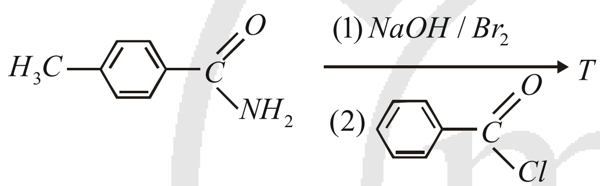
SOLUTIONS OF IIT-JEE 2010

PAPER - II
[CHEMISTRY]

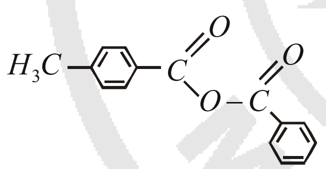
SECTION - I
Single Correct Choice Type

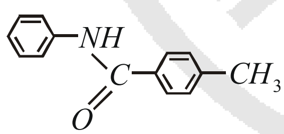
This section contains 6 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

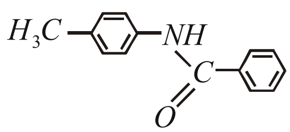
1. In the reaction

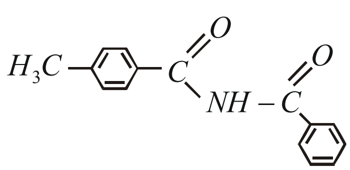


the structure of the Product T is

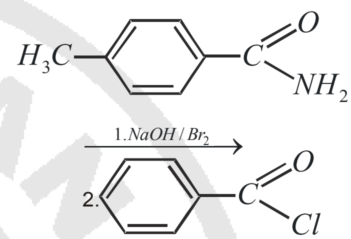
(a) 

(b) 

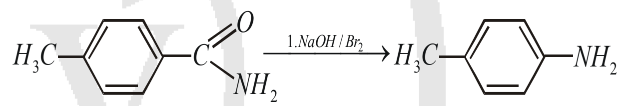
(c) 

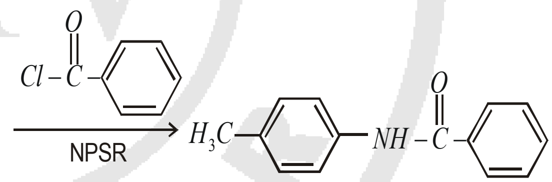
(d) 

1.Sol.(c)



Step I is Hofmann's bromamide reaction $\therefore$





2. Assuming that Hund's rule is violated, the bond order and magnetic nature of the diatomic molecule B_2 is

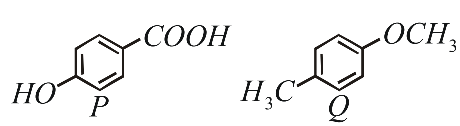
(a) 1 and diamagnetic
(b) 0 and diamagnetic
(c) 1 and paramagnetic
(d) 0 and paramagnetic

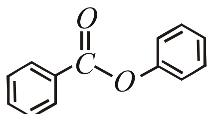
2.Sol.(a) $B_2 \rightarrow \sigma 1s^2 \sigma^* 1s^2 \sigma 2s^2 \sigma^* 2s^2 \pi 2p_y{}^2$

