{Na}_2\text{SO}_4$ ,  $\text{CaSO}_4$ ,  $\text{CaCl}_2$  and  $\text{MgCl}_2$  as impurities.

Q 8. Which of the alkali metal chloride (MCl) forms its dihydrate salt (MCl . 2H<sub>2</sub>O) easily?

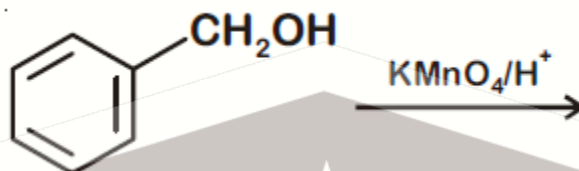
- Option A KCl  
Option B LiCl  
Option C CsCl  
Option D RbCl

**Correct Option B**

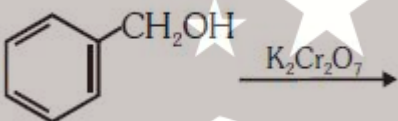
**Solution:** Out of alkali metal chlorides only LiCl forms a dihydrate, other metal chlorides (KCl, CsCl, RbCl) do not form hydrates.

Q 9. The reaction that does not give benzoic acid as the major product is

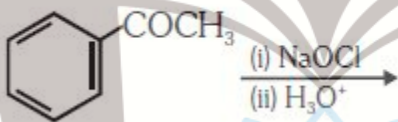
Option A



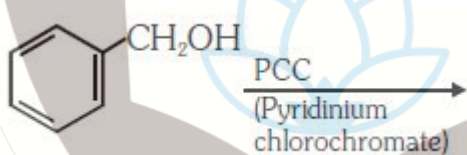
Option B



Option C



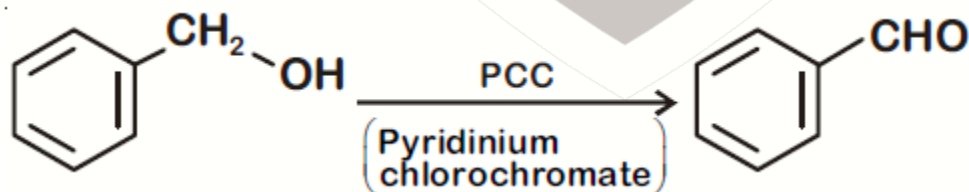
Option D



**Correct Option D**

**Solution:**

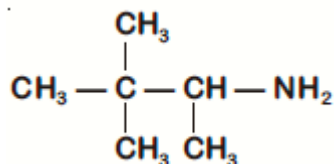
PCC is oxidising agent.



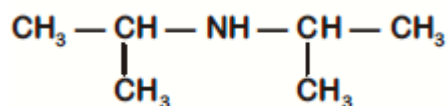
PCC oxidises primary alcohol to aldehyde.

Q 10. The amine that reacts with Hinsberg's reagent to give an alkali insoluble product is

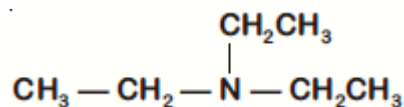
Option A



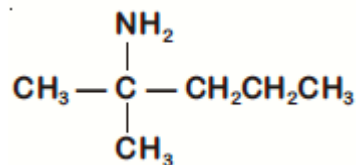
Option B



Option C



Option D



**Correct Option B**

**Solution:**

Secondary amines react with Hinsberg's reagent to give a product which is insoluble in alkali.

Option A is primary amine.

Option B is secondary amine.

Option C is tertiary amine

Option D is tertiary amine

**Q 11. Which structure(s) of proteins remain(s) intact during denaturation process?**

Option A Tertiary structure only

Option B Both secondary and tertiary structures

Option C Primary structure only

Option D Secondary structure only

**Correct Option C**

**Solution:**

During denaturation primary structure of proteins remain intact.

**Q 12. The polymer that is used as a substitute for wool in making commercial fibres is**

Option A Buna-N

Option B melamine

Option C nylon-6,6

Option D polyacrylonitrile

**Correct Option D**

**Solution:**

Polyacrylonitrile is used as a substitute for wool in making commercial fibre as orlon or acrilan.

**Q 13. The artificial sweetener stable at cooking temperature and does not provide calories is**

Option A alitame

Option B saccharin

Option C aspartame

Option D sucralose

**Correct Option D**

**Solution:**

Sucralose is trichloro derivative of sucrose. It is an artificial sweetner. It is stable at cooking temperature. It does not provide calories.

**Q 14. The density of 2 M aqueous solution of NaOH is  $1.28 \text{ g/cm}^3$ . The molality of the solution is [Given that molecular mass of NaOH =  $40 \text{ g mol}^{-1}$ ]**

- Option A 1.32 m
- Option B 1.20 m
- Option C 1.56 m
- Option D 1.67 m

**Correct Option D**

**Solution:**

Let, volume of solution = 1 litre

Moles of NaOH = 2

Mass of NaOH solution =  $1000 \times 1.28 = 1280 \text{ g}$

Mass of  $\text{H}_2\text{O}$  =  $(1280 - 2 \times 40) = 1200 \text{ g} = 1.2 \text{ kg}$

Molality is calculated by-

$$\begin{aligned}\text{Molality (m)} &= \frac{\text{Mole of NaOH}}{\text{Mass of solvent (kg)}} \\ &= \frac{2}{1.2} \\ &= 1.67\text{m}\end{aligned}$$

**Q 15. Orbital having 3 angular nodes and 3 total nodes is**

- Option A 6 d
- Option B 5 p
- Option C 3 d
- Option D 4 f

**Correct Option D**

**Solution:**

Total number of nodes =  $(n - 1)$

$$3 = n - 1$$

$$n = 4$$

n is principal quantum number.

Number of angular nodes =  $\ell = 3 \Rightarrow$  f-subshell

$\therefore$  Correct answer is 4f.

**Q 16. In hydrogen atom, the de Broglie wavelength of an electron in the second Bohr orbit is [Given that Bohr radius,  $a_0 = 52.9 \text{ pm}$ ]**

- Option A 105.8 pm
- Option B 211.6 pm
- Option C  $211.6 \pi \text{ pm}$
- Option D  $52.9 \pi \text{ pm}$

**Correct Option C**

**Solution:**

$$r_n = a_0 n^2$$

$$r_2 = 52.9 \times (2)^2 \text{ pm}$$

$$n\lambda = 2\pi r$$

$$\lambda = \frac{2\pi r}{n}$$

$$= \frac{2\pi}{2} \times 52.9 \times 4$$

$$\lambda = 211.6 \pi \text{ pm}$$

**Q 17. The volume occupied by 1.8 g of water vapour at 374°C and 1 bar pressure will be [Use R = 0.083 bar LK<sup>-1</sup> mol<sup>-1</sup>]**

- Option A 5.37 L  
 Option B 96.66 L  
 Option C 55.87 L  
 Option D 3.10 L

**Correct Option A**

**Solution:**

Ideal gas equation is-

$$PV = nRT$$

$$V = \frac{W}{M} \left( \frac{RT}{P} \right)$$

$$V = \frac{1.8}{18} \times \frac{0.083 \times 647}{1} = 5.37 \text{ L}$$

**Q 18. An ideal gas expands isothermally from 10<sup>-3</sup> m<sup>3</sup> to 10<sup>-2</sup> m<sup>3</sup> at 300 K against a constant pressure of 10<sup>5</sup> Nm<sup>-2</sup>. The work done on the gas is**

- Option A - 900 kJ  
 Option B + 270 kJ  
 Option C - 900 J  
 Option D + 900 kJ

**Correct Option C**

**Solution:**

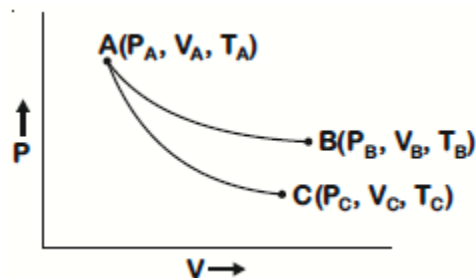
Work is calculated by-

$$W = -P_{\text{ext}}(V_f - V_i)$$

$$= -10^5 (10^{-2} - 10^{-3})$$

$$= -900 \text{ J}$$

**Q 19. Reversible expansion of an ideal gas under isothermal and adiabatic conditions are as shown in the figure.**



**AB → Isothermal expansion**

**AC → Adiabatic expansion**

**Which of the following options is not correct?**



- Option A  $T_C > T_A$   
 Option B  $\Delta S_{\text{isothermal}} > \Delta S_{\text{adiabatic}}$   
 Option C  $T_A = T_B$   
 Option D  $W_{\text{isothermal}} > W_{\text{adiabatic}}$

**Correct Option A**

**Solution:**

Since graph A to C represents adiabatic reversible expansion, so work is done on the expense of internal energy, therefore, internal energy is consumed and there is decrease in internal energy. So the temperature decreases.

i.e.,  $T_C < T_A$

**Q 20. Match the oxide given in column A with its property given in column B**

	Column-A		Column-B
(i)	$\text{Na}_2\text{O}$	(a)	Neutral
(ii)	$\text{Al}_2\text{O}_3$	(b)	Basic
(iii)	$\text{N}_2\text{O}$	(c)	Acidic
(iv)	$\text{Cl}_2\text{O}_7$	(d)	Amphoteric

Which of the following options has all correct pairs?

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

**Correct Option A**

**Solution:**

$\text{Na}_2\text{O}$ is basic oxide	$\Rightarrow$	(i) - (b)
$\text{Al}_2\text{O}_3$ is amphoteric oxide	$\Rightarrow$	(ii) - (d)
$\text{N}_2\text{O}$ is neutral	$\Rightarrow$	(iii) - (a)
$\text{Cl}_2\text{O}_7$ is acidic oxide	$\Rightarrow$	(iv) - (c)

**Q 21. Match the catalyst with the process**

	Catalyst		Process
(i)	$\text{V}_2\text{O}_5$	(a)	The oxidation of ethyne to ethanal
(ii)	$\text{TiCl}_4 + \text{Al}(\text{CH}_3)_3$	(b)	Polymerisation of alkynes
(iii)	$\text{PdCl}_2$	(c)	Oxidation of $\text{SO}_2$ in the manufacture of $\text{H}_2\text{SO}_4$
(iv)	Nickel complexes	(d)	Polymerisation of ethylene

Which of the following is the correct option?

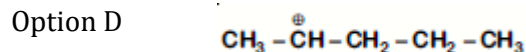
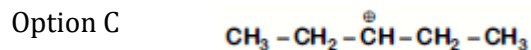
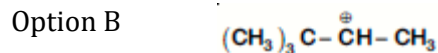
- Option A (i)-(c), (ii)-(a), (iii)-(d), (iv)-(b)  
 Option B (i)-(c), (ii)-(d), (iii)-(a), (iv)-(b)  
 Option C (i)-(a), (ii)-(b), (iii)-(c), (iv)-(d)  
 Option D (i)-(a), (ii)-(c), (iii)-(b), (iv)-(d)

**Correct Option B**

**Solution:**

- (i)  $\text{V}_2\text{O}_5$ : Used in the oxidation of  $\text{SO}_2$  used in the manufacture of  $\text{H}_2\text{SO}_4$  (Contact process).  
 (ii)  $\text{TiCl}_4 + \text{Al}(\text{CH}_3)_3$ : Used in the polymerisation of ethylene  
 (iii)  $\text{PdCl}_2$ : Used in the oxidation of ethyne to ethanal  
 (iv) Nickel Complex : Used in the polymerisation of alkynes

Q 22. The most stable carbocation, among the following, is



**Correct Option D**

**Solution:**

Stability of carbocation increases with hyperconjugation effect.

Stability of carbocation depends upon number of  $\alpha$ -H because of +H effect i.e. hyperconjugation effect.

Among the given carbocations,

$\text{CH}_3 - \overset{\oplus}{\text{C}}\text{H} - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$  is the most stable carbocation because number of  $\alpha$ -H is maximum (5  $\alpha$ -H)

Q 23. The alkane that gives only one mono-chloro product on chlorination with  $\text{Cl}_2$  in presence of diffused sunlight is

Option A Isopentane

Option B 2, 2-dimethylbutane

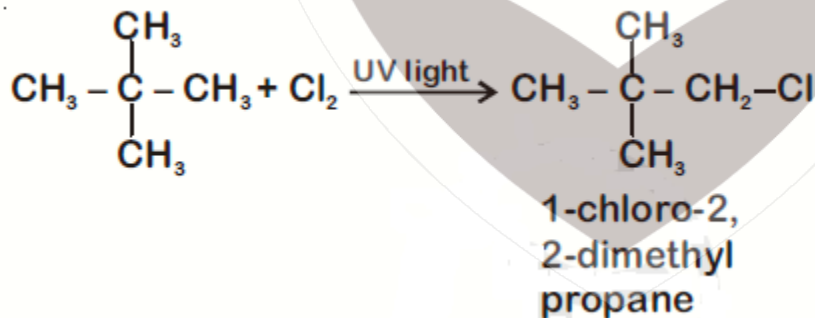
Option C neopentane

Option D n-pentane

**Correct Option C**

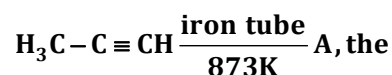
**Solution:**

Chlorination of neopentane with  $\text{Cl}_2$  in the presence of diffused sunlight gives only one mono-chloro compound.



Q 24. In the following reaction,

red hot



number of sigma ( $\sigma$ ) bonds present in the product A, is

Option A 18

Option B 21

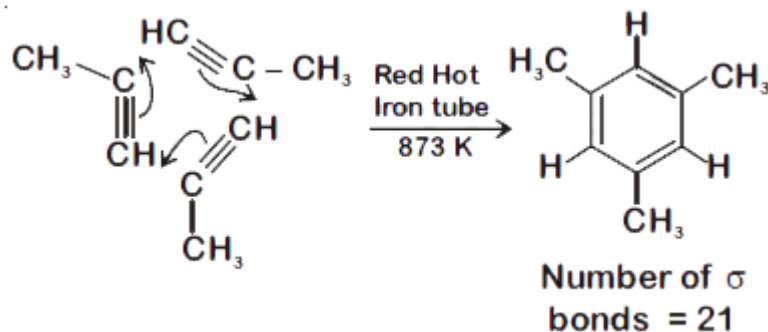
Option C 9

Option D 24

**Correct Option B**

**Solution:**

Number of sigma bonds in the compound A is calculated by-



**Q 25. Aluminium chloride in acidified aqueous solution forms a complex 'A', in which hybridisation state of Al is 'B'. What are 'A' and 'B', respectively?**

Option A  $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ ,  $d^2sp^3$

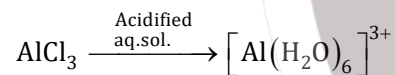
Option B  $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ ,  $sp^3d^2$

Option C  $[\text{Al}(\text{H}_2\text{O})_4]^{3+}$ ,  $sp^3$

Option D  $[\text{Al}(\text{H}_2\text{O})_4]^{3+}$ ,  $dsp^2$

**Correct Option B**

**Solution:**



Hybridisation in this co-ordination compound is  $sp^3d^2$ .

**Q 26. Which of the following compounds is used in cosmetic surgery?**

Option A Zeolites

Option B Silicas

Option C Silicates

Option D Silicones

**Correct Option D**

**Solution:** Silicones are used in cosmetic surgery. It is used in beauty products.

**Q 27. Identify the incorrect statement.**

Option A Gangue is an ore contaminated with undesired materials

Option B The scientific and technological process used for isolation of the metal from its ore is known as metallurgy

Option C Minerals are naturally occurring chemical substances in the earth's crust

Option D Ores are minerals that may contain a metal

**Correct Option A**

**Solution:** Gangue is the earthy or undesired material which is contaminating the ore.

Q 28. A compound 'X' upon reaction with H<sub>2</sub>O produces a colorless gas 'Y' with rotten fish smell. Gas 'Y' is absorbed in a solution of CuSO<sub>4</sub> to give Cu<sub>3</sub>P<sub>2</sub> as one of the products.

Predict the compound 'X'.

Option A Ca<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub>

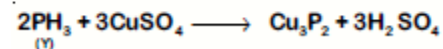
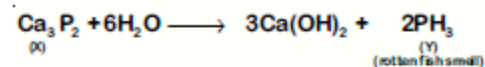
Option B Cu<sub>3</sub>P<sub>2</sub>

Option C NH<sub>4</sub>Cl

Option D As<sub>2</sub>O<sub>3</sub>

**Correct Option B**

**Solution:**



X=Cu<sub>3</sub>P<sub>2</sub>

Q 29. Which of the following oxoacids of phosphorus has strongest reducing property?

Option A H<sub>3</sub>PO<sub>4</sub>

Option B H<sub>4</sub>P<sub>2</sub>O<sub>7</sub>

Option C H<sub>3</sub>PO<sub>3</sub>

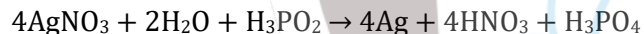
Option D H<sub>3</sub>PO<sub>2</sub>

**Correct Option D**

**Solution:**

H<sub>3</sub>PO<sub>2</sub> has strongest reducing property.

Hypophosphorous acid is a good reducing agent as it contains two P-H bonds.



Q 30. Identify the correct formula of 'oleum' from the following.

Option A H<sub>2</sub>S<sub>2</sub>O<sub>8</sub>

Option B H<sub>2</sub>S<sub>2</sub>O<sub>7</sub>

Option C H<sub>2</sub>SO<sub>3</sub>

Option D H<sub>2</sub>SO<sub>4</sub>

**Correct Option B**

**Solution:** Oleum is 'H<sub>2</sub>S<sub>2</sub>O<sub>7</sub>'. It is also known fuming sulfuric acid.

Q 31. When neutral or faintly alkaline KMnO<sub>4</sub> is treated with potassium iodide, iodide ion is converted into 'X'. 'X' is

Option A IO<sup>-</sup>

Option B I<sub>2</sub>

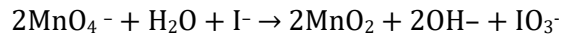
Option C IO<sub>4</sub><sup>-</sup>

Option D IO<sub>3</sub><sup>-</sup>

**Correct Option D**

**Solution:**

In neutral or faintly alkaline solutions, iodide ion is converted into iodate (IO<sub>3</sub><sup>-</sup>).



**Q 32. The Crystal Field Stabilisation Energy (CFSE) for  $[\text{CoCl}_6]^{4-}$  is  $18000 \text{ cm}^{-1}$ . The CFSE for  $[\text{CoCl}_4]^{2-}$  will be**

- Option A  $8000 \text{ cm}^{-1}$
- Option B  $6000 \text{ cm}^{-1}$
- Option C  $16000 \text{ cm}^{-1}$
- Option D  $18000 \text{ cm}^{-1}$

**Correct Option A**

**Solution:**

Crystal Field Stabilisation Energy (CFSE) in tetrahedral complex is calculated by-

$$\therefore \Delta_t = \frac{4}{9} \Delta_0$$

$$\Delta_t = \frac{4}{9} \times 18000 \text{ cm}^{-1} = 8000 \text{ cm}^{-1}$$

**Q 33. The liquified gas that is used in dry cleaning along with a suitable detergent is**

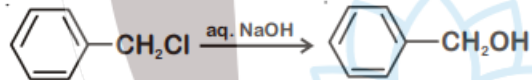
- Option A  $\text{CO}_2$
- Option B Water gas
- Option C Petroleum gas
- Option D  $\text{NO}_2$

**Correct Option A**

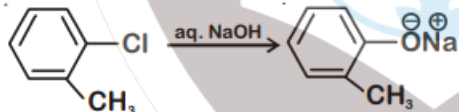
**Solution:** Liquified  $\text{CO}_2$  (carbon dioxide) with a suitable detergent is used in dry cleaning.

