MENIIT
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JEE MAIN-2021

COMPUTER BASED TEST (CBT)

DATE : 25-02-2021 (MORNING SHIFT) | TIME : (9.00 am to 12.00 pm)

Duration 3 Hours | Max. Marks : 300

QUESTION & SOLUTIONS

PART A : PHYSICS

Single Choice Type

This section contains **20 Single choice questions**. Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

1. Given below are two statement : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : When a rod lying freely is heated, no thermal stress is developed in it.

Reason R : On heating the length of the rod increases.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both A and R are true but R is NOT the correct explanation of A

(2) A is false but R is true

(3) A is true but R is false

(4) Both A and R are true and R is the correct explanation of A

Ans. (1)

Sol. A and R are true but R is not the correct explanation of A.

2. A student is performing the experiment of resonance column. The diameter of the column tube is 6 cm. The frequency of the tuning fork is 504 Hz. Speed of the sound at the given temperature is 336 m/s. The zero of the meter scale coincides with the top end of the resonance column tube. The reading of the water level in the column when the first resonance occurs is:

(1) 13 cm (2) 16.6 cm (3) 18.4 cm (4) 14.8 cm

Ans. (4)

Sol. d = 6cm, f = 504, v = 336 m/s

e = 0.3d

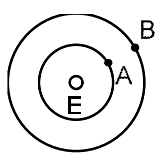
$\ell \quad e \quad \frac{}{4} \quad \frac{V}{4f}$

$\ell = 16.66 - 0.3 \times 6$

$\ell = 14.866$ cm

$\ell = 14.8$ cm

3. Two satellites A and B of masses 200kg and 400kg are revolving round the earth at height of 600 km and 1600 km respectively. If T_A and T_B are the time periods of A and B respectively then the value of $T_B - T_A$:



[Given : radius of earth = 6400km, mass of earth = 6×10^{24} kg]

(1) 1.33×10^3 s (2) 3.33×10^2 s (3) 4.24×10^3 s (4) 4.24×10^2 s

Ans. (1)

Sol. $T \quad 2 \sqrt{\frac{r^3}{GM}}$

$T_A \quad 2 \sqrt{\frac{(6400 \quad 600) \quad 10^3}{GM}}$

$T_A \quad 2 \quad 10^9 \sqrt{\frac{7^3}{GM}}$

$T_B \quad 2 \quad 10^9 \sqrt{\frac{8^3}{GM}}$

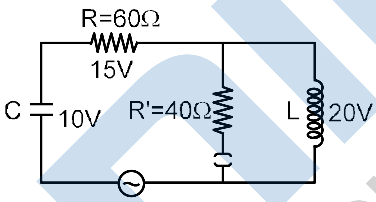
$T_B \quad T_A \quad \frac{2 \; 10^9}{\sqrt{GM}} \; 8\sqrt{8} \quad 7\sqrt{7}$

= 314 × 4.107

= 1289.64

= 1.289×10^3 s

4. The angular frequency of alternating current in a L-C-R circuit is 100 rad/s. The components connected are shown in the figure. Find the value of inductance of the coil and capacity of condenser.



(1) 0.8 H and 150 μF (2) 0.8 H and 250 μF (3) 1.33 H and 250 μF (4) 1.33 H and 150 μF

Ans. (2)

Sol. Current through 60W resistance $\frac{15}{60} \quad \frac{1}{4}$ A

thus capacitor current $\frac{1}{4}$ A

$\because V_C = I X_C$

$10 \quad \frac{1}{4} \quad \frac{1}{C}$

$\because C \quad \frac{1}{40} \quad \frac{1}{4000} \; 250 \quad F$

Now,

current through 40Ω resistance $\frac{20}{40} \quad \frac{1}{2}$ A

thus current through inductor $\frac{1}{2} \quad \frac{1}{4} \quad \frac{1}{4}$ A

$V_L \quad IX_L \quad \frac{1}{4} \quad L$

$20 \quad \frac{1}{4} \quad 100 \quad L$

$\Rightarrow L = 0.8 \text{ H}$

5. A proton, a deuteron and an α particle are moving with same momentum in a uniform magnetic field. The ratio of magnetic forces acting on them is ____ and their speed is ____ in the ratio.

(1) 1 : 2 : 4 and 2 : 1 : 1

(2) 2 : 1 : 1 and 4 : 2 : 1

(3) 4 : 2 : 1 and 2 : 1 : 1

(4) 1 : 2 : 4 and 1 : 1 : 2

Ans. (2)

Sol. $F \quad q\,\vec{v} \quad \vec{B} \quad \frac{q}{m}\vec{P} \quad \vec{B}$

$F \quad \frac{q}{m}$

thus $F_1 : F_2 : F_3 \quad \frac{q_1}{m_2} : \frac{q_2}{m_2} : \frac{q_3}{m_3}$

$\frac{e}{m_p} : \frac{e}{2m_p} : \frac{2e}{4m_p}$

$\frac{1}{1} : \frac{1}{2} : \frac{2}{4}$

$= 2 : 1 : 1$

Now for speed calculation

P = constant $\quad v \quad \frac{1}{m}$

thus $v_1 : v_2 : v_3 \quad \frac{1}{m_p} : \frac{1}{2m_p} : \frac{1}{4m_p}$

$\frac{1}{1} : \frac{1}{2} : \frac{1}{4}$

$= 4 : 2 : 1$

6. Given below are two statement :

Statement-I : A speech signal of 2 kHz is used to modulate a carrier signal of 1 MHz. The band width requirement for the signal is 4 kHz.

Statement-II : The side band frequencies are 1002 kHz. and 998 kHz.

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement I is true but Statement II is false

(2) Statement I is false but Statement II is true

(3) Both Statement I and Statement II are true

(4) Both Statement I and Statement II are false

Ans. (3)

Sol. f_m = 2kHz

f_c = 1MHz = 1000 kHz

Band width = $2f_m$ = 4kHz

$\therefore$ Side frequencies will be

= $f_c \pm f_m$

= (1000 ± 2) kHz

= 998 kHz & 1002 kHz

So statement-I & statement-II both are correct.

7. If the time period of a two meter long simple pendulum is 2s, the acceleration due to gravity at the place where pendulum is executing S.H.M. is :

(1) $\pi^2 ms^{-2}$ (2) 9.8 ms^{-2} (3) $2\pi^2 ms^{-2}$ (4) 16 m/s^2

Ans. (3)

Sol. $T \quad 2 \sqrt{\frac{\ell}{g}}$

$2 \quad 2 \sqrt{\frac{2}{g}}$

$\Rightarrow g = 2\pi^2$

8. The pitch of the screw gauge is 1mm and there are 100 divisions on the circular scale. When nothing is put in between the jaws, the zero of the circular scale lies 8 divisions below the reference line. When a wire is placed between the jaws, the first linear scale division is clearly visible while 72^{nd} division on circular scale coincides with the reference line. The radius of the wire is

(1) 1.64 mm (2) 0.82 mm (3) 1.80 mm 4) 0.90 mm

Ans. (2)

Sol. Least count $\frac{1mm}{100} \quad 0.01\,mm$

zero error = + 8 × LC = + 0.08 mm

True reading (Diameter)

= (1 mm + 72 × LC) – (Zero error)

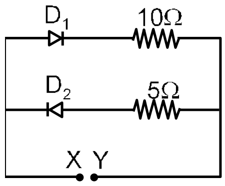
= (1mm+ 72 × 0.01mm) – 0.08 mm

= 1.72 mm – 0.08 mm

= 1.64 mm

therefore, radius $\frac{1.64}{2} \quad 0.82$ mm .

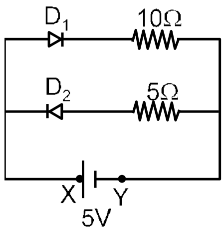
9. A 5V battery is connected across the points X and Y. Assume D_1 and D_2 to be normal silicon diodes. Find the current supplied by the battery if the +ve terminal of the battery is connected to point X.



(1) ~ 0.5 A   (2) ~ 1.5 A   (3) ~ 0.86 A   (4) ~ 0.43 A

Ans. (4)

Sol.



Here only D_1 will work and we know for silicon diode, potential drop on D_1 will be 0.7V

$$I \quad \frac{5 \quad 0.7}{10} \quad 0.43 \text{ A}$$

10. An α particle and a proton are accelerated from rest by a potential difference of 200 V. After this, their de Broglie wavelengths are λ_α and λ_p respectively. The ratio $\frac{\ \ _p}{}$ is :

(1) 3.8   (2) 8   (3) 7.8   (4) 2.8

Ans. (4)

Sol. $\frac{h}{p} \quad \frac{h}{\sqrt{2mqV}}$

$$\frac{\ \ _p}{} \quad \sqrt{\frac{m \ q}{m_p q_p}} \quad \sqrt{\frac{4m_p \quad 2e}{m_p \quad e}} \quad \sqrt{8} \quad 2\sqrt{2}$$

$$\frac{\ \ _p}{} \quad 2 \quad 1.4 \quad 2.8$$

11. A diatomic gas, having $C_p \ \frac{7}{2}R$ and $C_v \ \frac{5}{2}R$, is heated at constant pressure. The ratio dU : dQ : dW:

(1) 5 : 7 : 3   (2) 5 : 7 : 2   (3) 3 : 7 : 2   (4) 3 : 5 : 2

Ans. (2)

Sol. $dU = nC_v dT$

$dQ = nC_p dT$

$dW = PdV = nRdT$ (isobaric process)

$dU : dQ : dW : C_v : C_p : R$

$\frac{5R}{2} : \frac{7R}{2} : R \quad 5:7:2$

12. An engine of a train, moving with uniform acceleration, passes the signal-post with velocity u and the last compartment with velocity v. The velocity with which middle point of the train passes the signal post is:

(1) $\sqrt{\frac{v^2 \quad u^2}{2}}$ (2) $\frac{v \quad u}{2}$ (3) $\frac{v \quad u}{2}$ (4) $\sqrt{\frac{v^2 \quad u^2}{2}}$

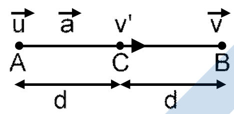
Ans. (1)

Sol. $(v')^2 = u^2 + 2ad$

$v^2 = (v')^2 + 2ad$

solving, we get

$v' \quad \sqrt{\frac{v^2 \quad u^2}{2}}$



13. Match List-I with List-II :

List-I	List-II
(a) h (Planck's constant)	(i) $[M L T^{-1}]$
(b) E (kinetic energy)	(ii) $[M L^2 T^{-1}]$
(c) V (electric potential)	(iii) $[M L^2 T^{-2}]$
(d) P (linear momentum)	(iv) $[M L^2 I^{-1} T^{-3}]$

Choose the correct answer from the options given below :

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

Ans. (2)

Sol. By dimensional analysis.

14. Magnetic fields at two points on the axis of a circular coil at a distance of 0.05m and 0.2 m from the centre are in the ratio 8 : 1. The radius of coil is ____.