B.O. $\dfrac{[6-4]}{2} = 1$

No unpaired electron is hence diamagnetic

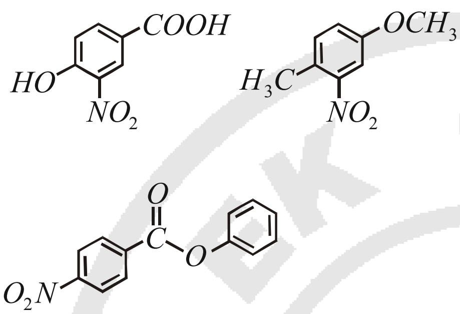
3. The compounds P, Q and S

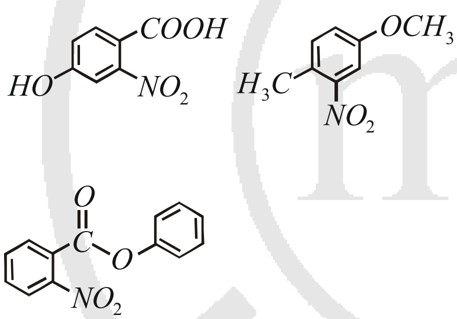


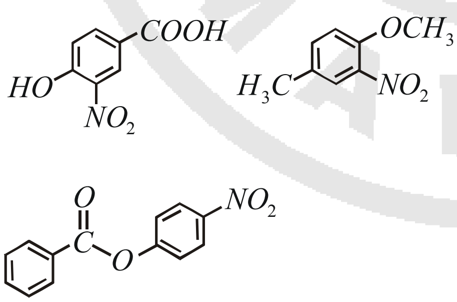


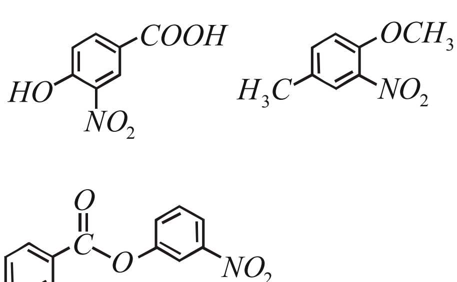
S

were separately subjected to nitration using HNO_3 / H_2SO_4 mixture. The major product formed in each case respectively, s

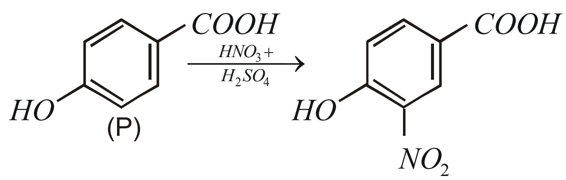
(a) 

(b) 

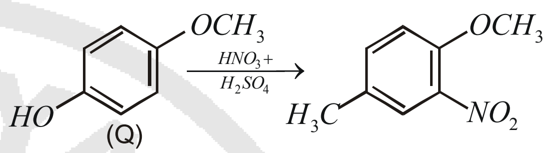
(c) 

(d) 

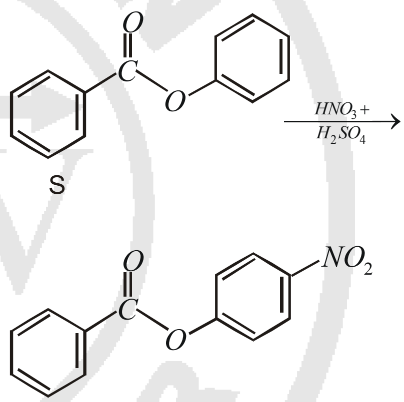
3.Sol.(c)



Because $-OH$ is more powerful group



Because $-OCH_3$ is more powerful group



because $-\ddot{O}-$ is more powerful group & P-is unoccupied.

Ans =c

4. The species having pyramidal shape is

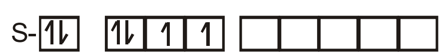
(a) SO_3 (b) BrF_3

(c) SiO_3^{2-} (d) OSF_2

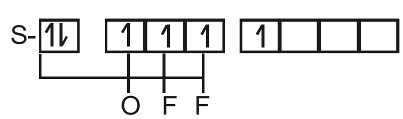
4.Sol.(d) SOF_2

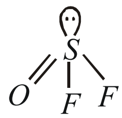
$S \rightarrow 3s^2 3p^4 3d^0$

Ground state



Exited state





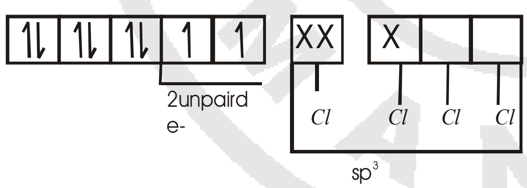
5. The complex showing a spin-only magnetic moment of $2.82\,B.M.$ is

(a) $Ni(CO)_4$ (b) $\left[NiCl_4\right]^{2-}$

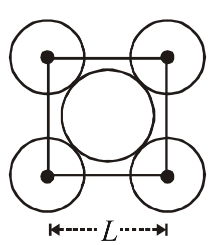
(c) $Ni(PPh_3)_4$ (d) $\left[Ni(CN)_4\right]^{2-}$