**Q 34. The hydrolysis reaction that takes place at the slowest rate, among the following is**

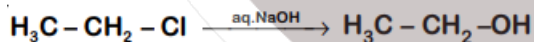
Option A



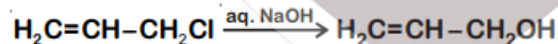
Option B



Option C



Option D



**Correct Option B**

**Solution:** aq. NaOH is used in substitution reaction. Aryl halides do not give substitution reactions due to partial double bond character.

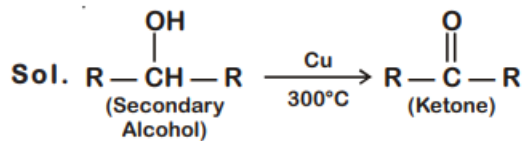
**Q 35. When vapours of a secondary alcohol is passed over heated copper at  $573 \text{ K}$ , the product formed is**

- Option A an alkene
- Option B a carboxylic acid
- Option C an aldehyde
- Option D a ketone

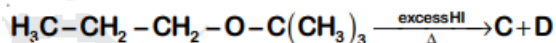
**Correct Option D**

**Solution:**

When vapours of a secondary alcohol is passed over heated copper at 573 K, the product formed is ketone.



Q 36. The major products C and D formed in the following reaction respectively are



Option A  $\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{OH}$  and  $\text{OH}-\text{C}(\text{CH}_3)_3$

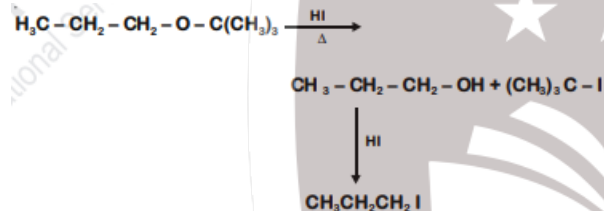
Option B  $\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{I}$  and  $\text{I}-\text{C}(\text{CH}_3)_3$

Option C  $\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{OH}$  and  $\text{I}-\text{C}(\text{CH}_3)_3$

Option D  $\text{H}_3\text{C}-\text{CH}_2-\text{CH}_2-\text{I}$  and  $\text{HO}-\text{C}(\text{CH}_3)_3$

**Correct Option B**

**Solution:**



Q 37. The pH of 0.01 M NaOH (aq) solution will be

Option A 9

Option B 7.01

Option C 2

Option D 12

**Correct Option D**

**Solution:**

$$[\text{OH}^-] = [\text{NaOH}] = 0.01 \text{ M} = 10^{-2} \text{ M}$$

$$\text{pOH} = -\log[\text{OH}^-] = -\log(10^{-2}) = 2$$

pH and pOH will be-

$$\text{pH} = 14 - \text{pOH} = 12$$

Q 38. Which of the following cannot act both as Bronsted acid and as Bronsted base?

Option A  $\text{HSO}_4^-$

Option B  $\text{HCO}_3^-$

Option C  $\text{NH}_3$

Option D  $\text{HCl}$

**Correct Option D**

**Solution:** Substance which can release and accept  $\text{H}^+$  can act as both Bronsted base and acid.  $\text{HCl}$  cannot accept  $\text{H}^+$  therefore cannot act as Bronsted base and it can release  $\text{H}^+$ , so it is Bronsted acid.

**Q 39. The molar solubility of  $\text{CaF}_2$  ( $K_{sp} = 5.3 \times 10^{-11}$ ) in 0.1 M solution of NaF will be**

Option A  $5.3 \times 10^{-10} \text{ mol L}^{-1}$

Option B  $5.3 \times 10^{-11} \text{ mol L}^{-1}$

Option C  $5.3 \times 10^{-8} \text{ mol L}^{-1}$

Option D  $5.3 \times 10^{-9} \text{ mol L}^{-1}$

**Correct Option D**

**Solution:**  $K_{sp}$  of  $\text{CaF}_2 = 5.3 \times 10^{-11}$



$t = 0, \quad 0 \quad 0.1$

At eq.  $s \quad s + 0.1 \approx 0.1$

$K_{sp}$  is calculated by-

$$K_{sp} = [\text{Ca}^{2+}][\text{F}^-]^2 = (s)(0.1)^2$$

$$s = \frac{K_{sp}}{(0.1)^2} = \frac{5.3 \times 10^{-11}}{(0.1)^2} = 5.3 \times 10^{-9} \text{ mol L}^{-1}$$

**Q 40. The oxidation state of Cr in  $\text{CrO}_6$  is**

Option A +4

Option B -6

Option C +12

Option D +6

**Correct Option D**

**Solution:** The most appropriate oxidation state of Cr in  $\text{CrO}_6$  is +6 although  $\text{CrO}_6$  has doubtful existence.

**Q 41. The number of hydrogen bonded water molecule(s) associated with  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  is**

Option A 5

Option B 3

Option C 1

Option D 2

**Correct Option C**

**Solution:** The actual structure of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  is  $[\text{Cu}(\text{H}_2\text{O})_4]\text{SO}_4 \cdot \text{H}_2\text{O}$ , so only one water molecule is associated with the molecule via hydrogen bond. Other 4  $\text{H}_2\text{O}$  molecule are bound with coordination bond.

**Q 42. Formula of nickel oxide with metal deficiency defect in its crystal is  $\text{Ni}_{0.98}\text{O}$ . The crystal contains  $\text{Ni}^{2+}$  and  $\text{Ni}^{3+}$  ions. The fraction of nickel existing as  $\text{Ni}^{2+}$  ions in the crystal is**

Option A 0.31

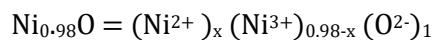
Option B 0.96

Option C 0.04

Option D 0.50

**Correct Option B**

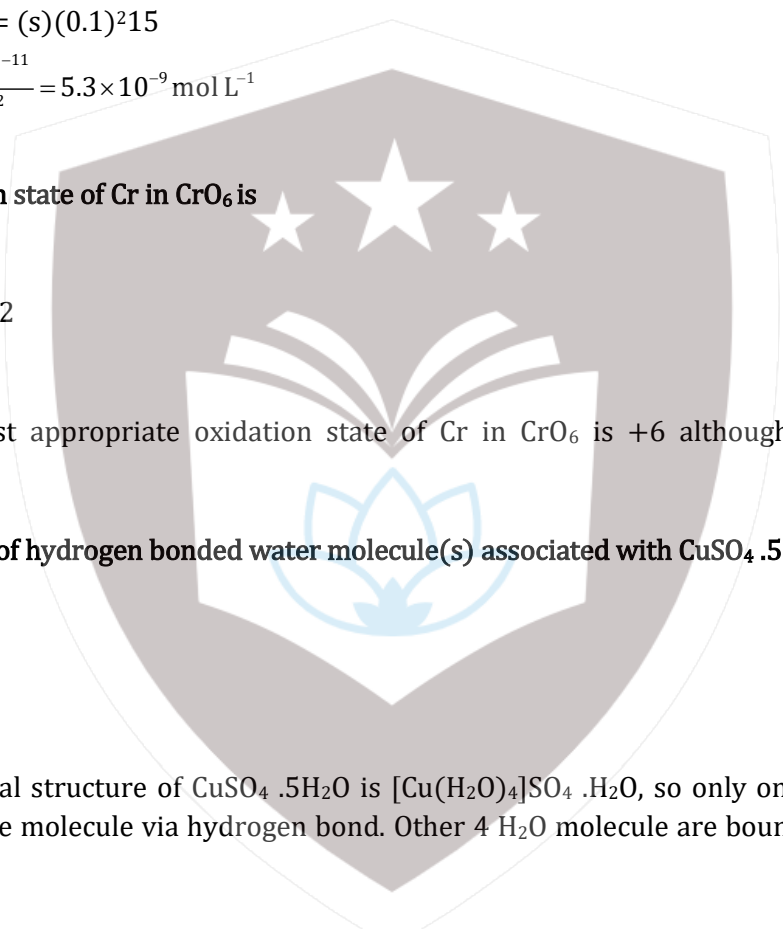
**Solution:**



Net charge = 0

$$[x \times 2] + [(0.98 - x) 3+] [-2 \times 1] = 0$$

$$x = 0.94$$



Fraction of nickel existing as-

$$\text{Ni}^{2+} = \frac{0.94}{0.98} = 0.959 \simeq 0.96$$

**Q 43. Which of the following statements is correct regarding a solution of two components A and B exhibiting positive deviation from ideal behaviour?**

- Option A Intermolecular attractive forces between A-A and B-B are equal to those between A-B.  
Option B Intermolecular attractive forces between A-A and B-B are stronger than those between A-B.  
Option C  $\Delta_{\text{mix}}H = 0$  at constant T and P.  
Option D  $\Delta_{\text{mix}}V = 0$  at constant T and P.

**Correct Option B**

**Solution:** Solution exhibiting positive deviation from ideal behaviour must have weaker A - B interactions than A - A and B - B interactions.

**Q 44. In water saturated air, the mole fraction of water vapour is 0.02. If the total pressure of the saturated air is 1.2 atm, the partial pressure of dry air is**

- Option A 0.98 atm  
Option B 1.18 atm  
Option C 1.76 atm  
Option D 1.176 atm

**Correct Option D**

**Solution:** Mole fraction of water vapour = 0.02

Mole fraction of dry air =  $1 - 0.02 = 0.98$

Total pressure of saturated air = 1.2 atm

Using Dalton's law of partial pressure,

$$\begin{aligned} P_{\text{Dry air}} &= P_{\text{Total}} \times X_{\text{Dry air}} = 1.2 \times 0.98 \\ &= 1.176 \text{ atm} \end{aligned}$$

**Q 45. The standard electrode potential ( $E^\ominus$ ) values of  $\text{Al}^{3+}/\text{Al}$ ,  $\text{Ag}^+/\text{Ag}$ ,  $\text{K}^+/\text{K}$  and  $\text{Cr}^{3+}/\text{Cr}$  are  $-1.66 \text{ V}$ ,  $0.80 \text{ V}$ ,  $-2.93 \text{ V}$  and  $-0.74 \text{ V}$ , respectively. The correct decreasing order of reducing power of the metal is**

- Option A  $\text{Al} > \text{K} > \text{Ag} > \text{Cr}$   
Option B  $\text{Ag} > \text{Cr} > \text{Al} > \text{K}$   
Option C  $\text{K} > \text{Al} > \text{Cr} > \text{Ag}$   
Option D  $\text{K} > \text{Al} > \text{Ag} > \text{Cr}$

**Correct Option B**

**Solution:** Lesser is the reduction potential greater is the reducing power.

Reduction Potential:  $\text{Ag}^+/\text{Ag} > \text{Cr}^{3+}/\text{Cr} > \text{Al}^{3+}/\text{Al} > \text{K}^+/\text{K}$

Reducing Power :  $\text{K} > \text{Al} > \text{Cr} > \text{Ag}$



# BIOLOGY

**Q 46. A selectable marker is used to:**

- Option A Mark a gene on a chromosome for isolation using restriction enzyme  
Option B Help in eliminating the non-transformants, so that the transformants can be regenerated  
Option C Identify the gene for a desired trait in an alien organism  
Option D Select a suitable vector for transformation in a specific crop

**Correct Option B**

**Solution:** Selectable markers help in identification and elimination of non-transformants whilst permitting selective growth of transformants.

**Q 47. Western Ghats have a large number of plant and animal species that are not found anywhere else. Which of the following terms will you use to notify such species?**

- Option A Keystone  
Option B Endemic  
Option C Vulnerable  
Option D Threatened

**Correct Option B**

**Solution:** Endemic species are those species that are confined to a particular region only and not found anywhere else.

**Q 48. Which of the following statements about ozone is correct?**

- Option A Stratospheric ozone protects us from UV radiations  
Option B Tropospheric ozone protects us from UV radiations  
Option C Stratospheric ozone is 'bad'  
Option D Tropospheric ozone is 'good'

**Correct Option A**

**Solution:** Ozone, in our atmosphere is found in two layers:

1. Stratosphere – good ozone, protects us from UV radiations
2. Troposphere – bad ozone, considered as a pollutant.

**Q 49. Exploration of molecular, genetic and species level diversity for novel products of economic importance is known as:**

- Option A Bioprospecting  
Option B Biopiracy  
Option C Bioenergetics  
Option D Bioremediation

**Correct Option A**

**Solution:** Bioprospecting refers to exploring molecular, genetic and species level diversity for products of economic importance.

**Q 50. Which of the following is an innovative remedy for plastic waste?**

- Option A Electrostatic precipitator  
Option B Burning in the absence of oxygen  
Option C Burying 500 m deep below soil surface

Option D Polyblend

**Correct Option D**

**Solution:**

Polyblend is an innovative remedy for plastic waste. Polyblend is a fine powder of recycled plastic waste which after mixing with bitumen, is used to lay roads.

**Q 51. Between which among the following, the relationship is not an example of commensalism?**

Option A Female wasp and fig species

Option B Orchid and the tree on which it grows

Option C Cattle Egret and grazing cattle

Option D Sea Anemone and Clown fish

**Correct Option A**

**Solution:** Female wasp and fig species show mutualism. Orchid and the tree on which it grows, cattle egret and grazing cattle, and sea anemone and clown fish show commensalism.

**Q 52. If an agricultural field is liberally irrigated for a prolonged period of time, it is likely to face a problem of :**

Option A Salinity

Option B Metal toxicity

Option C Alkalinity

Option D Acidity

**Correct Option A**

**Solution:** Irrigation of agricultural field for a prolonged time without proper drainage leads to waterlogging in the soil. Waterlogging draws salt to the surface of the soil and causes salinity.

**Q 53. Which of the following statements about methanogens is not correct?**

Option A They produce methane gas

Option B They can be used to produce biogas

Option C They are found in the rumen of cattle and their excreta

Option D They grow aerobically and breakdown cellulose-rich food

**Correct Option D**

**Solution:** Methanogens are anaerobic chemoautotrophs. They grow in anaerobic conditions and breakdown cellulose rich food.

**Q 54. In mung bean, resistance to yellow vein mosaic virus and powdery mildew were brought about by:**

Option A Hybridization and selection

Option B Mutation breeding

Option C Bio fortification

Option D Tissue culture

**Correct Option B**

**Solution:** In mung bean, resistance to yellow vein mosaic virus and powdery mildew were induced by mutations.

**Q 55. Coca alkaloid or cocaine is obtained from:**

Option A *Datura*

Option B *Panaver somniferum*

Option C *Atropa belladonna*

Option D *Erythroxylum coca*

**Correct Option D**

**Solution:** Coca alkaloids or cocaine is obtained from, *Erythroxylum coca*, a native to South America.

**Q 56. Among the following pairs of microbes, which pair has both the microbes that can be used as biofertilizers?**

Option A *Aspergillus and Cyanobacteria*

Option B *Aspergillus and Rhizopus*

Option C *Rhizobium and Rhizopus*

Option D *Cyanobacteria and Rhizobium*

**Correct Option D**

**Solution:** Cyanobacteria like *Anabaena*, *Nostoc* etc. and *Rhizobium* are able to fix atmospheric nitrogen and act as biofertilizers. *Rhizopus* and *Aspergillus* are used in the production of other compounds of human benefit.

**Q 57. Given below are four statements pertaining to separation of DNA fragments using Gel electrophoresis. Identify the incorrect statements.**

(a) DNA is negatively charged molecule and so it is loaded on gel towards the Anode terminal.

(b) DNA fragments travel along the surface of the gel whose concentration does not affect movement of DNA.

(c) Smaller the size of DNA fragment, larger is the distance it travels through it.

(d) Pure DNA can be visualized directly by exposing to UV radiation.

**Choose correct answer from the options given below:**

Option A (a), (b) and (d)

Option B (a), (c) and (d)

Option C (a), (b) and (c)

Option D (b), (c) and (d)

**Correct Option A**

**Solution:**

- DNA fragments are negatively charged molecules separated by forcing them to move towards positive electrode i.e. anode.
- Increasing the concentration of a gel reduces the migration speed of DNA.
- Smaller the fragment size, farther the DNA moves from the point of loading i.e. the well.
- DNA fragment can only be visualised under UV light after staining with ethidium bromide and not directly.

**Q 58. An enzyme catalysing the removal of nucleotides from the ends of DNA is :**

Option A Protease

Option B DNA ligase

Option C Endonuclease

Option D Exonuclease

**Correct Option D**

**Solution:** Restriction enzymes belong to a larger class of enzymes called nucleases. Nucleases are of two different kinds:

(1) Exonucleases which remove nucleotides from the end of a DNA molecule.

- (2) Endonucleases, which break internal phosphodiester bonds at palindromic sites that are highly specific.
- (3) DNA ligase helps in ligating/joining DNA fragments.

**Q 59. In RNAi, the genes are silenced using:**

- Option A ds - DNA  
 Option B ds - RNA  
 Option C ss - DNA  
 Option D ss - RNA

**Correct Option B**

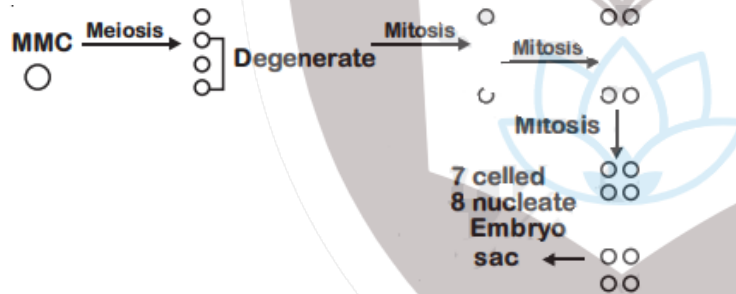
**Solution:** RNAi involves silencing of a specific mRNA and therefore the expression of a gene by formation of a dsRNA molecule. The dsRNA which is formed by binding of a complementary RNA (anti-sense RNA) molecule to original mRNA thereby preventing translation of the original mRNA

**Q 60. Which is the most common type of embryo sac in angiosperms?**

- Option A Bisporic with two sequential mitotic divisions  
 Option B Tetrasporic with one mitotic stage of divisions  
 Option C Monosporic with three sequential mitotic divisions  
 Option D Monosporic with two sequential mitotic divisions

**Correct Option C**

**Solution:** Monosporic embryo sac is the most common type of embryo sac in flowering plants which develops after one meiosis and three sequential mitosis in megaspore mother cell.



**Q 61. From the following, identify the correct combination of salient features of Genetic Code -**

- Option A Degenerate, Non-overlapping, Non-ambiguous  
 Option B Universal, Non-ambiguous, Overlapping  
 Option C Degenerate, Overlapping, Commaless  
 Option D Universal, Ambiguous, Degenerate

**Correct Option A**

**Solution:** Genetic code is universal, non-ambiguous, non-overlapping and degenerate in nature.

**Q 62. Which scientist experimentally proved that DNA is the sole genetic material in bacteriophage?**

- Option A Jacob and Monod  
 Option B Beadle and Tatum  
 Option C Meselson and Stahl  
 Option D Hershey and Chase

**Correct Option D**

**Solution:** A. Hershey and M. Chase using radiolabelled sulphur and phosphorus in bacteriophage, proved that DNA is the genetic material.

