बेतियाहाता चौक पर पिछले 21 वर्षो से संचालित पूर्वांचल की No.1 कोचिंग
Vikas Agrawal & Arvind Tripathi's
MOMENTUM
बेतियाहाता चौक Head Office | खजांची चौक Branch Office
IIT-JEE NEET (UG) Foundations

Memory Based Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

JEE (Main)-2025 (Online) Phase-1

(Physics, Chemistry and Mathematics)

IMPORTANT INSTRUCTIONS:

(1) The test is of **3 hours** duration.

(2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.

(3) This question paper contains **Three Parts**. **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is **Mathematics**. Each part has only two sections: **Section-A** and **Section-B**.

(4) **Section - A :** Attempt all questions.

(5) **Section - B :** Attempt all questions.

(6) **Section - A (01 – 20)** contains 20 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

(7) **Section - B (21 – 25) contains** 5 **Numerical value** based questions. The answer to each question should be rounded off to the **nearest integer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer:

1. Find the dimensions of $\frac{B}{\mu_0}$

(1) [AL] (2) $[AL^{-1}]$

(3) [MAL] (4) $[MALT^{-1}]$

Answer (2)

Sol. $\oint B \cdot dl = \mu_0 i \Rightarrow \frac{B}{\mu_0} = \frac{i}{l} \equiv [AL^{-1}]$

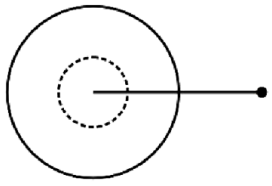
2. Solid sphere of mass M, radius R exerts force F on a point mass. Now a concentric spherical mass $\frac{M}{7}$ is removed. What is new force?

(1) $\frac{F}{7}$ (2) $\frac{6}{7}F$

(3) $\frac{5F}{7}$ (4) $\frac{3F}{7}$

Answer (2)

Sol.

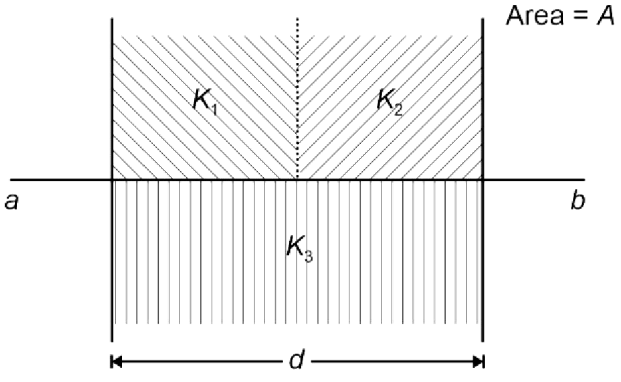


$$F = \frac{GMm}{r^2}$$

$$F' = \frac{G\left(M - \frac{M}{7}\right)m}{r^2}$$

$$\Rightarrow \quad F' = \frac{6}{7}F$$

3. Find out equivalent capacitance for the situation show in figure.



(1) $C_{eq} = \frac{A\varepsilon_0}{d}\left(\frac{K_1K_2 + K_2K_3 + K_3K_1}{K_1 + K_2}\right)$

(2) $C_{eq} = \frac{A\varepsilon_0}{d}\left(\frac{2K_1K_2 + K_2K_3 + K_3K_1}{2(K_1 + K_2)}\right)$

(3) $C_{eq} = \frac{A\varepsilon_0}{d}\left(\frac{K_1K_2 + K_2K_3 + K_3K_1}{2(K_1 + K_2)}\right)$

(4) $C_{eq} = \frac{A\varepsilon_0}{2d}\left(\frac{K_1K_2 + K_2K_3 + K_3K_1}{(K_1 + K_2)}\right)$

Answer (2)

Sol. Here,

$$C_1 = \frac{2 \times A\varepsilon_0K_1}{2d} = \frac{A\varepsilon_0K_1}{d}$$

$$C_2 = \frac{A\varepsilon_0K_2}{d}$$

$$C_3 = \frac{A\varepsilon_0K_3}{2d}$$

Now C_1 and C_2 are in series

So, $\frac{1}{C_1'} = \frac{1}{C_1} + \frac{1}{C_2}$

$$\Rightarrow \frac{1}{C_1'} = \frac{d}{A\varepsilon_0K}\left[\frac{1}{K_1} + \frac{1}{K_2}\right] = \frac{d(K_1 + K_2)}{A\varepsilon_0K_1K_2}$$

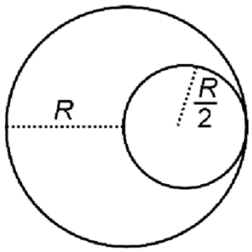
$$\Rightarrow C_1' = \frac{A\varepsilon_0K_1K_2}{d(K_1 + K_2)}$$

Now C_1' is parallel to C_3

$$\Rightarrow C_{eq} = \frac{A\varepsilon_0}{d}\left[\frac{K_1K_2}{K_1 + K_2} + \frac{K_3}{2}\right]$$

$$\Rightarrow C_{eq} = \frac{A\varepsilon_0}{d}\left[\frac{2K_1K_2 + K_2K_3 + K_3K_1}{2(K_1 + K_2)}\right]$$

4. From a sphere of mass M and radius R, a cavity of radius $\frac{R}{2}$ is created. Find the moment of inertia about an axis passing through the centre of sphere and cavity.



(1) $\frac{31}{48} MR^2$

(2) $\frac{31}{80} MR^2$

(3) $\frac{13}{32} MR^2$

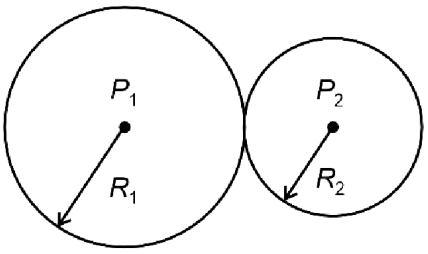
(4) $\frac{21}{32} MR^2$

Answer (2)

Sol. $I = \frac{2}{5} MR^2 - \frac{2}{5}\left(\frac{M}{8}\right)\left(\frac{R}{2}\right)^2$

$= \frac{31}{80} MR^2$

5. Find the radius of curvature of the common surface of two bubbles ($R_1 > R_2$)



(1) $R = \frac{R_1R_2}{R_1 + R_2}$

(2) $R = \frac{2R_1R_2}{R_1 - R_2}$

(3) $R = \frac{R_1R_2}{R_1 - R_2}$

(4) $R = \frac{R_1R_2}{(R_1 - R_2)}$

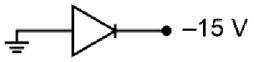
Answer (3)

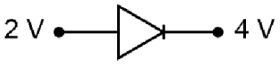
Sol. $P_1 - P_0 = \frac{4S}{R_1}; P_2 - P_0 = \frac{4S}{R_2}$

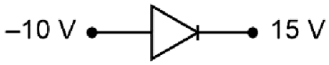
So, $P_2 - P_1 = \Delta P = \frac{4S}{R} = 4S\left[\frac{1}{R_2} - \frac{1}{R_1}\right]$

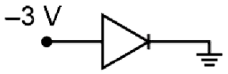
or $\frac{1}{R} = \frac{R_1 - R_2}{R_1R_2}$

6. From the given option, identify the diode connected in forward bias.

(1) 

(2) 

(3) 

(4) 

Answer (1)

Sol. Only in option (1), the p-side is connected at higher potential than the n-side of the diode.

7. Radius of electron in ground state for hydrogen is a_0, then radius of electron in He^+ ion in 3rd excited state is a. Then $\frac{a_0}{a}$ is

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

(2) $\frac{1}{4}$

(3) $\frac{1}{16}$

(4) $\frac{1}{8}$

Answer (4)

Sol. $\boxed{r = \frac{n^2}{z} r_0} \Rightarrow$ for H

$a_0 = \frac{1}{1} r_0$

$a = \frac{4^2}{2} r_0$

$\frac{a_0}{a} = \frac{1}{8}$

8. Ice at –10°C is to be converted into steam at 110°C. Mass of ice is 10^{-3} kg. What amount of heat is required?

(1) ΔQ = 730 cal (2) ΔQ = 900 cal

(3) ΔQ = 1210 cal (4) ΔQ = 870 cal

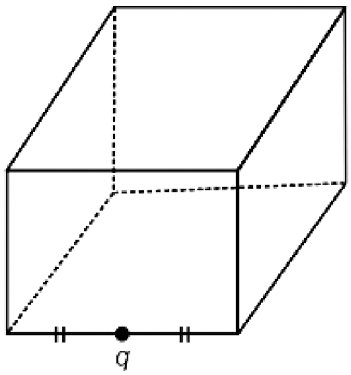
Answer (1)

Sol. –10°C ice to 0°C ice $\rightarrow$ 0°C ice to 0°C water + 0°C water to 100°C water + 100°C water to 100°C steam + 110°C steam.

$$\Rightarrow \quad \Delta Q = \left(1\times\frac{1}{2}\times 10\right) + (1\times 80) + (1\times 1\times 100)$$

$$+(1\times 540) + \left(1\times\frac{1}{2}\times 10\right) = 730 \text{ cal}$$

9. A charge of value q is placed at the edge of a imaginary cube of side a as shown in figure. Find the net flux through the cube



(1) $\frac{q}{6\varepsilon_0}$ (2) $\frac{q}{4\varepsilon_0}$

(3) $\frac{q}{8\varepsilon_0}$ (4) $\frac{q}{2\varepsilon_0}$

Answer (2)

Sol. ϕ_4 such cubes $= \frac{q}{\varepsilon_0}$

ϕ_1 cube $= \frac{q}{4\varepsilon_0}$

10. A closed organ pipe in 9th harmonic resonates with 4th harmonic of open organ pipe [l_{closed} = 10 cm]. Find length of open organ pipe.

(1) $L_0 = 15$ cm

(2) $L_0 = \frac{100}{9}$ cm

(3) $L_0 = \frac{110}{7}$ cm

(4) $L_0 = \frac{80}{9}$ cm

Answer (4)

Sol. $\frac{9v}{4L_c} = \frac{4v}{2L_0} \Rightarrow L_0 = \frac{8L_c}{9}$

11. A capacitor is charged by battery to charge Q_1. Now the battery is disconnected and dielectric slab of dielectric constant K is inserted between the gaps of the plates. Now charge on capacitor is Q_2. Find $\frac{Q_1}{Q_2}$.

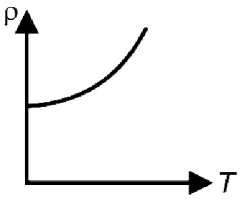
(1) 1 (2) $\frac{1}{2}$

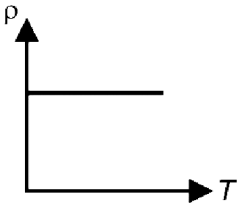
(3) 2 (4) $\frac{2}{3}$

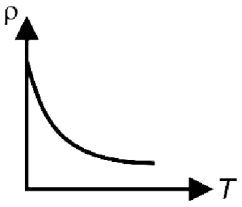
Answer (1)

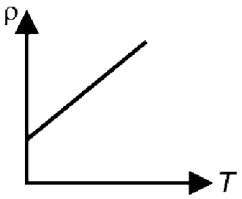
Sol. $\frac{Q_1}{Q_2}$ = 1 (No further charge is supplied)

12. Which of the following graphs correctly represents the variation of resistivity (ρ) with temperature (T).

(1) 

(2) 

(3) 

(4) 

Answer (1)

Sol. The resistivity of conductors increases with increase in temperature non-linearly.

13. If whole YDSE apparatus is immersed in a liquid of refractive index μ, then what is the effect on fringe width?

(1) Fringe width increases

(2) Fringe width decreases

(3) Fringe width remains unchanged

(4) It may increase on one side and decrease on other side

Answer (2)

Sol. $\Delta\omega = \frac{\lambda D}{\lambda}$

So, for RI of μ

$\Delta\omega' = \frac{\lambda D}{\mu d}$

14. Two spherical black bodies of radius 0.8 m and 0.2 m are at temperatures of 400 K and 800 K respectively. Find ratio of rate of heat loss.

(1) 8 (2) 4

(3) 2 (4) 1

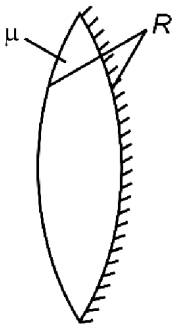
Answer (4)

Sol. $P_1 = \sigma 4\pi (0.8)^2 (400)^4$

$P_2 = \sigma 4\pi (0.2)^2 (800)^4$

$\frac{P_1}{P_2} = \frac{4\times 4}{2^4} = 1$

15. The equiconvex lens shown in figure is silvered on one side. For what distance of object from the lens is the image formed on the object itself?



(1) μR (2) $\frac{R}{\mu}$

(3) $\frac{R}{2\mu - 1}$ (4) $\frac{R}{2\mu - 2}$

Answer (3)

Sol. Silvering of lens

$\frac{1}{F_{eq}} = \frac{1}{f_m} - \frac{2}{f_\ell}$ $\qquad \frac{1}{f_\ell} = (\mu - 1)\left(\frac{1}{R} - \left(\frac{1}{-R}\right)\right)$

$= \frac{-2}{R} - \frac{4(\mu - 1)}{R}$ $\qquad \frac{1}{f_\ell} = \frac{2(\mu - 1)}{R}$

$= \frac{-2(1 + 2\mu - 2)}{R}$

$F = \frac{-R}{2(2\mu - 1)}$

For object-image to coincide distance should be $2f$

$|u| = 2|F|$

$= \frac{R}{2\mu - 1}$

16. Light of wavelength 550 nm is incident an surfaces of cerium and lithium. Work function are respectively 1.9 eV and 2.5 eV. Then electron will be ejected from

(1) Cerium only (2) Lithium only

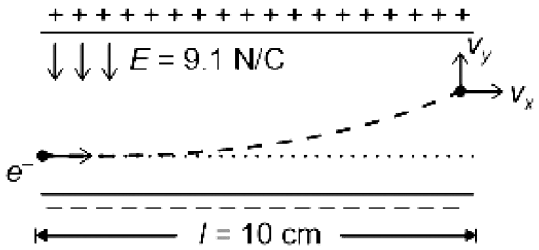
(3) From both of them (4) None of them

Answer (1)

Sol. $E(\text{eV}) = \frac{1240}{\lambda(\text{nm})} = \frac{1240}{550} \simeq 2.25$

$2.25 > 1.9$ for cerium only

17. The figure shows an electron entering the space between the plates of a parallel plate capacitor with an initial velocity, $v_x = 10^6$ m/s parallel to the plates. If the length of plates is $l = 10$ cm and the electric field in the region $E = 9.1$ N/C, then the value of v_y when the electron comes out of the plates is (Electronic mass = 9.1×10^{-31} kg)



(1) 1.6×10^4 m/s (2) 1.6×10^5 m/s

(3) 1.6×10^7 m/s (4) 1.6×10^3 m/s

Answer (2)

Sol. Time inside the electric field, $t = \frac{l}{v_x}$

Acceleration of electron along y-axis, $a = \frac{eE}{m}$

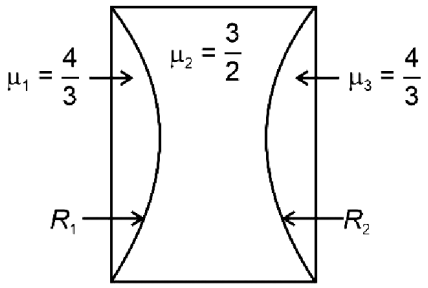
Velocity $v_y = at$

$= \frac{eE}{m} \cdot \frac{l}{v_x}$

$= \frac{1.6\times 10^{-19} \times 9.1 \times 10 \times 10^{-2}}{9.1 \times 10^{-31} \times 10^6}$ m/s

$= 1.6 \times 10^5$ m/s

18. Find the equivalent power of the thin lens combination shown in the figure.



(1) $+\left(\frac{R_1+R_2}{R_1+R_2}\right)$ (2) $-\left(\frac{R_1+R_2}{R_1R_2}\right)$

(3) $-\left(\frac{R_1+R_2}{6R_1R_2}\right)$ (4) $+\left(\frac{R_1+R_2}{6R_1R_2}\right)$

Answer (3)

Sol. Net power = $P_1 + P_2 + P_3$

$$= \frac{(\mu_1-1)}{R_1} + (\mu_2-1)\left(\frac{1}{-R_1}+\frac{1}{-R_2}\right) + \frac{(\mu_3-1)}{R_2}$$

$$= \frac{(\mu_1-\mu_2)}{R_1} + \frac{(\mu_3-\mu_2)}{R_2}$$

$$= \left(\frac{4}{3}-\frac{3}{2}\right)\frac{1}{R_1} + \left(\frac{4}{3}-\frac{3}{2}\right)\frac{1}{R_2}$$

$$= -\frac{1}{6}\left(\frac{1}{R_1}+\frac{1}{R_2}\right)$$

$$= -\left(\frac{R_1+R_2}{6R_1R_2}\right)$$

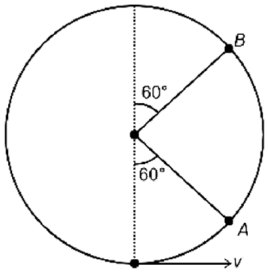
19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. The particle shown in figure is just able to complete the vertical circular motion. Find the ratio of kinetic energy at *A* to the kinetic energy at *B*.