(1) 0.2 m (2) 0.1 m (3) 0.15 m (4) 1.0 m

Ans. (2)

Sol. We know, the magnetic field on the axis of a current carrying circular ring is given by

$B \quad \frac{\ _0}{4} \frac{2NIA}{(R^2 \quad x^2)^{3/2}}$

$\frac{B_1}{B_2} \quad \frac{8}{1} \quad \left(\frac{R^2 \quad (0.2)^2}{R^2 \quad (0.05)^2}\right)^{3/2}$

$4[R^2 + (0.05)^2] = [R^2 + (0.2)^2]$

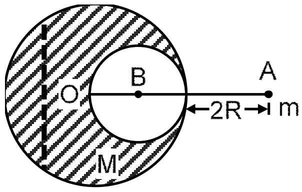
$4R^2 - R^2 = (0.2)^2 - 4 \times (0.05)^2$

$4R^2 - R^2 = (0.2)^2 - (0.1)^2$

$3R^2 = 0.3 \times 0.1$

$R^2 = (0.1)^2 \Rightarrow R = 0.1$

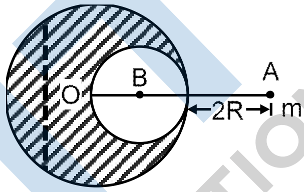
15. A solid sphere of radius R gravitationally attracts a particle placed at 3R form its centre with a force F_1. Now a spherical cavity of radius $\frac{R}{2}$ is made in the sphere (as shown in figure) and the force becomes F_2. The value of $F_1 : F_2$ is :



(1) 25 : 36 (2) 36 : 25 (3) 50 : 41 (4) 41 : 50

Ans. (3)

Sol. Let initial mass of sphere is m'. Hence mass of removed portion will be m'/8



$F_1 \quad m.F. \quad \frac{m.Gm'}{9R^2}$

$F_2 \quad m \quad \frac{G.m'}{(3R)^2} \quad \frac{G.m'/8}{(5R/2)^2}$

$\frac{G.m'}{9R^2} \quad \frac{G.m'}{8}\frac{4}{25}$

$\frac{1}{9} \quad \frac{1}{50} \quad \frac{G.m'}{R^2}$

$F_2 \quad \frac{41}{50 \quad 9} . \frac{G.m'}{R^2}$

$\frac{F_1}{F_2} \quad \frac{1}{9} \quad \frac{50 \quad 9}{41} \quad \frac{50}{41}$

16. Two radioactive substances X and Y originally have N_1 and N_2 nuclei respectively. Half life of X is half of the half life of Y. After three half lives of Y, number of nuclei of both are equal. The ratio $\frac{N_1}{N_2}$ will be equal to :

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

Ans. (3)

Sol. $T_x = t$; $T_y = 2t$

$3T_y = 6t,$

$N_1' = N_2'$

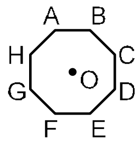
$N_1 e^{\quad _1 6t} \quad N_2 e^{\quad _2 6t}$

$\frac{N_1}{N_2} \quad e^{\quad _1 \quad _2 6t} \quad e^{\ln 2 \frac{1}{t} \frac{1}{2t} \quad 6t} \quad e^{(\ln 2) \; 3} \quad e^{\ln 8} \quad 8$

$\frac{N_1}{N_2} \quad \frac{8}{1}$

17. In an octagon ABCDEFGH of equal side, what is the sum of

$\overrightarrow{AB} \quad \overrightarrow{AC} \quad \overrightarrow{AD} \quad \overrightarrow{AE} \quad \overrightarrow{AF} \quad \overrightarrow{AG} \quad \overrightarrow{AH}'$ if $\overrightarrow{AO} \quad 2\hat{i} \quad 3\hat{j} \quad 4\hat{k}$



(1) $16\hat{i} \quad 24\hat{j} \quad 32\hat{k}$ (2) $16\hat{i} \quad 24\hat{j} \quad 32\hat{k}$ (3) $16\hat{i} \quad 24\hat{j} \quad 32\hat{k}$ (4) $16\hat{i} \quad 24\hat{j} \quad 32\hat{k}$

Ans. (2)

Sol. We know,

$\because \overrightarrow{OA} \quad \overrightarrow{OB} \quad \overrightarrow{OC} \quad \overrightarrow{OD} \quad \overrightarrow{OE} \quad \overrightarrow{OF} \quad \overrightarrow{OG} \quad \overrightarrow{OH} \quad \vec{0}$

By triangle law of vector addition, we can write

$\overrightarrow{AB} \quad \overrightarrow{AO} \quad \overrightarrow{OB}\,;\, \overrightarrow{AC} \quad \overrightarrow{AO} \quad \overrightarrow{OC}$

$\overrightarrow{AD} \quad \overrightarrow{AO} \quad \overrightarrow{OD}\,;\, \overrightarrow{AE} \quad \overrightarrow{AO} \quad \overrightarrow{OE}$

$\overrightarrow{AF} \quad \overrightarrow{AO} \quad \overrightarrow{OF}\,;\, \overrightarrow{AG} \quad \overrightarrow{AO} \quad \overrightarrow{OG}$

$\overrightarrow{AH} \quad \overrightarrow{AO} \quad \overrightarrow{OH}$

Now

$\overrightarrow{AB} \quad \overrightarrow{AC} \quad \overrightarrow{AD} \quad \overrightarrow{AE} \quad \overrightarrow{AF} \quad \overrightarrow{AG} \quad \overrightarrow{AH}$

$(7\overrightarrow{AO}) \quad \overrightarrow{OB} \quad \overrightarrow{OC} \quad \overrightarrow{OD} \quad \overrightarrow{OE} \quad \overrightarrow{OF} \quad \overrightarrow{OG} \quad \overrightarrow{OH}$

$(7\overrightarrow{AO}) \quad \vec{0} \quad \overrightarrow{OA}$

$(7\overrightarrow{AO}) \quad \overrightarrow{OA}$

$8\overrightarrow{AO} \quad 8(2\hat{i} \quad 3\hat{j} \quad 4\hat{k})$

$16\hat{i} \quad 24\hat{j} \quad 32\hat{k}$

18. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : The escape velocities of planet A and B are same. But A and B are of unequal mass.

Reason R : The product of their mass and radius must be same, $M_1R_1 = M_2R_2$

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both A and R are correct but R is NOT the correct explanation of A

(2) A is correct but R is not correct

(3) Both A and R are correct and R is the correct explanation of A

(4) A is not correct but R is correct

Ans. (2)

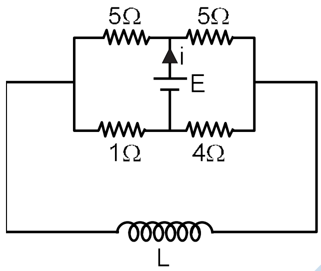
Sol. $V_e \quad \sqrt{\frac{2GM}{R}}$

$\frac{M_1}{R_1} \quad \frac{M_2}{R_2}$

$M_1R_2 = M_2R_1$

Hence reason R is not correct.

19. The current (i) at time t = 0 and t = ∞ respectively for the given circuit is :



(1) $\frac{18E}{55}, \frac{5E}{18}$ (2) $\frac{10E}{33}, \frac{5E}{18}$ (3) $\frac{5E}{18}, \frac{18E}{55}$ (4) $\frac{5E}{18}, \frac{10E}{33}$

Ans. (4)

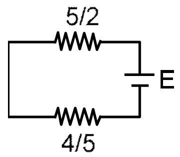
Sol. At t = 0, current through inductor is zero,

hence R_{eq} = (5+1) || (5+4) $\quad \frac{18}{5}$

$i_1 \quad \frac{E}{18/5} \quad \frac{5E}{18}$

At t = ∞, inductor becomes a simple wire and now the circuit will be as shown in figure

hence R_{eq} = (5||5) + (4||1) $\quad \frac{33}{10}$; (|| ⇒ parallel)



$i_2 \quad \frac{E}{33/10} \quad \frac{10E}{33}$

20. Two coherent light sources having intensity in the ratio 2x produce an interference pattern. The ratio $\frac{I_{max} \quad I_{min}}{I_{max} \quad I_{min}}$ will be :

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

Ans. (4)

Sol. Given that, $\frac{I_1}{I_2} \quad 2x$

We know,

$I_{max} \quad \left(\sqrt{I_1} \quad \sqrt{I_2}\right)^2$ & $I_{max} \quad \left(\sqrt{I_1} \quad \sqrt{I_2}\right)^2$

$$\frac{I_{max} \quad I_{min}}{I_{max} \quad I_{min}} \quad \frac{2\sqrt{I_1I_2}}{I_1 \quad I_2} \quad \frac{2\sqrt{\frac{I_1}{I_2}}}{\frac{I_1}{I_2} \quad 1} \quad \frac{2\sqrt{2x}}{2x \quad 1}$$

Numeric Value Type

This Section contains **10 Numeric Value Type question**, out of 10 only 5 have to be done.

1. A transmitting station releases waves of wavelength 960 m. A capacitor of 2.56 μF is used in the resonant circuit. The self inductance of coil necessary for resonance is ____ × 10^{-8} H.

Ans. (10)

Sol. λ = 960 m

C = 2.56 μF = 2.56 × 10^{-6} F

c = 3 × 10^{8} m/s

L = ?

Now at resonance, $w_0 \quad \frac{1}{\sqrt{LC}}$

[Resoant frequency]

$2 \quad f_0 \quad \frac{1}{\sqrt{LC}}$

On substituting $f_0 \quad \frac{c}{\ }$, we have $2 \quad \frac{c}{\ } \quad \frac{1}{\sqrt{LC}}$

Squaring both sides : $4 \quad ^2 \frac{c^2}{\ ^2} \quad \frac{1}{LC}$

$$\frac{4 \quad 10 \quad (3 \quad 10^8)^2}{(960)^2} \quad \frac{1}{L \quad 2.56 \quad 10^{\ 6}}$$

$$\frac{1}{L} \quad \frac{4 \quad 10 \quad 9 \quad 10^{16} \quad 2.56 \quad 10^{\ 6}}{960 \quad 960}$$

$\Rightarrow$ L = 10 × 10^{-8} H

2. The electric field in a region is given $\vec{E} \quad \frac{3}{5}E_0\hat{i} \quad \frac{4}{5}E_0\hat{j} \quad \frac{N}{C}$. The ratio of flux of reported field through the rectangular surface of area 0.2 m^2 (parallel to y – z plane) to that of the surface of area 0.3 m^2 (parallel to x – z plane) is a : b, where a = _____.