**Q 63. In the process of transcription in Eukaryotes, the RNA polymerase I transcribes -**

- Option A Precursor of mRNA, hnRNA
- Option B mRNA with additional processing, capping and tailing
- Option C tRNA, 5s rRNA and snRNAs
- Option D rRNAs – 28S, 18S and 5.8S

**Correct Option D**

**Solution:** During transcription in eukaryotes, RNA polymerase I transcribes 5.8S, 18S and 28S rRNA.

**Q 64. In which genetic condition, each cell in the affected person, has three sex chromosomes XXY?**

- Option A Turner's syndrome
- Option B Thalassemia
- Option C Klinefelter's syndrome
- Option D Phenylketonuria

**Correct Option C**

**Solution:** Klinefelter's syndrome is caused due to the presence of an additional copy of X-chromosome resulting into 44 + XXY type chromosome complement.

**Q 65. What initiation and termination factors are involved in transcription in Eukaryotes?**

- Option A  $\alpha$  and  $\sigma$ , respectively
- Option B  $\sigma$  and  $\rho$ , respectively
- Option C  $\alpha$  and  $\beta$ , respectively
- Option D  $\beta$  and  $\gamma$ , respectively

**Correct Option B**

**Solution:** Initiation and termination factors involved in transcription in eukaryotes are  $\sigma$  and  $\rho$ , respectively.

**Q 66. Which of the following statements is correct about the origin and evolution of men?**

- Option A Neanderthal men lived in Asia between 1,00,000 and 40,000 years back.
- Option B Agriculture came around 50,000 years back.
- Option C *Dryopithecus* and *Ramapithecus* primates existing 15 million years ago, walked like men.
- Option D *Homo habilis* probably ate meat.

**Correct Option A**

**Solution:**

- Agriculture began around 10,000 years back and human settlements started.
- *Homo habilis* probably did not eat meat.
- *Dryopithecus* and *Ramapithecus* primates existing 15 million years ago were hairy and walked like gorillas and chimpanzees.

**Q 67. The production of gametes by the parents, the formation of zygotes, the F<sub>1</sub> and F<sub>2</sub> plants, can be understood using**

- Option A Venn diagram
- Option B Pie diagram
- Option C A pyramid diagram
- Option D Punnet square

**Correct Option D**

**Solution:** With the help of Punnett square, the production of gametes, the formation of zygotes and the  $F_1$  and  $F_2$  plants can be understood.

**Q 68. In Hatch and Slack pathway, the primary  $CO_2$  acceptor is**

- Option A Rubisco
- Option B Oxaloacetic acid
- Option C Phosphoglyceric acid
- Option D Phosphoenol pyruvate

**Correct Option D**

**Solution:** PEP (Phosphoenol pyruvate) is the primary  $CO_2$  acceptor in  $C_4$  or Hatch and Slack pathway.

**Q 69. Removal of shoot tips is a very useful technique to boost the production of tea leaves. This is because:**

- Option A Gibberellins delay senescence of leaves.
- Option B Gibberellins prevent bolting and are inactivated.
- Option C Auxins prevent leaf drop at early stages.
- Option D Effect of auxins is removed and growth of lateral buds is enhanced.

**Correct Option D**

**Solution:** Auxins shows apical dominance. Elimination of auxins by the removal of shoot tips prevents apical dominance and promotes growth of lateral buds which is very useful in tea leaves production.

**Q 70. One scientist cultured *Cladophora* in a suspension of *Azotobacter* and illuminated the culture by splitting light through a prism. He observed that bacteria accumulated mainly in the region of:**

- Option A Blue and red light
- Option B Violet and green light
- Option C Indigo and green light
- Option D Orange and yellow light

**Correct Option A**

**Solution:** *Azotobacter* is an aerobic bacterium. *Cladophora* is a green alga. T.W. Engelmann split light into its spectral components and detected that aerobic bacteria accumulated mainly in the region of blue and red light of the split spectrum.

**Q 71. In order to increase the yield of sugarcane crop, which of the following plant growth regulators should be sprayed?**

- Option A Cytokinins
- Option B Ethylene
- Option C Auxins
- Option D Gibberellins

**Correct Option D**

**Solution:** Gibberellins show bolting. When gibberellin is sprayed on sugarcane crop, the length of the stem increases.

**Q 72. What type of pollination takes place in *Vallisneria*?**

- Option A Male flowers are carried by water currents to female flowers at surface of water.
- Option B Pollination occurs in submerged condition by water.
- Option C Flowers emerge above surface of water and pollination occurs by insects.

Option D      Flowers emerge above water surface and pollen is carried by wind.

**Correct Option A**

**Solution:** *Vallisneria* shows *epihydrophily*. Male flowers after breakage, float on the surface of water and reach the female flowers.

**Q 73. In which one of the following, both autogamy and geitonogamy are prevented?**

Option A      Maize

Option B      Wheat

Option C      Papaya

Option D      Castor

**Correct Option C**

**Solution:** Papaya is a dioecious plant in which male and female flowers are produced on two separate plants. Hence, it prevents both autogamy as well as geitonogamy. Castor and maize are monoecious and unisexual. Wheat is monoecious and bisexual.

**Q 74. Match the placental types (column-I) with their examples (column-II).**

Column-I	Column-II
(a) Basal	i. Mustard
(b) Axile	ii. China rose
(c) Parietal	iii. Dianthus
(d) Free central	iv. Sunflower

**Choose the correct answer from the following options:**

Option A      (a)-(iii), (b)-(iv), (c)-(i), (d)-(ii)

Option B      (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)

Option C      (a)-(i), (b)-(ii), (c)-(iii), (d)-(iv)

Option D      (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)

**Correct Option D**

**Solution:**

Basal placentation: Sunflower

Axile placentation: China rose

Parietal placentation: Mustard

Free central placentation: Dianthus

**Q 75. Match the column I with column II.**

Column I	Column II
(a) Golgi apparatus	(i) Synthesis of protein
(b) Lysosomes	(ii) Trap waste and excretory products
(c) Vacuoles	(iii) Formation of glycoproteins and glycolipids
(d) Ribosomes	(iv) Digesting biomolecules

**Choose the right match from options given below:**

Option A      (a)-(i), (b)-(ii), (c)-(iv), (d)-(iii)

Option B      (a)-(iii), (b)-(iv), (c)-(ii), (d)-(i)

Option C      (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)

Option D      (a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)

**Correct Option B**

**Solution:**

- (a) Golgi apparatus - (iii) Formation of glycoproteins and glycolipids
- (b) Lysosomes - (iv) Digesting biomolecules
- (c) Vacuoles - (ii) Trap waste and excretory products
- (d) Ribosomes - (i) Synthesis of protein

**Q 76. Prosthetic groups differ from co-enzymes in that-**

- Option A They can serve as co-factors in a number of enzyme - catalyzed reactions
- Option B They require metal ions for their activity
- Option C They (prosthetic groups) are tightly bound to apoenzymes
- Option D Their association with apoenzymes is transient

**Correct Option C**

**Solution:** Prosthetic groups are organic compounds that are tightly bound to the apoenzyme. Coenzymes are associated with the apoenzyme but only for a short period of time i.e. transiently.

**Q 77. Crossing over takes place between which chromatids and in which stage of the cell cycle?**

- Option A Non-sister chromatids of non-homologous chromosomes at Pachytene stage of prophase I
- Option B Non-sister chromatids of non-homologous chromosomes at Zygotene stage of prophase I
- Option C Non-sister chromatids of homologous chromosomes at Pachytene stage of prophase I
- Option D Non-sister chromatids of homologous chromosomes at Zygotene stage of prophase I

**Correct Option C**

**Solution:** Crossing over takes place between non-sister chromatids of homologous chromosomes during the pachytene stage of prophase I.

**Q 78. "Ramachandran plot" is used to confirm the structure of**

- Option A DNA
- Option B RNA
- Option C Proteins
- Option D Triacylglycerides

**Correct Option C**

**Solution:** "Ramachandran plot" is used to confirm the structure of proteins. Ramachandran plot, is a way to visualize energetically allowed regions for backbone dihedral angles  $\psi$  against  $\phi$  of amino acid residues to protein structure.

**Q 79. Which of the following is not a feature of active transport of solutes in plants?**

- Option A Requires ATP
- Option B Occurs against concentration gradient
- Option C Non-selective
- Option D Occurs through membranes

**Correct Option C**

**Solution:** Active transport is uphill transport which requires membrane proteins and ATP. It is highly selective.

**Q 80. Which of the following bacteria reduce nitrate in soil into nitrogen?**

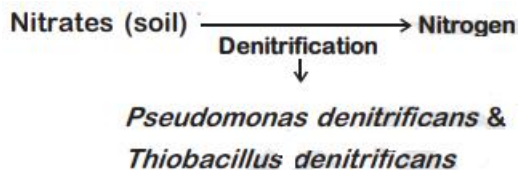
- Option A *Nitrosomonas*
- Option B *Nitrobacter*



- Option C *Nitrococcus*  
Option D *Thiobacillus*

**Correct Option D**

**Solution:**



**Q 81. What will be the direction of flow of water when a plant cell is placed in a hypotonic solution?**

- Option A No flow of water in any direction  
Option B Water will flow in both directions  
Option C Water will flow out of the cell  
Option D Water will flow into the cell

**Correct Option D**

**Solution:** When a plant cell is placed in a hypotonic solution, water will flow into the cell as water moves from high water potential to low water potential.

**Q 82. Where is the respiratory electron transport system (ETS) located in plants?**

- Option A Intermembrane space  
Option B Mitochondrial matrix  
Option C Outer mitochondrial membrane  
Option D Inner mitochondrial membrane

**Correct Option D**

**Solution:** Electron transport system is located in the inner mitochondrial membrane.

**Q 83. Which of the following is against the rules of ICBN?**

- Option A Generic and specific names should be written starting with small letters.  
Option B Hand written scientific names should be underlined.  
Option C Every species should have a generic name and a specific epithet.  
Option D Scientific names are in Latin and should be italicized.

**Correct Option A**

**Solution:** The first word denoting the genus starts with a capital letter while the specific epithet starts with a small letter.

**Q 84. Mad cow disease in cattle is caused by an organism which has:**

- Option A Free DNA without protein coat  
Option B Inert crystalline structure  
Option C Abnormally folded protein  
Option D Free RNA without protein coat

**Correct Option C**

**Solution:** Mad cow disease in cattle is caused by prions. Prions are disease-causing agents having abnormally folded proteins.

**Q 85. Which of the following statements is correct?**

- Option A Lichens are not good pollution indicators.  
Option B Lichens do not grow in polluted areas.  
Option C Algal component of lichens is called mycobiont  
Option D Fungal component of lichens is called phycobiont.

**Correct Option B**

**Solution:** Lichens are very good pollution indicators. They do not grow in polluted areas.

**Q 86. Match the organisms in column I with habitats in column II.**

Column-I	Column-II
(a) Halophiles	(i) Hot springs
(b) Thermoacidophiles	(ii) Aquatic environment
(c) Methanogens	(iii) Guts of ruminants
(d) Cyanobacteria	(iv) Salty areas

**Select the correct answer from the options given below:**

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

**Correct Option B**

**Solution:**

- Halophiles live in salty areas.
- Thermoacidophiles are present in hot springs.
- Methanogens are present in the gut of several ruminants.
- Cyanobacteria can be present in freshwater/ marine or terrestrial habitat.

**Q 87. In the dicot root vascular cambium originates from:**

- Option A Intrafascicular and interfascicular tissue in a ring  
Option B Tissue located below the phloem bundles and a portion of pericycle tissue above protoxylem.  
Option C Cortical region  
Option D Parenchyma between endodermis and

**Correct Option B**

**Solution:** Vascular cambium is a secondary meristematic tissue, in dicot roots. It originates from the tissue located below the phloem bundles and a portion of pericycle tissue above the protoxylem.

**Q 88. Which of the following shows whorled phyllotaxy?**

- Option A *Calotropis*  
Option B Mustard  
Option C China rose  
Option D *Alstonia*

**Correct Option D**

**Solution:** In whorled phyllotaxy, more than two leaves arise at each node and form a whorl or a circle. *Alstonia* shows whorled phyllotaxy.

**Q 89. Regeneration of damaged growing grass following grazing is largely due to:**

- Option A Secondary meristem
- Option B Lateral meristem
- Option C Apical meristem
- Option D Intercalary meristem

**Correct Option D**

**Solution:** Intercalary meristems are found in grasses, where they help to regenerate the parts removed by the grazing herbivores.

**Q 90. Bicarpellary ovary with obliquely placed septum is seen in:**

- Option A *Sesbania*
- Option B *Brassica*
- Option C *Aloe*
- Option D *Solanum*

**Correct Option D**

**Solution:** Bicarpellary ovary with obliquely placed septum is seen in the members of family Solanaceae, e.g. *Solanum*.

**Q 91. Select the incorrect statement regarding inbreeding.**

- Option A Inbreeding depression cannot be overcome by out-crossing
- Option B Inbreeding helps in elimination of deleterious alleles from the population
- Option C Inbreeding is necessary to evolve a pure line in any animal
- Option D Continued inbreeding reduces fertility and leads to inbreeding depression

**Correct Option A**

**Solution:** A single outcross often helps to overcome inbreeding depression. Inbreeding increases homozygosity and close inbreeding usually reduces fertility and even productivity causing inbreeding depression.

**Q 92. A biocontrol agent to be a part of an integrated pest management should be**

- Option A Species-specific and inactive on non-target organisms
- Option B Species-specific and symbiotic
- Option C Free living and broad spectrum
- Option D Narrow spectrum and symbiotic

**Correct Option A**

**Solution:** A good biocontrol agent should be species-specific and inactive on non-target organisms.

**Q 93. Match the following enzymes with their functions:**

a) Restriction endonuclease	(i) Joins the DNA fragments
b) Restriction exonuclease	(ii) Extends primers on genomic DNA template
c) DNA ligase	(iii) Cuts DNA at specific position
d) <i>Taq</i> polymerase	(iv) Removes nucleotides from the ends of DNA

**Select the correct option from the following:**

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

**Correct Option C**

**Solution:**

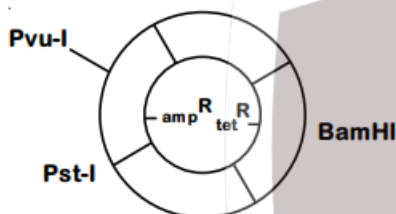
- a. Restriction endonuclease: Cuts DNA at specific position
- b. Restriction exonuclease: Removes nucleotides from the ends of DNA
- c. DNA ligase: Joins the DNA fragments
- d. Taq polymerase: Extends primers on genomic DNA template

**Q 94. The two antibiotic resistance genes on vector pBR322 are for**

- Option A Tetracycline and Kanamycin
- Option B Ampicillin and Tetracycline
- Option C Ampicillin and Chloramphenicol
- Option D Chloramphenicol and Tetracycline

**Correct Option B**

**Solution:** *E. Coli* cloning vector pBR322 contains antibiotic resistance genes for Ampicillin and Tetracycline.



**Q 95. Exploitation of bioresources of a nation by multinational companies without authorization from the concerned country is referred to as**

- Option A Biowar
- Option B Bioweapon
- Option C Biopiracy
- Option D Bioethics

**Correct Option C**

**Solution:** Biopiracy is the term used to refer to the use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment. In biowar/warfare disease-producing microorganism, toxins, or organic biocides e.g. *Bacillus anthracis* or *Yersinia pestis* are used to destroy, injure or immobilize livestock, vegetation, or human life. Bioweapon involves the use of biological toxins or infectious agents such as bacteria, viruses and fungi with the intent to kill human, animal or plant. Bioethics is the study of the ethical issues emerging from advances in biology and medicine.

**Q 96. Carnivorous animals - lions and leopards, occupy the same niche but lions predate mostly larger animals and leopards take smaller ones. This mechanism of competition is referred to as-**

- Option A Competitive exclusion
- Option B Character displacement
- Option C Altruism
- Option D Resource partitioning

**Correct Option D**

**Solution:** If two species compete for the same resource, they could avoid competition by choosing, for instance different times for feeding or different foraging patterns. Such mechanism is called resource partitioning.

**Q 97. Decline in the population of Indian native fishes due to introduction of *Clarias gariepinus* in river Yamuna can be categorised as**

- Option A Alien species invasion
- Option B Co-extinction
- Option C Habitat fragmentation
- Option D Over exploitation

**Correct Option A**

**Solution:** Introduction of the African catfish *Clarias gariepinus* for aquaculture purposes has become a threat to indigenous catfishes in our rivers. *Clarias gariepinus* is an alien species for the communities in Yamuna.

**Q 98. Match the following RNA polymerases with their transcribed products:**

a) RNA polymerase I	(i) tRNA
b) RNA polymerase II	(ii) rRNA
c) RNA polymerase III	(iii) hnRNA

**Select the correct option from the following :**

- Option A (a)-(iii), (b)-(ii), (c)-(i)
- Option B (a)-(i), (b)-(iii), (c)-(ii)
- Option C (a)-(i), (b)-(ii), (c)-(iii)
- Option D (a)-(ii), (b)-(iii), (c)-(i)

**Correct Option D**

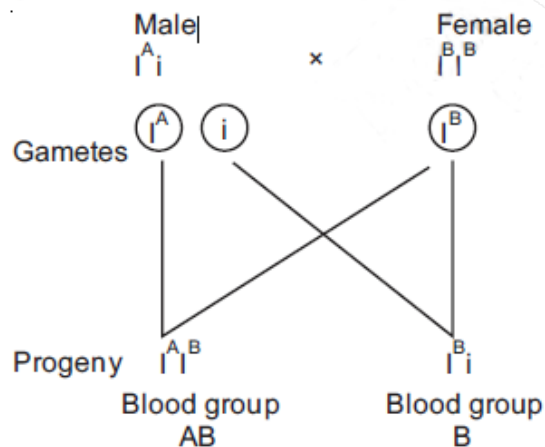
**Solution:** In eukaryotes, there are three types of RNA polymerases. RNA polymerase I transcribes rRNAs, RNA polymerase II transcribes hnRNAs, and RNA polymerase III transcribes tRNAs.

**Q 99. In a marriage between male with blood group A and female with blood group B, the progeny had either blood group AB or B. What could be the possible genotype of parents?**

- Option A  $I^A i$  (Male) ;  $I^B i$  (Female)
- Option B  $I^A i$  (Male) ;  $I^B I^B$  (Female)
- Option C  $I^A I^A$  (Male) ;  $I^B I^B$  (Female)
- Option D  $I^A I^A$  (Male) ;  $I^B i$  (Female)

**Correct Option B**

**Solution:** Male with blood group A can have genotype  $I^A i$  or  $I^A I^A$ . Female with blood group B can have genotype  $I^B I^B$ , or  $I^B i$



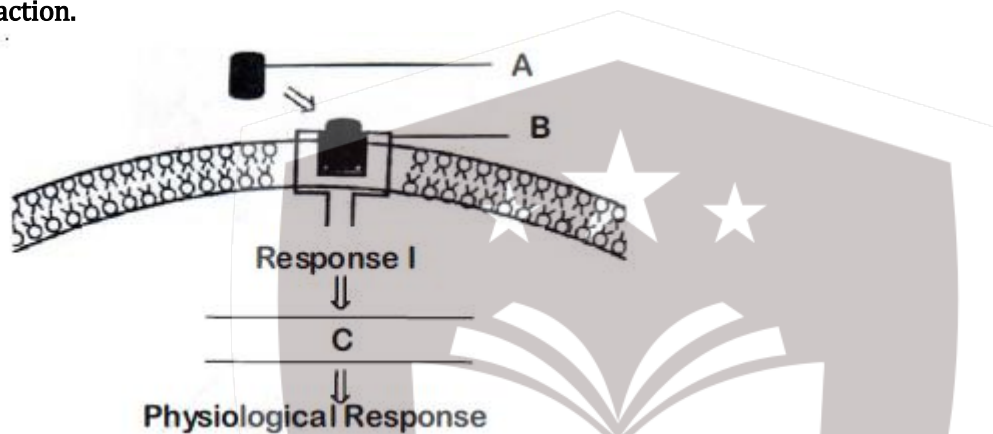
**Q 100. A population of a species invades a new area. Which of the following condition will lead to Adaptive Radiation?**

- Option A Area with many habitats occupied by a large number of species.
- Option B Area with large number of habitats having very low food supply.
- Option C Area with a single type of vacant habitat
- Option D Area with many types of vacant habitats.