5.Sol..(b) $\mu = \sqrt{n(n+2)}$

$$2.82 = \sqrt{n(n+2)}$$
$$7.9 = n(n+2)$$
$$8 = n^2 + 2n$$
$$n^2 + 2n - 8 = 0$$
$$\boxed{n = +2}$$
$$Ni(CO)_4 = 0;\left[Ni(Cl_4)\right]^{-2} = 2$$
$$Ni(PPh_3)_4 = 0;\left[Ni(CN)_4\right]^{-2} = 0$$
$$Ni^{2+} = 3d^8 4s^0$$



6. The packing efficiency of the two-dimensional square unit cell shown below is :



(a) 39.27% (b) 68.02%

(c) 74.05% (d) 78.54%

6. (d) Given diagram is a bcc arrangement

$\therefore$ volume of two sphere = $2\times\frac{4}{3}\pi r^3$

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

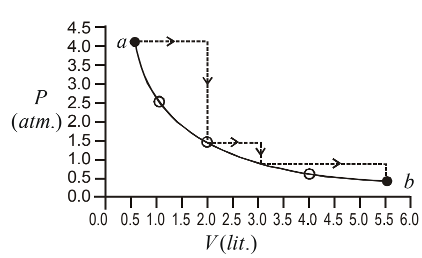
$$P.F = \frac{2\times\frac{4}{3}\times\pi r^3}{\left(\frac{4r}{\sqrt{3}}\right)^2\times 2r}$$
$$= \frac{2\times 4\pi r^3\times 3}{3\times 16r^2\times 2r}$$
$$= \frac{\pi}{4}$$
$$= \frac{3.14}{4}$$
$$= 0.785$$
$$= 78.5\%$$

SECTION - II

Integer Answer Type

This section contains a group of 5 questions. The answer to each of the questions is a single digit integer, ranging from 0 to 9. The correct digit below the question no. in the ORS is to be bubbled.

7. One mole of an ideal gas is taken from a to b along two paths denoted y the solid and the dashed lines as shown in he graph below. If the work done along the solid line path is w_s and that along the dotted line path is w_d, then the integer closest to the ratio w_d / w_s is :



7.Sol. Since process is the isothermal because

$P_1V_1 = P_2V_2$

i.e of point "a" $P_1V_1 = 4\times 0.5 = 2$

and at $V = 2lit$, $P = 1atm$

$\therefore P_2V_2 = 2\times 1 = 2$

$$w_s = -2.30RT\log\left(\frac{V_2}{V_1}\right)$$

$$= -2.303\times PV\log\frac{5.5}{0.5}$$

$= -2.303\times 2\log 11$ ....(1)

$w_s \approx 4.7$

$w_d = -\left[4\times 2.5 + 1\times 1 + 2.5\times 0.6\right]$

$= -10$

$$\therefore \frac{w_d}{w_s} = \frac{-10}{-4.6} = 2$$

Ans =2

8. Among the following, the number of elements showing only one non-zero oxidation state is

$O, Cl, F, N, P, Sn, Tl, Na, Ti$

8.Sol. $F \rightarrow$ Only -1 $\therefore$ three elements

$Na \rightarrow$ Only+1

$Tl \rightarrow$ Only +1

Ans= 3

9. Silver (atomic weight $= 108\,g\,mol^{-1}$) has a density of $10.5\,g\,cm^{-3}$. The number of silver atoms on a surface of area $10^{-12}m^2$ can be expressed in scientific notation as $y\times 10^x$. The value of x is

9 Sol. $1cm^3 = 10.5gm$

$$= \frac{10.5}{108}\times 6\times 10^{13}\times\frac{4}{3}\pi r^3$$

$\therefore r = 10^{-8}cm = 10^{-10}m$

Volume corresponding to $10^{-12}m^2 = 10^{-12}\times 2r$

$$\therefore wt = 3\times 10^{-22}\times\frac{10.5gm}{10^{-6}m^3}$$

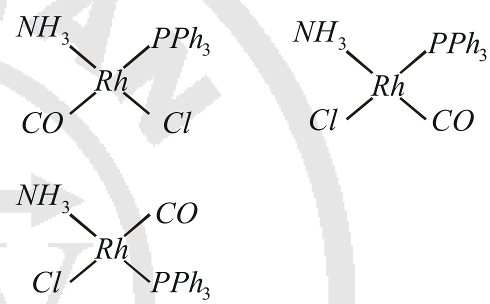
$$\therefore \text{no. of atom} = \frac{2\times 10^{-22}\times 10.5\times 6.023\times 10^{23}}{108\times 10^{-6}}$$