Answer (2)

Sol. $v = \sqrt{5gR}$

$$KE_A = \frac{1}{2}mv^2 - mg\frac{R}{2}$$

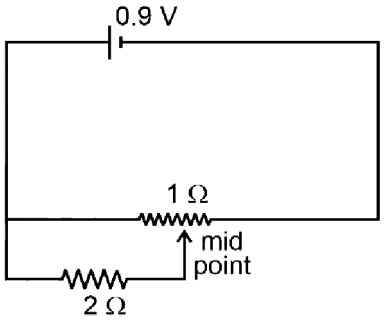
$$KE_A = 2mgR$$

$$KE_B = \frac{1}{2}mv^2 - mg\left(\frac{3R}{2}\right)$$

$$= mgR$$

$$\frac{KE_A}{KE_B} = 2$$

22. The current drawn from battery in the circuit shown below is _____ *A*



Answer (1)

Sol. $\frac{1}{R_1'} = \frac{1}{2} + 2 = \frac{5}{2}$

$$\Rightarrow R_1' = \frac{2}{5}\Omega$$

Now, $R = \frac{2}{5} + \frac{1}{2} = \frac{9}{10}\Omega$

So, $I = \frac{9 \times 10}{10 \times 9} = 1A$

23.

24.

25.

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. For complex ion $[NiCl_4]^{2-}$ what is the charge on metal and shape of complex respectively?

(1) +2, Tetrahedral (2) +2, Square planar

(3) +4, Tetrahedral (4) +4, Square Planar

Answer (1)

Sol. $[NiCl_4]^{2-} \Rightarrow Ni^{2+} \rightarrow 3d^8$

Cl^- ligand is weak field ligand and hybridisation is sp^3. Shape of complex is tetrahedral.

2. Compare boiling point of given solutions

(i) 10^{-4} M NaCl (ii) 10^{-3} M NaCl

(iii) 10^{-2} M NaCl (iv) 10^{-4} M urea

(1) I > II > III > IV (2) III > II > I > IV

(3) II > I > III > IV (4) III > I > II > IV

Answer (2)

Sol. Higher the elevation in boiling point, higher will be the boiling point

$\Delta Tb \propto i \times m$

For urea i = 1

For NaCl i = 2

Boiling point order III > II > I > IV

3. The correct decreasing order of electronegativity is

(1) F > Cl > I > Br (2) Cl > F > Br > I

(3) F > Cl > Br > I (4) Br > F > I > Cl

Answer (3)

Sol. The correct order is

F > Cl > Br > I

4. Which of the following has maximum size out of Al^{3+}, Mg^{2+}, F^-, Na^+?

(1) Al^{3+} (2) Mg^{2+}

(3) F^- (4) Na^+

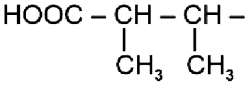
Answer (3)

Sol. For isoelectronic species, more the negative charge more will be the size, also more the positive charge smaller will be the size.

The correct order of ionic size is :

$Al^{3+} < Mg^{2+} < Na^+ < F^-$

5. The IUPAC name of given specie is



(1) 2, 3-dimethyl methyl carboxy butanoic acid

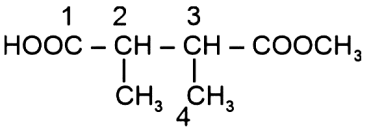
(2) 4-methoxy carbonyl-2, 3-dimethyl propanoic acid

(3) 3-methoxycarbonyl-2-methyl butanoic acid

(4) 1-carboxy-2, 3-dimethyl methyl butanoate

Answer (3)

Sol.



3-methoxycarbonyl-2-methyl butanoic acid

6. Compare crystal field splitting energy(Δ) for given complexes

(i) $K_4[Fe(CN)_6]$ (ii) $[Cu(NH_3)_4]^{+2}$s

(iii) $K_4[Fe(SCN)_6]$ (iv) $[Fe(en)_3]Cl_3$

(1) I > II > III > IV (2) II > I > IV > III

(3) IV > I > III > II (4) IV > III > I > II

Answer (2)

Sol. $K_4[Fe(CN)_6] \Rightarrow d^6 \Rightarrow$ SFL,

$K_2[Cu(NH_3)_4] \Rightarrow d^9 \Rightarrow dsp^2$

$K_4[Fe(SCN)_6] \Rightarrow d^6 \Rightarrow$ WFL

$[Fe(en)_3]Cl_3 \Rightarrow d^5 \Rightarrow$ SFL

Splitting energy $\propto$ Strength of ligand $\propto$ Charge of CA.

$\Delta_{sp} > \Delta_o$

II > I > IV > III

7. Consider the given equilibrium reaction

$$CO_2(g) + C(s) \rightleftharpoons 2CO(g)$$

If initial pressure of CO_2 is 0.6 atm and after equilibrium is established, total pressure is 0.8 atm. Then, find K_p.

(1) 0.4 (2) 0.2

(3) 0.6 (4) 0.8

Answer (1)

Sol. $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$

$t = 0 \quad 0.6$

$t = t_{eq} \quad 0.6 - p \qquad 2p$

P_t at equilibrium = 0.8 = 0.6 + p

0.2 = p

$$K_p = \frac{(p_{CO})^2}{(p_{CO_2})} = \frac{(2p)^2}{0.6-p} = \frac{4\times0.04}{0.6-0.2} = \frac{4\times0.04}{0.4} = 0.4$$

8. Statement-I: $CH_3 - O - CH_2 - Cl$ will show nucleophilic substitution by S_N1 mechanism in protic medium.

Statement-II: $CH_3 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - CH_2 - Cl$ will not undergo nucleophilic substitution via S_N2 mechanism easily.

(1) Statement-I and statement-II both are correct

(2) Statement-I and statement-II both are incorrect

(3) Statement-I is correct but statement-II is incorrect

(4) Statement-I is incorrect but statement-II is correct

Answer (1)

Sol. $CH_3 - O - \overset{\oplus}{C}H_2$ stabilised by resonance.

9. Which of the following acids is also known as vitamin C?

(1) Adipic acid (2) Ascorbic acid

(3) Saccharic acid (4) Aspartic acid

Answer (2)

Sol. Ascorbic acid is also known as vitamin C.

10. An electron of He^+ is present in 3rd excited state. Find its de-Broglie wavelength.

(1) 6.64 Å (2) 1.66 Å

(3) 3.32 Å (4) 13.28 Å

Answer (1)

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

For 3rd excited state, n = 4

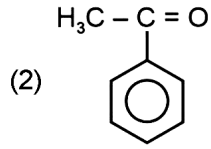
$$4\lambda = 2 \times \pi \times a_\circ \frac{n^2}{z}$$

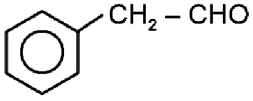
$$4\lambda = 2 \times \pi \times 0{\cdot}529 \frac{16}{2} \text{ Å}$$

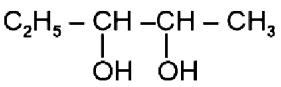
$\lambda = 2 \times 3{\cdot}14 \times 0{\cdot}529 \times 2$ Å = 6·64 Å

11. Which of the following will show positive Fehling test?

(1) 

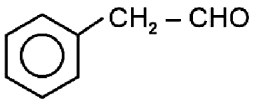
(2) 

(3) 

(4) 

Answer (3)

Sol. Fehling test is given by Aldehydes except benzaldehyde

 will give +ve Fehling test

12. $4f^7$ configuration is possible for

(a) Eu^{3+}, (b) Eu^{2+}, (c) Gd^{3+}, (d) Tb^{3+}, (e) Sm^{2+}

(1) (a) and (c)

(2) (b) and (c)

(3) (d) and (e)

(4) Only (c)

Answer (2)

Sol. Electronic configuration of:

$Eu^{3+} \Rightarrow 4f^6$ $\quad$ $Tb^{3+} \Rightarrow 4f^8$

$Eu^{2+} \Rightarrow 4f^7$ $\quad$ $Sn^{2+} \Rightarrow 4f^5$

$Gd^{3+} \Rightarrow 4f^7$

13. Given : $NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$

If the partial pressure of CO_2 gas at equilibrium is 0.4 atm and the total pressure is 1 atm, then the value of K_p at the same temperature is

(1) 0.027 atm^3

(2) 0.064 atm^3

(3) 0.144 atm^3

(4) 0.216 atm^3

Answer (3)

Sol. $NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$

Total pressure at equilibrium = 1.0 atm

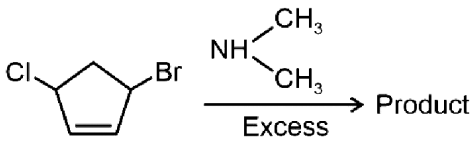
Partial pressure of CO_2 at equilibrium = 0.4 atm

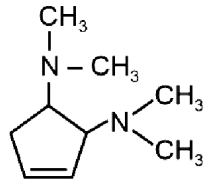
$\therefore$ Partial pressure of NH_3 at equilibrium = 0.6 atm

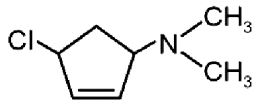
$K_p = (p_{NH_3})^2(p_{CO_2})$

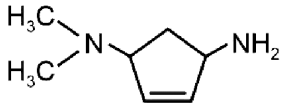
$= (0.6)^2(0.4)$

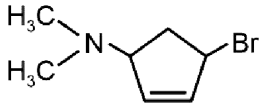
$= 0.144$ atm^3

14. 

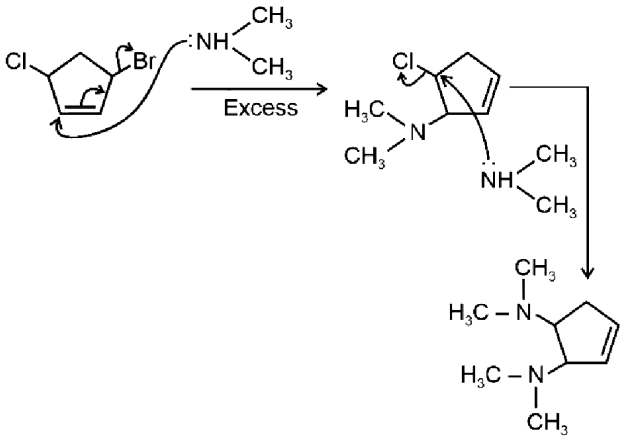
(1) 

(2) 

(3) 

(4) 

Answer (1)

Sol. 

15. CO_2 gas is taken at 1 atm, 273K. Now it is allowed to pass through 0.1 M $Ca(OH)_2$ aq. solution. Excess amount of $Ca(OH)_2$ is neutralised with 40 mL of 0.1 M HCl. Then find volume of $Ca(OH)_2$ initially taken if 50% $Ca(OH)_2$ is react with CO_2

(1) 40 mL (2) 20 mL

(3) 80 mL (4) 50 mL

Answer (1)

Sol. g meq of $Ca(OH)_2$ = 2 × gm eq of HCl

$$0.1\times\frac{V_{mL}}{1000}\times 2 = 2\times 0.1\times\frac{40}{1000}\times 1$$

$$V_{mL} = 40 \text{ mL}$$

16. In a closed insulated container, a liquid is stirred with a paddle to increase the temperature, which of the following is true?

(1) $w = 0, \Delta E = q \neq 0$ (2) $\Delta E = w \neq 0, q = 0$

(3) $\Delta E = w = 0, q \neq 0$ (4) $\Delta E = 0, w = q \neq 0$

Answer (2)

Sol. In closed insulated container a liquid stirred with a paddle to increase the temperature, it behaves as an adiabatic container, q = 0

From FLOT

$\Delta U = q + w; q = 0$

$\Delta E = w$ (but not zero)

17. Match the column and choose the correct option

	Column-I (Properties)		Column-II (Order)
(A)	Electronegativity	(1)	B < C < N < O
(B)	Cationic size	(2)	Li > Mg > Be
(C)	Metallic Character	(3)	K > Mg > Al
(D)	Electron affinity	(4)	Cl > F > Br > I

(1) A–1, B–2, C–3, D–4

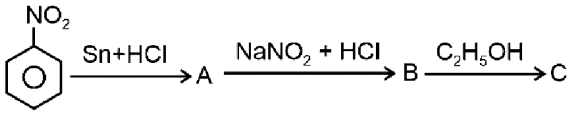
(2) A–4, B–3, C–2, D–1

(3) A–2, B–3, C–4, D–1

(4) A–3, B–2, C–4, D–1

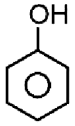
Answer (1)

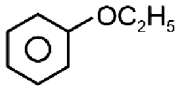
Sol. $\underset{76\,pm}{Li^+} > \underset{72\,pm}{Mg^{2+}} > \underset{31\,pm}{Be^{2+}}$

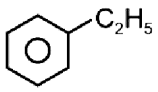
18. 

Identify C.

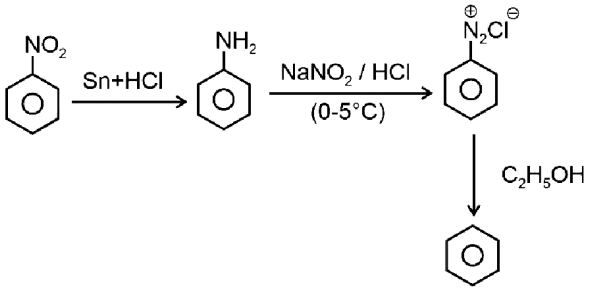
(1) 

(2) 

(3) 

(4) 

Answer (1)

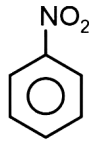
Sol. 

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. 

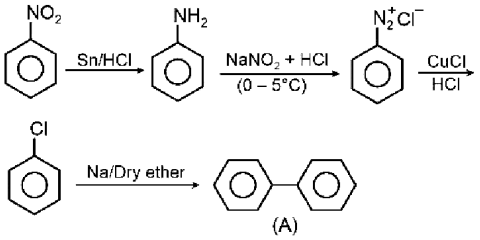
$\xrightarrow[\text{(ii) } NaNO_2/HCl(0 - 5\ ^\circ C)]{\text{(i) Sn/HCl}}$ A (major)

(iii) CuCl//HCl

(iv) Na/dry ether

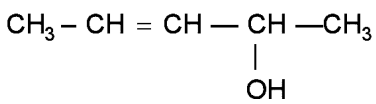
Find molecular weight of (A) in g mol^{-1}

Answer (154)

Sol. 

Molecular weight of (A) = 154 g mol^{-1}

22. Calculate Number of stereoisomers of



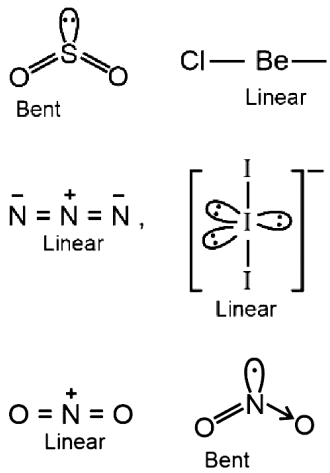
Answer (4)

Sol. Number of centres which can show stereoisomerism in molecule = 2

Number of isomers = $2^2 = 4$

23. How many compounds have linear shape SO_2, $BeCl_2$, N_3^-, I_3^-, NO_2^+, NO_2 ?

Answer (4)

Sol. 