[Here $\hat{i}$, $\hat{j}$ and $\hat{k}$ are unit vectors along x, y and z-axes respectively]

Ans. (1)

Sol. $\vec{E} \quad \frac{3E_0}{5}\hat{i} \quad \frac{4E_0}{5}\hat{j} \quad \frac{N}{C}$

A_1 = 0.2 m^2 [parallel to y – z plane]

$\vec{A}_1 \quad 0.2\ m^2\ \hat{i}$

A_2 = 0.3 m^2 [parallel to x – z plane]

$\vec{A}_2 \quad 0.3\ m^2\ \hat{j}$

Now $\quad _a \quad \frac{3E_0}{5}\hat{i} \quad \frac{4E_0}{5}\hat{j} \quad 0.2\hat{i} \quad \frac{3 \quad 0.2}{5}E_0$

& $\quad _b \quad \frac{3E_0}{5}\hat{i} \quad \frac{4E_0}{5}\hat{j} \quad 0.3\hat{i} \quad \frac{3 \quad 0.3}{5}E_0$

Now $\quad \frac{a}{b} \quad \frac{0.6}{1.2} \quad \frac{1}{2} \quad \frac{a}{b}$

$\Rightarrow$ a : b = 1 : 2

$\Rightarrow$ a = 1

3. In a certain thermodynamical process, the pressure of a gas depends on its volume as kV^3. The work done when the temperature changes from 100°C to 300°C will be ___ nR, where n denotes number of moles of a gas.

Ans. (50)

Sol. $P = kV^3$

$T_i = 100°C \qquad \& \qquad T_f = 300°C$

$\Delta T = 300 - 100$

$\Delta T = 200°C$

$P = kV^3$

now PV = nRT

$\therefore\ kV^4 = nRT$

now $4kV^3\ dV = nRdT$

$\therefore$ PdV = nRdT/4

Work $\quad$ PdV $\quad \frac{nRdT}{4} \quad \frac{nR}{4}\ T$

$\frac{200}{4} \quad nR \quad 50\,nR$

4. A small bob tied at one end of a thin string of length 1m is describing a vertical circle so that the maximum and minimum tension in the string are in the ratio 5 : 1. The velocity of the bob at the height position is _____ m/s.

(Take g = 10 m/s^2)

Ans. (5)

Sol. Let the speed of bob at lowest position be v_1 and at the highest position be v_2.

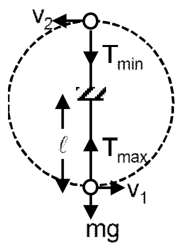
Maximum tension is at lowest position and minimum tension is at the highest position.

Now, using, conservation of mechanical energy,

$\frac{1}{2}mv_1^2 \quad \frac{1}{2}mv_2^2 \quad mg\ 2\ell$

$v_1^2 \quad v_2^2 \quad 4g\ell \qquad \ldots (1)$

Now $T_{max} \quad mg \quad \frac{mv_1^2}{\ell}$



$T_{max} \quad mg \quad \frac{mv_1^2}{\ell}$ & $T_{min} \quad mg \quad \frac{mv_2^2}{\ell}$

$T_{min} \quad \frac{mv_2^2}{\ell} \quad mg$

$\frac{T_{max}}{T_{min}} \quad \frac{5}{1}$ $\qquad \frac{mg \quad \frac{mv_1^2}{\ell}}{\frac{mv_2^2}{\ell} \quad mg} \quad \frac{5}{1}$

$mg \quad \frac{mv_1^2}{\ell} \quad \frac{mv_2^2}{\ell} \quad mg \;\; 5$

$mg \quad \frac{m}{\ell} \quad v_2^2 \quad 4g\ell \quad \frac{5mv_2^2}{\ell} \quad 5mg$

$mg \quad \frac{mv_2^2}{\ell} \quad 4mg \quad \frac{5mv_2^2}{\ell} \quad 5mg$

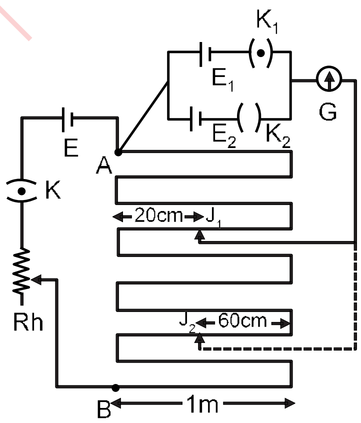
$10mg \quad \frac{4mv_2^2}{\ell}$

$v_2^2 \quad \frac{10 \quad 10 \quad 1}{4}$

$v_2^2 \quad 25$ $\qquad v_2 \quad 5 m/s$

Thus, velocity of bob at highest position is 5 m/s.

5. In the given circuit of potentiometer, the potential difference E across AB (10m length) is larger than E_1 and E_2 as well. For key K_1 (closed), the jockey is adjusted to touch the wire at point J_1 so that there is no deflection in the galvanometer. Now the first battery (E_1) is replaced by second battery (E_2) for working by making K_1 open and K_2 closed. The galvanometer gives then null deflection at J_2. The value of $\frac{E_1}{E_2}$ is $\frac{a}{b}$, where a = ___.



Ans. (1)

Sol. Length of AB = 10 m

For battery E_1, balancing length is ℓ_1

ℓ_1 = 380 cm [from end A]

For battery E_2, balancing length is ℓ_2

ℓ_2 = 760 cm [from end A]

Now, we know that $\frac{E_1}{E_2} \quad \frac{\ell_1}{\ell_2} \qquad \frac{E_1}{E_2} \quad \frac{380}{760} \quad \frac{1}{2} \quad \frac{a}{b}$

$\therefore$ a = 1 & b = 2.

a = 1

6. The same size images are formed by a convex lens when the object is placed at 20cm or at 10cm from the lens. The focal length of convex lens is _____ cm.

Ans. (15)

Sol. $m \quad \frac{f}{u \quad f}$

$m \quad \frac{f}{10 \quad f}$ ... (1)

$m \quad \frac{f}{20 \quad f}$ ... (2)

(1) / (2)

$1 \quad \frac{f \quad 20}{f \quad 10}$

10 – f = f – 20

30 = 2f

f = 15 cm

7. 512 identical drops of mercury are charged to a potential of 2V each. The drops are joined to form a single drop. The potential of this drop is ____ V.

Ans. (128)

Sol. Q = 512q

$Volume_i = Volume_f$

$512 \quad \frac{4}{3} \quad r^3 \quad \frac{4}{3} \quad R^3 \qquad 2^9 r^3 = R^3$

R = 8r

$2 \quad \frac{kq}{r}$

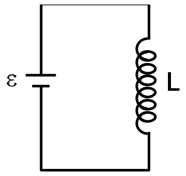
$v \quad \frac{kQ}{R} \quad \frac{k\,512\,q}{8\,r} \qquad V = 128.$

8. A coil of inductance 2H having negligible resistance is connected to a source of supply whose voltage is given by V = 3t volt. (where t is in second). If the voltage is applied when t = 0, then the energy stored in the coil after 4s is _____ J.

Ans. (144)

Sol. $\frac{LdI}{dt}$

$3\ {}_{0}^{4}\ t\ dt \quad 2\ {}_{0}^{I}\ dI$



$\frac{3}{2} \quad 16 \quad 2I$

I = 12

$V \quad \frac{1}{2}LI^2 \quad \frac{1}{2} \quad 2(12)^2 \quad 144\ J$

9. A monoatomic gas of mass 4.0 u is kept in an insulated container. Container is moving with velocity 30 m/s. If container is suddenly stopped then change in temperature of the gas (R = gas constant) is $\frac{x}{3R}$. Value of x is ___.

Ans. (3600)

Sol. Given that mass of gas is 4u hence its molar mass M is 4g/mol

$\frac{1}{2}mv^2 \quad nC_v \quad T$

$\frac{1}{2}m(30)^2 \quad \frac{m}{M} \quad \frac{3R}{2} \quad T \qquad\qquad T \quad \frac{3600}{3R}$

10. The potential energy (U) of a diatomic molecule is a function dependent on r (interatomic distance) as

$U \quad \frac{}{r^{10}} \quad \frac{}{r^5} \quad 3$

where, α and β are positive constants. The equilibrium distance between two atoms will be $\frac{2}{}^{\frac{a}{b}}$, where a = _____.

Ans. (1)

Sol. For equilibrium

$\frac{dU}{dr} \quad 0 \qquad\qquad \frac{10}{r^{11}} \quad \frac{5}{r^6} \quad 0$

$\frac{5}{r^6} \quad \frac{10}{r^{11}} \qquad\qquad r^5 \quad \frac{2}{}$

$r \quad \frac{2}{}^{\frac{1}{5}}$

a =1

PART B : CHEMISTRY

Single Choice Type

This section contains **20 Single choice questions.** Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

1. Given below are two statements :

Statement I : CeO_2 can be used for oxidation of aldehydes and ketones.

Statement II : Aqueous solution of $EuSO_4$ is a strong reducing agent.

In the light of the above statements, choose the correct answer form the options given below :

(1) Statement I is false but statement II is true

(2) Statement I is true but statement II is false

(3) Both statement I and statement II are true

(4) Both statement I and statement II are false

Ans. (3)

Sol. The +3 oxidation state of lanthanide is most stable and therefore lanthanide in +4 oxidation state has strong tendency to gain e^- and converted into +3 and therefore act as strong oxidizing agent.

eg Ce^{+4}

And therefore CeO_2 is used to oxidized alcohol aldehyde and ketones.

Lanthanide in +2 oxidation state has strong tendency to loss e^- and converted into +3 oxidation state therefore act as strong reducing agent.

$\therefore$ $EuSO_4$ act as strong reducing agent.

2. According to molecular theory, the species among the following that does not exist is :

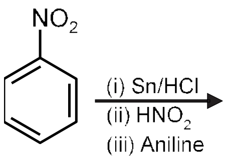
(1) He_2 (2) He_2 (3) Be_2 (4) O_2^2

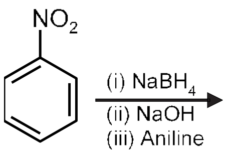
Ans. (3)

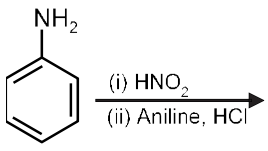
Chemical Species	Bond Order
He_2	0.5
He_2	0.5
Be_2	0
O_2^2	1

According to M.O.T. If bond order of chemical species is zero then that chemical species does not exist.

3. Which of the following reaction/s will not give p-aminoazobenzene ?

(A) 

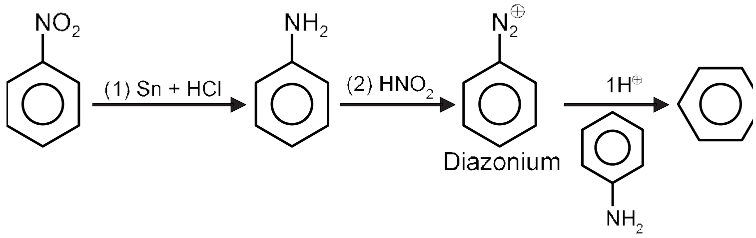
(B) 

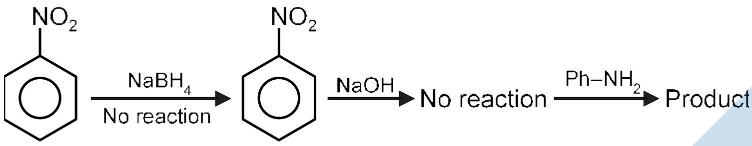
(C) 

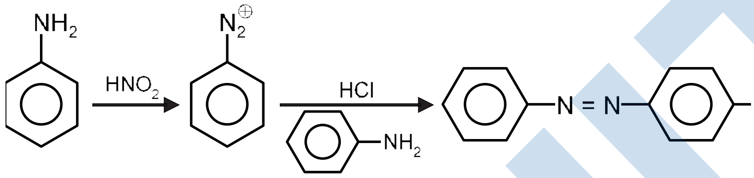
(1) A only (2) B only (3) C only (4) A and B

Ans. (2)

Sol. In basic or neutral medium N–N coupling favourable while in slightly acidic medium C–N coupling favourable.