$= 1.17\times 10^7$

$\therefore$ **Ans =7**

10. Total number of geometrical isomers for the complex $[RhCl(CO)(PPh_3)(NH_3)]$ is

10.Sol. $\left[Mabcd\right]$ type of complexes exist in 3 isomeric form



Ans=3

11. The total number of diprotic acids among the following is :

H_3PO_4	H_2SO_4	H_3PO_3
H_2CO_3	$H_2S_2O_7$	H_3BO_3
H_3PO_2	H_2CrO_4	H_2SO_3

11.Sol $H_2SO_4, H_3PO_3, H_2CO_3, H_2S_2O_7$

H_2CrO_4, H_2SO_3

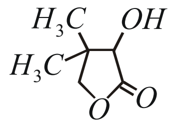
Ans= 6

SECTION - III
Paragraph Type

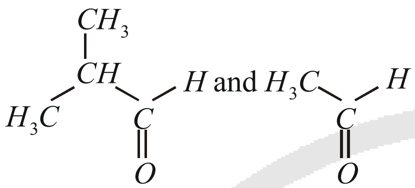
This section contains 2 paragraphs. Based upon each of the paragraphs 3 multiple choice questions have to e answered. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which **ONLY ONE** is correct.

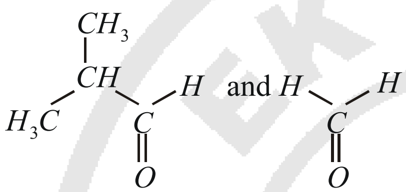
Paragraph for questions 12 to 14

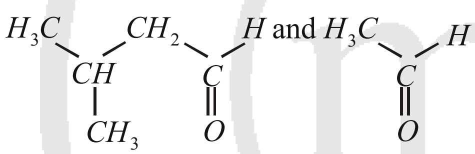
Two aliphatic aldehydes P and Q react in the presence of aqueous K_2CO_3 to give compound R, which upon treatment with HCN provides compound S. On acidification and heating, S gives the product shown below :

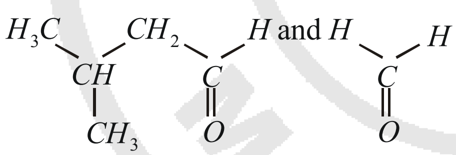


12. The compounds P and Q respectively are

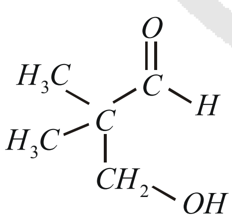
(a) 

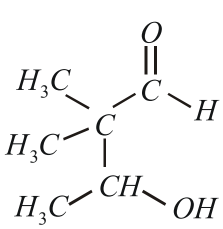
(b) 

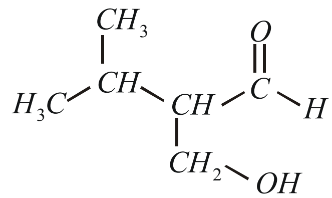
(c) 

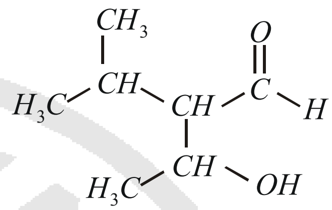
(d) 

13. The compound R is

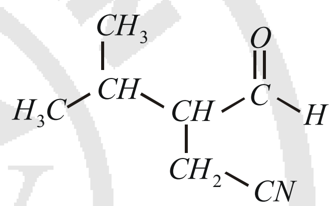
(a) 

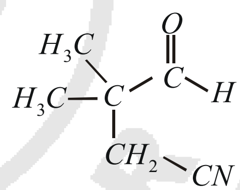
(b) 

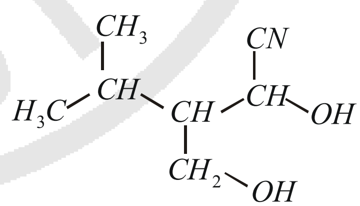
(c) 