24. In Carius method 180 mg of organic compound gives 143.5 mg of AgCl. Find the percentage of Cl in the organic compound. (Nearest integer)

Answer (20)

Sol. Mass of organic compound = 180 mg

Mass of AgCl = 143.5 mg

$$\text{Mass of Cl} = \frac{143.5}{143.5} \times 35.5 \text{ mg}$$

$$= 35.5 \text{ mg}$$

Percentage of Cl in the organic compound

$$= \frac{35.5 \times 100}{180}$$

$$= 19.72\% \simeq 20\%$$

25. Two ampere current is allowed to pass through molten $AlCl_3$ for 30 min. Find the mass (in mg) of aluminium deposited at cathode. (Nearest integer)

Answer (336)

Sol. Total charge passed = 2 × 30 × 60 C

$$\text{Number of Faradays passed} = \frac{2 \times 30 \times 60}{96500} \text{ F}$$

$$\text{Equivalents of Al deposited} = \frac{36}{965}$$

$$\text{Mass of Al deposited} = \frac{36 \times 9}{965} \text{ g}$$

$$= \frac{36 \times 9 \times 1000}{965} \text{ mg}$$

$$= 335.75 \text{ mg}$$

$$\simeq 336 \text{ mg}$$

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. The shortest distance between the lines

$\frac{x-1}{2}=\frac{y-2}{3}=\frac{z-1}{4}$ and

$\frac{x+2}{7}=\frac{y-2}{8}=\frac{z+1}{2}$ is

(1) $\frac{88}{\sqrt{1277}}$ (2) $\frac{78}{\sqrt{1277}}$

(3) $\frac{66}{\sqrt{1277}}$ (4) $\frac{55}{\sqrt{1277}}$

Answer (1)

Sol. $d=\frac{|(a_2-a_1)\cdot(b_1\times b_2)|}{|b_1\times b_2|}$

$b_1\times b_2=\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\2&3&4\\7&8&2\end{vmatrix}$

$=-26\hat{i}+24\hat{j}-5\hat{k}$, $a_2-a_1=3\hat{i}+2\hat{k}$

$d=\left|\frac{(3\hat{i}+2\hat{k})\cdot(-26\hat{i}+24\hat{j}-5\hat{k})}{\sqrt{26^2+24^2+5^2}}\right|$

$=\left|\frac{-78-10}{\sqrt{1277}}\right|=\frac{88}{\sqrt{1277}}$

2. In a bag there are 6 white and 4 black balls two balls are drawn at random, then the probability that both ball are white are

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

(3) $\frac{2}{3}$ (4) $\frac{1}{4}$

Answer (2)

Sol. $P(E)=\frac{{}^6C_2}{{}^{10}C_2}$

$=\frac{15}{45}=\frac{1}{3}$

3. Let $A = \{1, 2, 3\}$ number of non-empty equivalence relations from A to A are

(1) 4 (2) 5

(3) 6 (4) 8

Answer (2)

Sol. The partitions far a set with 3 elements, {1, 2, 3}

$\{\{1\},\{2\},\{3\}\}$ – Every element is in its own subset

$\{\{1,2\},\{3\}\}$ – Two elements are together, one separate

$\{\{1,3\},\{2\}\}$ – Two elements are together, one separate

$\{\{2,3\},\{1\}\}$ – Two elements are together, one separate

$\{\{1,2,3\}\}$ – All elements are together in one subset

$\therefore$ Therefore, total possible equivalence relation = 5

4. If $f(x)=16(\sec^{-1}x)^2+(\text{cosec}^{-1}x)^2$. Then the maximum and minimum value of $f(x)$ is

(1) $\frac{1001\pi^2}{33}$ and $\frac{2\pi^2}{9}$ (2) $\frac{1105\pi^2}{68}$ and $\frac{4\pi^2}{17}$

(3) $\frac{1117\pi^2}{59}$ and $\frac{6\pi^2}{19}$ (4) $\frac{1268\pi^2}{27}$ and $\frac{3\pi^2}{16}$

Answer (2)

Sol. $f(x)=(4\sec^{-1}x)^2+(\text{cosec}^{-1}x)^2$

$=(4\sec^{-1}x+\text{cosec}^{-1}x)^2-8\sec^{-1}x\,\text{cosec}^{-1}x$

$=\left(3\sec^{-1}x+\frac{\pi}{2}\right)^2-8\sec^{-1}x\left[\frac{\pi}{2}-\sec^{-1}x\right]$

$=9(\sec^{-1}x)^2+\frac{\pi^2}{4}+3\pi\sec^{-1}x-4\pi\sec^{-1}x+8(\sec^{-1}x)^2$

$=17(\sec^{-1}x)^2-\pi(\sec^{-1}x)+\frac{\pi^2}{4}$

$=17\left[\left(\sec^{-1}x\right)^2-\frac{\pi}{17}(\sec^{-1}x)+\frac{\pi^2}{34^2}\right]+\frac{\pi^2}{4}-\frac{17\pi^2}{34^2}$

$=17\left[\left(\sec^{-1}x-\frac{\pi}{34}\right)^2\right]+\frac{\pi^2}{4}-\frac{\pi^2}{68}$

$=17\left[\left(\sec^{-1}x-\frac{\pi}{34}\right)^2\right]+\frac{4\pi^2}{17}$

Min $=\frac{4\pi^2}{17}$

Max if $\sec^{-1}x=\pi$

$17\left[\left(\pi-\frac{\pi}{34}\right)^2\right]+\frac{4\pi^2}{17}$

$\frac{1089}{68}\pi^2+\frac{4\pi^2}{17}=\frac{1105\pi^2}{68}$

5. If $8 = 3 + \frac{1}{4}(3+p) + \frac{1}{4^2}\left(3+p^2\right) + \ldots \infty$ then the value of p is

(1) $\frac{14}{5}$ (2) $\frac{16}{5}$

(3) $\frac{3}{5}$ (4) $\frac{4}{5}$

Answer (2)

Sol. $8 = \left(3 + \frac{3}{4} + \frac{3}{4^2} + \ldots + \infty\right) + \left(\frac{p}{4} + \frac{p^2}{4^2} + \ldots + \infty\right)$

$8 = 3\left(1 + \frac{1}{4} + \frac{1}{4^2} + \ldots + \infty\right) + \left(\frac{p}{4} + \frac{p^2}{4^2} + \ldots + \infty\right)$

$8 = 3\left(\frac{1}{1-\frac{1}{4}}\right) + \frac{\frac{p}{4}}{1-\frac{p}{4}}$

$8 = 3\left(\frac{4}{3}\right) + \frac{p}{4-p}$

$4 = \frac{p}{4-p}$

$\Rightarrow$ $16 - 4p = p$

$\Rightarrow$ $5p = 16$

$\Rightarrow$ $p = \frac{16}{5}$

6. If $\frac{dx}{dy} + \frac{x}{y^2} = \frac{1}{y^3}$, $x(1) = 1$. Then $x\left(\frac{1}{2}\right)$ equals to

(1) $2 - e$ (2) $3 - e$

(3) $5 - e$ (4) $7 - e$

Answer (2)

Sol. I.F = $e^{\int \frac{1}{y^2}}$

I.F = $e^{-\frac{1}{y}}$

$\therefore$ $x \cdot e^{-\frac{1}{y}} = \int e^{-\left(\frac{1}{y}\right)} \cdot \left(\frac{1}{y^3}\right) dy$

$x \cdot e^{-\frac{1}{y}} = \int e^{-\left(\frac{1}{y}\right)} \cdot \left(\frac{1}{y}\right)\left(\frac{1}{y^2}\right) dy$

Put $\frac{1}{y} = t$

$-\frac{1}{y^2} dy = dt$

$\therefore$ $xe^{-t} = -\int e^{-t} \cdot t \, dt$

$xe^{-t} = -\left[t\, e^{-t} - \int \left(\frac{d(t)}{dt} \cdot \int e^{-t} \cdot dt\right) dt\right]$

$xe^{-t} = -\left[-t\, e^{-t} - e^{-t}\right] + c$

$xe^{-t} = te^{-t} + e^{-t} + c$ ...(1)

Given $x(1) = 1$

$e^{-1} = e^{-1} + e^{-1} + c$

$\boxed{-e^{-1} = c}$

$\therefore$ from (1)

$x = t + 1 - (e^{-t} \cdot e^{t})$

Put $y = \frac{1}{2}$

$\boxed{x = 3 - e}$

7. Let $T_r = \frac{(2r-1)(2r+1)(2r+3)(2r+5)}{64}$, then $\lim\limits_{n\to\infty} \sum\limits_{r=1}^{n} \frac{1}{T_r}$ is equal to

(1) $\frac{22}{45}$ (2) $\frac{32}{35}$

(3) $\frac{27}{45}$ (4) $\frac{32}{45}$

Answer (4)

Sol. $T_r = \frac{(2r-1)(2r+1)(2r+3)(2r+5)}{64}$

$\Rightarrow$ $\frac{1}{T_r} = \frac{64}{16\left(r-\frac{1}{2}\right)\left(r+\frac{1}{2}\right)\left(r+\frac{3}{2}\right)\left(r+\frac{5}{2}\right)}$

$\Rightarrow$ $\frac{1}{T_r} = \frac{\frac{4}{3}\left[\left(r+\frac{5}{2}\right) - \left(r-\frac{1}{2}\right)\right]}{\left(r-\frac{1}{2}\right)\left(r+\frac{1}{2}\right)\left(r+\frac{3}{2}\right)\left(r+\frac{5}{2}\right)}$

$\Rightarrow$ $\frac{1}{T_r} = \frac{4}{3}\left[\frac{1}{\left(r-\frac{1}{2}\right)\left(r+\frac{1}{2}\right)\left(r-\frac{3}{2}\right)} - \frac{1}{\left(r+\frac{1}{2}\right)\left(r+\frac{3}{2}\right)\left(r+\frac{5}{2}\right)}\right]$

$\lim\limits_{n\to\infty} \sum\limits_{r=1}^{n} \frac{1}{T_r} = \frac{4}{3}\left[\frac{1}{\frac{1}{2}\cdot\frac{3}{2}\cdot\frac{5}{2}} - \frac{1}{\frac{3}{2}\cdot\frac{5}{2}\cdot\frac{7}{2}}\right]$

$\frac{1}{\frac{3}{2}\cdot\frac{5}{2}\cdot\frac{7}{2}} - \frac{1}{\frac{5}{2}\cdot\frac{7}{2}\cdot\frac{9}{2}}$

$= \frac{4}{3}\left[\frac{8}{15}\right] = \frac{32}{45}$

8. Coefficient of x^{2012} in $(1-x)^{2008}(1+x+x^2)^{2007}$

(1) 0 (2) 1

(3) 2 (4) 3

Answer (1)

Sol. $(1-x)\,[(1-x)\,(1+x+x^2)]^{2007}$

$= (1-x)\,(1-x^3)^{2007}$

$= (1-x^3)^{2007} - x(1-x^3)^{2007}$

$[(1-x^3)^{2007}$ contains 3λ types of exponents while $x(1-x^3)^{2007}$ will have $(3\lambda+1)$ type while 2012 is $(3\lambda+2)$ type] that is not possible $\Rightarrow 0$

Coefficient of x^{2012} in $(1-x^3)^{2007} = 0$

Coefficient of x^{2011} in $(1-x^3)^{2007} = 0$

$\Rightarrow$ Coefficient of x^{2012} in $(1-x)^{2008}\,(1+x+x^2)^{2007} = 0$

9. If the images of the points $A(1, 3)$, $B(3, 1)$ and $C(2, 4)$ in the line $x + 2y = 4$ are D, E and F respectively, then the centroid of the triangle DEF is

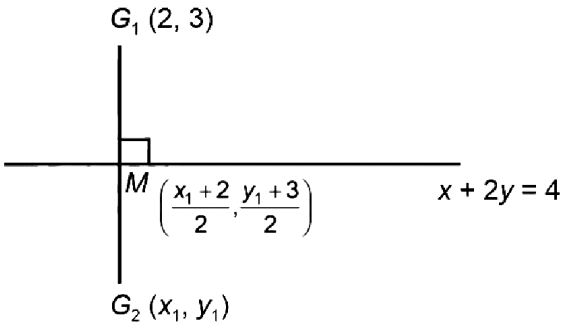
(1) $(3, -1)$ (2) $\left(-\frac{3}{5}, -\frac{2}{5}\right)$

(3) $\left(\frac{2}{5}, -\frac{1}{5}\right)$ (4) $\left(\frac{1}{5}, -\frac{2}{5}\right)$

Answer (3)

Sol. Centroid of the ΔDEF is the mirror image of the centroid of the ΔABC about the line $x + 2y = 4$.

G_1 = Centroid of $\Delta ABC \equiv (2, 3)$, $G_2 \equiv$ Centroid of ΔDEF.



$$\Rightarrow \frac{y_1-3}{x_1-2} = 2,\ \frac{x_1+2}{2} + (y_1+3) = 4$$

$$\Rightarrow x_1 = \frac{2}{5},\ y_1 = -\frac{1}{5}$$

$$\Rightarrow G_2 = \left(\frac{2}{5}, -\frac{1}{5}\right)$$

10. If $A = \{1, 2, 3, \ldots, 10\}$.

$B = \left\{\frac{m}{n},\ m,n \in A \text{ and } m < n \text{ and gcd of } (m,n) = 1\right\}$.

Then number of elements in set B is

(1) 30 (2) 31

(3) 28 (4) 29

Answer (2)

Sol. $n = 1\ \ m \in \phi$ ...0

$n = 2\ \ m = 1 \Rightarrow \frac{m}{n}$ can be $\frac{1}{2}$ ...1

$n = 3\ \ m = 1, 2 \Rightarrow \frac{m}{n}$ can be $\frac{1}{3}, \frac{2}{3}$ ...2

$n = 4\ \ m = 1,3 \Rightarrow \frac{m}{n}$ can be $\frac{1}{4}, \frac{3}{4}$ ...2

$n = 5\ \ m = 1, 2, 3, 4 \Rightarrow \frac{m}{n} = \frac{1}{5}, \frac{2}{5}, \frac{3}{5}, \frac{4}{5}$ ...4

$n = 6\ \ m = 1, 5 \Rightarrow \frac{m}{n} = \frac{1}{6}, \frac{5}{6}$ ...2

$n = 7\ \ m = 1, 2, 3, 4, 5, 6 \Rightarrow \frac{m}{n} = \frac{1}{7}, \frac{2}{7}, \frac{3}{7}, \frac{4}{7}, \frac{5}{7}, \frac{6}{7}$ ...6

$n = 8\ \ m = 1, 3, 5, 7 \Rightarrow \frac{m}{n} = \frac{1}{8}, \frac{3}{8}, \frac{5}{8}, \frac{7}{8}$ ...4

$n = 9\ \ m = 1, 2, 4, 5, 7, 8 \Rightarrow \frac{m}{n} = \frac{1}{9}, \frac{2}{9}, \frac{3}{9}, \frac{4}{9}, \frac{5}{9}, \frac{7}{9}, \frac{8}{9}$ ...6

$n = 10\ \ m = 1, 3, 7, 9 \Rightarrow \frac{m}{n} = \frac{1}{10}, \frac{3}{10}, \frac{7}{10}, \frac{9}{10}$ ...4

11. How many ways are there to pick 5 letters from English alphabets such that M is the middle of the letters (repetition not allowed).

(1) ${}^{26}C_5 . 5!$ (2) ${}^{25}C_4 . 4!$

(3) ${}^{26}C_4 . 4!$ (4) ${}^{25}C_5 . 5!$

Answer (2)

Sol. $\underline{A_1}\ \underline{A_2}\ \underset{\uparrow \text{fixed}}{\underline{M}}\ \underline{A_3}\ \underline{A_4}$

${}^{25}C_4 \times 4!$

12. Let $|Z_i| = 1$ for $i = 1, 2, 3$ satisfying $\left|\bar{Z}_1Z_2 + \bar{Z}_2Z_3 + \bar{Z}_3Z_1\right|^2 = a + b\sqrt{2}$, where a, b an rational numbers such that $\arg(Z_1) = \frac{\pi}{4}$, $\arg(Z_2) = 0$ and $\arg(Z_3) = \frac{-\pi}{4}$, then find (a, b)

(1) $(5, 2)$ (2) $(-5, -2)$

(3) $(5, -2)$ (4) $(-5, 2)$

Answer (3)

Sol. $Z_1 = |1|\, e^{i\frac{\pi}{4}} = \frac{1}{\sqrt{2}} + i \cdot \frac{1}{\sqrt{2}}$

$Z_2 = |1|\, e^{-(0)} 1 + 0i$

$Z_3 = |1|\, e^{-i\frac{\pi}{4}} = \frac{1}{\sqrt{2}} - \frac{i}{\sqrt{2}}$

$\bar{Z}_1Z_2 = \left(\frac{1}{\sqrt{2}} - \frac{i}{\sqrt{2}}\right)(1)$

$\bar{Z}_2Z_3 = 1\left(\frac{1}{\sqrt{2}} - \frac{i}{\sqrt{2}}\right)$

$\bar{Z}_3Z_1 = \left(\frac{1}{\sqrt{2}} + \frac{i}{\sqrt{2}}\right)\left(\frac{1}{\sqrt{2}} + \frac{i}{\sqrt{2}}\right)$

$\Rightarrow \bar{Z}_1Z_2 + \bar{Z}_2Z_3 + \bar{Z}_3Z_1 = \left(\frac{1}{\sqrt{2}} - \frac{i}{\sqrt{2}}\right) + \left(\frac{1}{\sqrt{2}} - \frac{i}{\sqrt{2}}\right)$

$$+\left(\frac{1}{2}-\frac{1}{2}\right)+2i\left(\frac{1}{2}\right)$$

$$=\sqrt{2}-\sqrt{2}i+i$$

$$\Rightarrow \left|\bar{Z}_1Z_2+\bar{Z}_2Z_3+\bar{Z}_3Z_1\right|^2=\left|\sqrt{2}+i\left(-\sqrt{2}+1\right)\right|^2$$

$$=\left(\sqrt{\left(\sqrt{2}\right)^2+\left(1-\sqrt{2}\right)^2}\right)^2$$

$$=5-2\sqrt{2}$$

$(a, b) = (5, -2)$

13. Let a coin is tossed thrice. Let the random variable x is tail follows head. Let the mean of x is μ and variance is σ^2. Find 64 $(\mu + \sigma^2)$.