(A) 

(B) 

(C) 

4. Which of the following equation depicts the oxidizing nature of H_2O_2 ?

(1) $KIO_4 + H_2O_2 \longrightarrow KIO_3 + H_2O + O_2$

(2) $2I^- + H_2O_2 + H^+ \longrightarrow I_2 + 2H_2O$

(3) $I_2 + H_2O_2 + 2OH^- \longrightarrow 2I^- + 2H_2O + O_2$

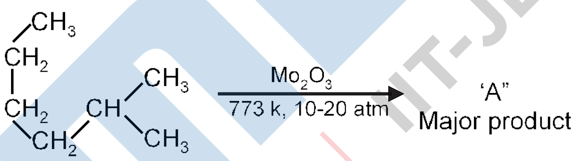
(2) $Cl_2 + H_2O_2 \longrightarrow 2HCl + O_2$

Ans. (2)

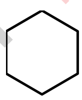
Sol. I^- is oxidised to I_2 by H_2O_2

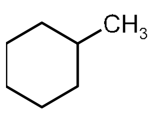
Hence answer is (2)

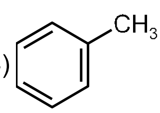
5. Identify A in the given chemical reaction.



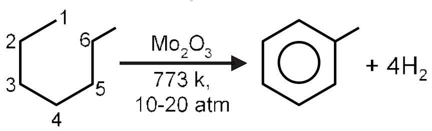
(1) 

(2) 

(3) 

(4) 

Ans. (4)

Sol. 

Mo_2O_3 at 773 k temperature and 10-20 atm pressure is aromatizing agent.

6. Complete combustion of 1.80 g of an oxygen containing compound ($C_xH_yO_z$) gave 2.64 g of CO_2 and 1.08 g of H_2O. The percentage of oxygen in the organic compound is :

(1) 51.63 (2) 63.53 (3) 53.33 (4) 50.33

Ans. (3)

Sol. $n_C \quad n_{CO_2} \quad \frac{2.64}{44} \quad 0.06$

$n_h \quad 2 \quad n_{H_2O} \quad \frac{1.08}{18} \quad 2 \quad 0.12$

$m_0 \quad 1.80 \quad 12 \quad \frac{2.64}{44} \quad \frac{1.08}{18} \quad 2$

$= 1.80 - 0.72 - 0.12 = 0.96$ gm

$\%0 \quad \frac{0.96}{1.80} \quad 100 \quad 53.33\%$

Hence answer is (3)

7. Which one of the following reactions will not form acetaldehyde ?

(1) $CH_3CH_2OH \xrightarrow[573\text{ K}]{Cu}$

(2) $CH_3CN \xrightarrow[\text{(ii) } H_2O]{\text{(i) DIBAL } H}$

(3) $CH_2 \quad CH_2 \quad O_2 \xrightarrow[H_2O]{Pd(II)/Cu(II)}$

(4) $CH_3CH_2OH \xrightarrow{CrO_3 \quad H_2SO_4}$

Ans. (4)

Sol. $CH_3 - CH_2 - OH \xrightarrow[\text{Strong oxidising agent}]{CrO_3 \cdot H_2SO_4} CH_3 - \overset{\overset{\displaystyle O}{\|}}{C} - OH$

(carboxylic acid is formed by complete oxidation)

8. The correct statement about B_2H_6 is :

(1) Terminal B–H bonds have less p-character when compared to bridging bonds.

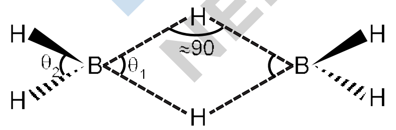
(2) The two B–H–B bonds are not of same length

(3) All B–H–B angles are of 120°

(4) Its fragment, BH_3 behaves as a Lewis base

Ans. (1)

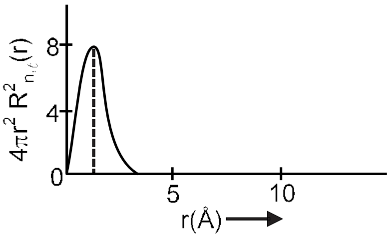
Sol.

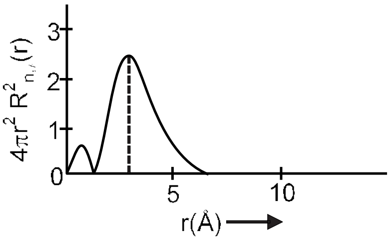


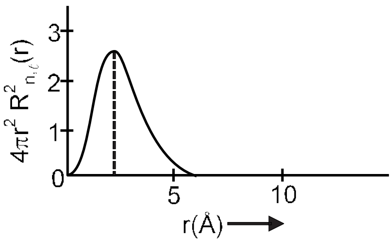
$\theta_2 > \theta_1$

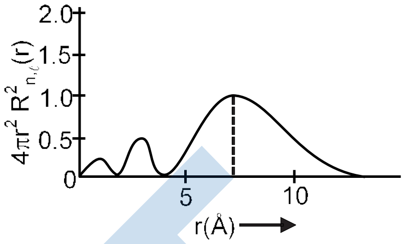
- $\theta_2 > \theta_1$, $\therefore$ B–H (terminal having less p-character as compare to bridge bond.
- Both B–H–B bridge bond having same bond length.
- B–H–B bond angle is $\approx 90°$
- BH_3 is e^- deficient species and therefore act as lewis acid.

9. The plots of radial distribution functions for various orbitals of hydrogen atom against ‘r’ are given below:

(A)


(B)


(C)


(D)


The correct plot for 3s orbital is :

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

Ans. (3)

Sol. Number of radial nodes = $n - \ell - 1$

$= 3 - 0 - 1 = 2$

Therefor corresponding graph is (D)

Hence answer is (3)

10. Given below are two statements:

Statement I : An allotrope of oxygen is an important intermediate in the formation of reducing smog.

Statement II : Gases such as oxides of nitrogen and sulphur present in troposphere contribute to the formation of photochemical smog.

In the light of the above statements, choose the correct answer from the options given below:

(1) Both statement I and Statement II are false (2) Statement I is true but Statement II is false

(3) Both Statement I and Statement II are true (4) Statement I is false but Statement II is true

Ans. (1)

Sol. Reducing smog is a mixture of smoke, fog and sulphur dioxide.

Tropospheric pollutants such as hydrocarbon and nitrogen oxide contribute to the formation of photochemical smog.

11. In which of the following pairs, the outer most electronic configuration will be the same ?

(1) Cr^{+} and Mn^{2+} (2) Ni^{2+} and Cu^{+} (3) Fe^{2+} and Co^{+} (4) V^{2+} and Cr^{+}

Ans. (1)

Sol.

Option – 1 $Mn^{+2}[Ar]3d^5$, $Cr^{+}[Ar]3d^5$

Option – 2 $Ni^{+2}[Ar]3d^8$, $Cu^{+}[Ar]3d^{10}$

Option – 3 $Fe^{+2}[Ar]3d^6$, $Co^{+}[Ar]3d^7 4s^1$

Option – 4 $V^{+2}[Ar]3d^3$, $Cr^{+}[Ar]3d^5$

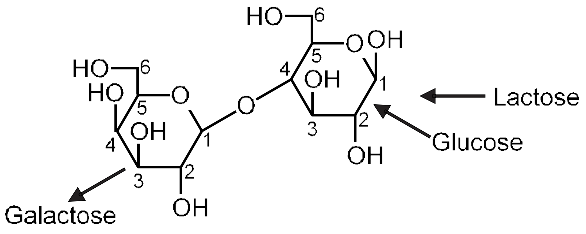
12. Which of the glycosidic linkage between galactose and glucose is present in lactose ?

(1) C-1 of galactose and C-4 of glucose (2) C-1 of glucose and C-6 of galactose

(3) C-1 of glucose and C-4 of galactose (4) C-1 of galactose and C-6 of glucose

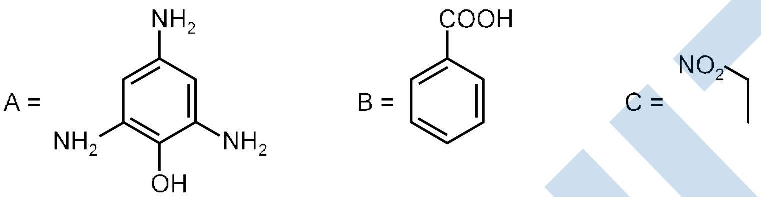
Ans. (1)

Sol.



In lactose linkage is formed between C_1 of galactose and C_4 of glucose.

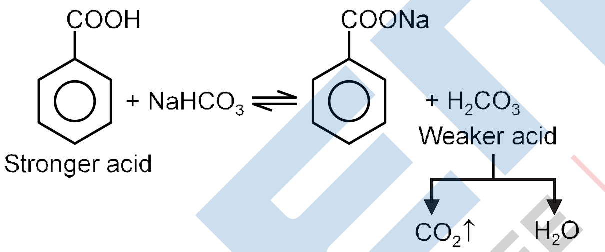
13. Compound(s) which will liberate carbon dioxide with sodium bicarbonate solution is/are :



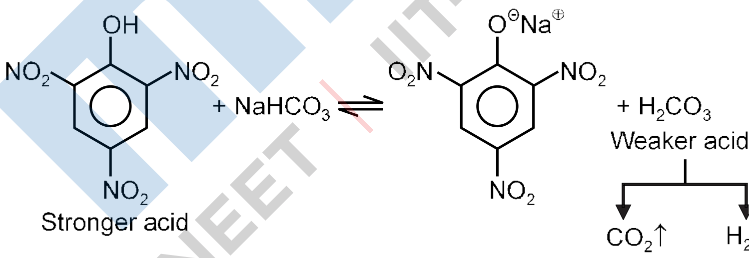
(1) B only (2) C only (3) B and C only (4) A and B only

Ans. (3)

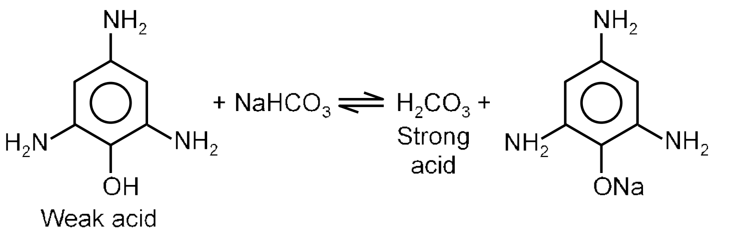
Sol.