**Correct Option D**

**Solution:** When a population of a species invades a new area with many types of vacant habitats, they face different environmental pressures and eventually adapt exhibiting adaptive radiation.

**Q 101. Identify A, B and C in the diagrammatic representation of the mechanism of hormone action.**



**Select the correct option from the following :**

- Option A A = Protein Hormone; B = Cyclic AMP; C = Hormone-receptor Complex
- Option B A = Steroid Hormone; B = Hormone receptor Complex; C = Protein
- Option C A = Protein Hormone; B = Receptor C = Cyclic AMP
- Option D A = Steroid Hormone; B = Receptor; C = Second Messenger

**Correct Option C**

**Solution:** 'A' is a hormone such as FSH that cannot cross lipid bilayer therefore it interacts with the membrane-bound receptors and does not enter the target cell, but generates second messengers. Peptide, polypeptide, protein hormones and catecholamines act through this mechanism.

'B' represents the extracellular receptors present on the cell surface that forms a hormone-receptor complex which brings about conformational changes in the cytoplasmic part of the receptor. This cytoplasmic part can produce second messengers such as  $Ca^{+2}$ , cAMP,  $IP_3$  etc. which activates the existing enzyme system of the cell and accelerates the biochemical reactions in the cell.

'C' represents the second messenger.

**Q 102. Humans have acquired immune system that produces antibodies to neutralize pathogens. Still innate immune system is present at the time of birth because it**

- Option A provides passive immunity
- Option B is very specific and uses different macrophages.
- Option C produces memory cells for mounting fast secondary response.
- Option D has natural killer cells which can phagocytose and destroy microbes

**Correct Option D**

**Solution:** Innate immunity is non-specific and is accomplished by providing different types of barriers to the entry of foreign agent or any pathogen into our body. Passive immunity is specific and is a

branch of humoral immunity. Natural killer cells are a type of lymphocytes which will produce proteins called perforins that create pores on plasma membrane of tumor cells and virally infected cells through which ECF enters and kill the cells. Innate immunity does not produce memory cells hence, no secondary immune response is seen.

**Q 103. Select the correct sequence of events.**

- Option A Gametogenesis → Gamete transfer → Syngamy → Zygote → Cell differentiation → Cell division (Cleavage) → Organogenesis.
- Option B Gametogenesis → Gamete transfer → Syngamy → Zygote → Cell division (Cleavage) → Cell differentiation → Organogenesis.
- Option C Gametogenesis → Gamete transfer → Syngamy → Zygote → Cell division → (Cleavage) → Organogenesis → Cell differentiation.
- Option D Gametogenesis → Syngamy → Gamete transfer → Zygote → Cell division (Cleavage) → Cell differentiation → Organogenesis.

**Correct Option B**

**Solution:** Gametogenesis → Gamete transfer → Syngamy → Zygote → Cell division (Cleavage) → Cell differentiation → Organogenesis  
⇒ Gametogenesis → Formation of gametes  
⇒ Gamete transfer → Insemination  
⇒ Syngamy → Fusion of gametes and leading to the formation of zygote  
⇒ Cleavage → Repeated cell division  
⇒ Cell differentiation → Specialization of cell to perform specific function.  
⇒ Organogenesis → Formation of organs

**Q 104. Which of the following hormones is responsible for both the milk ejection reflex and the foetal ejection reflex?**

- Option A Relaxin  
Option B Estrogen  
Option C Prolactin  
Option D Oxytocin

**Correct Option D**

**Solution:** Foetal ejection reflex triggers release of oxytocin from the maternal anterior pituitary gland. Oxytocin acts on the uterine muscles and causes stronger uterine contractions. Milk ejection reflex is caused by combined neurogenic and hormonal reflexes that involve release of oxytocin from posterior pituitary gland.

**Q 105. No new follicles develop in the luteal phase of the menstrual cycle because:**

- Option A Both FSH and LH levels are low in the luteal phase.  
Option B Follicles do not remain in the ovary after ovulation.  
Option C FSH levels are high in the luteal phase.  
Option D LH levels are high in the luteal phase.

**Correct Option A**

**Solution:** Ovulation is followed by the luteal phase during which the corpus luteum secretes estrogen and progesterone that exerts negative feedback on hypothalamus which in turn inhibits the release of FSH and LH. This prevents the development of new follicles during the luteal phase.

Q 106. In Australia, marsupials and placental mammals have evolved to share many similar characteristics. This type of evolution may be referred to as

- Option A Convergent Evolution
- Option B Adaptive Radiation
- Option C Divergent Evolution
- Option D Cyclical Evolution

**Correct Option A**

**Solution:** In Australia, marsupials and placental mammals have evolved to share many similar characteristics. This type of evolution may be referred to as convergent evolution. Many placental mammals resemble the marsupial mammals not only in structure but also in leading similar ways of life. These similarities in these two different types of mammals (Marsupials and placentals) w.r.t. ancestors are due to living in the similar ecological niches. Hence, when two different types of organisms converge towards functional similarity, one can conclude that convergent evolution has occurred.

Q 107. Match the items of Column-I with Column-II :

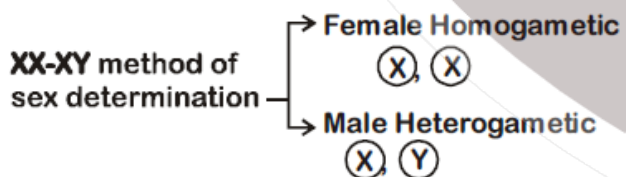
Column-I	Column-II
(a) XX-XO method	(i) Turner's of Sex Syndrome Determination
(b) XX-XY method	(ii) Female of Sex Heterogametic Determination
(c) Karyotype-45	(iii) Grasshopper
(d) ZW-ZZ method	(iv) Female of Sex homogametic Determination

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

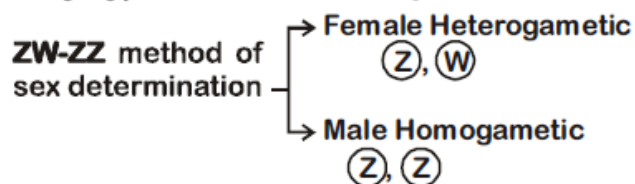
**Correct Option D**

**Solution:**

**XX-XO type sex determination- Grasshopper**



**Karyotype-45 — Turner's syndrome**



Q 108. What will be the sequence of mRNA produced by the following stretch of DNA?

3' ATGCATGCATGCATG 5' TEMPLATE STRAND

5' TACGTACGTACGTAC 3' CODING STRAND

- Option A 3' AUGCAUGCAUGCAUG 3'



- Option B 3' AUGCAUGCAUGCAUG 5'  
Option C 5' UACGUACGUACGUAC 3'  
Option D 3' UACGUACGUACGUAC 5'

**Correct Option C**

**Solution:** 5' TACGTACGTACGTAC 3' (Coding strand)

5' UACGUACGUACGUAC 3' (m-RNA)

In m-RNA, uracil is present in place of thymine in coding strand.

**Q 109. Which of the following statements is not correct?**

- Option A In the knee-jerk reflex, stimulus is the stretching of muscle and response is its contraction  
Option B An action potential in an axon does not move backward because the segment behind is in a refractory phase  
Option C Depolarisation of hair cells of cochlea results in the opening of the mechanically gated potassium-ion channels  
Option D Rods are very sensitive and contribute to day light vision

**Correct Option D**

**Solution:** Cones are very sensitive to operate in day light. Rods are very sensitive in dim light. In cochlea, endolymph contains large amount of K<sup>+</sup> ions. Depolarisation of sensory hair cells present in cochlea takes place by opening of mechanical gated K<sup>+</sup> channels.

**110. Match the following joints with the bones involved:**

- |                   |  |
|-------------------|--|
| (a) Gliding joint | (i) Between carpal and metacarpal of thumb |
| (b) Hinge joint   | (ii) Between Atlas and Axis                |
| (c) Pivot joint   | (iii) Between the Carpals                  |
| (d) Saddle joint  | (iv) Between Humerus and Ulna              |

**Select the correct option from the following :**

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

**Correct Option B**

**Solution:**

Gliding joint is present between the carpals.

Hinge joint is present between humerus and ulna.

Pivot joint is present between atlas and axis.

Saddle joint is present between carpal and metacarpal of thumb.

**111. Which of the following diseases is an autoimmune disorder?**

- Option A Gout  
Option B Myasthenia gravis  
Option C Arthritis  
Option D Osteoporosis

**Correct Option B**

**Solution:** Myasthenia gravis is an autoimmune disorder that affects neuromuscular junction leading to fatigue, weakening and paralysis of skeletal muscles. Arthritis is inflammation of joints. Gout is

inflammation of joints due to accumulation of uric acid crystals. Osteoporosis is an age related disorder characterised by decreased bone mass and increased chances of fractures.

**112. Artificial light, extended work-time and reduced sleep-time disrupt the activity of –**

- Option A Posterior pituitary gland
- Option B Thymus gland
- Option C Pineal gland
- Option D Adrenal gland

**Correct Option C**

**Solution:** Artificial light, extended work time and reduced sleep-time disrupt the activity of the pineal gland. Melatonin hormone of pineal gland plays a very important role in the regulation of a 24-hours (diurnal) rhythm of our body. Melatonin helps in maintaining the normal rhythms of sleep-wake cycle and body temperature.

**Q 113. Which of the following conditions will stimulate parathyroid gland to release parathyroid hormone?**

- Option A Rise in blood  $\text{Ca}^{+2}$  levels
- Option B Fall in active Vitamin D levels
- Option C Fall in blood  $\text{Ca}^{+2}$  levels
- Option D Fall in bone  $\text{Ca}^{+2}$  levels

**Correct Option C**

**Solution:** Parathyroid hormone (PTH) is a hypercalcemic hormone. i.e. it increases the blood  $\text{Ca}^{2+}$  level. PTH acts on bones and stimulates the process of bone resorption (dissolution/demineralisation). PTH also stimulates reabsorption of  $\text{Ca}^{2+}$  by the renal tubules and increases  $\text{Ca}^{2+}$  absorption from the digested food.

**Q 114. Which of the following is a correct statement?**

- Option A IUDs suppress gametogenesis
- Option B IUDs once inserted need not be replaced
- Option C IUDs are generally inserted by the user herself
- Option D IUDs increase phagocytosis of sperms in the uterus

**Correct Option D**

**Solution:** IUDs of all types are in general treated as a foreign body thus inviting phagocytic cells to the uterus. They increase phagocytosis of sperms within the uterus and Cu ions released suppress sperm motility and the fertilising capacity of sperms. IUDs need to be inserted by an experienced nurse and have to be replaced after few years depending on copper or hormonal level.

**Q 115. Which of the following sexually transmitted diseases do not specifically affect reproductive organs?**

- Option A Chlamydia and AIDS
- Option B Genital warts and Hepatitis-B
- Option C Syphilis and Genital herpes
- Option D AIDS and Hepatitis B

**Correct Option D**

**Solution:** AIDS and Hepatitis B are sexually transmitted infections. However, they do not specifically affect the reproductive organs only. AIDS is an HIV infection affecting the immune system and opportunistic pathogens can infect various body organs. Hepatitis B affects liver. Agents causing

genital herpes, genital warts and chlamydia produce lesions on genital organs and also directly affect the reproductive system.

**Q 116. Select the correct statement.**

- Option A Expiration is initiated due to contraction of diaphragm.
- Option B Expiration occurs due to external intercostal muscles.
- Option C Intrapulmonary pressure is lower than the atmospheric pressure during inspiration.
- Option D Inspiration occurs when atmospheric pressure is less than intrapulmonary pressure.

**Correct Option C**

**Solution:** During inspiration, the diaphragm and external intercostal muscles contract causing an increase in the volume of the thoracic cage. As a result intrapulmonary pressure decreases to a level less than atmospheric pressure, causing inspiration. Expiration is initiated due to relaxation of the diaphragm.

**Q 117. The maximum volume of air a person can breathe in after a forced expiration is known as :**

- Option A Total Lung Capacity
- Option B Expiratory Capacity
- Option C Vital Capacity
- Option D Inspiratory Capacity

**Correct Option C**

**Solution:** Maximum amount of air expired by a person after forceful inspiration or inspired after forceful expiration is known as vital capacity (4600 ml). Total amount of air in the lungs at the end of forceful inspiration is known as the total lung capacity (5800 ml).

**Q 118. All the components of the nodal tissue are auto-excitabile. Why does the SA node act as the normal pacemaker?**

- Option A SA node has the highest rate of depolarisation.
- Option B SA node has the lowest rate of depolarisation.
- Option C SA node is the only component to generate the threshold potential.
- Option D Only SA node can convey the action potential to the other components.

**Correct Option A**

**Solution:** SA node acts as pace-maker of heart because its auto-excitabile tissue generates heart impulses at the highest rate (frequency).

**Q 119. A specialised nodal tissue embedded in the lower corner of the right atrium, close to Atrio-ventricular septum, delays the spreading of impulses to heart apex for about 0.1 sec. This delay allows**

- Option A the atria to empty completely.
- Option B blood to enter aorta.
- Option C the ventricles to empty completely.
- Option D blood to enter pulmonary arteries.

**Correct Option A**

**Solution:** The delay in transmission of impulse from SAN to the ventricles provided by AVN prevents simultaneous contraction of ventricles and auricles. This allows atria to empty completely before ventricles start contraction.

**Q 120. Match the following parts of a nephron with their function :**

- (a) Descending limb of Henle's loop (i) Reabsorption of salts only  
 (b) Proximal convoluted tubule (ii) Reabsorption of water only  
 (c) Ascending limb of Henle's loop (iii) Conditional reabsorption of sodium ions and water  
 (d) Distal convoluted tubule (iv) Reabsorption of ions, water and organic nutrients

Select the correct option from the following :

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

**Correct Option C**

**Solution:**

- ⇒ Descending limb of Henle's loop → Reabsorption of water only  
 ⇒ PCT → Reabsorption of ions, water organic nutrients  
 ⇒ Ascending limb of Henle's loop → Reabsorption of salts only.  
 ⇒ DCT → Conditional reabsorption of sodium ions and water

**Q 121. Match the items in Column-I with those in Column-II.**

Column-I	Column-II
(a) Podocytes	(i) Crystallised oxalates
(b) Protonephridia	(ii) Annelids
(c) Nephridia	(iii) Amphioxus
(d) Renal calculi	(iv) Filtration slits

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

**Correct Option D**

- Solution:** Podocytes → Filtration slits  
 Protonephridia → Amphioxus  
 Nephridia → Annelids  
 Renal calculi → Crystallised oxalates

**Q 122. Which of the following receptors are specifically responsible for maintenance of balance of body and posture?**

- Option A Crista ampullaris and macula  
 Option B Basilar membrane and otoliths  
 Option C Hair cells and organ of corti  
 Option D Tectorial membrane and macula

**Correct Option A**

**Solution:** Crista ampullaris → Maintains the dynamic balance of the body

Otolith organ → Consists of two structures i.e. saccule and utricle. The projecting ridge of the saccule and utricle is called macula. The otolith organ maintains the static balance of the body.

**Q 123. Which of the following cell organelles is present in the highest number in secretory cells?**

- Option A Lysosome

- Option B Mitochondria
- Option C Golgi complex
- Option D Endoplasmic reticulum

**Correct Option C**

**Solution:** The important function of Golgi apparatus is to process, package and transport materials for secretion. Therefore secretory cells have Golgi apparatus in highest number

**Q 124. Non-membranous nucleoplasmic structures in nucleus are the sites for active synthesis of**

- Option A tRNA
- Option B protein synthesis
- Option C mRNA
- Option D rRNA

**Correct Option D**

**Solution:** Nucleolus is non-membranous nucleoplasmic structure in the nucleus. Nucleolus is the site of ribosomal RNA (rRNA) synthesis.

**Q 125. Which of the following nucleic acids is present in an organism having 70 S ribosomes only?**

- Option A Double stranded circular DNA with histone proteins
- Option B Single stranded DNA with protein coat
- Option C Double stranded circular naked DNA
- Option D Double stranded DNA enclosed in nuclear membrane

**Correct Option C**

**Solution:** Organisms which have ribosomes of 70 S type are prokaryotes. Prokaryotes have double stranded circular naked DNA which is not enclosed in a membrane.

**Q 126. After meiosis I, the resultant daughter cells have**

- Option A four times the amount of DNA in comparison to haploid gamete.
- Option B same amount of DNA as in the parent cell in S phase.
- Option C twice the amount of DNA in comparison to haploid gamete.
- Option D same amount of DNA in comparison to haploid gamete.

**Correct Option C**

**Solution:** Meiosis I is reductional division, thus the resultant cell just after meiosis I will have half the number of chromosomes as compared to diploid parent cells. Therefore, if the parent cell has 4C amount of DNA the daughter cell will have 2C amount of DNA and each gamete will have 1C amount of DNA.

**Q 127. Which of the following organic compounds is the main constituent of Lecithin?**

- Option A Phosphoprotein
- Option B Arachidonic acid
- Option C Phospholipid
- Option D Cholesterol

**Correct Option C**

**Solution:** Lecithin is an example of phospholipids found in cell membrane. Casein is a phosphoprotein found in milk.

**Q 128. The main difference between active and passive transport across cell membrane is :**

- Option A active transport occurs more rapidly than passive transport.

- Option B passive transport is non-selective whereas active transport is selective.
- Option C passive transport requires a concentration gradient across a biological membrane whereas active transport requires energy to move solutes.
- Option D passive transport is confined to anionic carrier proteins whereas active transport is confined to cationic channel proteins.

**Correct Option C**

**Solution:** In active transport, materials are transported across a membrane with the help of mobile carrier proteins and ATP. In passive transport, substances move along the concentration gradient, i.e., from its higher concentration to its lower concentration.

**Q 129. Match the items given in Column-I with those in Column-II and choose the correct option.**

Column-I	Column-II
(a) Rennin	(i) Vitamin B <sub>12</sub>
(b) Enterokinase	(ii) Facilitated transport
(c) Oxyntic cells	(iii) Milk proteins
(d) Fructose	(iv) Trypsinogen

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

**Correct Option A**

**Solution:** Rennin is a milk digesting protein enzyme. Enterokinase converts trypsinogen into trypsin. Fructose shows facilitated transport. Oxyntic cells secrete HCl and intrinsic factors that are essential for the absorption of vitamin B<sub>12</sub>.

**Q 130. Kwashiorkor disease is due to -**

- Option A protein deficiency not accompanied by calorie deficiency
- Option B simultaneous deficiency of proteins and fats
- Option C simultaneous deficiency of proteins and calories
- Option D deficiency of carbohydrates

**Correct Option A**

**Solution:** Kwashiorkor is produced by protein deficiency but unaccompanied by calorie deficiency. It results from the replacement of mother's milk by a high calorie-low protein diet in a child, who is more than one year of age.