(1) 48 (2) 64

(3) 132 (4) 128

Answer (1)

Sol.

	x_i	P_i
HHH	0	$\frac{1}{8}$
TTT	0	$\frac{1}{8}$
HHT	1	$\frac{1}{8}$
HTH	1	$\frac{1}{8}$
THH	0	$\frac{1}{8}$
TTH	0	$\frac{1}{8}$
THT	1	$\frac{1}{8}$
HTT	1	$\frac{1}{8}$

$$\mu=\Sigma P_i\ x_i=\frac{1}{2}$$

$$\sigma^2=\Sigma P_i x_i^2-\mu^2$$

$$=\frac{1}{2}-\frac{1}{4}=\frac{1}{4}$$

$$64\left(\frac{1}{2}+\frac{1}{4}\right)=64\times\frac{3}{4}=48$$

14. Let $g(x)=3f\left(\frac{x}{3}\right)+f(3-x)\forall x\in(0,3)$ and $f''(x)>0\forall x\in(0,3)$ then $g(x)$ decreases in interval $(0, \alpha)$, then α is

(1) $\frac{7}{4}$ (2) $\frac{2}{3}$

(3) $\frac{9}{4}$ (4) $\frac{7}{3}$

Answer (3)

Sol. $g(x)=3f\left(\frac{x}{3}\right)+f(3-x)$

$$g'(x)=3\cdot\frac{1}{3}f'\left(\frac{3}{3}\right)-f'(3-x)$$

$$=f'\left(\frac{x}{3}\right)-f'(3-x)$$

$$g''(x)=\frac{f''(x)}{3}+f''(3-x)$$

$\Rightarrow g'(x)>0$

$$f'\left(\frac{3}{3}\right)-f'(3-x)>0$$

$f'(x)>0\Rightarrow f'(x)$ is increasing

15. Let $\vec{b}=\lambda\hat{i}+4\hat{k},\lambda>0$ and the projection vector of $\vec{b}$ on $\vec{a}=2\hat{i}+2\hat{j}-\hat{k}$ is $\vec{c}$. If $|\vec{a}+\vec{c}|=7$, then the area of the parallelogram formed by vector $\vec{b}$ and $\vec{c}$ is (in square units)

(1) 8

(2) 16

(3) 32

(4) 64

Answer (3)

Sol. $\vec{c}=(\vec{b}\cdot\hat{a})\hat{a}=\frac{2\lambda-4}{6}\vec{a}$

$$\because\ |\vec{a}+\vec{c}|=7\ \Rightarrow\ \left|\vec{a}\left(1+\frac{2\lambda-4}{9}\right)\right|=7$$

$$\left|\frac{5+2\lambda}{9}\right|\times3=7\ \Rightarrow|5+2\lambda|=21$$

$$\because\ \lambda>0\ \Rightarrow\ \lambda=8$$

$$\Rightarrow\ \vec{c}=\frac{4}{3}\vec{a}\ \text{ and }\vec{b}=4(2\hat{i}-\hat{k})$$

$$\Rightarrow\ \vec{b}\times\vec{c}=\frac{16}{3}\begin{vmatrix}\hat{i}&\hat{j}&\hat{k}\\2&0&1\\2&2&-1\end{vmatrix}=\frac{16}{3}(-2\hat{i}+4\hat{j}+4\hat{k})$$

$$\Rightarrow\ \left|\vec{b}\times\vec{c}\right|=\frac{32}{3}|-\hat{i}+2\hat{j}+2\hat{k}|=32$$

$\Rightarrow$ Area of parallelogram formed by $\vec{b}$ and $\vec{c}$

$$\Rightarrow\ \left|\vec{b}\times\vec{c}\right|=32$$

16. Let the parabola $y = x^2 + px - 3$ cuts the coordinate axes at P, Q and R. A circle with centre $(-1, -1)$ passes through P, Q and R, then the area of triangle PQR.

(1) $\frac{5}{2}$ (2) $\frac{3}{2}$

(3) 3 (4) 5

Answer (2)

Sol. Since at $x = 0$, $y = -3$, parabola cuts the coordinate y-axe at $(0, -3)$

$\Rightarrow$ Equation of circle will be

$(x + 1)^2 + (y + 1)^2 = (-1 - 0)^2 + (-1 + 3)^2$

$= 1 + 4 = 5$

$x^2 + 2x + y^2 + 2y = -3 = 0$

Circle cuts x-axis at $y = 0$

$\Rightarrow x^2 + 2x - 3 = 0, (x + 3)(x - 1) = 0$

$\Rightarrow (-3, 0), (1, 0)$

$\Rightarrow$ Area of Δ

$$\Rightarrow \frac{1}{2}\begin{vmatrix} -3 & 0 & 1 \\ 0 & -3 & 0 \\ 1 & 0 & 0 \end{vmatrix} = \frac{1}{2}(3) = \frac{3}{2}$$

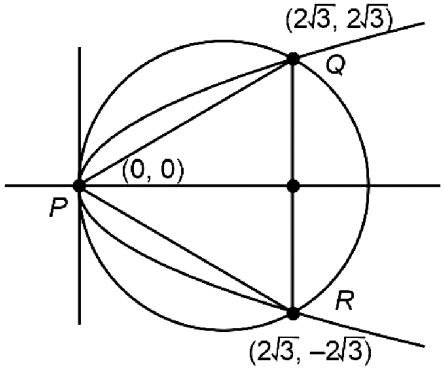
17. If the circle $\left(x - 2\sqrt{3}\right)^2 + y^2 = 12$ and parabola $y^2 = 2\sqrt{3}x$ intersects at P, Q and R. Then the area of triangle PQR is

(1) 10 sq. units (2) 12 sq. units

(3) 14 sq. units (4) 16 sq. units

Answer (2)

Sol. Simply solving both we get $x = 0,\ 2\sqrt{3}$



$$\Delta PQR = \frac{1}{2} \times (4\sqrt{3})(2\sqrt{3})$$

18. A hyperbola with foci (1, 14) and (1, –12) passes through the point (1, 6). The length of the latus rectum of the hyperbola is

(1) $\frac{144}{5}$

(2) 50

(3) $\frac{288}{5}$

(4) 100

Answer (3)

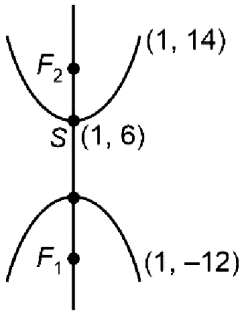
Sol. $|sp - s'p| = 2a$, $ss' = 2ae$

$s(1, 14)$, $s'(1, -12)$, $P(1, 6)$

$\Rightarrow 2a = |8 - 18|$

$\Rightarrow a = 5$; $2ae = 26$

$\Rightarrow ae = 13$



Length of latus rectum $1 = \frac{2b^2}{a} = \frac{2a^2(e^2 - 1)}{a}$

$$= \frac{2(169 - 25)}{5} = \frac{288}{5}$$

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. If A be a 3×3 square matrix such that $\det(A) = -2$. If $\det(3\ \text{adj}(-6\ \text{adj}(3A))) = 2^n \cdot 3^m$, where $m \geq n$, then $4m + 2n$ is equal to

Answer (104)

Sol. Concept: A. $\text{adj}(A) = |A|I$, $\det(\lambda A) = \lambda^n \det(A)$

$\Rightarrow \det(A) = |A|^{n-1}$, where n is order

$\Rightarrow \det(3\ \text{adj}(-6\ \text{adj}(3A)))$

$= 3^3 \cdot \det(\text{adj}(-6\ \text{adj}(3A)))$

$= 3^3 \cdot (-6\ \text{adj}(3A)))^2$

$= 3^3 \cdot (-6)^6\ |3A|^4$

$= 3^9 \cdot 2^6 \cdot 3^{12} \cdot (-2)^4$

$= 3^{21} \cdot 2^{10}$

$\therefore\ n = 10,\ m = 21$

$\therefore\ 4m + 2n = 104$

22. If $a_1, a_2, a_3..., a_n$ are in geometric progression such that $a_1a_5 = 28$, $a_2 + a_4 = 29$, then the value of a_6 is

(1) 635 (2) 784

(3) 872 (4) 898

Answer (2)

Sol. $a_1a_5 = 28 \Rightarrow a^2r^4 = 28$

$a_2 + a_4 = 29 \Rightarrow ar + ar^3 = 29$

ar, ar^3 are roots of $k^2 - 29k + 28 = 0$

$\Rightarrow k = 1, k = 28$

$\Rightarrow ar = 1, ar^3 = 28$

$\Rightarrow r^2 = 28, a^2 = \frac{1}{28}$

$a_6 = ar^5 \Rightarrow a_6^2 = a^2r^{10} = \frac{1}{28} \times (28)^5 = (28)^4$

$\Rightarrow a_6 = (28)^2 = 784$

23.

24.

25.

बेतियाहाता चौक पर पिछले 21 वर्षों से संचालित पूर्वांचल की No.1 कोचिंग
Arvind Tripathi & Vikas Agrawal's
MOMENTUM
बेतियाहाता चौक Head Office | खजांची चौक Branch Office
IIT-JEE | NEET (UG) | Foundations

Memory Based
Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

JEE (Main)-2025 (Online) Phase-2

(Physics, Chemistry and Mathematics)

IMPORTANT INSTRUCTIONS:

(1) The test is of **3 hours** duration.

(2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.

(3) This question paper contains **Three Parts**. **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is **Mathematics**. Each part has only two sections: **Section-A** and **Section-B**.

(4) **Section - A :** Attempt all questions.

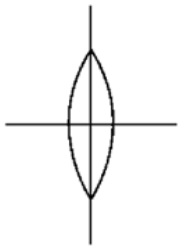
(5) **Section - B :** Attempt all questions.

(6) **Section - A (01 – 20)** contains 20 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

(7) **Section - B (21 – 25) contains** 5 **Numerical value** based questions. The answer to each question should be rounded off to the **nearest integer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

PHYSICS

1. The thin Biconvex lens is divided in to 4 equal parts by plane AB and CB. The original power is 4D. The after dividing power of each piece is



a) 2D b) 4D c) D d) 8D

Ans: (a)

2. **Assertion:-** simple pendulum is taken on a planet of mass 4 times of earth and radius 2 time of earth then the time period is remains constant

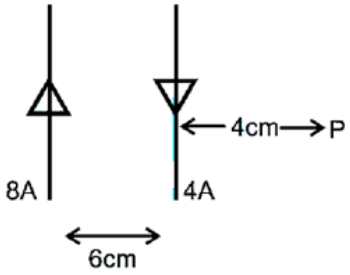
Reason:- Time period of simple pendulum is constant on earth and on any other planet

a) A is true and R is false b) Both A and R are true

c) A is false and R is true d) Both A and R are false

Ans: (a)

3. Find (B_{net}) at point P (in T)?



a) 4×10^{-8} b) 4×10^{-4} c) 4×10^{-6} d) 4×10^{-10}

Ans: (c)

4. Find the correct dimensional formula for the capacitance in terms of M, L, T and C where they stand for unit of mass, length, time and charge.

a) $[C^2M^{-1}L]$ b) $[C^2M^{-1}L^{-2}T^2]$ c) $[C^2M^{-1}L^{-2}]$ d) $[CM^{-1}L^{-2}T^2]$

Ans: (b)

5. The maximum percentage error in the measurement of density of a wire is

$m = (0.60 \pm 0.003)$g

$r = (0.50 \pm 0.01)$cm

$l = (10.00 \pm 0.05)$cm

a) 2% b) 5% c) 6% d) 3%

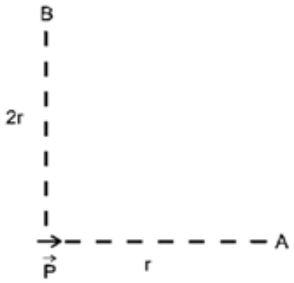
Ans: (b)

6. Given position vector and Force $r = \hat{i} + \hat{j} + \hat{k}$, $F = 2i + j + 2k$. Find Torque

a) $\sqrt{4}$ b) $\sqrt{5}$ c) $\sqrt{3}$ d) $\sqrt{2}$

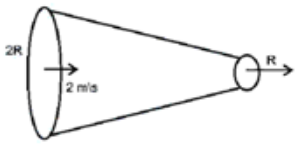
Ans: (d)

7. If $E_A=E_0$ & $V_A=V_0$ then find E_B and V_B



a) $\frac{E_0}{16}, 0$ b) $\frac{E_0}{24}, 0$ c) $\frac{E_0}{18}, 0$ d) $\frac{E_0}{14}, 0$

Ans: (a)

8. 

Find V=?

a) 6m/s b) 10m/s c) 8m/s d) 4m/s

Ans: (c)

9. A ball of mass 100 g thrown at a speed of 20 m/s with angle 60° with horizontal. Find the decrease in kinetic energy from point of throwing of ball to max height.

a) 12J b) 15J c) 25J d) 18J

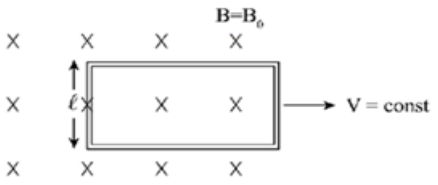
Ans: (b)

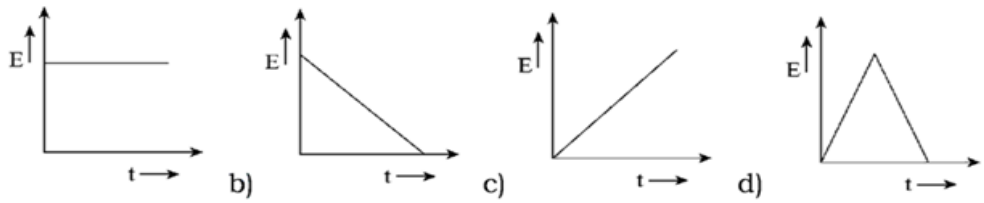
10. For a diatomic gas if $\gamma_1 = C_p/C_v$ for rigid molecules and $\gamma_2 = C_p/C_v$ for another diatomic molecule having vibrational modes then

a) $\gamma_2 < \gamma_1$ b) $\gamma_2 > \gamma_1$ c) $\gamma_2 = \gamma_1$ d) $\gamma_2 = 2\gamma_1$

Ans: (a)

11. Find the correct plot of EMF versus time when a rectangular wire frame is been taken out of uniform magnetic field region with constant speed as shown





Ans: (a)

12. **Assertion:-** In a YDSE experiment the fringe of red colour is wider as compared to the fringe of blue colour

Reason:- The fringe width is directly proposition to the wave length of light

a) Both A and R true and R is the correct explanation of A

b) Both A and R true and R is the not correct explanation of A

c) A is true and R is false

d) A is false and R is true

Ans: (a)

13. Force on the particle is given by $\vec{F} = 2\hat{\imath} - 2\hat{\jmath} + 2\hat{k}$ and its position is given by $\vec{r} = \hat{\imath} + b\hat{\jmath} + \hat{k}$ and work done is said to be zero then the value of b is

a) 2 b) 1/2 c) 5 d) 9

Ans: (a)

14. An electron is moving in a magnetic field B in a circular orbit. Assume Bohr's quantisation to be valid. Find the radius of orbit in 1st excited state?

a) $\sqrt{\frac{4h}{\pi Be}}$ b) $\sqrt{\frac{h}{2\pi Be}}$ c) $\sqrt{\frac{h}{\pi Be}}$ d) $\sqrt{\frac{2h}{\pi Be}}$

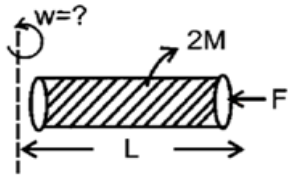
Ans: (c)

15. In a LCR circuit the current amplitude at resonance is I. If the value of resistance is doubled then find the new current amplitude at resonance?

a) I b) $\frac{I}{2}$ c) 2I d) 4I

Ans: (b)

16. Find the angular speed of the cylinder of length L if the force exerted by the ideal fluid of mass 2M on the outer face of the cylinder is F



a) $\sqrt{\frac{F}{ml}}$ b) $\sqrt{\frac{F}{2ml}}$ c) $\sqrt{\frac{2F}{ml}}$ d) $\sqrt{\frac{F}{4ml}}$

Ans: (a)

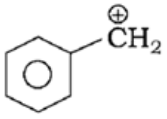
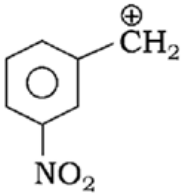
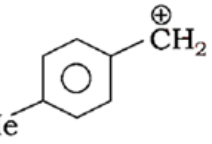
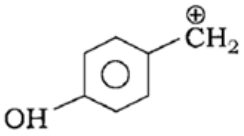
CHEMISTRY

1. 3 M of NaCl whose density is 1.25 g/ml. Find its Molality.

   a) 3.86 mol/Kg b) 2.79 mol/Kg c) 1.97 mol/Kg d) 0.786 mol/Kg

   Ans: (b)

2. The most stabled carbocation is

   a) 
   b) 
   c) 
   d) 

   Ans: (d)

3. The sum of number of 4d-electrons in Ru and Nb

   a) 11 b) 13 c) 17 d) 7

   Ans: (a)

4. Identify the extensive and intensive property?

   a) Mass, volume, conductivity - Intensive property

   b) Mass, temperature, heat, volume - Extensive property

   c) Mass, volume, internal energy - Extensive property

   d) Density, temperature, moles, internal energy – Intensive property

   Ans: (c)

5. Nickel di methyl glyoxime complex has how many Hydrogen bondings

   a) 4 b) 6 c) 2 d) 8

   Ans: (c)

6. 200 ml of 0.2 M solution of NaOH and 400 ml of 0.5 M of NaOH solution are mixed together. Find the Molarity of mixture

   a) 0.3 b) 0.15 c) 0.9 d) 0.4

   Ans: (d)

7. Which of the following has two secondary Hydrogens

   a) 4 -ethyl-2,2-dimethyl hexane b) 2,2,3,3-tetramethyl pentane

   c) 2,2,4,4-tetramethyl heptane d) None of these

   Ans: (b)

8. Which of the following anion will not undergo disproportionation?

   a) ClO_4^- b) ClO_3^- c) ClO_2^- d) ClO^-

   Ans: (a)

9. Given below are two statements

S-I: Lassaigne test is used for detection of Nitrogen, phosphorous, sulphur and Halogens.