Equilibrium favours forward direction and $CO_2\uparrow$ is liberated.



Equilibrium favours forward direction and $CO_2\uparrow$ is liberated.



Equilibrium favours back word direction and $CO_2\uparrow$ is not liberated.

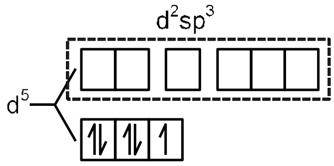
14. The hybridization and magnetic nature of $[Mn(CN)_6]^{4-}$ and $[Fe(C)_6]^{3-}$, respectively are :

(1) d^2sp^3 and diamagnetic (2) sp^3d^2 and diamagnetic

(3) d^2sp^3 and paramagnetic (4) sp^3d^2 and paramagnetic

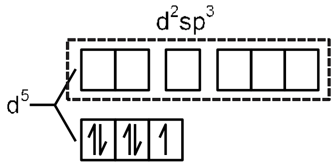
Ans. (3)

Sol. $[Mn(Cn)_6]^{4-}$
Mn^{+2} d^5
CN^- – SFL
$\Delta_0 > P$



$\therefore$ hybridisation is d^2sp^3 and use due to presence of unpaired e^- complex is paramagnetic in nature.

$[Fe(Cn)_6]^{3-}$
Fe^{+3} d^5
CN^- – SFL
$\Delta_0 > P$



$\therefore$ hybridisation is d^2sp^3 and use due to presence of unpaired e^- complex is paramagnetic in nature.

15. Ellingham diagram is a graphical representation of :

(1) ΔH vs T (2) ΔG vs T (3) ΔG vs P (4) $(\Delta G - T\Delta S)$ vs T

Ans. (2)

Sol. Ellingham diagram is a graphical representation of ΔG vs T when metal heated with oxygen to form metal oxide.

16. The solubility of AgCN in a buffer solution of pH = 3 is x. The value of x is:

[Assume : No cyano complex is formed; $K_{sp}(AgCN) = 2.2 \times 10^{-16}$ and $K_a(HCN) = 6.2 \times 10^{-10}$]

(1) 0.625×10^{-6} (2) 1.9×10^{-5} (3) 2.2×10^{-16} (4) 1.6×10^{-6}

Ans. (2)

Sol. $\frac{K_{sp}}{K_a} = \frac{s^2}{(H^+)}$; $\quad s = \sqrt{\frac{K_{sp}}{K_a}(H^+)}$

$s = \sqrt{\frac{2.2 \times 10^{-16}}{6.2 \times 10^{-10}} \times 10^{-3}}$

$s = 1.9 \times 10^{-5}$

17. In Freundlich adsorption isotherm at moderate pressure, the extent of adsorption $\frac{x}{m}$ is directly proportional to P^x. The value of x is

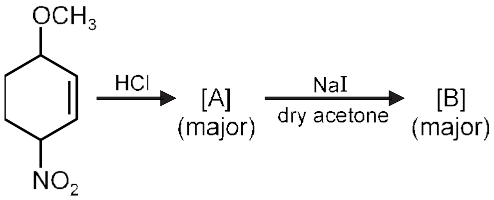
(1) zero (2) $\frac{1}{n}$ (3) 1 (4) ∞

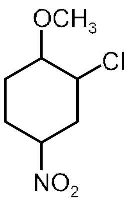
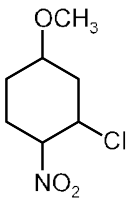
Ans. (2)

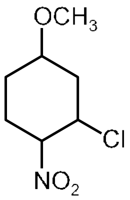
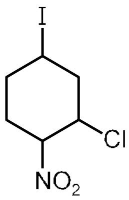
Sol. As per Freundlich adsorption isotherm

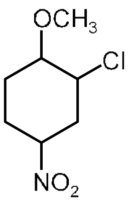
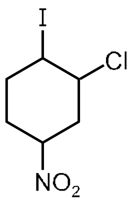
$\frac{x}{m} = KP^{\frac{1}{n}} \quad x = \frac{1}{n}$

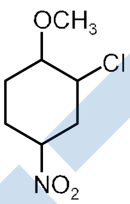
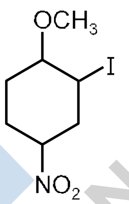
18. Identify A and B in the chemical reaction.



(1) A =  B = 

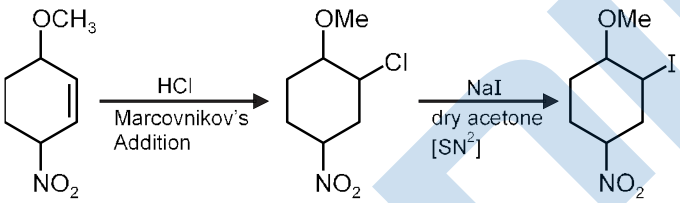
(2) A =  B = 

(3) A =  B = 

(4) A =  B = 

Ans. (4)

Sol.



⇒ I[st] reaction marcovnikov's addition of HCl on double bond while 2[nd] reaction is halide substitution by Finkel stein reaction.

19. Which statement is correct ?

(1) Synthesis of Buna-S needs nascent oxygen.

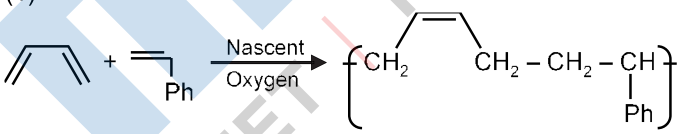
(2) Neoprene is an addition copolymer used in plastic bucket manufacturing.

(3) Buna-S is a synthetic and linear thermosetting polymer.

(4) Buna-N is natural polymer.

Ans. (1)

Sol.



20. The major product of the following chemical reaction is :

$$CH_3CH_2CN \xrightarrow[(3)\ Pd/BaSO_4,\ H_2]{(1)\ H_3O^+,\ (2)\ SOCl_2} ?$$

(1) $CH_3CH_2CH_3$ (2) $CH_3CH_2CH_2OH$ (3) $(CH_3CH_2CO)_2O$ (4) CH_3CH_2CHO

Ans. (4)

Sol.

$$Et-C\equiv N \xrightarrow{(1)\ H_3O^+} Et-\overset{O}{\overset{\|}{C}}-OH \xrightarrow{(2)\ SOCl_2} Et-\overset{O}{\overset{\|}{C}}-Cl \xrightarrow[\text{Resonmur reductio}]{(3)\ Pd/BaS\ H_2}$$

Final product of reaction is propanaldehyde.

Numeric Value Type

This Section contains **10 Numeric Value Type question**, out of 10 only 5 have to be done.

1. Among the following, the number of halide(s) which is/are inert to hydrolysis is _______.

(A) BF_3 (B) $SiCl_4$ (C) PCl_5 (D) SF_6

Ans. (1)

Sol. SF_6 is inert towards hydrolysis

2. 1 molal aqueous solution of an electrolyte A_2B_3 is 60% ionised. The boiling point of the solution at 1 atm is _______ K.

[Given K_b for (H_2O) = 0.52 K kg mol^{-1}]

Ans. (375)

Sol. $\Delta T_b = iK_bm$

$= (1 + 4\alpha) \times 0.52 \times 1$

$= 3.4 \times 0.52 \times 1 = 1.768$

$T_b = 1.768 + 313.15 = 374.918$ K = 375K

3. In basic medium CrO_4^{2} oxidises $S_2O_3^{2}$ to form SO_4^{2} and itself changes into $Cr(OH)_4$. The volume of 0.154 M CrO_4^{2} required to react with 40 mL of 0.25 M $S_2O_3^{2}$ is _______ mL.

Ans. (173)

Sol. $\overset{6}{C}rO_4^{2}$ $\overset{2}{S}_2O_3^{2}$ $\overset{6}{S}O_4^{2}$ $\overset{3}{C}r(OH)_4$

gm equi. of CrO_4^{2} $S_2O_3^{2}$

$0.154 \times 3 \times v = 0.25 \times 40 \times 8$

$v = 173.16 = 173$ ml

4. A car tyre is filled with nitrogen gas at 35 psi at 27°C. It will burst if pressure exceeds 40 psi. The temperature in °C at which the car tyre will burst is _______.

Ans. (70)

Sol. $P \propto T$

$\frac{P_2}{P_1}$ $\frac{T_2}{T_1}$ $\frac{40}{35}$ $\frac{T_2}{300}$

$T_2 = 342.854$ K = 69.70°C = 70°C

5. The reaction of cyanamide, $NH_2CN(s)$ with oxygen was run in a bomb calorimeter and ΔU was found to be –742.24 kJ mol^{-1}. The magnitude of ΔH_{298} for the reaction

$NH_2CN(s)$ $\frac{3}{2}O_2(g)$ $N_2(g)$ $O_2(g)$ $H_2O(\ell)$

is _______ kJ.

[Assume ideal gases and R = 8.314 J mol^{-1} K^{-1}]

Ans. (741)

Sol. $\Delta H = \Delta U + \Delta n_g RT$

$$742.24 \quad \frac{1}{2} \quad \frac{8.314}{1000} \quad 298$$

= –741 kJ/mol

6. Using the provided information in the following paper chromatogram :

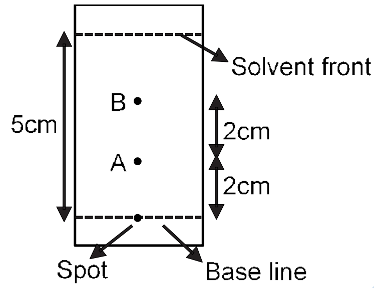


Figure : Paper chromatography for compounds A and B.

the calculate R_f value of A _______ × 10^{-1}.

Ans. (4)

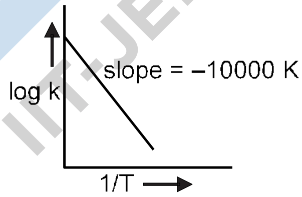
Sol. $R_f \quad \frac{\text{Distance travelled by compound}}{\text{Distance travelled by solvent}}$

on chromatogram distance travelled by compound is → 2 cm

Distance travelled by solvent = 5 cm

So $R_f \quad \frac{2}{5} \quad 4 \quad 10^{1} \quad 0.4$

7. For the reaction, aA + bB → cC + dD, the plot of log k vs $\frac{1}{T}$ is given below :



The temperature at which the rate constant of the reaction is 10^{-4} s^{-1} is _______ K.

[Given : The rate constant of the reaction is 10^{-5} s^{-1} at 500 K.]