**Q 131. Match the following genera with their respective phylum :**

- (a) *Ophiura* (i) Mollusca
- (b) *Physalia* (ii) Platyhelminthes
- (c) *Pinctada* (iii) Echinodermata
- (d) *Planaria* (iv) Coelenterata

**Select the correct option :**

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

**Correct Option C****Solution:**

- (a) *Ophiura* is an echinoderm commonly known as brittle star.  
 (b) *Physalia* is a coelenterate (Cnidarian) commonly known as Portuguese man of war.  
 (c) *Pinctada* is pearl oyster belonging to taxon bivalve molluscs.  
 (d) *Planaria* belongs to Platyhelminthes (flatworms).

**Q 132. Which of the following animals are true coelomates with bilateral symmetry?**

- Option A Annelids  
 Option B Adult Echinoderms  
 Option C Aschelminthes  
 Option D Platyhelminthes

**Correct Option A**

**Solution:** Annelids exhibit bilateral symmetry with metameric segmentation where external segments correspond to internal segments. Aschelminthes are pseudocoelomates and platyhelminthes are acoelomates. Adult echinoderms are bilaterally symmetrical.

**Q 133. The contrasting characteristics generally in a pair used for identification of animals in Taxonomic Key are referred to as :**

- Option A Alternate  
 Option B Lead  
 Option C Couplet  
 Option D Doublet

**Correct Option C**

**Solution:** The keys are based on the set of contrasting characters in a pair known as couplet.

**Q 134. Match the following cell structure with its characteristic feature:**

- |                        |   |
|------------------------|---|
| (a) Tight junctions    | (i) Cement neighbouring cells together to form sheet                          |
| (b) Adhering junctions | (ii) Transmit information through chemical to another cells                   |
| (c) Gap junctions      | (iii) Establish a barrier to prevent leakage of fluid across epithelial cells |
| (d) Synaptic junctions | (iv) Cytoplasmic channels to facilitate communication between adjacent cells  |

**Select correct option from the following:**

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

**Correct Option D****Solution:**

- Tight junctions provide a barrier which prevents leakage of fluid across epithelial cells.
- Adherens junctions aid to cement adjacent cells to form a sheet.
- Gap junctions provide cytoplasmic channels to facilitate communication between adjacent cells.
- Synaptic junctions help in transmission of information through chemicals.

**Q 135. Which of the following statements is INCORRECT?**

- Option A Female cockroach possesses sixteen ovarioles in the ovaries.  
 Option B Cockroaches exhibit mosaic vision with less sensitivity and more resolution.

Option C A mushroom-shaped gland is present in the 6<sup>th</sup> -7<sup>th</sup> abdominal segments of male cockroach.

Option D A pair of spermatheca is present in the 6<sup>th</sup> segment of female cockroach.

**Correct Option B**

**Solution:** Cockroaches receive several images of an object with the help of ommatidia. This kind of vision possessed by cockroaches is known as mosaic vision which has more sensitivity but less resolution.

## PHYSICS

**Q 136.** The radius of the first permitted Bohr orbit, for the electron, in a hydrogen atom equals

$0.51 \text{ \AA}$  and its ground state energy equals  $-13.6 \text{ eV}$ . If the electron in the hydrogen atom is replaced by muon ( $\mu^-$ ) [charge same as electron and mass  $207 m_e$ ], the first Bohr radius and ground state energy will be \_\_\_\_\_.

Option A  $2.56 \times 10^{-13} \text{ m}$ ,  $-13.6 \text{ eV}$

Option B  $0.53 \times 10^{-13} \text{ m}$ ,  $-3.6 \text{ eV}$

Option C  $25.6 \times 10^{-13}$ ,  $-2.8 \text{ eV}$

Option D  $2.56 \times 10^{-13} \text{ m}$ ,  $-2.8 \text{ keV}$

**Correct Option D**

**Solution:**

Given that,

$$r_e = 0.51 \text{ \AA} = 0.51 \times 10^{-10} \text{ m}$$

As we know according to Bohr's model.

Mass of muon,  $m_\mu = 207 \times m_e$

$$r_e \propto \frac{1}{m_e}$$

Now, At equilibrium

$$m_\mu r_\mu = m_e r_e$$

$$\therefore r_\mu = \frac{m_e}{m_\mu} \times r_e = \frac{m_e}{207m_e} \times r_e = 2.56 \times 10^{-13} \text{ m}$$

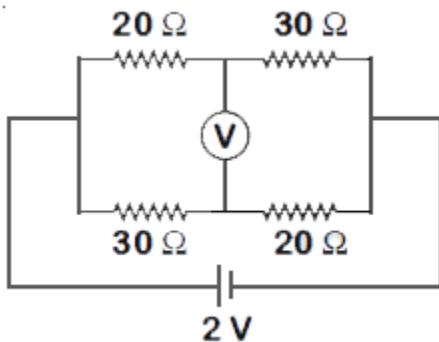
Similarly, energy of muon is given as

$$E_e \propto m_e \Rightarrow \frac{E_e}{E_\mu} = \frac{m_e}{m_\mu}$$

$$\therefore (E)_\mu = -13.6 \times 207 \\ = -2.8 \text{ keV}$$



Q 137. The reading of an ideal voltmeter in the circuit shown is,



- Option A     0.4 V
- Option B     0.6 V
- Option C     0 V
- Option D     0.5 V

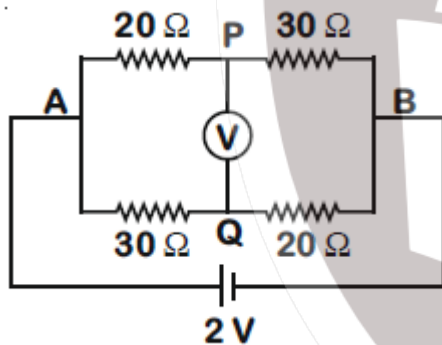
**Correct Option A**

**Solution:**

Now, by applying the Kirchhoff's junction law.

$$\text{Current in APB} = \frac{2}{50} A$$

$$\text{Current in AQB} = \frac{2}{50} A$$



$\Delta V$  from A to P

$$V_A - \frac{2}{50} \times 20 = V_P$$

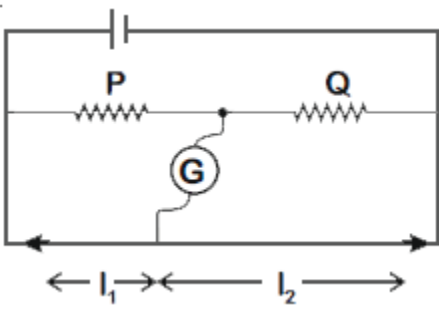
$\Delta V$  from A to Q

$$V_A - \frac{2}{50} \times 30 = V_Q$$

$$V_P + \frac{2}{50} \times 20 = V_Q + \frac{2}{50} \times 30 \Rightarrow V_P - V_Q = 0.4V$$

Q 138. The metre bridge shown is in balance position with  $\frac{P}{Q} = \frac{I_1}{I_2}$ . If we now interchange the positions

of galvanometer and cell, will the bridge work? If yes, what will be balance condition?



Option A      yes,  $\frac{P}{Q} = \frac{I_1}{I_2}$

Option B      yes,  $\frac{P}{Q} = \frac{I_2 - I_1}{I_2 + I_1}$

Option C      no, no null point

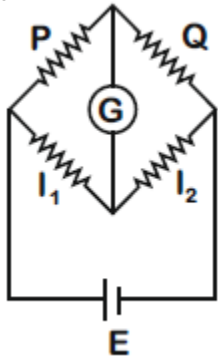
Option D      yes,  $\frac{P}{Q} = \frac{I_2}{I_1}$

**Correct Option A**

**Solution:**

According to given condition for the balanced bridge connection, the relation between P, Q,  $I_1$  and  $I_2$  is

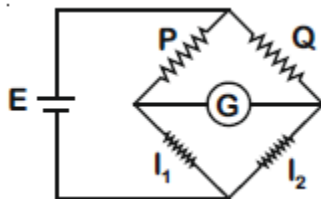
$$\frac{P}{Q} = \frac{I_1}{I_2}$$



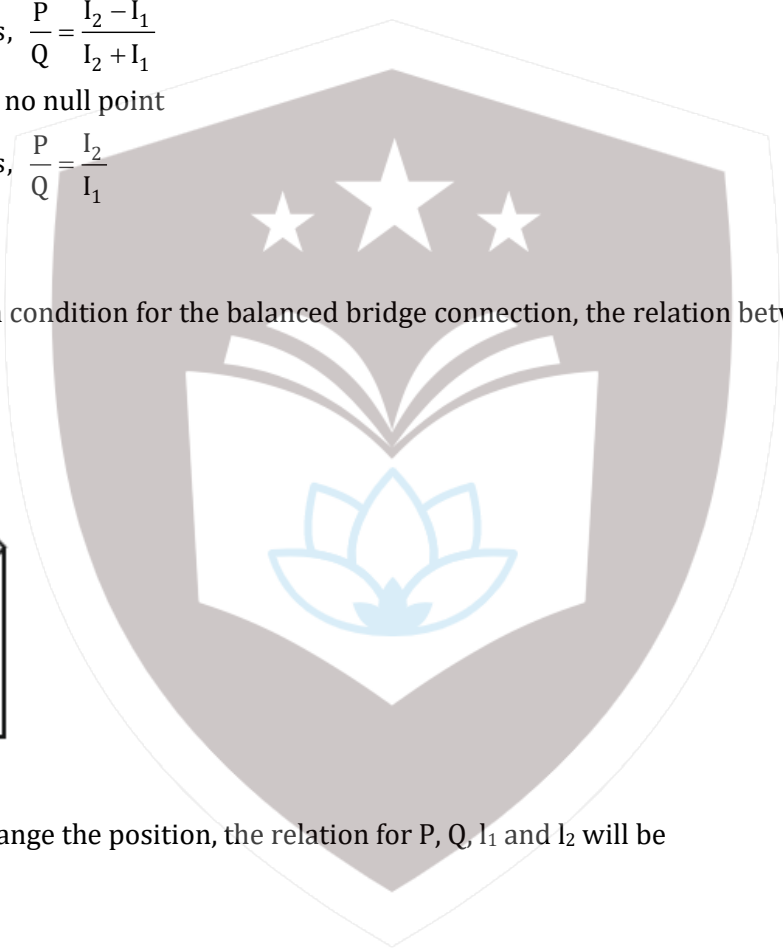
Now, if we interchange the position, the relation for P, Q,  $I_1$  and  $I_2$  will be

$$\frac{P}{I_1} = \frac{Q}{I_2}$$

$$\frac{P}{Q} = \frac{I_1}{I_2}$$



As we can see from the above relation that on interchanging galvanometer and battery positions, the balance condition remains unchanged.



**Q 139.** The relations amongst the three elements of earth's magnetic field, namely horizontal component  $H$ , vertical component  $V$  and dip  $\delta$  are, ( $B_E =$  total magnetic field)

Option A  $V = B_E, H = B_E \tan\delta$

Option B  $V = B_E, \tan\delta, H = B_E$

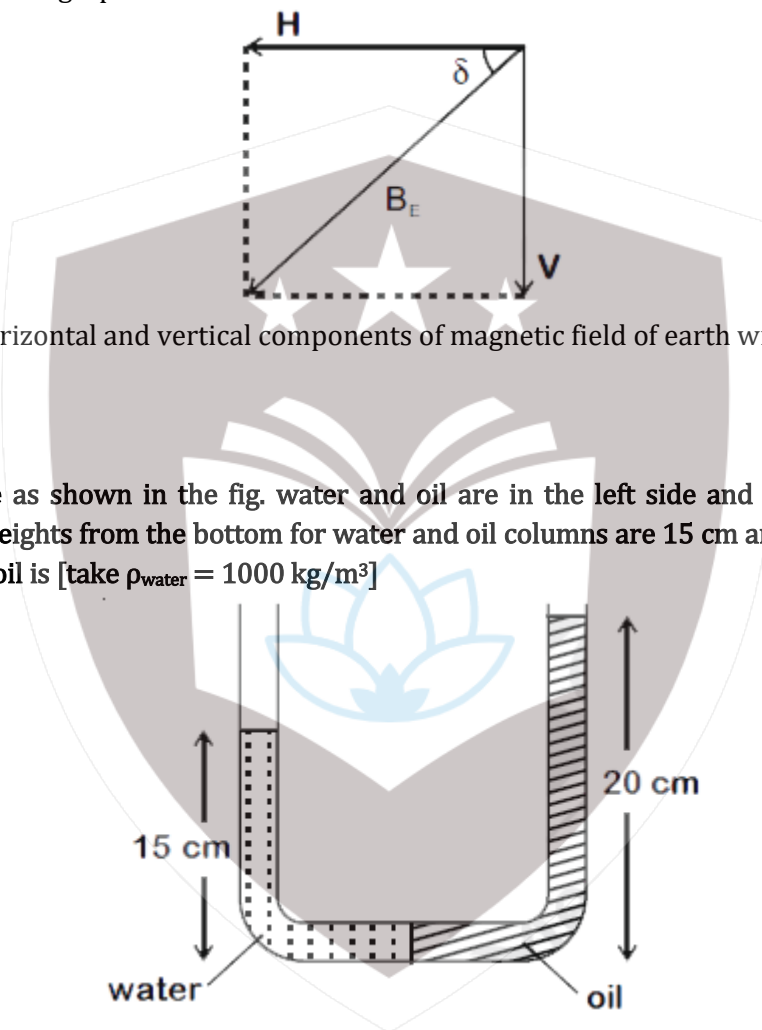
Option C  $V = B_E \sin\delta, H = B_E \cos\delta$

Option D  $V = B_E \cos\delta, H = B_E \sin\delta$

**Correct Option C**

**Solution:**

As we can see from the graph



The relation for horizontal and vertical components of magnetic field of earth will be.

$$H = B_E \cos\delta$$

$$V = B_E \sin\delta$$

**Q 140.** In a u-tube as shown in the fig. water and oil are in the left side and right side of the tube respectively. The heights from the bottom for water and oil columns are 15 cm and 20 cm respectively. The density of the oil is [take  $\rho_{\text{water}} = 1000 \text{ kg/m}^3$ ]

Option A  $1333 \text{ kg/m}^3$

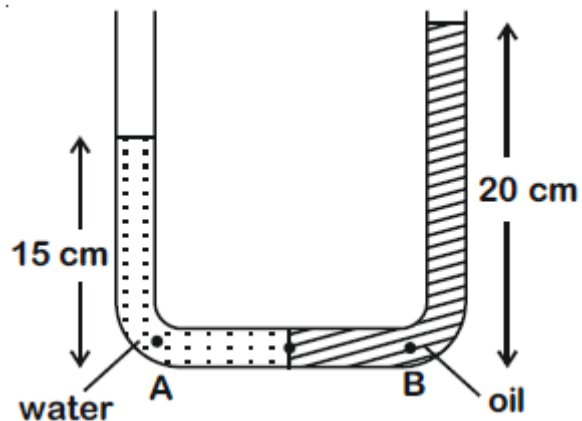
Option B  $1200 \text{ kg/m}^3$

Option C  $750 \text{ kg/m}^3$

Option D  $1000 \text{ kg/m}^3$

**Correct Option C**

**Solution:**



As we know, at equilibrium

Pressure at A = Pressure at B.

$$P_a + 0.15 \times 10^3 \times g = P_a + 0.20 \times d_o g$$

$$d_o = \frac{0.15 \times 10^3}{0.20}$$

$$= 0.75 \times 10^3$$

$$= 750 \text{ kg/m}^3$$

Q 141. A deep rectangular pond of surface area A, containing water (density =  $\rho$ ), specific heat capacity = s), is located in a region where the outside air temperature is at a steady value of  $-26^\circ\text{C}$ . The thickness of the frozen ice layer in this pond, at a certain instant is x.

Taking the thermal conductivity of ice as K, and its specific latent heat of fusion as L, the rate of increase of the thickness of ice layer, at this instant, would be given by

Option A  $26K/\rho x(L + 4s)$

Option B  $26K/\rho x(L - 4s)$

Option C  $26K/(\rho x^2 L)$

Option D  $26K/(\rho x L)$

**Correct Option D**

**Solution:**

For the given case, we can assume that at any instant thickness of ice is x. And time taken to form additional thickness (dx) is dt.



$$mL = \frac{KA[26 - 0]dt}{x}$$

$$(A dx)\rho L = \frac{KA(26)dt}{x}$$

$$\frac{dx}{dt} = \frac{26K}{x\rho L}$$

Q 142. An LED is constructed from a p-n junction diode using GaAsP. The energy gap is 1.9 eV. The wavelength of the light emitted will be equal to

- Option A  $654 \times 10^{-11} \text{ m}$
- Option B  $10.4 \times 10^{-26} \text{ m}$
- Option C 654 nm
- Option D  $654 \text{ \AA}$

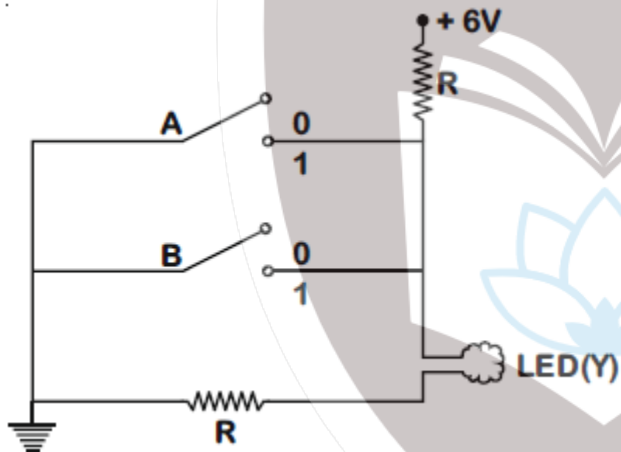
**Correct Option C**

**Solution:**

Now, wavelength of light emitted by p-n junction diode of energy gap 1.9 eV.

$$\lambda = \frac{12400 \text{ \AA}}{E_g \text{ (in eV)}}$$
$$= \frac{12400}{1.9} = 6526 \text{ \AA}$$
$$= 653 \text{ nm}$$
$$\approx 654 \text{ nm}$$

Q 143. The circuit diagram shown here corresponds to the logic gate



- Option A NAND
- Option B NOR
- Option C AND
- Option D OR

**Correct Option B**

**Solution:**

Now,

For the given case, consider when the output is low (Key is open) it can be denoted as '0'.

Similarly, when the output is high (Key is closed) it can be denoted as '1'.

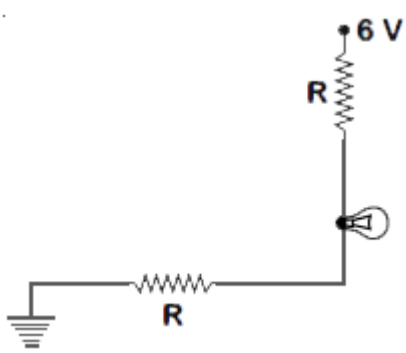
Hence,

Case-1:

When,  $A = 0, B = 0$

LED will glow

$\therefore Y = 1$

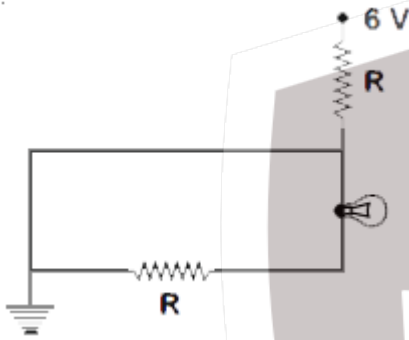


Case-2:

$$A = 0, B = 1$$

No current will through LED

$$\therefore Y = 0$$



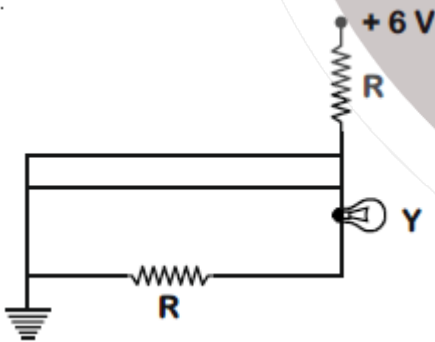
Case-3 :  $A = 1, B = 0$

Again no current will through LED

$$\therefore Y = 0$$

Case-4 :  $A = 1, B = 1$

Again  $Y = 0$



$\therefore$

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

Hence corresponding circuit will behave as NOR gate.