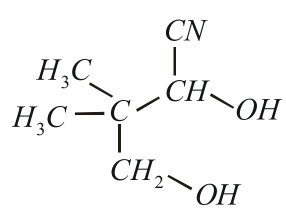
(d) 

14. The compound S is

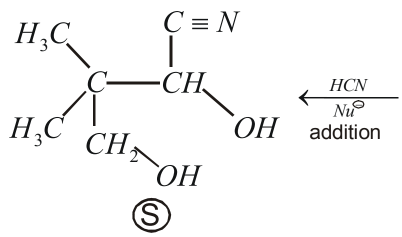
(a) 

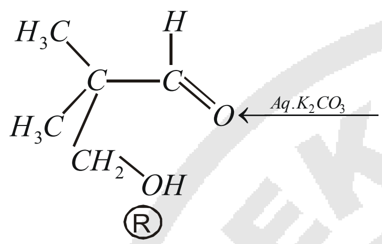
(b) 

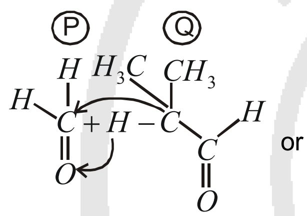
(c) 

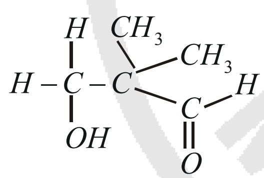
(d) 

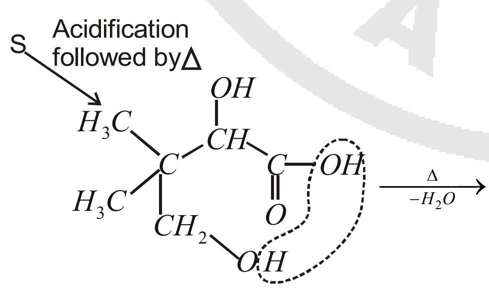
12 to 14 Sol.

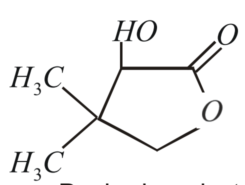












Desired product

$\therefore$ **Ans** $12 \rightarrow (b); 13 \rightarrow (a); 14 \rightarrow (d)$

Paragraph for questions 15 to 17

The hydrogen-like species Li^{2+} is in a spherically symmetric state S_1 with one radial node. Upon absorbing light the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to the ground state energy of the hydrogen atom.

15. The state S_1 is

(a) $1s$ (b) $2s$

(c) $2p$ (d) $3s$

16. Energy of the state S_1 in units of the hydrogen atom ground state energy is

(a) 0.75 (b) 1.50

(c) 2.25 (d) 4.50

17. The orbital angular momentum quantum number of the state S_2 is

(a) 0 (b) 1

(c) 2 (d) 3

15 - 17 Solution :

15.(b) Ground state energy of hydrogen atom

s $= -13.6eV$

$$\therefore\ -13.6 = -13.6 \times \frac{Z^2}{n^2}$$

$$= -13.6 \times \frac{3^2}{n^2}$$

$\therefore\ n = 3\ \therefore\ S_2 = 3$ hence $S_1 < S_2$

Since S_1 is spherically symmetric an one radial node therefore it will be $2s$.

16.(c) Energy of $2s$ = E_1 of H-atom $\times \frac{Z^2}{n^2}$

E_1 of H-atom $\times \frac{3^2}{2^2}$

$= 2.25 \times E_1$ of H-atom

17.(b) Since state S_2 has also one radial node. Hence it will be $3p$.

$\therefore\ l = 1$

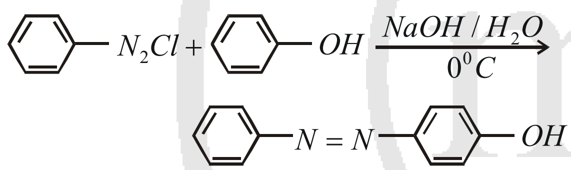
SECTION - IV
Matrix - Match Type

This section contains 2 questions. Each question has four statements (A,B,C and D) given in **Column-I** and five statements (p, q, r, s and t) in **Column-II.** Any given statement in **Column-I** can have correct matching with **ONE OR MORE** statement(s) given in **Column-II**. For example, if for a given questions, statement B matches with the statements given in q and r, then for that particular questions, against statement B, darken the bubbles coresponding to q and r in the ORS.