S-II: Lassaigne extract is made with magnesium metal.

a) Both S-I and S-II are correct
b) Both S-I and S-II are incorrect
c) S-I is correct but S-II is incorrect
d) S-I is incorrect but S-II is correct

Ans: (c)

10. Compare dipole moment of

(I) NF_3 (II) $CHCl_3$ (III) H_2S (IV) HBr

a) I > II > III > IV b) II > III > I > IV c) II > III > IV > I d) III > I > IV > II

Ans: (c)

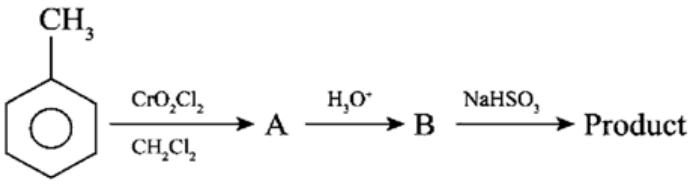
11. Arrange according to CFSE.

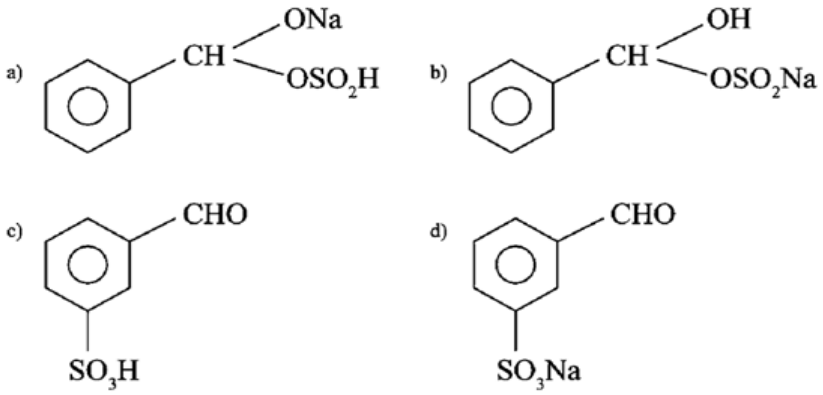
(i) $[Co(NH_3)_4]^{2+}$ (ii) $[Co(NH_3)_6]^{3+}$ (iii) $[Co(NH_3)_6]^{2+}$ (iv) $[Co(en)_3]^{3+}$

a) (iv) > (ii) > (iii) > (i)
b) (iv) > (iii) > (ii) > (i)
c) (i) > (iii) > (ii) > (iv)
d) (i) > (ii) > (iii) > (iv)

Ans: (a)

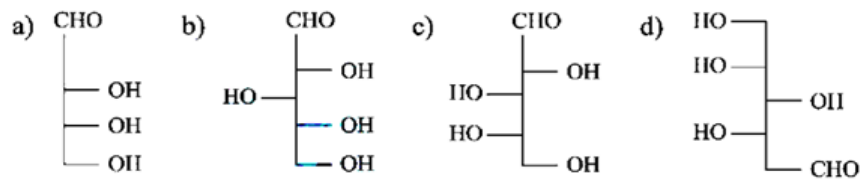
12.





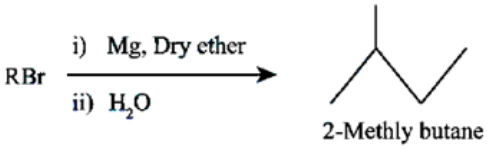
Ans: (b)

13. Identify number of structures which can be correlated to D- glyceraldehyde



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

Ans: (a)

14. 

The maximum number of RBr producing 2-methyl butane by above sequence of reactions is

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

Ans: (d)

15. Among Group-15 elements, what is the maximum covalency of an element having weakest E – E covalent bond (E = element)

a) 4 b) 3 c) 5 d) 2

Ans: (a)

16. **Statement - 1:** In corrosion of metal, the metal acts as cathode.

Statement - 2: Alkaline medium increases rate of corrosion.

a) Both S-I and S-II are correct b) Both S-I and S-II are incorrect

c) S-I is correct but S-II is incorrect d) S-I is incorrect but S-II is correct

Ans: (b)

17.

a) b) c) d)

Ans: ()

MATHEMATICS

1. $\sum_{r=1}^{30} \frac{r^2\left({}^{30}c_r\right)^2}{{}^{30}c_{r-1}} = \alpha \times 2^{29}$, then $\alpha =$

Ans: (930)

2. Let $A = \{1,2,3\}$ then the number of relations on A which consist of ordered pair (1, 2) & (2, 3) and must be reflexive and transitive but not symmetric.

a) 6 b) 8 c) 4 d) 10

Ans: (a)

3. Perpendicular distance from the point P(−2,0,2) to the line $\frac{x+1}{2} = \frac{y-1}{-1} = \frac{z+3}{2}$

a) $2\sqrt{3}$ b) $3\sqrt{2}$ c) $2\sqrt{5}$ d) $3\sqrt{7}$

Ans: (b)

4. Find the area between the curves $y = x^2 - 4x + 4$ and $y^2 = 16 - 8x$

a) 2/3 b) 2/5 c) 9/7 d) 8/3

Ans: (d)

5. $x + y + 2z = 6, 2x + 3y + az = a + 1, -x - 3y + bz = 2b$ has infinitely many solutions then $7a + 3b =$

a) 18 b) 16 c) 11 d) 21

Ans: (b)

6. The total number of terms in A.P are $2k$. The sum of odd terms is 40 and the sum of even terms is 55 and last term of the A.P exceeds the first term by 27. Then find the value of k.

a) 9 b) 3 c) 5 d) 7

Ans: (c)

7. There are 3 girls and 4 boys. Number of ways of arrangement if all girls stand together and all boys stand together in a line such that boys B_1 and B_2 from the group are not adjacent.

a) 35 b) 81 c) 64 d) 144

Ans: (d)

8. Let α, β, γ and δ be the coefficient of x^7, x^5, x^3 and x respectively in the expansion of $\left(x + \sqrt{x^3 - 1}\right)^5 + \left(x - \sqrt{x^3 - 1}\right)^5, x > 1$. If u and v satisfy the equations $\alpha u + \beta v = 18, \gamma u + \delta v = 20$ then u + v equals

a) 4 b) 5 c) 6 d) 3

Ans: (b)

9. If A and B are two events such that $p(A \cap B) = 0.1, P(A/B)$ and $P(B/A)$ are the roots of the equation $12x^2 - 7x + 1 = 0$ then the value of $\frac{P(\bar{A} \cup \bar{B})}{P(\bar{A} \cap \bar{B})}$ is

a) 9/4 b) 7/4 c) 5/3 d) 4/3

Ans: (a)

10. $\int e^x \left(\frac{x\sin^{-1} x}{\sqrt{1-x^2}} + \frac{\sin^{-1} x}{(1-x^2)^{3/2}} + \frac{x}{1-x^2}\right) dx = g(x) + c$, where c is the constant of the integration then $g(1/2)$ equals

a) $\frac{\pi}{4}\sqrt{\frac{e}{2}}$ b) $\frac{\pi}{6}\sqrt{\frac{e}{3}}$ c) $\frac{\pi}{6}\sqrt{\frac{e}{2}}$ d) $\frac{\pi}{4}\sqrt{\frac{e}{3}}$

Ans: (b)

11. Let $f(x) = \int_0^{x^2} \frac{t^2-8t+15}{e^t} dt, x \in R$, the number of local maximum and minimum point of $f(x)$ respectively are

a) 2 and 3 b) 3 and 2 c) 1 and 3 d) 1 and 2

Ans: (a)

12. The sum of all values of $\theta \in [0, 2\pi]$ satisfying $2\sin^2\theta = \cos\theta$, $2\cos^2\theta = 3\sin\theta$ is

a) $\frac{\pi}{2}$ b) $\frac{5\pi}{6}$ c) 4π d) π

Ans: (d)

13. Let $A = \{1, 2, 3, 4\}$ and $B = \{1, 4, 9, 16\}$, then the number of many one function $f: A \to B$ such that $1 \in f(A)$ equal to

a) 139 b) 127 c) 163 d) 151

Ans: (d)

बेतियाहाता चौक पर पिछले 21 वर्षो से संचालित पूर्वांचल की No.1 कोचिंग
Vikas Agrawal & Arvind Tripathi's
MOMENTUM
बेतियाहाता चौक Head Office | खजांची चौक Branch Office
IIT-JEE NEET (UG) Foundations

Memory Based Answers & Solutions

Time : 3 hrs. *for* M.M. : 300

JEE (Main)-2025 (Online) Phase-1

(Physics, Chemistry and Mathematics)

23 Jan 2025 (Morning Shift)

IMPORTANT INSTRUCTIONS:

(1) The test is of **3 hours** duration.

(2) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.

(3) This question paper contains **Three Parts**. **Part-A** is Physics, **Part-B** is Chemistry and **Part-C** is **Mathematics**. Each part has only two sections: **Section-A** and **Section-B**.

(4) **Section - A :** Attempt all questions.

(5) **Section - B :** Attempt all questions.

(6) **Section - A (01 – 20)** contains 20 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

(7) **Section - B (21 – 25) contains** 5 **Numerical value** based questions. The answer to each question should be rounded off to the **nearest integer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

PART I : PHYSICS

1. Radius of electron in ground state of hydrogen is a_0, and radius of electron in He^+ ion in 3rd excited state is a, then $\frac{a_0}{a}$ is

(1) $\frac{1}{2}$ (2) $\frac{1}{4}$ (3) $\frac{1}{16}$ (4) $\frac{1}{8}$

Ans. **(4)**

Sol. $a = a_0 \frac{n^2}{Z}$

$\frac{Z}{n^2} = \frac{a_0}{a}$

$\frac{2}{16} = \frac{a_0}{a}$

$\frac{a_0}{a} = \frac{1}{8}$

2. Electric flux ϕ is related with linear charge density λ and surface charge density σ as $\phi = \alpha\lambda + \beta\sigma$ where α and β are of appropriate dimension then dimension of (β/α) is:

(1) Displacement (2) Area (3) Electric field (4) Velocity

Ans. **(1)**

Sol. $\phi = \alpha\lambda + \beta\sigma$

$\alpha\lambda = \beta\sigma$

$\frac{\beta}{\alpha} = \frac{\lambda}{\sigma} = \frac{Q/L}{Q/L^2} = \frac{Q}{L} \times \frac{L^2}{Q}$

$= L$ (Length)

3. The displacement of a particle as function of time is $x(t) = A\sin(t) + B\cos^2(t) + Ct^2 + D$. Find dimension of $\left[\frac{ABC}{D}\right]$

(1) L^2 (2) L^2T^{-2} (3) LT^{-2} (4) L^3T

Ans. **(2)**

Sol. Dimension $\rightarrow$ A $\rightarrow$ [L]

Dimension $\rightarrow$ B $\rightarrow$ [L]

$C[T^2] = [L]$

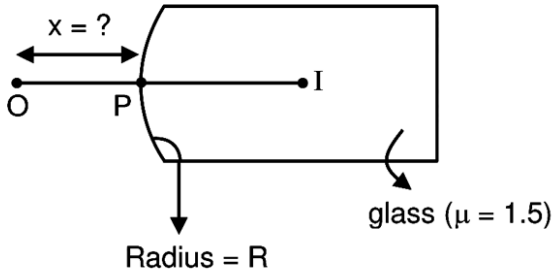
Dimension $\rightarrow$ C $\rightarrow$ $[LT^{-2}]$

Dimension $\rightarrow$ D $\rightarrow$ [L]

So, $\frac{ABC}{D} \Rightarrow \frac{[L][L][LT^{-2}]}{[L]}$

Dimension = $[L^2T^{-2}]$

4. A small point object is placed at some distance from a convex spherical surface of radius of curvature R and refractive index 1.5 as shown in the diagram. It was found that image is formed at equal distance from P. If the distance at which object is placed from point P is x then find x.



(1) 1.5 R (2) 2 R (3) 3 R (4) 5 R

Ans. **(4)**

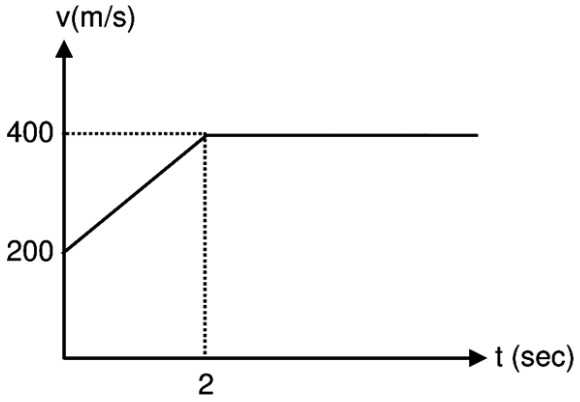
Sol. $\frac{\mu_2}{v} - \frac{\mu_1}{v} = \frac{\mu_2 - \mu_1}{R}$

$\frac{1.5}{v} + \frac{1}{v} = \frac{0.5}{R}$

$= \frac{2.5}{v} = \frac{0.5}{R}$

$v = 5\,R$

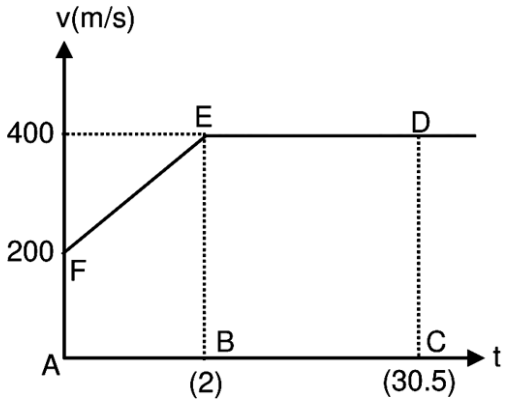
5. For given velocity - time (v-t) graph. Find the distance travelled upto 30.5 sec



(1) 10 Km (2) 11 Km (3) 12 Km (4) 13 Km

Ans. **(3)**

Sol. Distance = $\int_0^{30.5} |\vec{v}|\,dt$ = Area under v-t graph with +ve sign.



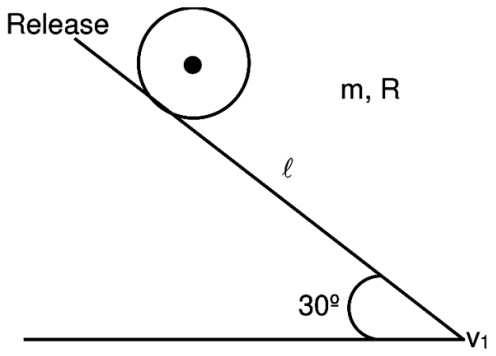
$\Rightarrow$ Area (ABEF) + Area (BCDE)

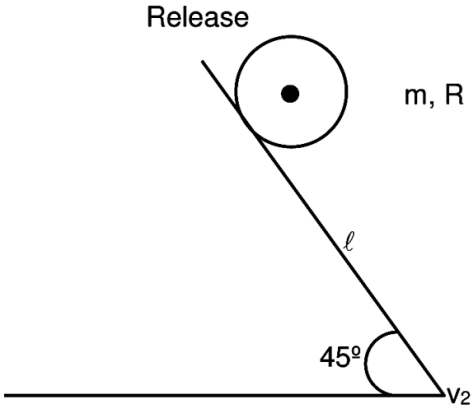
$\Rightarrow \frac{1}{2} \times (200 + 400) \times 2 + 400\,(30.5 - 2)$

$= 600 + \frac{400 \times 2865}{10}$

$= 600 + 11400 = 12000$ m $= 12$ Km

6. Two identical ball of mass m and radius R are released from rest on two inclined planes of length ℓ as shown in diagram. If balls are rolling without sliding then find the ratio of the square of the speed $(v_1^2 : v_2^2)$ with which they will reach on the ground.