144. The value of  $\gamma \left( \frac{C_p}{C_v} \right)$ , for hydrogen, helium and another ideal diatomic gas X (whose molecules are not rigid but have an additional vibrational mode), are respectively equal to,

Option A  $\frac{7}{5}, \frac{5}{3}, \frac{7}{5}$

Option B  $\frac{7}{5}, \frac{5}{3}, \frac{9}{7}$

Option C  $\frac{5}{3}, \frac{7}{5}, \frac{9}{7}$

Option D  $\frac{5}{3}, \frac{7}{5}, \frac{7}{5}$

**Correct Option B**

**Solution:**

Now, as we know diatomic gases have 5 degrees of freedom, if vibrational mode is neglected.

$$\therefore \text{For Hydrogen } \gamma = 1 + \frac{2}{f} = 1 + \frac{2}{5} = \frac{7}{5}$$

Similarly, for monoatomic gases like Helium, the degree of freedom will be 3.

$$\therefore \text{For Helium } \gamma = 1 + \frac{2}{f} = 1 + \frac{2}{3} = \frac{5}{3}$$

If vibrational mode is also considered then degrees of freedom of diatomic gas molecules are 7.

For gas X,  $f = 7$ .

$$\gamma = 1 + \frac{2}{f} = 1 + \frac{2}{7} = \frac{9}{7}$$

$$\therefore \left( \frac{7}{5}, \frac{5}{3}, \frac{9}{7} \right)$$

145. The main scale of a vernier callipers has  $n$  divisions/cm.  $n$  divisions of the vernier scale coincide with  $(n - 1)$  divisions of main scale. The least count of the vernier callipers is,

Option A  $\frac{1}{n(n+1)}$  cm

Option B  $\frac{1}{(n+1)(n-1)}$  cm

Option C  $\frac{1}{n}$  cm

Option D  $\frac{1}{n^2}$  cm

**Correct Option D**

**Solution:**

Now,

Vernier scale division = VSD

Main scale division = MSD

Now,

$$n \times \text{VSD} = (n - 1) \text{MSD}$$

$$1 \text{VSD} = \frac{(n-1)}{n} \text{MSD}$$

Least count, L.C. = 1 MSD - 1 VSD

$$\begin{aligned}
 &= 1 \text{ MSD} - \frac{(n-1)}{n} \text{ MSD} \\
 &= \frac{1}{n} \text{ MSD} \\
 &= \frac{1}{n} \times \frac{1}{n} \text{ cm} \\
 &= \frac{1}{n^2} \text{ cm}
 \end{aligned}$$

146. A person travelling in a straight line moves with a constant velocity  $v_1$  for certain distance 'x' and with a constant velocity  $v_2$  for next equal distance. The average velocity  $v$  is given by the relation

Option A  $V = \sqrt{V_1 V_2}$

Option B  $\frac{1}{v} = \frac{1}{v_1} + \frac{1}{v_2}$

Option C  $\frac{2}{v} = \frac{1}{v_1} + \frac{1}{v_2}$

Option D  $\frac{v}{2} = \frac{v_1 + v_2}{2}$

**Correct Option C**

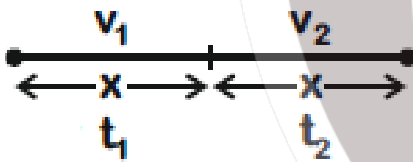
**Solution:**

Consider,

Velocity travelled by person in time  $t_1 = v_1$

Velocity travelled by person in time  $t_2 = v_2$

Total distance travelled =  $2x$



$$\text{As } t_1 = \frac{x}{v_1} \text{ and } t_2 = \frac{x}{v_2}$$

$$\therefore v = \frac{x+x}{t_1+t_2}$$

$$= \frac{2x}{\frac{x}{v_1} + \frac{x}{v_2}} = \frac{2v_1 v_2}{v_1 + v_2}$$

$$\therefore \frac{2}{v} = \frac{1}{v_1} + \frac{1}{v_2}$$

147. Assuming that the gravitational potential energy of an object at infinity is zero, the change in potential energy (final - initial) of an object of mass  $m$ , when taken to a height  $h$  from the surface of earth (of radius  $R$ ), is given by,

Option A  $\frac{GMm}{R+h}$

Option B  $-\frac{GMm}{R+h}$



Option C  $\frac{GMmh}{R(R+h)}$

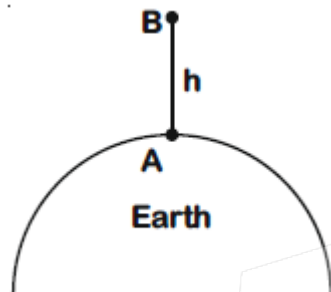
Option D  $mgh$

**Correct Option C**

**Solution:**

Given that,

Potential energy at  $\infty$  distance from centre,  $P.E_{\infty} = 0$  J



Now,

$$(P.E)_A = -\frac{GMm}{R}$$

$$(P.E)_B = -\frac{GMm}{R+h}$$

$$\therefore \Delta U = (P.E)_B - (P.E)_A$$

$$= -\frac{GMm}{R+h} + \frac{GMm}{R} = \frac{GMmh}{(R)(R+h)}$$

**148. 1 g of water, of volume 1 cm<sup>3</sup> at 100°C, is converted into steam at same temperature under normal atmospheric pressure ( $\approx 1 \times 10^5$  Pa). The volume of steam formed equals 1671 cm<sup>3</sup>. If the specific latent heat of vaporisation of water is 2256 J/g, the change in internal energy is,**

Option A 2256 J

Option B 2423 J

Option C 2089 J

Option D 167 J

**Correct Option C**

**Solution:**

Given that,

Mass of water at 100° C,  $m_1 = 1$  g

Volume of water,  $V_1 = 1$  cm<sup>3</sup>

Latent heat of water,  $L_1 = 2256$  J/g

Volume of steam,  $V_2 = 1671$  cm<sup>3</sup>

Now,

$$\Delta Q = L \times m$$

$$= 2256 \times 1 = 2256 \text{ J} \dots\dots\dots(i)$$

$$\Delta W = P \times [V_2 - V_1]$$

$$= 1 \times 10^5 [1671 - 1] \times 10^{-6}$$

$$= 1670 \times 10^5 \times 10^{-6}$$

$$= 167 \text{ J} \dots\dots\dots(ii)$$

By first law of thermodynamics:

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

$$2256 = \Delta U + 167$$

$$\therefore \Delta U = 2089 \text{ J}$$

149. Angular width of the central maxima in the Fraunhofer diffraction for  $\lambda = 6000 \text{ \AA}$  is  $\theta_0$ . When the same slit is illuminated by another monochromatic light, the angular width decreases by 30%. The wavelength of this light is

Option A  $420 \text{ \AA}$

Option B  $1800 \text{ \AA}$

Option C  $4200 \text{ \AA}$

Option D  $6000 \text{ \AA}$

**Correct Option C**

**Solution:**

Now,

$$\beta = \frac{D\lambda}{d}$$

$$\beta \propto \lambda$$

$$\therefore \frac{\beta'}{\beta} = \frac{\lambda'}{6000}$$

$$\Rightarrow \lambda' = 0.7 \times 6000 \quad \left( \text{as } \beta' = \frac{100-30}{100} \times \beta = 0.7 \beta \right)$$

$$\Rightarrow 4200 \text{ \AA}$$

150. The work function of a photosensitive material is 4.0 eV. The longest wavelength of light that can cause photon emission from the substance is (approximately)

Option A  $310 \text{ nm}$

Option B  $3100 \text{ nm}$

Option C  $966 \text{ nm}$

Option D  $31 \text{ nm}$

**Correct Option A**

**Solution:**

Given that,

$$\text{Work function, } \phi = 4.0 \text{ V}$$

Now,

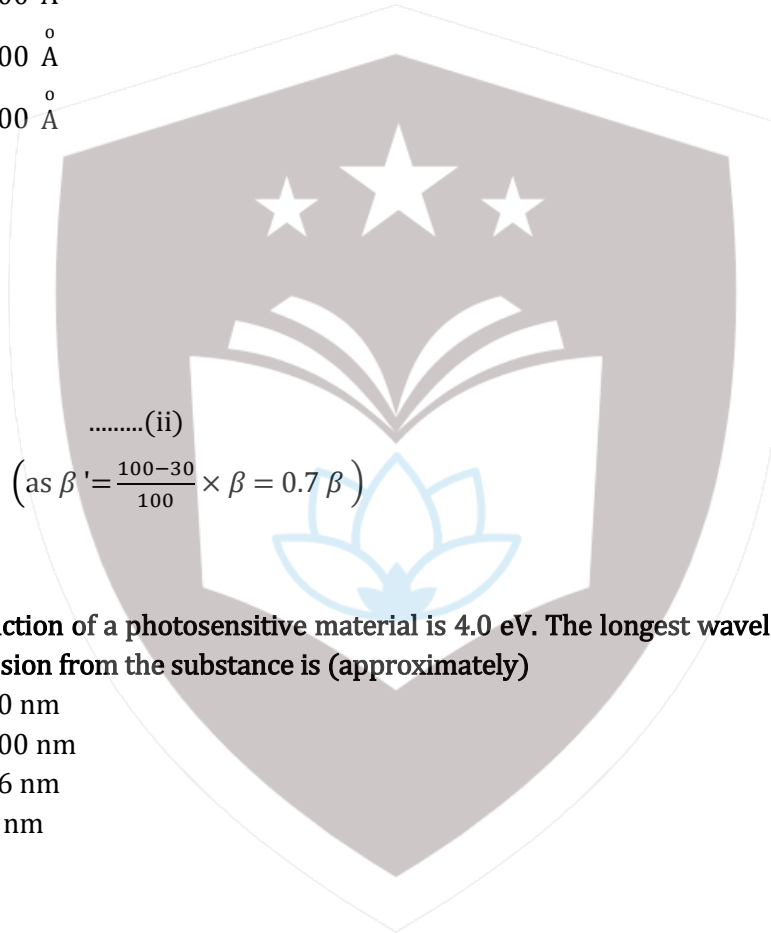
$$\text{Work function, } \phi = \frac{hc}{\lambda_0} \Rightarrow \lambda_0 = \frac{hc}{\phi}$$

$$\therefore \lambda_0 = \frac{6.62 \times 10^{-34} \times 3 \times 10^8}{4 \times 1.6 \times 10^{-19}}$$

$$\lambda = \frac{12400}{4}$$

$$= 3100 \text{ \AA}$$

$$\therefore \lambda = 310 \text{ nm}$$



151. A proton and an  $\alpha$ -particle are accelerated from rest to the same energy. The de Broglie wavelengths  $\lambda_p$  and  $\lambda_\alpha$  are in the ratio,

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

**Correct Option B**

**Solution:**

Now, for de Broglie waves

$$\text{As } \lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK.E}}$$

$$\therefore \lambda \propto \frac{1}{\sqrt{m}} \quad (\text{Kinetic energies are same})$$

$$\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{m_\alpha}{m_p}}$$

$$\frac{\lambda_p}{\lambda_\alpha} = \sqrt{\frac{4m_p}{m_p}}$$

$$\therefore \frac{\lambda_p}{\lambda_\alpha} = \frac{2}{1}$$

152. An object kept in a large room having air temperature of  $25^\circ\text{C}$  takes 12 minutes to cool from  $80^\circ\text{C}$  to  $70^\circ\text{C}$ . The time taken to cool for the same object from  $70^\circ\text{C}$  to  $60^\circ\text{C}$  would be nearly,

- Option A 15 min
- Option B 10 min
- Option C 12 min
- Option D 20 min

**Correct Option A**

**Solution:**

Given that,

Initial air temperature,  $T_0 = 25^\circ\text{C}$

Initial temperature of object,  $T_1 = 80^\circ\text{C}$

Final temperature of object,  $T_2 = 70^\circ\text{C}$

Initial temperature of object,  $T'_1 = 70^\circ\text{C}$

Final temperature of object,  $T_2 = 60^\circ\text{C}$

Now,

By using Newton's law of cooling for the given case we get

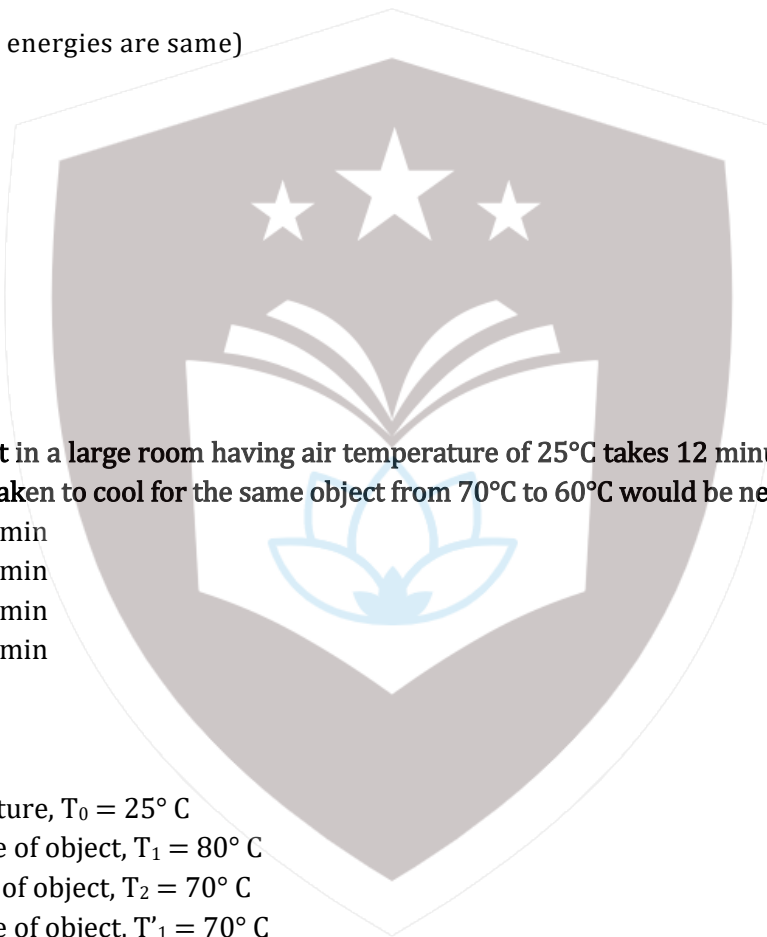
$$\frac{(T'_1 - T'_2)}{t} = K \left( \frac{T_1 + T_2}{2} - T_0 \right)$$

$$\frac{(80-70)}{12} = K(75 - 25) \quad \dots(i)$$

$$\frac{(70-60)}{t'} = K(65 - 25) \quad \dots(ii)$$

Divide eq. (i) by (ii)

$$t' = 12 \times \frac{5}{4} = 15 \text{ min}$$



153. Two small spherical metal balls, having equal masses, are made from materials of densities  $\rho_1$  and  $\rho_2$  ( $\rho_1 = 8\rho_2$ ) and have radii of 1 mm and 2 mm, respectively, they are made to fall vertically (from rest) in a viscous medium whose coefficient of viscosity equals  $\eta$  and whose density is  $0.1\rho_2$ . The ratio of their terminal velocities would be,

Option A  $\frac{79}{36}$

Option B  $\frac{79}{72}$

Option C  $\frac{19}{36}$

Option D  $\frac{39}{72}$

**Correct Option A**

**Solution:**

$$\text{As } V_T = \frac{2a^2}{9\eta}(\rho - \sigma)g$$

$$V_{T_1} = \frac{2 \times (1)^2}{9\eta}(\rho_1 - 0.1\rho_2)g$$

$$V_{T_1} = \frac{2 \times 1}{9\eta}(8\rho_2 - 0.1\rho_2)g \quad \dots(i)$$

$$V_{T_2} = \frac{2 \times (2)^2}{9\eta}(\rho_2 - 0.1\rho_2)g \quad \dots(ii)$$

$$\therefore \frac{V_{T_1}}{V_{T_2}} = \frac{7.9}{4(0.9)} = \frac{79}{36}$$

154. A particle starting from rest, moves in a circle of radius 'r'. It attains a velocity of  $V_0$  m/s in the  $n^{\text{th}}$  round. Its angular acceleration will be,

Option A  $\frac{V_0^2}{4\pi nr} \text{ rad/S}^2$

Option B  $\frac{V_0}{n} \text{ rad/S}^2$

Option C  $\frac{V_0^2}{2\pi nr^2} \text{ rad/S}^2$

Option D  $\frac{V_0^2}{4\pi nr^2} \text{ rad/S}^2$

**Correct Option D**

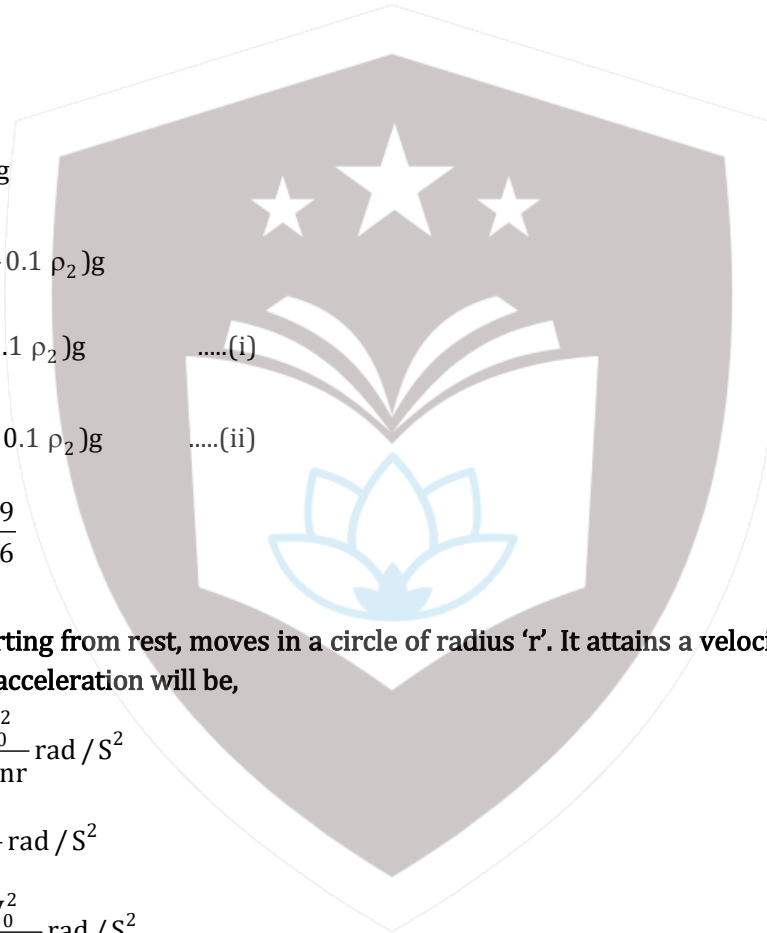
**Solution:** Initial speed = 0

Final speed =  $V_0$

Tangential acceleration =  $\alpha r$

$$V^2 = u^2 + 2as$$

$$V_0^2 = 0 + 2r\alpha(2\pi r)n$$



$$\alpha = \frac{V_0^2}{4\pi nr^2}$$

155. A person standing on the floor of an elevator drops a coin. The coin reaches the floor in time  $t_1$  if the elevator is at rest and in time  $t_2$  if the elevator is moving uniformly. Then

Option A  $t_1 = t_2$

Option B  $t_1 < t_2$  or  $t_1 > t_2$  depending upon whether the lift is going up or down

Option C  $t_1 < t_2$

Option D  $t_1 > t_2$

**Correct Option A**

**Solution:** In both case elevator is an inertial frame of reference so effective gravity remains same from both the frames.