Ans. (526)

Sol. $\log K \quad \log A \quad \frac{E_a}{2.303\,RT}$

$$|\text{Slope}| \quad \frac{E_a}{2.303R} \quad 10{,}000$$

$$\log \frac{K_2}{K_1} \quad \frac{E_a}{2.303R} \quad \frac{1}{T_1} \quad \frac{1}{T_2}$$

$\log \frac{10^{4}}{10^{5}} \quad 10{,}000 \quad \frac{1}{500} \quad \frac{1}{T_2}$

$T_2 = 526.31$; 526K

8. 0.4 g mixture of NaOH, Na_2CO_3 and some inert impurities was first titrated with $\frac{N}{10}$ HCl using phenolphthalein as an indicator, 17.5 mL of HCl was required at the end point. After this methyl orange was added and titrated. 1.5 mL of same HCl was required for the next end point. The weight percentage of Na_2CO_3 in the mixture is _______.

Ans. (4)

Sol. Upto first end point

gm equi. of $(NaOH + Na_2CO_3) = HCl$

$x \quad y \quad 1 \quad \frac{1}{10} \quad 17.5$

$x + y = 1.75$ ...(1)

Upto second end point

$NaOH + Na_2CO_3 \equiv HCl$

$x \quad y \quad 2 \quad \frac{1}{10} \quad 19$

$x + 2y = 1.9$ ...(2)

$y = 0.15$

$\%Na_2CO_3 \quad \frac{0.15 \quad 10^{3} \quad 106}{0.4} \quad 100$

$= 3.975\%$

$= 4\%$

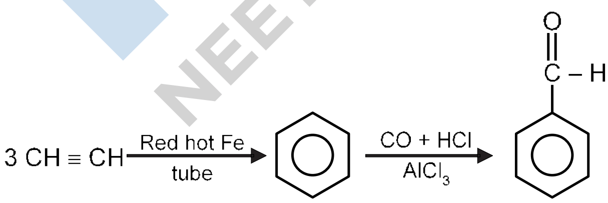
9. Consider the following chemical reaction.

CH CH $\xrightarrow[\text{(2) CO, HCl, AlCl}_3]{\text{(1) Red hot Fe tube, 873 K}}$ Prodcut

The number of sp^2 hybridized carbon atom(s) present in the product is _______.

Ans. (7)

Sol.

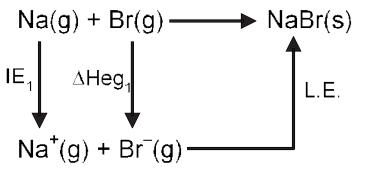


In benzaldehyde total number of sp^2 'C' are 7.

10. The ionization enthalpy of Na^+ formation from Na(g) is 495.8 kJ mol^{-1}, while the electron gain enthalpy of Br is –325.0 kJ mol^{-1}. Given the lattice enthalpy of NaBr is –728.4 kJ mol^{-1}. The energy for the formation of NaBr ionic solid is (–) _______ × 10^{-1} kJ mol^{-1}.

Ans. (5576)

Sol.



$\Delta H_{formation} = IE_1 + \Delta Heg_1 + LE$

$= 495.8 + (-325) + (-728.4)$

$= -557.6$

$= -5576 \times 10^{-1}$ KJ/mol.

Note: The above calculation is not for $\Delta H_{formation}$ but for $\Delta H_{Reaction}$.

But on the basis of given data it is the best ans.

PART C : MATHEMATICS

Single Choice Type

This section contains **20 Single choice questions**. Each question has 4 choices (1), (2), (3) and (4) for its answer, out of which **Only One** is correct.

1. When a missile is fired from a ship, the probability that it is intercepted is $\frac{1}{3}$ and the probability that the missile hits the target, given that it is not intercepted, is $\frac{3}{4}$. If three missiles are fired independently from the ship, then the probability that all three hit the target, is :

(1) $\frac{1}{27}$ (2) $\frac{3}{4}$ (3) $\frac{1}{8}$ (4) $\frac{3}{8}$

Ans. (3)

Sol. Required probability $\frac{2}{3}\ \frac{3}{4}\ ^{3}\ \frac{1}{8}$

2. If $0 < \theta,\ \frac{}{2}$, $x\ _{n\ 0}\ \cos^{2n}$, $y\ _{n\ 0}\ \sin^{2n}$ and $z\ _{n\ 0}\ \cos^{2n}\ \sin^{2n}$ then :

(1) xy – z = (x + y) z (2) xy + yz + zx = z (3) xyz = 4 (4) xy + z = (x + y)z

Ans. (4)

Sol. $x\ \frac{1}{1\ \cos^2}\ \ \sin^2\ \ \frac{1}{x}$

Also, $\cos^2\ \ \frac{1}{y}$ & $1\ \ \sin^2\ \cos^2\ \ \frac{1}{z}$

So, $1\ \ \frac{1}{x}\ \frac{1}{y}\ \frac{1}{z}\ \ z(xy\ \ 1)\ \ xy$ ....(1)

Also, $\frac{1}{x}\ \frac{1}{y}\ \ 1\ \ \ \ x\ \ y\ \ xy$ .....(2)

From (i) and (ii)

xy + z = xyz = (x + y) z

3. Let f, g : N → N such that f(n + 1) = f(n) + f(1) ∀ n ∈ N and g be any arbitrary function. Which of the following statements is NOT true?

(1) If fog is one-one, then g is one-one (2) If f is onto, then f(n) = n ∀ n ∈ N

(3) f is one-one (4) If g is onto, then fog is one-one

Ans. (4)

Sol. f(n + 1) – f(n) = f(1)

⇒ f(n) = nf (1)

⇒ f is one-one

Now, Let f $(g(x_2)) = f(g(x_1))$

⇒ $g(x_2) = g(x_1)$ (as f is one-one)

⇒ $x_1 = x_2$ (as fog is one-one)

$\Rightarrow$ g is one-one

Now, f(g(n)) = g(n) f(1)

may be many-one if

g(n) is many-one

4. The equation of the line through the point (0,1,2) and perpendicular to the line $\frac{x\ \ 1}{2}\ \ \frac{y\ \ 1}{3}\ \ \frac{z\ \ 1}{2}$ is :

(1) $\frac{x}{3}\ \ \frac{y\ \ 1}{4}\ \ \frac{z\ \ 2}{3}$ (2) $\frac{x}{3}\ \ \frac{y\ \ 1}{4}\ \ \frac{z\ \ 2}{3}$ (3) $\frac{x}{3}\ \ \frac{y\ \ 1}{4}\ \ \frac{z\ \ 2}{3}$ (4) $\frac{x}{3}\ \ \frac{y\ \ 1}{4}\ \ \frac{z\ \ 2}{3}$

Ans. (4)

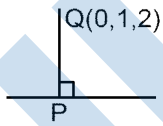
Sol. $\frac{x\ \ 1}{2}\ \ \frac{y\ \ 1}{3}\ \ \frac{z\ \ 1}{2}\ \ r$

$\Rightarrow$ P(x, y, z) = (2r + 1, 3r – 1, –2r + 1)

Since, $\overline{QP}\ \ (2\hat{i}\ \ 3\hat{j}\ \ 2\hat{k})$

$\Rightarrow$ 4r + 2 + 9r – 6 + 4r + 2 = 0

$r\ \ \frac{2}{17}$



$P\ \ \frac{21}{17},\frac{11}{17},\frac{13}{17}$

$\overrightarrow{PQ}\ \ \frac{21\hat{i}\ \ 28\hat{j}\ \ 21\hat{k}}{17}$

So, $\overline{PQ} : \frac{x}{3}\ \ \frac{y\ \ 1}{4}\ \ \frac{z\ \ 2}{3}$

5. Let α be the angle between the lines whose direction cosines satisfy the equations ℓ + m – n = 0 and $\ell^2 + m^2 - n^2 = 0$. Then the value of $\sin^4\alpha + \cos^4\alpha$ is :

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

Ans. (3)

Sol. n = ℓ +m

Now, $\ell^2 + m^2 = n^2 = (\ell + m)^2$

$\Rightarrow 2\ell m = 0$

If $\ell = 0 \Rightarrow m = n\ \ \frac{1}{\sqrt{2}}$

And, If $m = 0 \Rightarrow n = \ell\ \ \frac{1}{\sqrt{2}}$

So, direction cosines of two lines are

$0, \frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}$ and $\frac{1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}}$

Thus, $\cos \quad \frac{1}{2} \qquad \overline{3}$

6. The value of the integral $\frac{\sin \quad \sin 2 \quad \sin^6 \quad \sin^4 \quad \sin^2 \quad \sqrt{2\sin^4 \quad 3\sin^2 \quad 6}}{1 \quad \cos 2} d$ is :

(where c is a constant of integration)

(1) $\frac{1}{18} \; 11 \quad 18\sin^2 \quad 9\sin^4 \quad 2\sin^2 \;^{\frac{3}{2}} \quad c$ (2) $\frac{1}{18} \; 9 \quad 2\cos^6 \quad 3\cos^4 \quad 6\cos^2 \;^{\frac{3}{2}} \quad c$

(3) $\frac{1}{18} \; 9 \quad 2\sin^6 \quad 3\sin^4 \quad 6\sin^2 \;^{\frac{3}{2}} \quad c$ (4) $\frac{1}{18} \; 11 \quad 18\cos^6 \quad 9\cos^4 \quad 2\cos^2 \;^{\frac{3}{2}} \quad c$

Ans. (4)

Sol. $I \quad \frac{\sin \quad \sin 2 \quad \sin^6 \quad \sin^4 \quad \sin^2 \quad \sqrt{2\sin^4 \quad 3\sin^2 \quad 6}}{1 \quad \cos 2} d$

$I \quad \frac{\sin \quad 2\sin \quad \cos \quad \sin^2 \quad \sin^4 \quad \sin^2 \quad 1 \;\; 2\sin^4 \quad 3\sin^2 \quad 6 \;^{1/2}}{2\sin^2} d$

$\sin^2 \quad \cos \quad \sin^4 \quad \sin^2 \quad 1 \;\; 2\sin^4 \quad 3\sin^2 \quad 6 \;^{1/2} d$

Let $\sin\theta = t \Rightarrow \cos\theta \, d\theta = dt$

$I \quad t^2 \;\; t^4 \quad t^2 \quad 1 \;\; 2t^4 \quad 3t^2 \quad 6 \;^{1/2} dt$

$t^5 \quad t^3 \quad t \;\; t \;\; 2t^4 \quad 3t^2 \quad 6 \;^{1/2} dt$

$t^5 \quad t^3 \quad t \quad t^2 \;^{1/2} \;\; 2t^4 \quad 3t^2 \quad 6 \;^{1/2} dt$

$t^5 \quad t^3 \quad t \quad 2t^6 \quad 3t^4 \quad 6t^2 \;^{1/2} dt$

Let $2t^6 + 3t^4 + 6t^2 = u^2$

$\Rightarrow 12(t^5 + t^3 + t)\, dt = 2udu$

$I \quad u^2 \;^{1/2} \; \frac{2udu}{12}$

$\frac{u^2}{6} du \quad \frac{u^3}{18} \quad C$

$\frac{2t^6 \quad 3t^4 \quad 6t^2 \;^{3/2}}{18} \quad C$

when $t = \sin\theta$

and $t^2 = 1 - \cos^2\theta$ will give option (4)