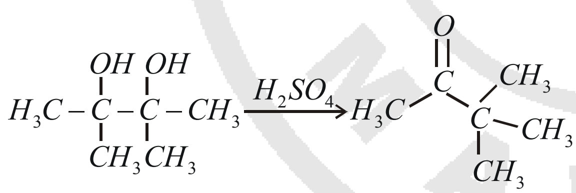
18. Match the reactions in **Column-I** with appropriate options in **Column-II**.

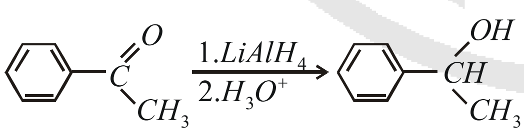
COLUMN - I

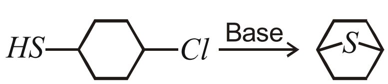
(A)



(B)



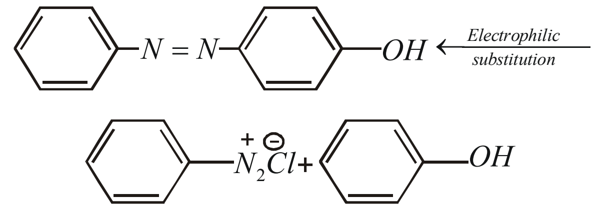
(C) 

(D) 

COLUMN - II

(p) Racemic mixture
(q) Addition reaction
(r) Substitution reaction
(s) Coupling reaction
(t) Carbocation intermediate

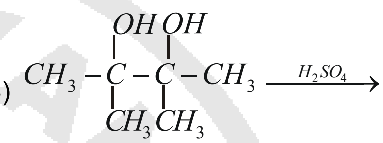
18.Sol. (A)



Electrophile O & P-directing group

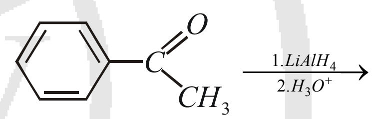
$\therefore$ In electrophilic substitution reaction carbocation i.e. cycloarenium is formed

Ans = r, s

(B) 

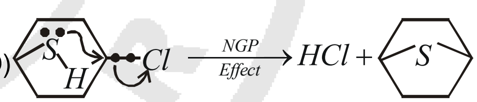
Pinacol- pinacolone rearrangement in which first we get carbocation

Ans= t

(C) 

First is addition reaction & then we get optically active compound $\therefore$ Racemic mixture

Ans= p, q

(D) 

Ans= r

Ans=

$$A \to (r,s)\ B \to (t); (C) \to (p,q); (D) \to (r)$$

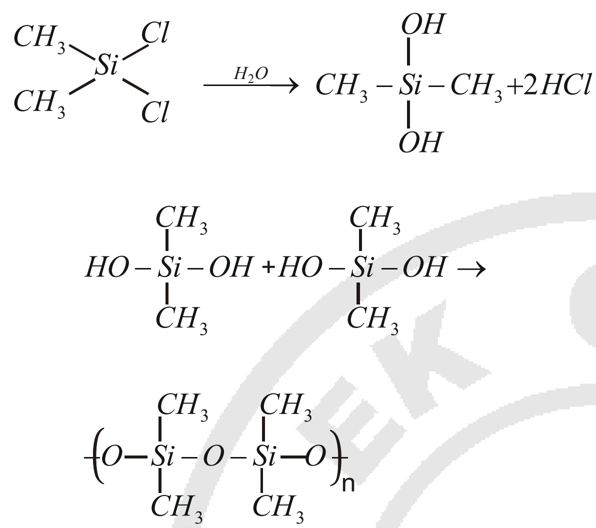
19. All the compounds listed in **Column-I** react with water. Match the result of the respective reactions with the appropriate options listed in **Column-II**.

COLUMN - I		COLUMN - II
(A) $(CH_3)_2 SiCl_2$	(p)	Hydrogen halide formation
(B) XeF_4	(q)	Redox reaction
(C) Cl_2	(r)	Reacts with glass
(D) VCl_5	(s)	Polymerization
	(t)	O_2 formation

19.Sol.