So, time of fall remains same in both cases (since initial velocity is same in both frames).

Hence  $t_1 = t_2$

156. A truck is stationary and has a bob suspended by a light string, in a frame attached to the truck. The truck suddenly moves to the right with an acceleration of  $a$ . The pendulum will tilt

Option A to the left and angle of inclination of the pendulum with the vertical is  $\tan^{-1}\left(\frac{g}{a}\right)$

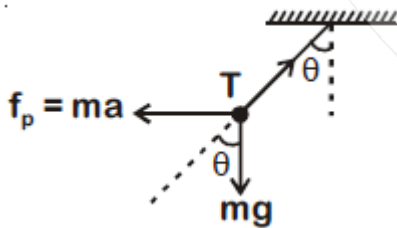
Option B to the left and angle of inclination of the pendulum with the vertical is  $\sin^{-1}\left(\frac{g}{a}\right)$

Option C to the left and angle of inclination of the pendulum with the vertical is  $\tan^{-1}\left(\frac{a}{g}\right)$

Option D to the left and angle of inclination of the pendulum with the vertical is  $\sin^{-1}\left(\frac{a}{g}\right)$

**Correct Option C**

**Solution:**



Now, for the given case according to free body diagram and from the frame of truck

$$T \sin \theta = ma$$

$$T \cos \theta = mg$$

$$\tan \theta = \frac{a}{g}$$

$$\theta = \tan^{-1}\left(\frac{a}{g}\right)$$

157. Two toroids 1 and 2 have total no. of turns 200 and 100 respectively with average radii 40 cm and 20 cm respectively. If they carry same current  $i$ , the ratio of the magnetic fields along the two loops is,

- Option A 1 : 2
- Option B 1 : 1
- Option C 4 : 1
- Option D 2 : 1

**Correct Option B**

**Solution:**

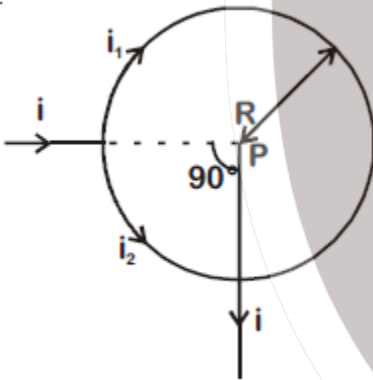
Magnetic field inside a toroid is given as

$$B = \frac{\mu_0 N.I}{2\pi R}$$

$$\text{Here, } \frac{B_1}{B_2} = \frac{N_1 R_2}{N_2 R_1} = \frac{200 \cdot 20}{100 \cdot 40} = 1$$

$$\text{SO, } \frac{B_1}{B_2} = 1$$

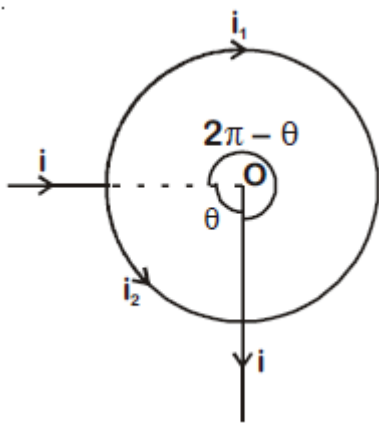
158. A straight conductor carrying current  $i$  splits into two parts as shown in the figure. The radius of the circular loop is  $R$ . The total magnetic field at the centre  $P$  of the loop is,



- Option A  $\frac{\mu_0 i}{2R}$ , inward
- Option B Zero
- Option C  $3\mu_0 i / 32R$ , outward
- Option D  $3\mu_0 i / 32R$ , inward

**Correct Option B**

**Solution:**



Net magnetic field at point 'P'

$$B_{\text{net}} = \overline{B_1} + \overline{B_2}$$

Here  $\overline{B_1}$  and  $\overline{B_2}$  are equal in magnitude and opposite in direction.

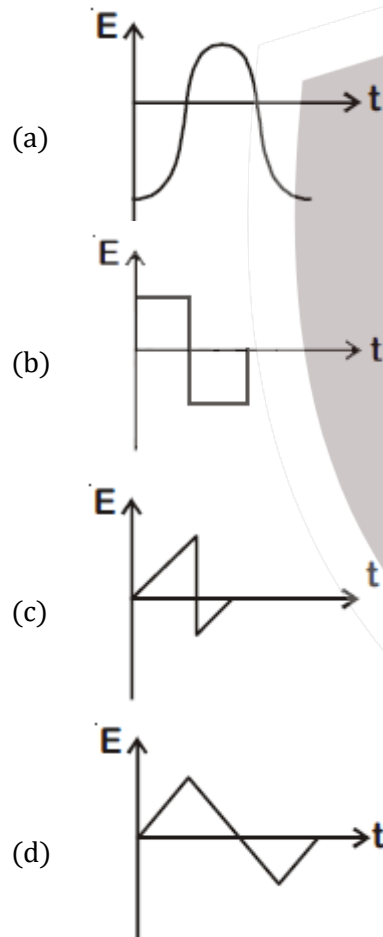
Hence,  $B_{\text{net}} = B_1 - B_2$

$$i_1 = i \left( \frac{\theta}{2\pi} \right) \Rightarrow B_1 = \frac{\mu_0 i_1}{2R} \left( \frac{2\pi - \theta}{2\pi} \right)$$

$$i_2 = i \left( \frac{2\pi - \theta}{2\pi} \right) \Rightarrow B_2 = \frac{\mu_0 i_2}{2R} \left( \frac{\theta}{2\pi} \right)$$

$$B_{\text{net}} = B_1 - B_2 = 0$$

159. The variation of EMF with time for four types of generators are shown in the figures. Which amongst them can be called AC?



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

**Correct Option C**

**Solution:**

A current which changes its direction periodically is called alternating current.

Hence given all options are AC.

160. Two metal spheres, one of radius  $R$  and the other of radius  $2R$  respectively have the same surface charge density  $\sigma$ . They are brought in contact and separated. What will be the new surface charge densities on them?

Option A  $\sigma_1 = \frac{5}{3}\sigma, \sigma_2 = \frac{5}{6}\sigma$

Option B  $\sigma_1 = \frac{5}{6}\sigma, \sigma_2 = \frac{5}{2}\sigma$

Option C  $\sigma_1 = \frac{5}{2}\sigma, \sigma_2 = \frac{5}{6}\sigma$

Option D  $\sigma_1 = \frac{5}{2}\sigma, \sigma_2 = \frac{5}{3}\sigma$

**Correct Option A**

**Solution:**

Given that,

$$Q_1 = \sigma 4\pi R_1^2 = \sigma 4\pi R^2$$

$$Q_2 = \sigma 4\pi (2R)^2 = \sigma 16\pi R^2$$

After Redistribution of charges

$$\frac{Q'_1}{Q'_2} = \frac{R}{2R} \Rightarrow Q'_2 = 2Q'_1 \quad \dots(i)$$

$$Q'_1 + Q'_2 = 20\sigma\pi R^2 \quad \dots(ii)$$

From eq. (i) and (ii)

$$Q'_1 = \frac{20}{3} \sigma\pi R^2 \Rightarrow \sigma'_1 = \frac{5}{3} \sigma$$

$$Q'_2 = \frac{40}{3} \sigma\pi R^2 \Rightarrow \sigma'_2 = \frac{5}{6} \sigma$$

161. The distance covered by a particle undergoing SHM in one time period is (amplitude =  $A$ ),

Option A  $4A$

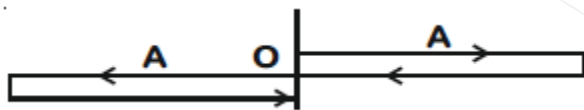
Option B Zero

Option C  $A$

Option D  $2A$

**Correct Option A**

**Solution:**



In one time period total distance travelled by the particle is  $4A$ .

162. A mass falls from a height ' $h$ ' and its time of fall ' $t$ ' is recorded in terms of time period  $T$  of a simple pendulum. On the surface of earth it is found that  $t = 2T$ . The entire set up is taken on the surface of another planet whose mass is half of that of earth and radius the same. Same experiment is repeated and corresponding times noted as  $t'$  and  $T'$ . Then we can say

Option A  $t' = 2T'$

Option B  $t' = \sqrt{2}T'$

Option C  $t' > 2T'$



Option D  $t' < 2T'$

**Correct Option A**

**Solution:**

For surface of earth time taken in falling h distance.

$$t = \sqrt{\frac{2h}{g}}$$

$$\text{and } T = 2\pi\sqrt{\frac{I}{g}}$$

Given  $t = 2T$

$$\frac{t}{T} = 2$$

For surface of other planet

$$g' = \frac{g}{2}$$

Time taken in falling h distance

$$t' = \sqrt{\frac{2h}{g'}} = \sqrt{2} t$$

$$\text{and } T' = 2\pi\sqrt{\frac{I}{g'}} = \sqrt{2} T$$

$$\text{Here } \frac{t'}{T'} = \frac{\sqrt{2} t}{\sqrt{2} T} = 2$$

$$\boxed{t' = 2T'}$$

**163. A tuning fork with frequency 800 Hz produces resonance in a resonance column tube with upper end open and lower end closed by water surface. Successive resonance are observed at lengths 9.75 cm, 31.25 cm and 52.75 cm. The speed of sound in air is, \_\_\_\_.**

Option A 172 m/s

Option B 500 m/s

Option C 156 m/s

Option D 344 m/s

**Correct Option D**

**Solution:**

Given that,

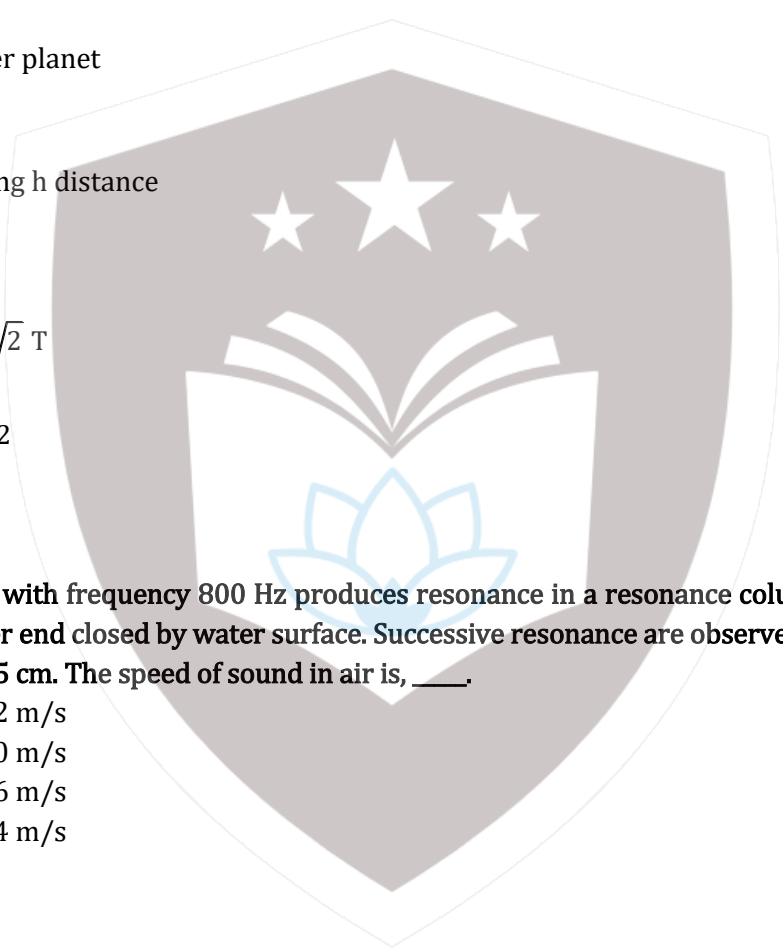
$$l_1 = 9.75 \text{ cm}$$

$$l_2 = 31.25 \text{ cm}$$

$$l_3 = 52.75 \text{ cm}$$

e = end correction

Now, for an open ended tube the relation of wavelength can be expressed as.



$$\frac{\lambda}{4} + e = 9.75 \text{ cm} \quad \dots(i)$$

$$\frac{3\lambda}{4} + e = 31.25 \text{ cm} \quad \dots(ii)$$

$$\frac{3\lambda}{4} - \frac{\lambda}{4} = 31.25 - 9.75$$

$$\frac{\lambda}{2} = 21.5$$

$$\lambda = 43 \text{ cm}$$

$$v = \lambda \times f$$

$$v = 43 \times 800$$

$$v = 34400 \times 10^{-2}$$

$$\boxed{v = 344 \text{ m/s}}$$

164. An object flying in air with velocity  $(20\hat{i} + 25\hat{j} - 12\hat{k})$  suddenly breaks into two pieces whose masses are in the ratio 1 : 5. The smaller mass flies off with a velocity  $(100\hat{i} + 35\hat{j} - 8\hat{k})$ . The velocity of the larger piece will be,

Option A  $-20\hat{i} - 15\hat{j} - 80\hat{k}$

Option B  $4\hat{i} + 23\hat{j} - 16\hat{k}$

Option C  $-100\hat{i} - 35\hat{j} - 8\hat{k}$

Option D  $20\hat{i} + 15\hat{j} - 80\hat{k}$

**Correct Option B**

**Solution:**

Now by applying law of conservation of linear momentum we get

$$\vec{P}_1 = \vec{P}_f$$

$$m\vec{v}_i = \left( \frac{m}{6}\vec{v}_1 + \frac{5m}{6}\vec{v}_2 \right)$$

$$\vec{v}_i = \left( \frac{\vec{v}_1}{6} + \frac{5}{6}\vec{v}_2 \right)$$

$$20\hat{i} + 25\hat{j} - 12\hat{k} = \frac{(100\hat{i} + 35\hat{j} + 8\hat{k})}{6} + \frac{5\vec{v}_2}{6}$$

$$12\hat{i} + 150\hat{j} - 72\hat{k} = 100\hat{i} + 35\hat{j} + 8\hat{k} + 5\vec{v}_2$$

$$20\hat{i} + 115\hat{j} - 60\hat{k} = 5\vec{v}_2$$

$$\vec{v}_2 = \frac{20\hat{i} + 115\hat{j} - 60\hat{k}}{5}$$

$$\boxed{\vec{v}_2 = 4\hat{i} + 23\hat{j} - 16\hat{k}}$$

165. The rate of radioactive disintegration at an instant for a radioactive sample of half life  $2.2 \times 10^9$  s is  $10^{10} \text{ s}^{-1}$ . The number of radioactive atoms in that sample at that instant is, \_\_\_\_\_.

Option A  $3.17 \times 10^{19}$

Option B  $3.17 \times 10^{20}$

Option C  $3.17 \times 10^{17}$

Option D  $3.17 \times 10^{18}$

**Correct Option A**

**Solution:**

Given that,

Half life of radio active sample,  $T_{1/2} = 2.2 \times 10^9$  s

Rate of radioactive disintegration,  $R = 10^{10}$  /s

$$T_{1/2} = \frac{\ln 2}{\lambda} = \frac{0.693}{\lambda}$$

$$2.2 \times 10^9 = \frac{0.693}{\lambda}$$

$$\lambda = \frac{0.693}{2.2 \times 10^9} = 3.15 \times 10^{-10}$$

$$R = \lambda N$$

$$N = \frac{R}{\lambda} = \frac{10^{10}}{3.15 \times 10^{-10}} = 3.17 \times 10^{19}$$

**166. The time period of a geostationary satellite is 24 h, at a height  $6R_E$  ( $R_E$  is radius of earth) from surface of earth. The time period of another satellite whose height is  $2.5 R_E$  from surface will be,**

Option A  $\frac{12}{2.5}$  h

Option B  $6\sqrt{2}$  h

Option C  $12\sqrt{2}$  h

Option D  $\frac{24}{2.5}$  h

**Correct Option B**

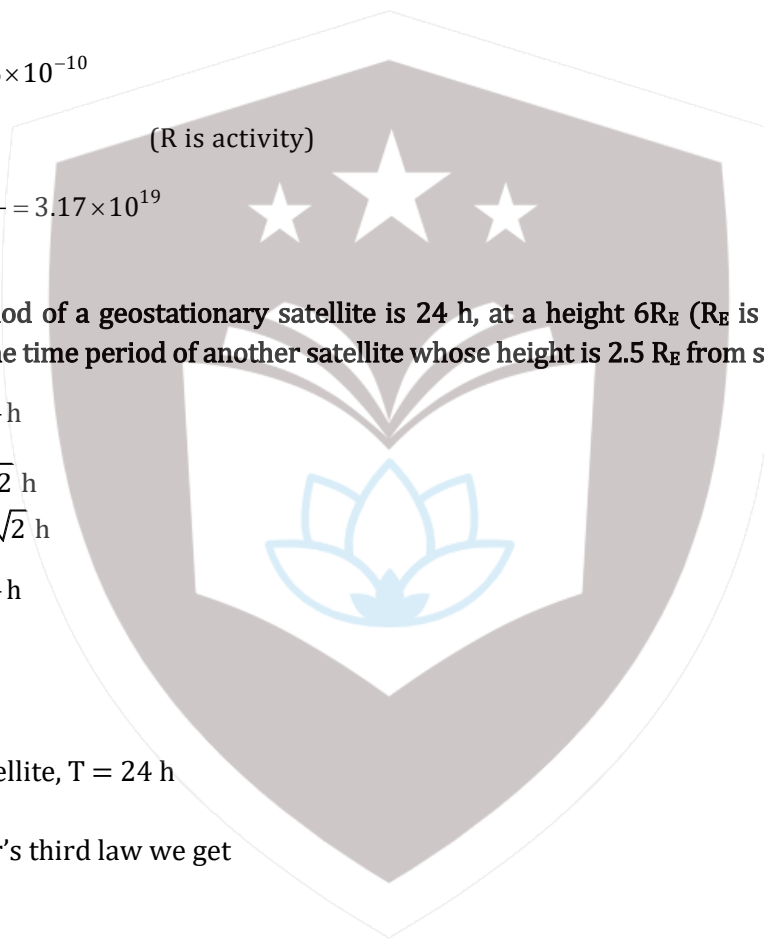
**Solution:**

Given that,

Time period of satellite,  $T = 24$  h

Now,

By applying Kepler's third law we get



$$T^2 \propto r^3$$

$$T^2 \propto (R_E + h)^3$$

$$\frac{T_1^2}{T_2^2} = \frac{(R_E + 6R_E)^3}{(R_E + 2.5R_E)^3}$$

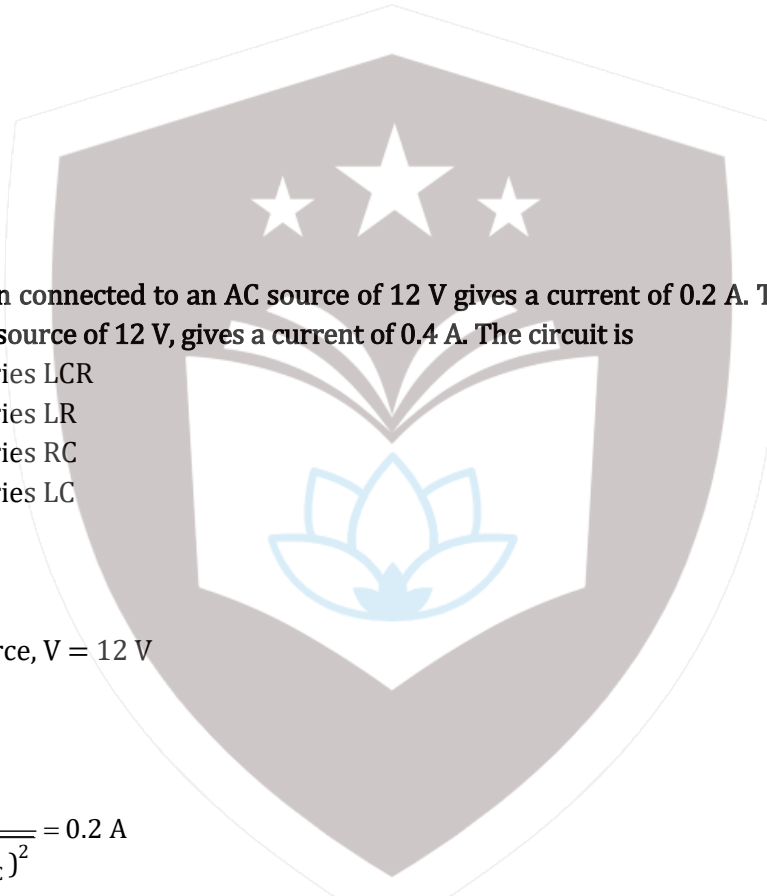
$$\frac{T_1^2}{T_2^2} = \frac{7^3}{\left(\frac{7}{3}\right)^3}$$

$$\frac{T_1^2}{T_2^2} = 8$$

$$T_2 = \frac{T_1}{2\sqrt{2}}$$

$$T_2 = \frac{24}{2\sqrt{2}}$$

$$T_2 = 6\sqrt{2} \text{ h}$$



**167. A circuit when connected to an AC source of 12 V gives a current of 0.2 A. The same circuit when connected to a DC source of 12 V, gives a current of 0.4 A. The circuit is**