(1) $\frac{1}{\sqrt{3}}$ (2) $\frac{1}{\sqrt{2}}$ (3) $\frac{1}{2}$ (4) $\frac{1}{2\sqrt{2}}$

Ans. **(2)**

Sol. H.S

$$a_1 = \frac{g\sin\theta}{1+\frac{I}{mR^2}} \qquad v_1^2 : v_2^2$$

$$a_1 = \frac{g\times\sin30}{1+\frac{2/3mR^2}{mR^2}} \qquad a_2 = \frac{g\sin45}{1+\frac{2/3mR^2}{mR^2}}$$

$$a_1 = \frac{g/2}{5/3} = \frac{3g}{10} \qquad a_2 = \frac{g/\sqrt{5}}{5/3} = \frac{3g}{5\sqrt{2}}$$

$$\frac{v_1^2}{v_2^2} = \frac{2\times a_1\times l}{2a_2\times 1} = \frac{3g/10}{7g/5\sqrt{2}} = \frac{5\sqrt{2}}{10} = \frac{1}{\sqrt{2}} \Rightarrow \boxed{\frac{v_1^2}{v_2^2} = \frac{1}{\sqrt{2}}}$$

7. **Statement-I :** Hot water moves faster than cold water.
Statement-II : Soap water have higher surface tension than fresh water.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

Ans. **(3)**

Sol. **Statement –I:** Due to increase in temperature Viscosity decreases and K.E. increases so hot water moves faster so it is true

Statement-II : Soap water have Lower surface tension than fresh water.

8. If force $\vec{F} = x^2y\hat{i} + y^2\hat{j}$ is acting on a particle along the line y = x for displacement from A(0, 0) to B(4, 4). Find work done by the force

(1) $\frac{256}{3}$ J (2) 64 J (3) $\frac{64}{3}$ J (4) 256 J

Ans. **(1)**

Sol. Given force $\vec{F} = x^2y\hat{i} + y^2\hat{j}$

Work done $W = \int\vec{F}.d\vec{r} = \int(x^2y\hat{i} + y^2\hat{j}).(dx\hat{i} + dy\hat{j})$

$$= \int_0^4 x^2 y\,dx + \int_0^4 y^2\,dy$$

$$= \int_0^4 x^3\,dx + \int_0^4 y^2\,dy = \frac{256}{3}\,J$$

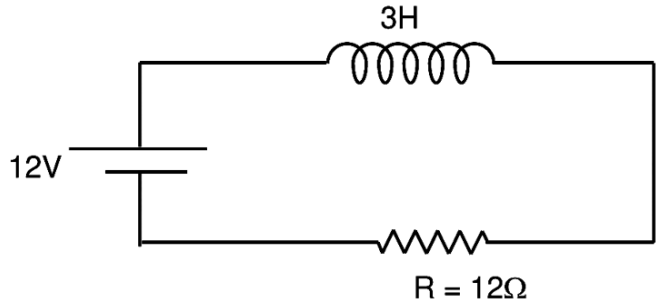
9. Match the column

Column-I	**Column-II**
(P) When volume change is zero	(i) Isochoric process
(Q) When pressure is constant	(ii) Adiabatic process
(C) When no heat is exchanged	(iii) Isobaric process
(D) Work done by the gas is equal to heat given to the gas	(iv) Isothermal process

(1) P → (i) ,Q → (iii), R → (ii), S → (iv)
(2) P → (ii) ,Q → (iii), R → (i), S → (iv)
(3) P → (iii) ,Q → (i), R → (ii), S → (iv)
(4) P → (iv) ,Q → (iii), R → (ii), S → (i)

Ans. **(1)**

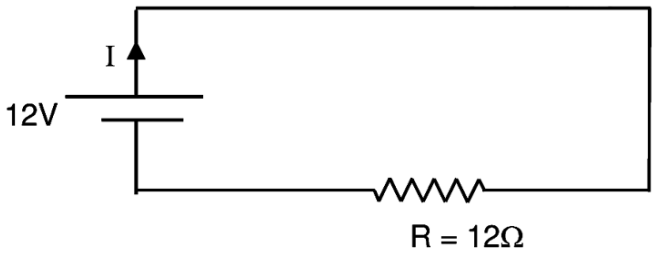
10. In the given DC circuit, find the current through R = 12Ω in steady state



(1) 2A (2) 3A (3) 1A (4) 4A

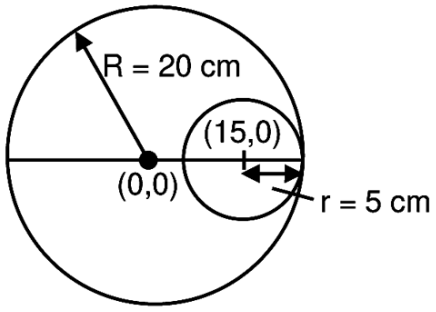
Ans. **(3)**

Sol. In steady state inductor is short circuited



$$I = \frac{12}{12} = 1\ A$$

11. Find the position of centre of mass of uniform dics of radius 20 cm with respect to previous origin if small disc of radius 5 cm cut from the disc



(1) (–2, 0) (2) (1, 0) (3) (–1, 0) (4) (–5, 0)

Sol. Let surface mass density = σ

M_1 (mass of disc before removal = $\sigma(\pi R^2)$

M_2 (mass of smaller disc = $\sigma(\pi r^2)$

COM of smaller disc = (15, 0)

COM of disc after removal of disc

$$x_{COM} = \frac{M_1x_1 - M_2x_2}{M_1 - M_2} = \frac{\sigma(\pi R^2 \times 0) - (\sigma\pi r^2) \times 15}{\sigma\pi(R^2 - r^2)}$$

$$x_{COM} = \frac{-15r^2}{R^2 - r^2} = \frac{-15 \times 5 \times 5}{(20)^2 - (5)^2} = \frac{-15 \times 5 \times 5}{25 \times 15} = -1$$

$y_{COM} = 0$

COM (–1, 0)

12. The ratio of electric force to gravitational force between two particles having charges q_1, q_2 and masses m_1 and m_2 respectively (where symbols have their usual meanings).

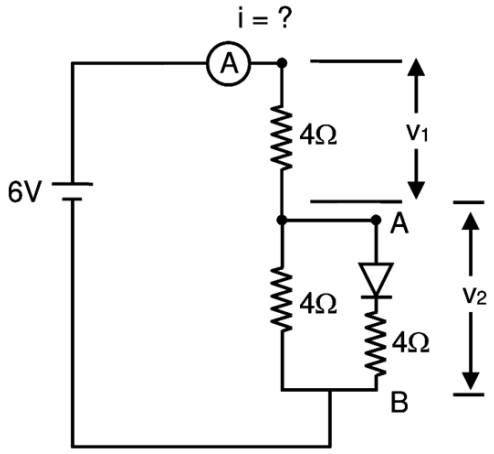
(1) $\frac{4\pi\varepsilon_0 m_1 m_2 G}{q_1 q_2}$ (2) $\frac{4\pi\varepsilon_0 G m_1 m_2}{q_1 q_2 r^4}$

(3) $\frac{q_1 q_2 r^4}{4\pi\varepsilon_0 G m_1 m_2}$ (4) $\frac{q_1 q_2}{4\pi\varepsilon_0 G m_1 m_2}$

Ans. **(4)**

Sol. $$\frac{F_E}{F_G} = \frac{\frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}}{G\frac{m_1 m_2}{r^2}} = \frac{q_1 q_2}{4\pi\varepsilon_0 G m_1 m_2}$$

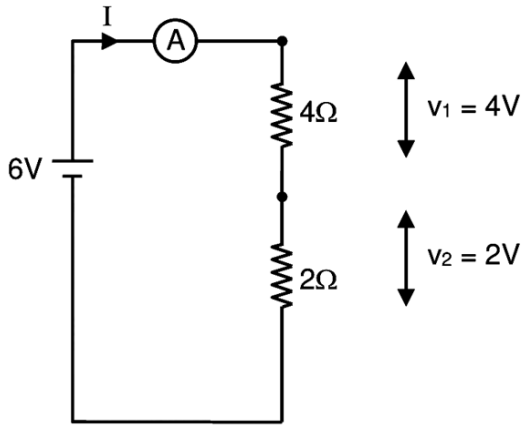
13. Which one is the correct option for given circuit for i,v_1, and v_2



(1) 1 Amp. 2V, 4V (2) 1 Amp. 4V, 2V (3) 2 Amp. 4V, 2V (4) 0.1 Amp. 2V, 4V

Ans. **(2)**

Sol.



$v_4 = \frac{4}{8} \times 6 = \frac{1}{2} \times 6 = 3$ volt

Diode on

$I = \frac{6}{6} = 1$ A

14. Self inductance depends on

(1) only on geometry

(2) only on medium property

(3) Geometry and medium property

(4) value of current through inductor

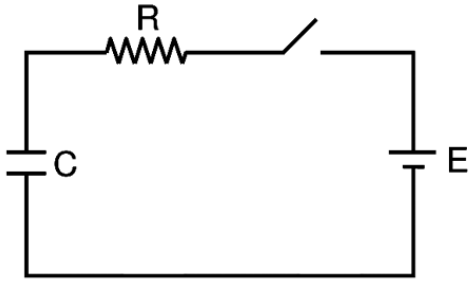
Ans. **(3)**

Sol. Self-inductance = $\mu_r \mu_0$ N_2 Al

Medium Geometry

So, depends on Geometry and medium.

15. The key shown in the circuit is closed at t = 0.
Choose the incorrect option regarding the condition at t = 0



(1) Current in the circuit is zero

(2) Voltage across the capacitor is minimum

(3) Current in the circuit is maximum

(4) Voltage across resistance is maximum

Ans. **(1)**

Sol. $i(t) = \frac{E}{R} e^{-t/RC}$

$q(t) = CE(1 - e^{-t/RC})$

$t = 0, \quad i(t = 0) = \frac{E}{R}$

option (1) $\rightarrow$ incorrect t

$t = 0, q(t = 0) = 0$

$v_C = \frac{q}{c} = 0$ (minimum voltage)

options (ii) $\rightarrow$ correct

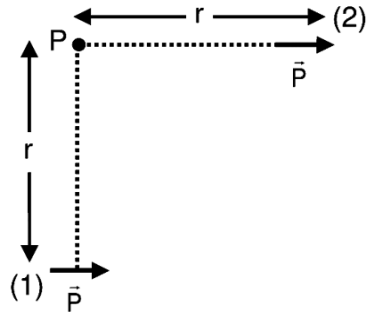
$i\,(t = 0) = \frac{E}{R}$ (maximum correct)

options (iii) $\rightarrow$ correct

$v_R = iR = \frac{E}{R} \times R = E$ $(t = 0)$

option (iv) $\rightarrow$ correct

16. If two dipoles of dipole moment p are placed as shown in figure. Find the net electric force which feels by a point unit charge at point P?



(1) $\frac{2KP}{r^3}$ (2) $\frac{KP}{2r^3}$ (3) $\frac{\sqrt{2}KP}{r^3}$ (4) $\frac{KP}{r^3}$

Ans. **(4)**

Sol. Net electric force at point P

$\vec{F} = \vec{F}_1 + \vec{F}_2$

$= \frac{kP}{r^3}(-\hat{i}) + \frac{2KP}{r^3}(+\hat{i})$

$\vec{F} = \frac{KP}{r^3}\hat{i}$

17. Adiabatic constant of a gas is $\frac{3}{2}$. If volume of gas initially at 0ºC is reduced to one fourth of the original volume then new temperature is

(1) 0K (2) 273 K (3) 546ºC (4) 546 K

Ans. **(4)**

Sol. PV^y = constant

TV^{y-1} = constant

$T_1V_1^{y-1} = T_2V_2^{y-1}$

$T_2 = T_1\left(\frac{V_1}{V_2}\right)^{y-1} = 273\left(\frac{4V_1}{V_1}\right)^{\frac{3}{2}-1}$

$T_2 = 273 \times 2 = 546$ K

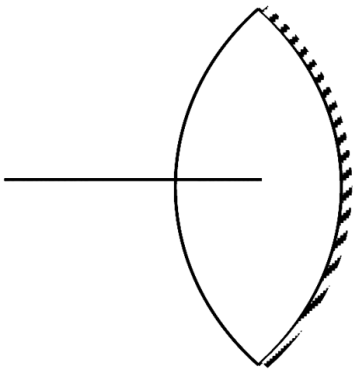
18. Given a convex lens of refractive index μ_2 in a liquid of refractive index μ_1, $\mu_1 < \mu_2$ having radii of curvature R_1, R_2 then R_2 surface a silver polished. Where should an object be placed on the optical axis so that the real and inverted image is formed at the same place

(1) $\frac{(\mu_2 + \mu_1)|R_1|}{(\mu_2 - \mu_1)}$ (2) $\frac{\mu_1|R_1||R_2|}{\mu_2(|R_1| + |R_2| - \mu_1|R_2|)}$

(3) $\frac{\mu_1|R_1||R_2|}{\mu_2(2|R_1| + |R_2| - \mu_1|R_2|)}$ (4) $\frac{\mu_1|R_1| - |R_2|}{\mu_2(|R_1| + |R_2| - \mu_1\sqrt{|R_1| - |R_2|})}$

Ans. **(2)**

Sol.



$$\frac{1}{f_C} = -\frac{-2}{f_L} + \frac{1}{f_M}$$

$$\Rightarrow \frac{1}{f_C} = -2\left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} + \frac{1}{R_2}\right) - \frac{2}{R}$$

$$\Rightarrow \frac{1}{f_C} = \frac{-2(\mu_2 - \mu_1)}{\mu_1}\frac{(R_1 + R_2)}{R_1R_2} - \frac{2}{R_2} \times \frac{\mu_1R_1}{\mu_1R_1}$$

$$= \frac{-\mu_1R_1R_2}{(\mu_2 - \mu_1)(R_1 + R_2) + \mu_1R_1} = \frac{-\mu_1R_1R_2}{\mu_2(R_1 + R_2) - \mu_1R_2}$$

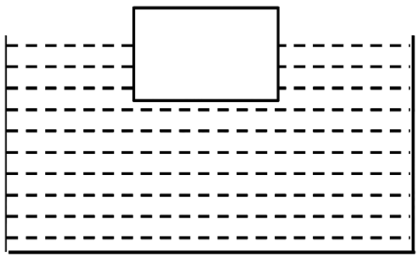
19. What is the dimensional formula of torsional constant ?

(1) $[ML^2T^{-2}]$ (2) $[ML^3T^2]$ (3) $[M^0LT^2]$ (4) $[M^2L^1T^2]$

Ans. **(1)**

Sol. $[ML^2T^{-2}]$

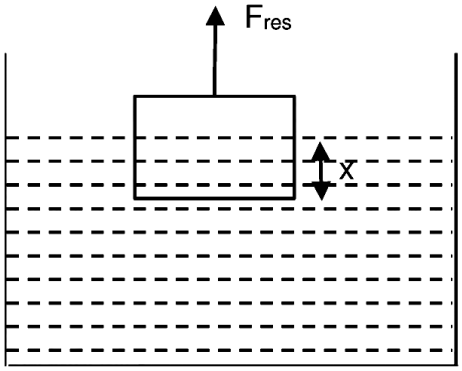
20. Find the time period of a cube of side length 10 cm and mass 10 gm oscillating in water (Density of water = 10^3 kg/m^3 and g = 10 m/s^2)



(1) $\frac{\pi}{25}$ second (2) $\frac{\pi}{50}$ seconds (3) $\frac{\pi}{100}$ second (4) $\frac{2\pi}{25}$ second

Ans. **(2)**

Sol.



$F_{res} = -(V_{in})\rho_w g = -(Ax)\rho_w g$

$-(Ax)\rho_w g = ma$

$-Ax\rho_w g = m(\omega^2 x)$

$$\omega^2 = -\frac{A\rho_\omega}{m} g$$

$$\Rightarrow \omega = \frac{2\pi}{T} = \sqrt{\frac{A\rho_w g}{m}}$$

$$\Rightarrow T = 2\pi\sqrt{\frac{m}{A\rho_\omega g}}$$

$$\Rightarrow T = 2\pi\sqrt{\frac{10\times10^{-3}}{10\times10\times10^{-4}\times10^{-3}\times10}}$$

$$T = 2\pi\sqrt{\frac{10^{-3}}{10}} = 2\pi\sqrt{10^{-4}}$$

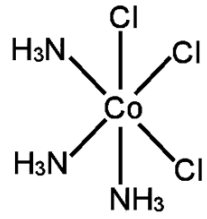
$$= 2\pi \times 10^{-2}$$

1. Which complex will show facial and meridional form-

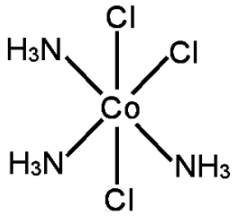
(1) $[Co(NH_3)_6]$ (2) $[Co(NH_3)_5Cl]$ (3) $[Co(NH_3)_4Cl_2]$ (4) $[Co(NH_3)Cl_3]$

Ans. **(4)**

Sol.