7. The value of $\int_{1}^{1} x^2 e^{\; x^3} dx$, where [t] denotes the greatest integer $\leq$ t, is :

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

Ans. (3)

Sol. $I \quad {}^{1}_{1}\ x^2e^{\ x^3}\ dx$

$\ {}^{0}_{1}\ x^2e^{\ x^3}\ dx \quad {}^{1}_{0}\ x^2e^{\ x^3}\ dx$

$\ {}^{0}_{1}\ x^2e^{\ 1}dx \quad {}^{1}_{0}\ x^2e^{0}dx$

$\frac{1}{e}\ \left.\frac{x^3}{3}\right|^{0}_{\ 1} \quad \left.\frac{x^3}{3}\right|^{1}_{0}$

$\frac{1}{e}\quad 0 \quad \frac{1}{3} \quad \frac{1}{3}$

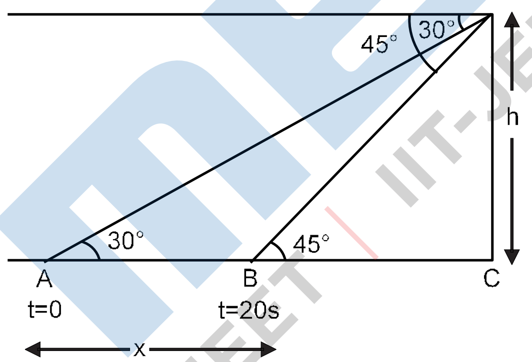
$\frac{1}{3e}\ \ \frac{1}{3}\ \ \frac{1\quad e}{3e}$

8. A man is observing, from the top of a tower, a boat speeding towards the tower from a certain point A, with uniform speed. At that point, angle of depression of the boat with the man's eye is 30° (Ignore man's height). After sailing for 20 seconds, towards the base of the tower (which is at the level of water), the boat has reached a point B, where the angle of depression is 45°. Then the time taken (in seconds) by the boat from B to reach the base of the tower is:

(1) 10 (2) $10\sqrt{3}$ (3) $10(\sqrt{3}\quad 1)$ (4) $10(\sqrt{3}\quad 1)$

Ans. (3)

Sol.



Let speed of boat is u m/s and height of tower is h meter & distance AB = x metre

$\therefore$ x = h cot 30° – h cot 45°

$x \quad h(\sqrt{3}\quad 1)$

$u \quad \frac{x}{20} \quad \frac{h(\sqrt{3}\quad 1)}{20}m/s$

$\therefore$ Time taken to travel from B to C (Distance = h meter)

$$\frac{h}{u} \quad \frac{h}{h\frac{(\sqrt{3} \quad 1)}{20}} \quad \frac{20}{\sqrt{3} \quad 1} \quad 10(\sqrt{3} \quad 1)\text{ sec.}$$

9. A tangent is drawn to the parabola $y^2 = 6x$ which is perpendicular to the line $2x + y = 1$. Which of the following points does NOT lie on it?

(1) (–6, 0) (2) (4, 5) (3) (5, 4) (4) (0, 3)

Ans. (3)

Sol. Slope of tangent = $m_T = m$

So, $m(-2) = -1 \Rightarrow m \quad \frac{1}{2}$

Equation : $y \quad mx \quad \frac{a}{m}$

$$y \quad \frac{1}{2}x \quad \frac{3}{2\frac{1}{2}} \quad a \quad \frac{6}{4} \quad \frac{3}{2}$$

$$y \quad \frac{x}{2} \quad 3$$

$\Rightarrow 2y = x + 6$

Point (5, 4) will not lie on it

10. All possible values of $\theta \in [0, 2\pi]$ for which $\sin 2\theta + \tan 2\theta > 0$ lie in :

(1) $0, \frac{}{2} \quad , \frac{3}{2}$ (2) $0, \frac{}{2} \quad \frac{}{2}, \frac{3}{4} \quad , \frac{7}{6}$

(3) $0, \frac{}{4} \quad \frac{}{2}, \frac{3}{4} \quad \frac{3}{2}, \frac{11}{6}$ (4) $0, \frac{}{4} \quad \frac{}{2}, \frac{3}{4} \quad , \frac{5}{4} \quad \frac{3}{2}, \frac{7}{4}$

Ans. (4)

Sol. $\sin 2\theta + \tan 2\theta > 0$

$$\sin 2 \quad \frac{\sin 2}{\cos 2} \quad 0$$

$$\sin 2 \quad \frac{(\cos 2 \quad 1)}{\cos 2} \quad 0 \quad \tan 2 \ (2\cos^2 \quad) \quad 0$$

Note : $\cos 2\theta \neq 0$

$$1 \quad 2\sin^2 \quad 0 \quad \sin \quad \frac{1}{\sqrt{2}}$$

Now, $\tan 2\theta (1 + \cos 2\theta) > 0$

$\Rightarrow \tan 2\theta > 0$ (as $\cos 2\theta + 1 > 0$)

$$0, \frac{}{2} \quad , \frac{3}{2} \quad , \frac{5}{2} \quad 3 \ , \frac{7}{2}$$

$0, \frac{}{4} \quad \frac{}{2}, \frac{3}{4} \quad , \frac{5}{4} \quad \frac{3}{2}, \frac{7}{4}$

As sin $\frac{1}{\sqrt{2}}$ which has been already considered

11. Let the lines $(2 \quad i)z \quad (2 \quad i)\bar{z}$ and $(2 \quad i)z \quad (i \quad 2)\bar{z} \quad 4i \quad 0$, (here $i^2 = -1$) be normal to a circle C. If the line $iz \quad \bar{z} \quad 1 \quad i \quad 0$ is tangent to this circle C, then its radius is:

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

Ans. (4)

Sol. (i) $(2 \quad i)z \quad (2 \quad i)\bar{z}$

$\boxed{y \quad \frac{x}{2}}$

(ii) $(2 \quad i)z \quad (i \quad 2)\bar{z} \quad 4i \quad 0$

$\boxed{x \quad 2y \quad 2}$

(iii) $iz \quad \bar{z} \quad 1 \quad i \quad 0$

Eq^n of tangent $\boxed{x \quad y \quad 1 \quad 0}$

Solving (i) and (ii)

$x \quad 1, y \quad \frac{1}{2}$

Now, $p \quad r \quad \left|\frac{1 \quad \frac{1}{2} \quad 1}{\sqrt{2}}\right| \quad r$

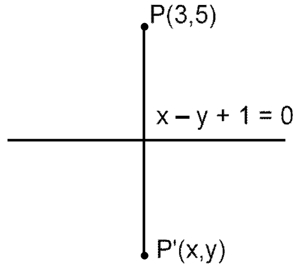
$r \quad \frac{3}{2\sqrt{2}}$

12. The image of the point (3, 5) in the line $x - y + 1 = 0$, lies on :

(1) $(x-2)^2 + (y-2)^2 = 12$ (2) $(x-4)^2 + (y+2)^2 = 16$

(3) $(x-4)^2 + (y-4)^2 = 8$ (4) $(x-2)^2 + (y-4)^2 = 4$

Ans. (4)



Sol. $\frac{x \quad 3}{1} \quad \frac{y \quad 5}{1} \quad 2\frac{3 \quad 5 \quad 1}{1 \quad 1}$

So, x = 4, y = 4

Hence, $(x-2)^2 + (y-4)^2 = 4$

13. If the curves, $\frac{x^2}{a} \quad \frac{y^2}{b} \quad 1$ and $\frac{x^2}{c} \quad \frac{y^2}{d} \quad 1$ intersect each other at an angle of 90°, then which of the following relations is TRUE?

(1) a + b = c + d   (2) a – b = c – d   (3) a – c = b + d   (4) ab $\frac{c \quad d}{a \quad b}$

Ans. (2)

Sol. For orthogonal curves a – c = b – d

$\Rightarrow$ a – b = c – d

14. $\lim\limits_{n} 1 \left(\frac{1 \; \frac{1}{2} \; .... \; \frac{1}{n}}{n^2} \right)^{n}$ is equal to :

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

Ans. (4)

Sol. Given limit is of 1^{∞} form

So, ℓ exp $\lim\limits_{n} \frac{1 \; \frac{1}{2} \; \frac{1}{3} \; .... \; \frac{1}{n}}{n}$

Now, 0 $\quad 1 \; \frac{1}{2} \; \frac{1}{3} \; .... \; \frac{1}{n} \quad 1 \; \frac{1}{\sqrt{2}} \; \frac{1}{\sqrt{3}} \; ..... \; \frac{1}{\sqrt{n}} \quad 2\sqrt{n} \quad 1$

So, ℓ = exp (0) (from sandwich theorem) = 1

15. The coefficients a, b and c of the quadratic equation, $ax^2 + bx + c = 0$ are obtained by throwing a dice three times. The probability that this equation has equal roots is:

(1) $\frac{1}{72}$ (2) $\frac{5}{216}$ (3) $\frac{1}{36}$ (4) $\frac{1}{54}$

Ans. (2)

Sol. $ax^2 + bx + c = 0$

For equal roots D = 0

$\Rightarrow b^2 = 4ac$

Case I : ac = 1

(a, b, c) = (1, 2, 1)

Case II : ac = 4

(a, b, c) = (1, 4, 4)   or (4, 4, 1)   or (2, 4, 2)

Case III : ac = 9

(a, b, c) = (3, 6, 3)

Required probability $\frac{5}{216}$

16. The total number of positive integral solutions (x, y, z) such that xyz = 24 is :

(1) 36   (2) 24   (3) 45   (4) 30

Ans. (4)

Sol. $xyz = 2^3 \times 3^1$

Let $x \quad 2^{\ 1} \quad 3^{\ 1}$

$y \quad 2^{\ 2} \quad 3^{\ 2}$

$z \quad 2^{\ 3} \quad 3^{\ 3}$

Now $\alpha_1 + \alpha_2 + \alpha_3 = 3$.

No. of non-negative integral sol $= {}^5C_2 = 10$

& $\beta_1 + \beta_2 + \beta_3 = 1$

No. of non-negative integral sol^n $= {}^3C_2 = 3$

Total ways $= 10 \times 3 = 30$.

17. The integer 'k', for which the inequality $x^2 - 2(3k - 1)x + 8k^2 - 7 > 0$ is valid for every x in R, is :

(1) 3 (2) 2 (3) 0 (4) 4

Ans. (1)

Sol. $x^2 - 2(3K - 1)x + 8K^2 - 7 > 0$

Now, $D < 0$

$\Rightarrow 4(3K - 1)^2 - 4 \times 1 \times (8K^2 - 7) < 0$

$\Rightarrow 9K^2 - 6K + 1 - 8K^2 + 7 < 0$

$\Rightarrow K^2 - 6K + 8 < 0$

$\Rightarrow (K - 4)(K - 2) < 0$

$\boxed{K \quad (2,4)}$

18. If a curve passes through the origin and the slope of the tangent to it at any point (x, y) is $\frac{x^2 \quad 4x \quad y \quad 8}{x \quad 2}$, then this curve also passes through the point:

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

Ans. (4)

Sol. Given

$y(0) = 0$ & $\frac{dy}{dx} \quad \frac{(x \quad 2)^2 \quad y \quad 4}{x \quad 2}$

$\frac{dy}{dx} \quad \frac{y}{x \quad 2} \quad (x \quad 2) \quad \frac{4}{x \quad 2}$

$I.F \quad e^{\ \frac{1}{x \ 2}dx} \quad \frac{1}{x \quad 2}$

Solution of L.D.E.