- Option A      Series LCR
- Option B      Series LR
- Option C      Series RC
- Option D      Series LC

**Correct Option B**

**Solution:**

Given that,

Voltage of A.C source,  $V = 12 \text{ V}$

Current,  $I_1 = 0.2 \text{ A}$

$$I_1 = \frac{V}{Z}$$

$$I_1 = \frac{12}{\sqrt{R^2 + (X_L - X_C)^2}} = 0.2 \text{ A}$$

Now, In second case for DC source, capacitor would provide infinite resistance but current is present in circuit, it means resistor and inductor can be present in the circuit.

As the current with AC source and DC source are different, inductor must be present with resistance.

**168. A cycle wheel of radius 0.5 m is rotated with constant angular velocity of 10 rad/s in a region of magnetic field of 0.1 T which is perpendicular to the plane of the wheel. The EMF generated between its centre and the rim is,**

- Option A      Zero
- Option B      0.25 V
- Option C      0.125 V
- Option D      0.5 V

**Correct Option C**

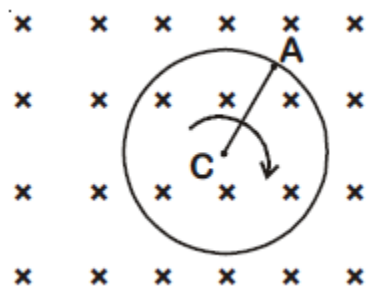
**Solution:**

Given that,

Radius,  $R = 0.5 \text{ m}$

Angular velocity,  $\omega = 10 \text{ rad/s}$

Magnetic field strength,  $B = 0.1 \text{ T}$



Now,

$$\begin{aligned} e &= \frac{Bl^2\omega}{2} \\ &= \frac{1}{2} \times 0.1 \times \left(\frac{1}{2}\right)^2 \times 10 \\ &= \frac{1}{8} \\ &= 0.125 \text{ V} \end{aligned}$$

**169. For a transparent medium, relative permeability and permittivity,  $\mu_r$  and  $\epsilon_r$  are 1.0 and 1.44 respectively. The velocity of light in this medium would be,**

Option A  $4.32 \times 10^8 \text{ m/s}$

Option B  $2.5 \times 10^8 \text{ m/s}$

Option C  $3 \times 10^8 \text{ m/s}$

Option D  $2.08 \times 10^8 \text{ m/s}$

**Correct Option B**

**Solution:**

Now,

According to Maxwell's electromagnetic wave equation, the relation between velocity, permeability and permittivity.

$$\begin{aligned} v &= \frac{1}{\sqrt{\mu \epsilon}} = \frac{c}{\sqrt{\mu_r \epsilon_r}} \\ &= \frac{3 \times 10^8}{\sqrt{1 \times 1.44}} \\ &= 2.5 \times 10^8 \text{ m/s} \end{aligned}$$

**170. A sphere encloses an electric dipole with charges  $\pm 3 \times 10^{-6} \text{ C}$ . What is the total electric flux across the sphere?**

Option A  $6 \times 10^{-6} \text{ Nm}^2/\text{C}$

Option B  $-3 \times 10^{-6} \text{ Nm}^2/\text{C}$

Option C Zero

Option D  $3 \times 10^{-6} \text{ Nm}^2/\text{C}$

**Correct Option C****Solution:**

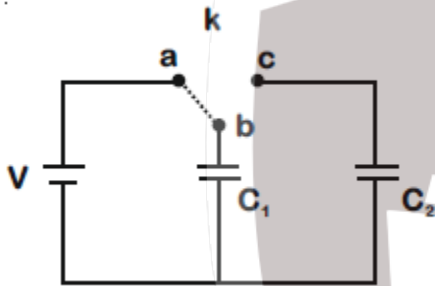
Now, according to Gauss law

$$\phi_{\text{Total}} = \frac{q_{\text{enclosed}}}{\epsilon_0}$$

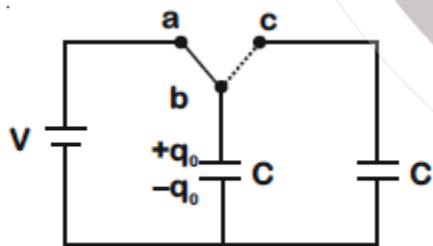
Dipole have equal and opposite charge, so net charge inside the sphere will be zero ( $q_{\text{enclosed}} = 0$ )

$$\begin{aligned}\phi_{\text{Total}} &= \frac{0}{\epsilon_0} \\ &= 0\end{aligned}$$

171. Two identical capacitors  $C_1$  and  $C_2$  of equal capacitance are connected as shown in the circuit. Terminals a and b of the key k are connected to charge capacitor  $C_1$  using battery of emf  $V$  volt. Now disconnecting a and b the terminals b and c are connected. Due to this, what will be the percentage loss of energy?



- Option A      25%
- Option B      75%
- Option C      0%
- Option D      50%

**Correct Option D****Solution:**

$$U_i = \frac{1}{2} CV^2$$

On switching key at point c

$$\frac{q_0 - q}{C} = \frac{q}{C}$$

$$2q = q_0$$

$$q = \left(\frac{q_0}{2}\right)$$

$$U_f = \frac{1}{2} \left(\frac{q_0}{2}\right)^2 \times \frac{1}{C} + \frac{1}{2} \left(\frac{q_0}{2}\right)^2 \times \frac{1}{C}$$

$$U_f = \frac{q_0^2}{4C}$$

$$U_f = \frac{1}{4} CV^2$$

$$\text{loss} = \left(\frac{U_i - U_f}{U_i}\right) \times 100$$

$$= \frac{\left(\frac{1}{2} - \frac{1}{4}\right) CV^2}{\frac{1}{2} CV^2} \times 100$$

$$= 50\%$$

172. An equiconvex lens has power P. It is cut into two symmetrical halves by a plane containing the principal axis. The power of one part will be,

Option A P

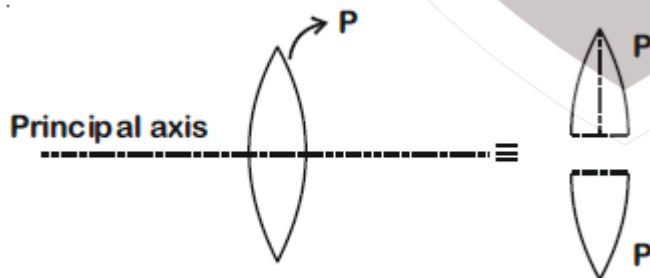
Option B 0

Option C  $\frac{P}{2}$

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

**Correct Option A**

**Solution:**



If lens is cut in two half as shown in the figure, then power of one part will be same. i.e. P, as focal length remains same.

173. In a Young's double slit experiment, if there is no initial phase difference between the light from the two slits, a point on the screen corresponding to the fifth minimum has path difference

Option A  $11 \frac{\lambda}{2}$

Option B  $5\frac{\lambda}{2}$

Option C  $10\frac{\lambda}{2}$

Option D  $9\frac{\lambda}{2}$

**Correct Option D**

**Solution:**

Now,

Path difference for destructive interference in Young's double slit experiment.

$$\Rightarrow \Delta X_n = \frac{(2n-1)\lambda}{2} \quad n=1,2,3,\dots$$

$$\Delta X_{5^{\text{th}}} = \left(\frac{2 \times 5 - 1}{2}\right)\lambda = \frac{9\lambda}{2}$$

**174. A double convex lens has focal length 25 cm. The radius of curvature of one of the surfaces is double of the other. Find the radii if the refractive index of the material of the lens is 1.5.**

Option A 50 cm, 100 cm

Option B 100 cm, 50 cm

Option C 25 cm, 50 cm

Option D 18.75 cm, 37.5 cm

**Correct Option D**

**Solution:**

Given that,

Focal length,  $f = 25$  cm

Refractive index,  $\mu = 1.5$

Now,

Focal length of lens for given combination will be.

$$\frac{1}{f} = (\mu - 1) \left( \frac{1}{R_1} - \frac{1}{R_2} \right)$$

$$\frac{1}{25} = (1.5 - 1) \left( \frac{1}{R} + \frac{1}{2R} \right)$$

$$\frac{1}{25} = 0.5 \left( \frac{3}{2R} \right)$$

$$2R = 37.5 \text{ cm}$$

$$R = 18.75 \text{ cm}$$

Hence radii are 18.75 cm, 37.5 cm

**175. Two bullets are fired horizontally and simultaneously towards each other from roof tops of two buildings 100 m apart and of same height of 200 m, with the same velocity of 25 m/s. When and where will the two bullets collide? ( $g = 10 \text{ m/s}^2$ )**

Option A They will not collide

Option B After 2 s at a height of 180 m

Option C After 2 s at a height of 20 m

Option D After 4 s at a height of 120 m

**Correct Option B**



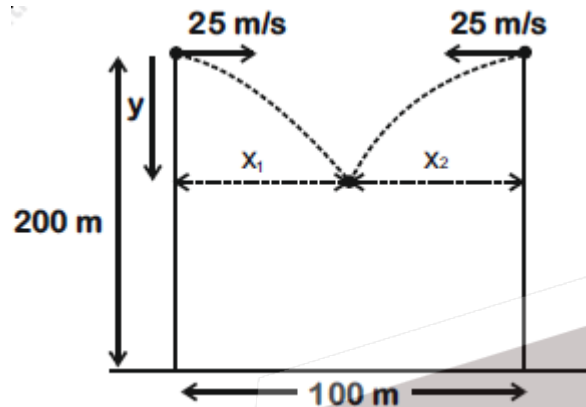
**Solution:**

Given that,

Distance between two building,  $d = 100 \text{ m}$

Height of each building,  $h = 200 \text{ m}$

Initial speed of bullet fired from each building,  $u = 25 \text{ m/s}$



Let bullets collide at time  $t$

$$x_1 + x_2 = 100 \text{ m}$$

$$25t + 25t = 100$$

$$t = 2 \text{ s}$$

$$y = \frac{1}{2}gt^2 = \frac{1}{2} \times 10 \times 2^2$$

$$= 20 \text{ m}$$

$$h = 200 - 20 = 180 \text{ m}$$

Hence bullets will collide after 2 s at height 180 m above the ground.

**176. The stress-strain curves are drawn for two different materials X and Y. It is observed that the ultimate strength point and the fracture point are close to each other for material X but are far apart for material Y.**

**We can say that materials X and Y are likely to be (respectively),**

Option A Plastic and ductile

Option B Ductile and brittle

Option C Brittle and ductile

Option D Brittle and plastic

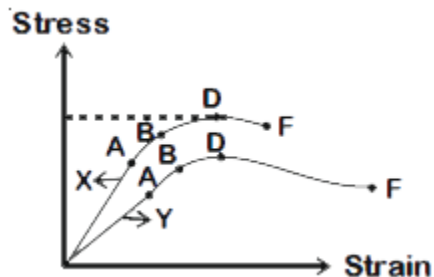
**Correct Option C**

**Solution:**

Now, for the given case, the fracture point and ultimate strength point for material are close.

As a result, material X is brittle, whereas material Y has two points that are far apart, making it ductile.

i.e X is brittle and Y is ductile in nature.



177. A body of mass  $m$  is kept on a rough horizontal surface (coefficient of friction =  $\mu$ ). A horizontal force is applied on the body, but it does not move. The resultant of normal reaction and the frictional force acting on the object is given by  $F$ , where  $F$  is,

Option A  $|\vec{F}| = mg$

Option B  $|\vec{F}| = mg + \mu mg$

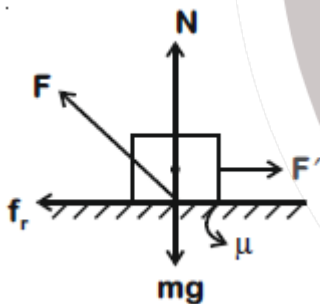
Option C  $|\vec{F}| = \mu mg$

Option D  $|\vec{F}| \leq mg\sqrt{1 + \mu^2}$

**Correct Option D**

**Solution:**

Now, for the given case the body does not move  
Hence, we can say that body is in equilibrium.



Consider

frictional force which is less than or equal to limiting friction =  $f_r$

Normal force =  $N$

Horizontal force =  $F$

Coefficient of friction =  $\mu$

Now,

$$N = mg$$

$$\therefore \vec{F} = \vec{N} + \vec{f}_r$$

$$|\vec{F}| \leq (mg)^2 + (\mu mg)^2$$

$$|\vec{F}| \leq mg\sqrt{1 + \mu^2}$$

178. A particle of mass  $5m$  at rest suddenly breaks on its own into three fragments. Two fragments of mass  $m$  each move along mutually perpendicular direction with speed  $v$  each. The energy released during the process is,

Option A  $\frac{4}{3}mv^2$

Option B  $\frac{4}{5}mv^2$

Option C  $\frac{5}{3}mv^2$

Option D  $\frac{3}{2}mv^2$

**Correct Option A**

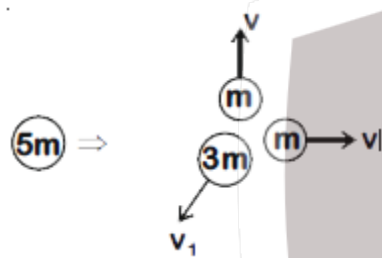
**Solution:**

Given that,

Initial mass,  $M = 5m$

Initial velocity,  $u = 0 \text{ m/s}$

Now, by applying the law of conservation of linear momentum.



Thus, for the given case

$$0 = mv\hat{j} + mv\hat{i} + 3m\vec{v}_1$$

$$\vec{v}_1 = -\frac{v}{3}(\hat{i} + \hat{j})$$

$$V_1 = \frac{\sqrt{2}}{3}v$$

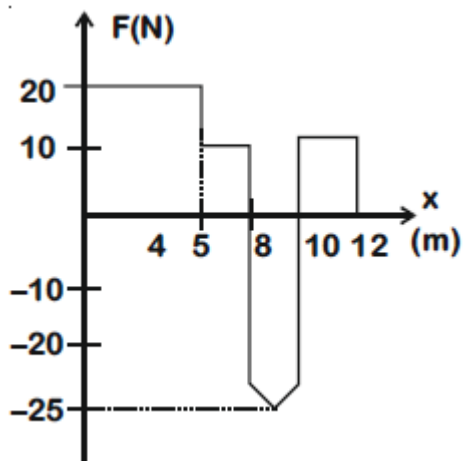
$$KE_i = 0$$

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

$$= mv^2 + \frac{mv^2}{3} = \frac{4}{3}mv^2$$

$$\Delta KE = KE_f - KE_i = \frac{4}{3}mv^2$$

179. An object of mass 500 g, initially at rest, is acted upon by a variable force whose X-component varies with X in the manner shown. The velocities of the object at the points  $X = 8 \text{ m}$  and  $X = 12 \text{ m}$ , would have the respective values of (nearly)



- Option A 18 m/s and 20.6 m/s  
 Option B 18 m/s and 24.4 m/s  
 Option C 23 m/s and 24.4 m/s  
 Option D 23 m/s and 20.6 m/s

**Correct Option D**

**Solution:**

From work-energy theorem we know that

$\Delta K = \text{work} = \text{area under } F - x \text{ graph}$

From  $x = 0$  to  $x = 8$  m

$$\frac{1}{2}mv^2 = 100 + 30$$

$$v^2 = 520$$

$$v = \sqrt{520} \approx 23 \text{ m/s}$$

From  $x = 0$  to  $x = 12$  m

$$\frac{1}{2}mv^2 = 100 + 30 - 47.5 + 20$$

$$v = \sqrt{410}$$

$$v \approx 20.6 \text{ m/s}$$

Hence appropriate option is 23 m/s and 20.6 m/s

**180. A solid cylinder of mass 2 kg and radius 50 cm rolls up an inclined plane of angle of inclination  $30^\circ$ . The centre of mass of the cylinder has speed of 4 m/s. The distance travelled by the cylinder on the inclined surface will be, \_\_\_\_\_.**

**[take  $g = 10 \text{ m/s}^2$ ]**

- Option A 2.4 m  
 Option B 2.2 m  
 Option C 1.6 m  
 Option D 1.2 m

**Correct Option A**

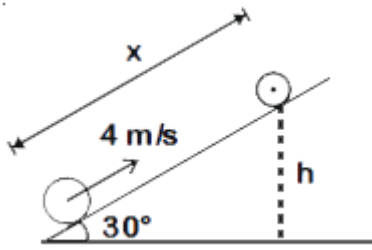
**Solution:**

Now, by applying law of conservation of energy we get

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

Thus, for the given case velocity of solid cylinder while rolling upward will be

$$v = \sqrt{\frac{2gh}{1 + \frac{K^2}{R^2}}}$$



$$v^2 = \frac{2gh}{1 + \frac{1}{2}} \left[ \because \frac{K^2}{R^2} = \frac{1}{2} \text{ for solid cylinder} \right]$$

$$2gh = 4^2 \times \frac{3}{2}$$

$$h = \frac{12}{10} = 1.2 \text{ m}$$

$$\therefore x = \frac{h}{\sin 30^\circ}$$

$$= \frac{1.2}{\frac{1}{2}} = 2.4 \text{ m}$$

$$x = 2.4 \text{ m}$$