Facial form



Meridional form

2. The depression in freezing point of 0.1 molal solution is 0.558, then complex will be-

(1) $[Co(NH_3)_6Cl_2]$ (2) $[Co(NH_3)_5Cl]Cl$ (3) $[Co(NH_3)_4Cl_2]$ (4) $[Co(NH_3)Cl_3]$

Ans. **(1)**

Sol. $\Delta T_f = i.K_f.m$

$0.558 = i \times 1.86 \times 0.1$

$$i = \frac{0.558}{1.86 \times 0.1} = 3$$

3. Which of the following element does not lie in same period.

(1) Osmium (2) Iridium (3) Palladium (4) Platinum

Ans. **(3)**

Sol.

4. Which of the following pair of ions are same coloured ?

(1) Ti^{4+}, V^{3+}, Sc^{3+} (2) Cr^{2+}, Cu^{2+}, V^{4+} (3) Cr^{3+}, Ni^{2+}, V^{4+} (4) Mn^{3+}, Fe^{2+}, Zn^{2+}

Ans. **(2)**

Sol. Cr^{2+}, Cu^{2+}, V^{4+} (Blue)

5. Find ΔG of reaction at 298 K

$N_2O_4(g) \rightleftharpoons 2NO_2$;

$\Delta H = +50$ kJ/mol & $\Delta S = 5$ J/mol-k

Ans. **(48.5)**

Sol. $\because \Delta G = \Delta H - T\Delta S$

$$= 50 \text{ kJ/mol} - 298 \times \frac{5}{1000} \text{ kJ}$$

$= 50 - 1.5$ kJ/mol

$= 48.5$ kJ/mol.

6. The pH of 0.1 M $C_2H_5NH_2$ solution is 9. if $K_b = 10^{-x}$ then find x.

Ans. **(9)**

Sol. $$pOH = \frac{1}{2}(pK_b - \log C)$$

$$5 = \frac{1}{2}(pK_b - \log 10^{-1})$$

$10 - 1 = pK_b = 9$

$k_b = 10^{-9} \Rightarrow x = 9$

7. Match the column-I and column-II

Column-I		Column-II	
(A)	Octet complete	(i)	BCl_3, $BeCl_2$
(B)	Octet expanded	(ii)	NO_2, NO
(C)	Octet incomplete	(iii)	CCl_4, CO_2
(D)	Odd electron	(iv)	H_2SO_4, PCl_5

(1) (A) → (iii) ; (B) → (iv) ; (C) → (i) ; (D) → (ii) (2) (A) → (iii) ; (B) → (i) ; (C) → (iv) ; (D) → (ii)
(3) (A) → (iv) ; (B) → (i) ; (C) → (ii) ; (D) → (iii) (4) (A) → (iv) ; (B) → (ii) ; (C) → (iii) ; (D) → (i)

Ans. **(1)**

8. If 10^{21} molecules are removed from x mg of $CO_2(g)$ then 2.8×10^{-3} mole are left. Calculate the value of x.

Ans. **(196.53)**

Sol. $(mole)_i = \left(\frac{x \times 10^{-3}}{44}\right)$, $(mole)_{Removed} = \left(\frac{10^{21}}{6 \times 10^{23}}\right) = \frac{1}{6} \times 10^{-2}$

$(mole)_{left} = 2.8 \times 10^{-3}$

Now,

$(mole)_i - (mole)_{Removed} = (mole)_{left}$

$$= \frac{x \times 10^{-3}}{44} - \frac{10^{21}}{6 \times 10^{23}} = 2.8 \times 10^{-3}$$

$$\frac{x \times 10^{-3}}{44} = 2.8 \times 10^{-3} + \frac{1}{6} \times 10^{-2} = \left(2.8 + \frac{10}{6}\right) \times 10^{-3}$$

$$\frac{x \times 10^{-3}}{44} = \left(\frac{16.8 + 10}{6}\right) \times 10^{-3}$$

$x = 196.53$

9. Incorrect statement among the following is :

(1) SO_2 act as oxidising agent but not reducing agent.
(2) NO_2 exist as dimer
(3) PF_5 exist but NF_5 does not
(4) PH_3 has lower proton affinity than NH_3

Ans. **(1)**

10. Two radioactive decays are

$A \xrightarrow{\lambda_1}$ product $\quad \lambda_1 = 3\lambda_2$

$B \xrightarrow{\lambda_2}$ product $\quad N_{A_0} = N_{B_0}$

Find ratio of $(N_A)_t$ and $(N_B)_t$ after one half life of A

Ans. **(4)**

Sol. Radioactive decays obeys 1st order kinetics

$$\frac{(N_B)_t}{(N_A)_t} = \frac{N_{B_0} e^{-\lambda_2 (t_{1/2})_A}}{N_{A_0} e^{-\lambda_1 (t_{1/2})_A}} \qquad (N_{A_0} = N_{B_0})$$

$$= \frac{e^{-\lambda_2 \times \frac{\ln 2}{\lambda_1}}}{e^{-\lambda_1 \times \frac{\ln 2}{\lambda_1}}} = \frac{e^{-\ln 8}}{e^{-\ln 2}} \Rightarrow \frac{(N_A)_t}{(N_B)_t} = 4$$

11. Calculate the percentage by weight of S if 160 g of organic compound produce 466 g of $BaSO_4$.

Ans. **(40)**

Sol. $S \rightarrow BaSO_4$

$(\text{atoms of S})_S = (\text{atoms of S})_{BaSO_4}$

$$\left(\frac{wt}{32}\right) \times N_A \times 1 = \left(\frac{466}{233}\right) \times N_A \times 1$$

$$(wt)_s = \left(\frac{466 \times 32}{233}\right)$$

$(wt)_s = 64$ g

$$\% \text{ S} = \frac{(wt)_s}{(wt)_{\text{org. compound}}} \times 100 = \frac{64}{160} \times 100 = 40\ \%$$

12. Find the spectral line of H-atom, which have $\lambda = 900$ nm, $R_H = 10^5\ cm^{-1}$

(1) $n_2 = \infty \rightarrow n_1 = 1$, Lyman (2) $n_2 = \infty \rightarrow n_1 = 2$, Balmer

(3) $n_2 = 5 \rightarrow n_1 = 3$, Paschan (4) $n_2 = \infty \rightarrow n_1 = 3$, Paschan

Ans. **(4)**

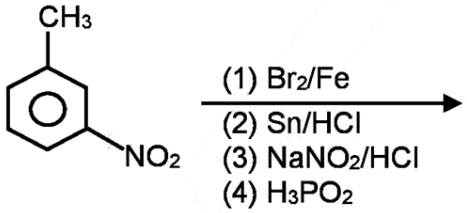
Sol. $$\frac{1}{\lambda} = R_H \times 2^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{\lambda} = 10^5 \times 1 \times \left(\frac{1}{3^2} - \frac{1}{\infty^2}\right)$$

$$\frac{1}{\lambda} = \frac{10^5}{9}$$

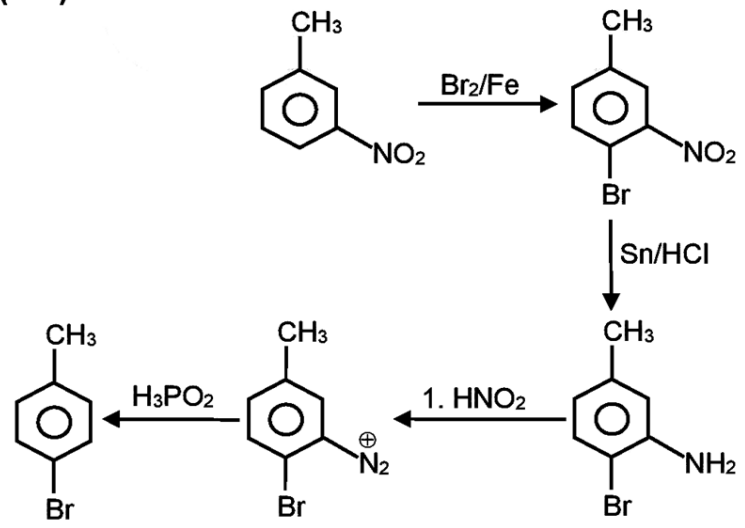
$\Rightarrow \quad \lambda = 9 \times 10^{-5}\ cm = 900 \times 10^{-7}\ cm = 900\ nm$

13. Find molecular mass of final product.

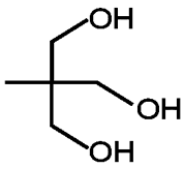
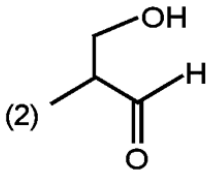
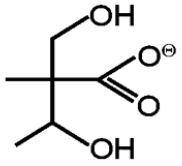
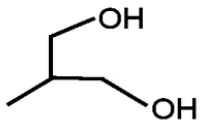


Ans. **(171)**

Sol.

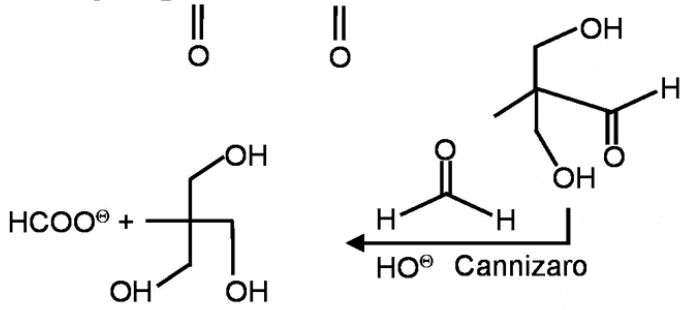


14. $CH_3-CH_2-\underset{\underset{O}{\|}}{C}-H + H-\underset{\underset{O}{\|}}{C}-H \xrightarrow[\text{(Excess)}]{\text{Alkali reflux}}$

(1)  (2)  (3)  (4) 

Ans. **(1)**

Sol. $CH_3-CH_2-\underset{\underset{O}{\|}}{C}-H + H-\underset{\underset{O}{\|}}{C}-H \longrightarrow$ Aldol reaction



15. **Statement 1 :** Fructose gives silver mirror with Tollens reagent although $-\underset{\underset{O}{\|}}{C}-H$ group is absent in it.

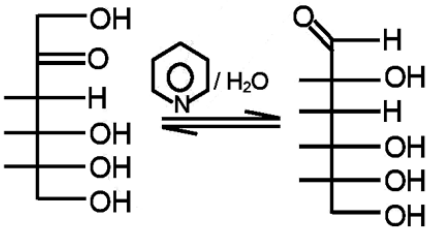
Statement 2 : Fructose in Alkaline (Base) medium converts into Aldose Sugar Glucose which has $-\underset{\underset{O}{\|}}{C}-H$ group.

(1) Both Statement 1 and statement 2 are true (2) Both statement 1 and statement 2 are false
(3) Statement 1 is true but statement 2 is false (4) Statement 1 is false but statement 2 is true

Ans. **(1)**

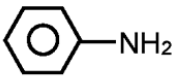
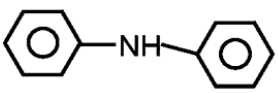
Sol. **Statement 1 :** Correct

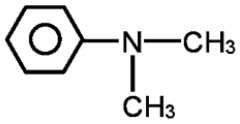
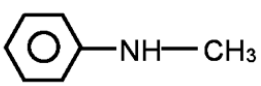
Statement 2 : Correct



Rearrangement or inter conversion between fructose and glucose.

16. Which of the following reacts with Hinsberg reagent.

(A)  (B) CH_3-NH_2 (C) 

(D)  (E) 

(1) A, B, C, E (2) B, C, D (3) A, C, D, E (4) C, D, E

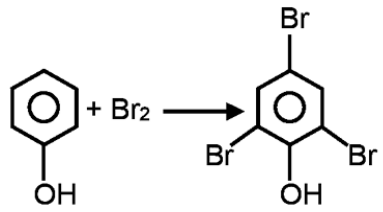
Ans. **(1)**

Sol. Only primary and sec. amine reacts with Hinsberg reagent.

17. 2 g phenol react with Br_2 water to give trisubstituted phenol.
How much Br_2 is needed to complete reaction in grams. (Rounded off to nearest integer)

Ans. **(10)**

Sol.

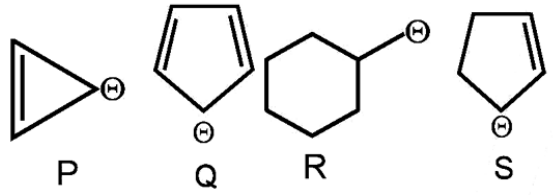


1 : 3 mol ratio

$\frac{2g}{94}$ $\frac{2}{94} \times 3$ mol Br_2

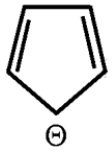
Hence $\frac{2 \times 3}{94} \times 160g\, Br_2$ used in reaction. = 10.21 g

18 Which of the following the most stable carbanion is



(1) P (2) Q (3) R (4) S

Ans. **(2)**

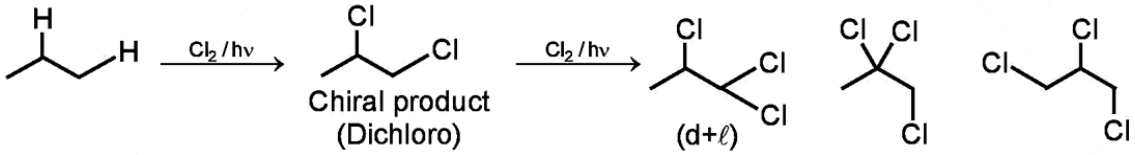
Sol.  Follows Huckel rule hence is Aromatic stabilised resonance energy.

19. Propane reacts with Cl_2 in sunlight to give chiral product [x] which is dichloro product.

[x] is further chlorinated in sunlight to give how many trichloro product.

Ans. **(4)**

Sol.



Total 4 product are formed.

20. In estimation of sulphur by carius method, 160 g of organic compound gives 466 g of Barium sulphate.
% of sulphur in the organic compound is.

Ans. **(40)**

Sol. $BaSO_4(233)$

Moles = $\frac{466}{233} = 2$

Mass(s) = 2 × 32 = 64

% of S = $\frac{64}{160} \times 100 = 40\%$

21. Match the reactions name in given column to correct product formed.

	Column-I		**Column-II**
(A)	Wurtz fittig reaction	(P)	Fluoride product
(B)	Finkelstein Reaction	(Q)	Iodide product
(C)	Sand Meyer Reaction	(R)	Chloride product
(D)	Swart Reaction	(S)	Hydrocarbon product

(1) A-(S); (B)-(Q); (C)-(R); (D)-(P)

(2) A-(R); (B)-(P); (C)-(S); (D)-(P)

(3) A-(P); (B)-(R); (C)-(Q); (D)-(R)

(4) A-(Q); (B)-(R); (C)-(S); (D)-(P)

Ans. **(1)**

1. Find number of words by using all letters of the word "DAUGHTER" such that no two vowels come together

(1) 5200 (2) 7200 (3) 14400 (4) $3\times\lfloor 5$

Ans. **(3)**

Sol.

D	G	H	T	R

Number of ways of arrangement of consonants = $\lfloor 5$

Now there are 6 gaps between these consonants.

So, number of ways of arrangement of three vowels A, U, E = ${}^6P_3$

So total number of words = $\lfloor 5\times {}^6P_3 = 120 \times 6 \times 5 \times 4 = 120 \times 120 = 14400$

2. Find sum of all rational terms in expansion of $(1 + 2^{1/3} + 3^{1/2})^6$

(1) 144 (2) 612 (3) 720 (4) 562

Ans. **(2)**

Sol. General term = $\frac{\lfloor 6}{\lfloor r_1 \lfloor r_2 \lfloor r_3} \times 2^{\frac{r_2}{3}} \times 3^{\frac{r_3}{2}}$; $0 \le r_1, r_2, r_3 \le 6$ and $r_1 + r_2 + r_3 = 6$.