$y\frac{1}{x \quad 2} \qquad \frac{1}{x \quad 2} \ (x \quad 2) \quad \frac{4}{x \quad 2} \ .dx$

$\frac{y}{x\ \ 2}\quad x\quad \frac{4}{x\ \ 2}\quad C$

Now, at x = 0, y = 0 ⇒ C = –2

y = x (x – 2) – 4 – 2 (x – 2)

⇒ $y = x^2 - 4x$

This curve passes through (5, 5)

19. The statement $A \to (B \to A)$ is equivalent to :

(1) $A \to (A \wedge B)$ (2) $A \to (A \to B)$ (3) $A \to (A \leftrightarrow B)$ (4) $A \to (A \vee B)$

Ans. (4)

Sol. $A \to (B \to A)$

$\equiv A \to (\sim B \vee A)$

$\equiv \sim A \vee (\sim B \vee A)$

$\equiv (\sim A \vee A) \vee \sim B$

$\equiv T \vee \sim B \equiv T$

$\therefore T \vee B = T$

$\equiv (\sim A \vee A) \vee B$

$\equiv \sim A \vee (A \vee B)$

$\equiv A \to (A \vee B)$

20. If Rolle's theorem holds for the function $f(x) = x^3 - ax^2 + bx - 4$, $x \in [1, 2]$ with $f'\ \frac{4}{3}\quad 0$ then ordered pair (a, b) is equal to :

(1) (5, 8) (2) (–5, 8) (3) (5, –8) (4) (–5, –8)

Ans. (1)

Sol. f(1) = f(2)

⇒ 1 – a + b – 4 = 8 – 4a + 2b – 4

⇒ 3a – b = 7 ......(1)

Also $f'\ \frac{4}{3}\quad 0$ (given)

$3x^2\quad 2ax\quad b\ _{x\ \frac{4}{3}}\quad 0$

$\frac{16}{3}\quad \frac{8a}{3}\quad b\quad 0$

⇒ 8a – 3b – 16 = 0 ....(2)

Solving (1) and (2)

a = 5, b = 8

Numeric Value Type

This Section contains **10 Numeric Value Type question**, out of 10 only 5 have to be done.

1. Let f(x) be a polynomial of degree 6 in x, in which the coefficient of x^6 is unity and it has extrema at $x = -1$ and $x = 1$. If $\lim_{x \to 0} \frac{f(x)}{x^3} = 1$, then 5.f(2) is equal to _______.

Ans. (144)

Sol. Let $f(x) = x^6 + ax^5 + bx^4 + cx^3 + dx^2 + ex + f$

as $\lim_{x \to 0} \frac{f(x)}{x^3} = 1$ non-zero finite

So, d = e = f = 0

and $f(x) = x^3(x^3 + ax^2 + bx + c)$

Hence, $\lim_{x \to 0} \frac{f(x)}{x^3} = c = 1$

Now, as $f(x) = x^6 + ax^5 + bx^4 + x^3$

and f'(x) = 0 at x = 1 and x = –1

i.e., $f'(x) = 6x^5 + 5ax^4 + 4bx^3 + 3x^2$

f'(1) = 0

$\Rightarrow 6 + 5a + 4b + 3 = 0$

$\Rightarrow 5a + 4b = -9$

& f'(-1) = 0

$\Rightarrow -6 + 5a - 4b + 3 = 0$

$\Rightarrow 5a - 4b = 3$

Solving both we get,

$a = -\frac{6}{10} = -\frac{3}{5}; \quad b = -\frac{3}{2}$

$f(x) = x^6 - \frac{3}{5}x^5 - \frac{3}{2}x^4 + x^3$

$5f(2) = 5\left(64 - \frac{3}{5} \times 32 - \frac{3}{2} \times 16 + 8\right)$

$= 320 - 96 - 120 + 40$

$= 144$

2. The number of points, at which the function $f(x) = |2x + 1| - 3|x + 2| + |x^2 + x - 2|$, $x \in R$ is not differentiable, is _______.

Ans. (2)

Sol. $f(x) = |2x + 1| - 3|x + 2| + |x^2 + x - 2|$

$= |2x + 1| - 3|x + 2| + |x + 2|\,|x - 1|$

$= |2x + 1| + |x + 2|\,(|x - 1| - 3)$

Critical points are $x \quad \frac{1}{2}, \; 2, \; 1$

but x = –2 is making a zero.

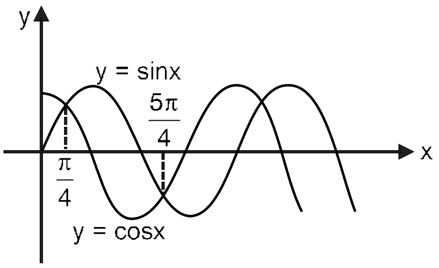
twice in product so, points of non differentiability are $\boxed{x \quad \frac{1}{2} \text{ and } x \quad 1}$

$\therefore$ Number of points of non-differentiability = $\boxed{2}$

3. The graphs of sine and cosine functions, intersect each other at a number of points and between two consecutive points of intersection, the two graphs enclose the same area A. Then A^4 is equal to ______.

Ans. (64)

Sol.



$$A \int_{/4}^{5\ /4} \sin x \quad \cos x \; dx$$

$$\cos x \quad \sin x \Big|_{/4}^{5\ /4}$$

$$\frac{1}{\sqrt{2}} \quad \frac{1}{\sqrt{2}} \qquad \frac{1}{\sqrt{2}} \quad \frac{1}{\sqrt{2}}$$

$$A \quad \frac{2}{\sqrt{2}} \quad \frac{2}{\sqrt{2}} \quad 2\sqrt{2}$$

$$A^4 \quad 2\sqrt{2}^{\,4} \quad 16 \quad 4 \quad 64$$

4. Let A_1, A_2, A_3, ... be squares such that for each $n \geq 1$, the length of the side of A_n equals the length of diagonal of A_{n+1}. If the length of A_1 is 12 cm, then the smallest value of n for which area of A_n is less than one, is ______.

Ans. (9)

Sol. Let an be the side length of A_n.

So, $a_n \quad \sqrt{2}a_{n\ 1}, \; a_1 \quad 12$

$$a_n \quad 12 \quad \frac{1}{\sqrt{2}}^{\,n\ 1}$$

Now, $a_n^{\ 2} \quad 1 \quad \frac{144}{2^{(n\ 1)}} \quad 1$

$\Rightarrow 2^{(n-1)} > 144$

$\Rightarrow n - 1 \geq 8$

$\Rightarrow n \geq 9$

5. Let A $\begin{matrix} x & y & z \\ y & z & x \\ z & x & y \end{matrix}$, where x, y and z are real numbers such that x + y + z > 0 and xyz = 2. If $A^2 = I_3$,

then the value of $x^3 + y^3 + z^3$ is_____.

Ans. (7)

Sol. $A^2 = I$

$\Rightarrow AA' = I$ (as A' = A)

$\Rightarrow$ A is orthogonal

So, $x^2 + y^2 + z^2 = 1$ and $xy + yz + zx = 0$

$\Rightarrow (x + y + z)^2 = 1 + 2 \times 0$

$\Rightarrow x + y + z = 1$

Thus,

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

$= 7$

6. If A $\begin{matrix} 0 & \tan\frac{}{2} \\ \tan\frac{}{2} & 0 \end{matrix}$ and $(I_2 \quad A)(I_2 \quad A)^{1}$ $\begin{matrix} a & b \\ b & a \end{matrix}$, then $13(a^2 + b^2)$ is equal to ________ .

Ans. (13)

Sol. $a^2 \quad b^2 \quad |I_2 \quad A||I_2 \quad A|^{1}$

$\sec^2\frac{}{2} \quad \cos^2\frac{}{2} \quad 1$

7. The total number of numbers, lying between 100 and 1000 that can be formed with the digits 1, 2, 3, 4, 5, if the repetition of digits is not allowed and numbers are divisible by either 3 or 5, is ______.

Ans. (32)

Sol. We need three digits numbers.

Since 1 + 2 + 3 + 4 + 5 = 15

So, number of possible triplets for multiple of

15 is 1 × 2 × 2

so Ans. $4 \quad \lfloor 3 \quad 4 \quad 3 \quad 1 \quad 2 \quad \lfloor 2 \quad 32$

8. Let $\vec{a}$ $\hat{i}$ $2\hat{j}$ $\hat{k}, \vec{b}$ $\hat{i}$ $\hat{j}$ and $\vec{c}$ $\hat{i}$ $\hat{j}$ $\hat{k}$ be three given vectors. If $\vec{r}$ is a vector such that $\vec{r}$ $\vec{a}$ $\vec{c}$ $\vec{a}$ and $\vec{r}$ $\vec{b}$ 0, then $\vec{r}$ $\vec{a}$ is equal to _________.

Ans. (12)

Sol. $(\vec{r} \quad \vec{c}) \quad \vec{a} \quad 0$

$\vec{r} \quad \vec{c} \quad \vec{a}$

Now, $0 \quad \vec{b}\ \vec{c} \quad \vec{a}\ \vec{b}$

$\dfrac{\vec{b}\ \vec{c}}{\vec{a}\ \vec{b}} \quad \dfrac{2}{1} \quad 2$

So, $\vec{r}\ \vec{a} \quad \vec{a}\ \vec{c} \quad 2a^2 \quad 12$

9. If the system of equations

$kx + y + 2z = 1$

$3x - y - 2z = 2$

$-2x - 2y - 4z = 3$

has infinitely many solutions, then k is equal to ________.

Ans. (21)

Sol. We observe $5P_2 - P_1 = 3P_3$

So, $15 - K = -6$

$\Rightarrow K = 21$

10. The locus of the point of intersection of the lines $(\sqrt{3})kx \quad ky \quad 4\sqrt{3} \quad 0$ and $\sqrt{3}x \quad y \quad 4(\sqrt{3})k \quad 0$ is a conic, whose eccentricity is ___________.

Ans. (2)

Sol. $k \quad \dfrac{4\sqrt{3}}{\sqrt{3}x \quad y} \quad \dfrac{\sqrt{3}x \quad y}{4\sqrt{3}}$

$\Rightarrow 3x^2 - y^2 = 48$

$\dfrac{x^2}{16} \quad \dfrac{y^2}{48} \quad 1$

Now, $48 = 16(e^2 - 1)$

$e \quad \sqrt{4} \quad 2$