For rational term : $r_2 = 0 \rightarrow r_1 + r_3 = 6$ $\begin{cases} r_3 = 0, r_1 = 6 \\ r_3 = 2, r_1 = 4 \\ r_3 = 4, r_1 = 2 \\ r_3 = 6, r_1 = 0 \end{cases}$

$r_2 = 3 \rightarrow r_1 + r_3 = 3$ $\begin{cases} r_3 = 0,\ r_1 = 3 \\ r_3 = 2,\ r_1 = 1 \end{cases}$

$r_2 = 6 \rightarrow r_1 + r_2 = 0$ $(r_1 = 0, r_2 = 0$

Sum of all rational terms =

$$\frac{\lfloor 6}{\lfloor 0 \lfloor 0 \lfloor 6} 2^0.3^0 + \frac{\lfloor 6}{\lfloor 0 \lfloor 2 \lfloor 4} 2^0.3^1 + \frac{\lfloor 6}{\lfloor 0 \lfloor 4 \lfloor 2} 2^0.3^2 + \frac{\lfloor 6}{\lfloor 0 \lfloor 6 \lfloor 0} 2^0.3^3 + \frac{\lfloor 6}{\lfloor 3 \lfloor 0 \lfloor 3} 2^1.3^0 + \frac{\lfloor 6}{\lfloor 3 \lfloor 2 \lfloor 1} 2^1.3^1 + \frac{\lfloor 6}{\lfloor 6 \lfloor 0 \lfloor 0} 2^2.3^0$$

$= 1 + 45 + 135 + 27 + 40 + 360 + 4 = 612$

3. If for an AP, if first term is 3 and sum of first four terms is equal to $\frac{1}{5}$ of the sum of next four terms, then the sum of first 20 terms is:

(1) –540 (2) –1080 (3) 2016 (4) 4080

Ans. **(2)**

Sol. a = 3, let common difference = d.

$$\frac{4}{2}[2\times 3 + (4-1)d] = \frac{4}{5\times 2}[2\times(3+4d) + (4-1)d]$$

$5(6 + 3d) = 6 + 8d + 3d$

$30 + 15d = 6 + 11d$

$4d = -24$

$d = -6$

$S_{20} = \frac{20}{2}[2\times 3 + 19(-6)] = 10[6 - 114] = 10 \times (-108) = -1080$

4. Value of $\sin70^\circ(\cot10^\circ\cot70^\circ - 1)$ is:

(1) 2 (2) 1 (3) $\frac{1}{2}$ (4) 3

Ans. **(2)**

Sol. $\sin70^\circ\left(\frac{\cos10^\circ}{\sin10^\circ}\frac{\cos70^\circ}{\sin70^\circ}-1\right)$

$\sin70^\circ\left(\frac{\cos70^\circ\cos10^\circ-\sin70^\circ\sin10^\circ}{\sin70^\circ\sin10^\circ}\right) = \frac{\cos(70^\circ+10^\circ)}{\sin10^\circ} = \frac{\cos80^\circ}{\sin10^\circ} = \frac{\sin10^\circ}{\sin10^\circ} = 1$

5. Value of $\cos^{-1}\left[\frac{12}{13}\cos x + \frac{5}{13}\sin x\right]$ is, if $x \in \left(\frac{\pi}{2}, \frac{3\pi}{4}\right)$

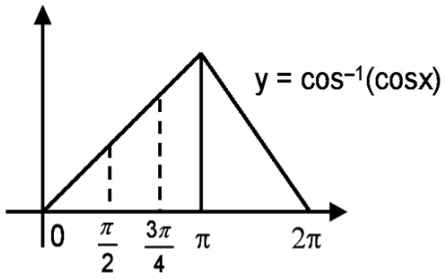
(1) $x + \tan^{-1}\frac{12}{5}$ (2) $x - \tan^{-1}\frac{12}{5}$ (3) $x - \tan^{-1}\frac{5}{12}$ (4) $x + \tan^{-1}\frac{5}{12}$

Ans. **(3)**

Sol. $\cos^{-1}\left[\frac{12}{13}\cos x + \frac{5}{13}\sin x\right]$

$\cos^{-1}[\cos(x-\phi]$

Let $\cos\phi = \frac{12}{13}$ and $\sin\phi = \frac{5}{13}$, so $\tan\phi = \frac{5}{12}$



$= x - \phi$

$= x - \tan^{-1}\frac{5}{12}$

6. If function $f(x) = \begin{cases} \frac{2}{x}\{\sin(k_1+1)x + \sin(k_2+1)x\} & x < 0 \\ 4 & x = 0 \\ \frac{2}{x}\ell n\left(\frac{k_2x+1}{k_1x+1}\right) & x > 0 \end{cases}$ is continuous at x = 0, then value of $k_1^2 + k_2^2$ is equal to –

(1) 6 (2) 2 (3) 4 (4) 8

Ans. **(2)**

Sol. $f(0) = 4$

$$f(0^-) = \lim_{h\to 0} \frac{2\{\sin(k_1+1)h + \sin(k_2+1)h\}}{h}$$

$$= \lim_{h\to 0} \frac{2\{(k_1+1)\cos(k_1+1)h + (k_2+1)\cos(k_2+1)h\}}{1}$$

$= 2\ (k_1 + 1 + k_2 + 1) = 2\ (k_1 + k_2 + 2)$

$$f(0^+) = \lim_{h\to 0} \frac{2\{\ell n(k_2h+1) - \ell n(k_1h+1)\}}{h}$$

$$= \lim_{h\to 0} \frac{2\left\{\frac{k_2}{k_2h+1} - \frac{k_1}{k_1h+1}\right\}}{1}$$

$= 2\ (k_2 - k_1)$

Now $2\ (k_1 + k_2 + 2) = 4$

$k_1 + k_2 = 0$ …(i)

and $2(k_2 - k_1) = 4$

$k_2 - k_1 = 2$ …(ii)

So $k_1 = -1$ and $k_2 = 1$

So $k_1^2 + k_2^2 = 1 + 1 = 2$

7. A relation defined on set A = {1, 2, 3, 4}, then how many ordered pairs are added to R = {(1, 2), (2, 3), (3,3)} so that it becomes equivalence?

Ans. **(7)**

Sol. For equivalence it must be transitive, symmetric and reflexive all.

For reflexive → (1, 1), (2, 2), (4, 4)

For symmetric → (2, 1), (3, 2)

For transitive → (1, 3), (3, 1)

Total 7 pairs has to be added to make it's an equivalence relation.

8. Find value of λ for which system of equation:

$(\lambda - 1)x + (\lambda + 2)y + (\lambda - 1)z = 0$

$\lambda x + (\lambda - 1)y + (\lambda + 1)z = 0$

$(\lambda - 1)x + (\lambda + 1)y + (\lambda + 2)z = 0$ has infinite solution.

(1) 0 (2) $\frac{2}{11}$ (3) 2 (4) $\frac{3}{11}$

Ans. **(2)**

Sol. Homogeneous system of equation:

$$\begin{vmatrix} (\lambda-1) & (\lambda+2) & \lambda-1 \\ \lambda & \lambda-1 & \lambda+1 \\ \lambda-1 & \lambda+1 & (\lambda+2) \end{vmatrix} = 0$$

$R_2 \to R_2 - R_1$

$R_3 \to R_3 - R_1$

$$\begin{vmatrix} \lambda-1 & \lambda+2 & \lambda-1 \\ 1 & -3 & 2 \\ 0 & -1 & 3 \end{vmatrix} = 0$$

$(\lambda - 1)(-9 + 2) - (\lambda + 2)(3 - 0) + (\lambda - 1)(-1 - 0) = 0.$

$-7(\lambda - 1) - 3(\lambda + 2) - (\lambda - 1) = 0.$

$-7\lambda + 7 - 3\lambda - 6 - \lambda + 1 = 0$

$\Rightarrow \quad \lambda = \frac{2}{11}$

9. There are two biased dice such that, for first dice two faces show 1, 2 faces show 2, one face show 3 and one face show 4. For second dice one face show 1, two faces show 2, one face show 3, and two faces show 4. Then find probability of getting sum 4 or 5, when dice are thrown together.

(1) $\frac{5}{9}$ (2) $\frac{4}{9}$ (3) $\frac{2}{9}$ (4) $\frac{8}{9}$

Ans. **(2)**

Sol. First dice have 1, 1, 2, 2, 3, 4

Second dice have 1, 2, 2, 3, 4, 4

Now P (sum 4 or sum 5) = P (sum 4) + P (sum 5)

= P (1, 3) + P (2, 2) + P (3, 1) + P (1, 4) + P(2, 3) + P(3, 2) + P(4, 1)

$$= \frac{2}{6}\times\frac{1}{6}+\frac{2}{6}\times\frac{2}{6}+\frac{1}{6}\times\frac{1}{6}+\frac{2}{6}\times\frac{2}{6}+\frac{2}{6}\times\frac{1}{6}+\frac{1}{6}\times\frac{2}{6}+\frac{1}{6}\times\frac{1}{6}$$

$$= \frac{2+4+1+4+2+2+1}{36} = \frac{16}{36} = \frac{4}{9}$$

10. If $\left|\frac{\bar{z}-i}{2\bar{z}+i}\right| = \frac{1}{3}$ represent a circle whose centre is C and area of triangle whose vertices are (0, 0), C and $(\alpha, 0)$ is 11 then find α^2.

Ans. **(100)**

Sol. $3|\bar{z} - i| = |2\bar{z} + i|$

$3|x - i(y + 1)| = |2x + i(1 - 2y)|$

$\Rightarrow \quad 9(x^2 + (y + 1)^2) = 4x^2 + (1 - 2y)^2$

$\Rightarrow \quad 5x^2 + 5y^2 + 22y + 8 = 0$

Centre $C\left(0, \frac{-11}{5}\right)$

Area $\Delta = \left|\frac{1}{2}.\frac{11}{5}.\alpha\right| = 11$

$|\alpha| = 10$

$\alpha^2 = 100$

11. If both roots of quadratic equation

$a(b-c)x^2 + b(c-a)x + c(a-b) = 0$ are equal and $a + c = 15$, $b = 2/15$ then value of $a^2 + c^2$ is:

(1) 217 (2) 223 (3) 213 (4) 211

Ans. **(2)**

Sol. Clearly one root is one

$\therefore$ Product of roots = 1

$$\frac{c(a-b)}{a(b-c)} = 1$$

$ac - bc = ab - ac$

$2ac = b(a + c)$

$$2ac = \frac{2}{15} \times 15$$

$ac = 1$

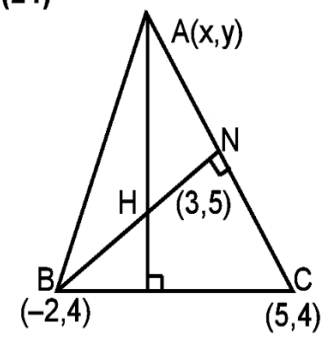
Now $a^2 + c^2 = (a + c)^2 - 2ac$

$= (15)^2 - 2 = 223$

12. Two vertices of triangle are (–2, 4) and (5, 4) and its orthocentre is (3, 5) and centroid is (c, d) then the value of c + 3d is:

Ans. **(24)**

Sol.



BC $\Rightarrow$ parallel to x – axis

AH $\Rightarrow$ parallel to y – axis

so x = 3

$M_{AC} \times M_{BN} \Rightarrow -1$

$$\frac{4-y}{5-3} \times \frac{5-4}{3+2} = -1$$

$= (4 - y) = -10$

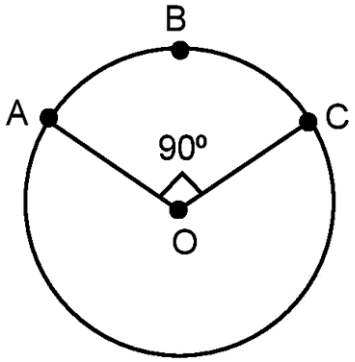
$\Rightarrow$ y = 14

A (3,14)

$$G \equiv (c, d) \equiv \left(2, \frac{22}{3}\right) \quad \Rightarrow \quad c = 2,\ d = \frac{22}{3}$$

c + 3d = 24

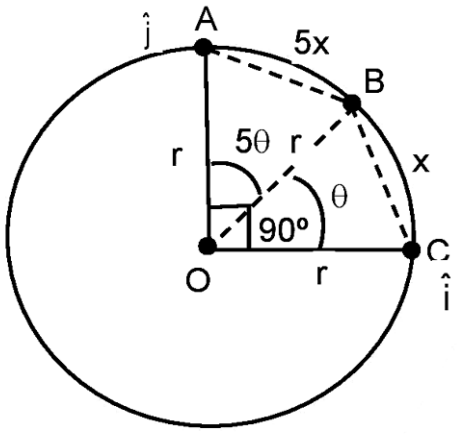
13. In the given figure, $\frac{AB}{BC}=\frac{1}{5}$, $\overrightarrow{OC}=\alpha\overrightarrow{OA}+\beta\overrightarrow{OB}$; find $\alpha+\sqrt{2}\left(\sqrt{3}-1\right)\beta$



(1) $\left(\sqrt{3}+1\right)\frac{3}{2\sqrt{2}}$ (2) $\left(\sqrt{3}-1\right)\frac{5}{2\sqrt{2}}$ (3) $\left(\sqrt{3}-1\right)\frac{3}{2\sqrt{2}}$ (4) $\left(\sqrt{3}+1\right)\frac{5}{2\sqrt{2}}$

Ans. **(3)**

Sol.



$5\theta+\theta=\frac{\pi}{2}$

$\theta=\frac{\pi}{12}$

$\overrightarrow{OC}=r\cos\theta\hat{i}$

$\overrightarrow{OA}=r\hat{j}$

$\overrightarrow{OB}=r\cos\theta\hat{i}+r\sin\theta\hat{j}$

$\overrightarrow{OC}=\alpha\overrightarrow{OA}+\beta\overrightarrow{OB}$

$r\cos\theta\hat{i}=\alpha(r\hat{j})+\beta(r\cos\theta\hat{i}+r\sin\theta\hat{j})$

$r\cos\theta=\beta r\cos\theta$

$\beta=1$

$\alpha r+r\sin\theta.\beta=0$

$\alpha=-\sin\theta$

$\alpha=-\left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right)$

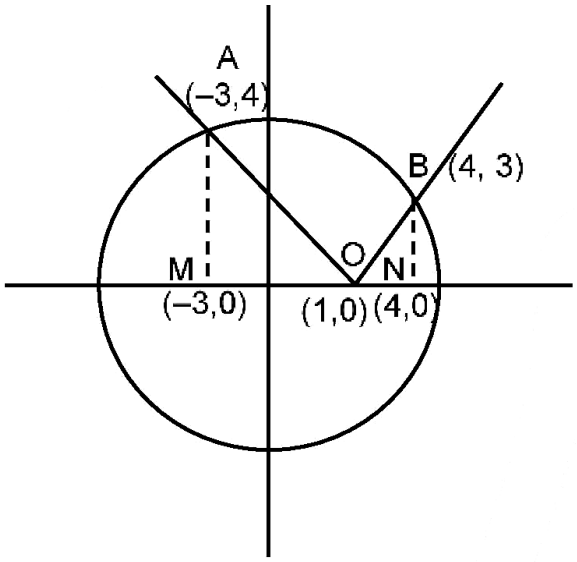
$-\left(\frac{\sqrt{3}-1}{2\sqrt{2}}\right)+\sqrt{2}\left(\sqrt{3}-1\right).1=\left(\sqrt{3}-1\right)\frac{3}{2\sqrt{2}}$

14. Area of the larger region bounded by curves $y = |x - 1|$ and $x^2 + y^2 = 25$ is:

(1) $\left(\frac{75\pi}{4} + \frac{1}{2}\right)$ (2) $\left(\frac{75\pi}{4} - \frac{1}{2}\right)$ (3) $\left(\frac{25\pi}{4} + \frac{1}{2}\right)$ (4) $\left(\frac{25\pi}{4} - \frac{1}{2}\right)$

Ans. **(1)**

Sol. Area of shaded of region = area of circle – area AOB (unshaded)



$\therefore$ Area of AOB $= \int_{-3}^{4} \sqrt{25 - x^2}$ – Area of ΔAOM – Area of ΔONB

$$= \int_{-3}^{4} \sqrt{25 - x^2} - \frac{1}{2} \times 4 \times 4 - \frac{1}{2} \times 3 \times 3$$

$$= \int_{-3}^{4} \sqrt{25 - x^2} - 8 - \frac{9}{2} \qquad \ldots(i)$$

$$= \left[\frac{x}{2}\sqrt{25 - x^2} + \frac{25}{2}\sin^{-1}\frac{x}{5}\right]_{-3}^{4} - \frac{25}{2}$$

$$= \frac{25\pi}{4} - \frac{1}{2}$$

$\therefore$ Required area $= \pi(5^2) - \left(\frac{25\pi}{4} - \frac{1}{2}\right) = \frac{75\pi}{4} + \frac{1}{2}$

15. Given $f(x) = \ell nx$ and $g(x) = \dfrac{x^4 - 2x^3 + 3x^2 - 2x + 2}{2x^2 - 2x + 1}$, then the domain of f(g(x)) is :

(1) $(0, \infty)$ (2) $(1, \infty)$ (3) R (4) $(-\infty, 0)$

Ans. **(3)**

Sol. $f(g(x)) = \ell n(g(x)) \quad \Rightarrow \quad g(x) > 0$

$$g(x) = \frac{x^4 - 2x^3 + 3x^2 - 2x + 2}{2x^2 - 2x + 1} > 0$$

$\Rightarrow \quad 2x^2 - 2x + 1 > 0 \ \forall \ x \in R \qquad (\because a > 0, D < 0)$

Now, $x^4 - 2x^3 + 3x^2 - 2x + 2 = x^4 - 2x^3 + 2x^2 + x^2 - 2x + 2$

$x^4 - 2x^3 + 2x^2 + x^2 - 2x + 2 = (x^2 + 1)(x^2 - 2x + 2) > 0 \ \forall \ x \in R$

$x^4 - 2x^3 + 3x^2 - 2x + 2 > 0$

$g(x) > 0 \ \forall \ x \in R$

Therefore, domain of f(g(x)) is R.