$A \to (p,s); B \to (p,q,t); C \to (p,q,t); D \to (s)$

(A)



Polymer silicone

(B)

$$3XeF_4 + 6H_2O \to 2Xe + XeO_3 + 12HF + 1\frac{1}{2}O_2$$

(C) $Cl_2 + H_2O \to \underset{-1}{HCl} + \underset{+1}{HOCl}$

(Redox hydrogen halide)

$$Cl_2 + 3H_2O \to H_3O^+ + 2Cl^- + \frac{1}{2}O_2$$

(Oxygen formation)

(D) $(I)V$ in five oxidation state on hydrolysis form

$$V^{+5} \to \overset{+5}{V}O_2^+ + \overset{+5}{V}O_4^{3-}$$

No change in oxidation state when solution of vanatate ion is concentrated they are polymerised to form $[V_2O_7]^{4-}$ and higher vanadates i.e. $[V_{10}O_{28}]^{6-}$ $[V_{12}O_{32}]^{4-}$

PAPER - II
[MATHEMATICS]

Section - I
Single Correct Choice Type

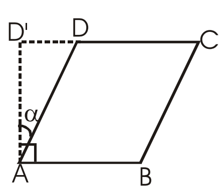
20. Two adjacent sides of a parallelogram $ABCD$ are given by $\overrightarrow{AB} = 2\hat{i} + 10\hat{j} + 11\hat{k}$ and $\overrightarrow{AD} = -\hat{i} + 2\hat{j} + 2\hat{k}$

The side AD is rotated by an acute angle α in the plane of the parallelogram so that AD becomes AD'. If AD' makes a right angle with the side AB, then the cosine of the angle α is given by

(a) $\frac{8}{9}$ (b) $\frac{\sqrt{17}}{9}$

(c) $\frac{1}{9}$ (d) $\frac{4\sqrt{5}}{9}$

Sol.(b) $\alpha = 90^0 - \angle ADB$



$$\cos\alpha = \cos(90^0 - \angle ADB)$$

$$= \sin\angle ADB$$

$$\cos\angle ADB = \frac{\overrightarrow{AB}\cdot\overrightarrow{AD}}{|\overrightarrow{AB}||\overrightarrow{AD}|}$$

$$= \frac{40}{15\cdot 3} = 8/9$$

$$\therefore \cos\alpha = \sin\angle ADB = \sqrt{1-(8/9)^2} = \frac{\sqrt{17}}{9}$$

21. Let f be a real-valued function defined on the interval $(-1, 1)$ such that $e^{-x}f(x) = 2 + \int_0^x \sqrt{t^4+1}\,dt$, for all $x \in (-1, 1)$, and let f^{-1} be the inverse function of f. Then $(f^{-1})'(2)$ is equal to

(a) 1 (b) $\frac{1}{3}$

(c) $\frac{1}{2}$ (d) $\frac{1}{e}$

Sol.(b) $f\left(f^{-1}(x)\right)=x$

$\Rightarrow f'\left(f^{-1}(x)\right)\left(f^{-1}(x)\right)'=1$

$\Rightarrow \left(f^{-1}(2)\right)'=\frac{1}{f'\left(f^{-1}(2)\right)}$

Now, $f(0)=2$

$\Rightarrow \left(f^{-1}(2)\right)'=\frac{1}{f'(0)}=\frac{1}{3}$

22. For $r=0, 1, \ldots\ldots, 10$, let A_2, B_r and C_r denote, respectively, the coefficient of x^r in the expansions of $(1+x)^{10}, (1+x)^{20}$ and $(1+x)^{30}$. Then $\sum_{r=1}^{10} A_r\left(B_{10}B_r - C_{10}A_r\right)$ is equal to

(a) $B_{10}-C_{10}$

(b) $A_{10}\left(B_{10}^2-C_{10}A_{10}\right)$

(c) 0 (d) $C_{10}-B_{10}$

Sol.(d) $A_r = {}^{10}C_r, B_r = {}^{20}C_r, C_r = {}^{30}C_r$

$\sum A_r\left(B_{10}B_r - C_{10}A_r\right)$

$=B_{10}\sum_{r=1}^{10} {}^{10}C_r\, {}^{20}C_r - {}^{30}C_{10}\sum_{r=1}^{10}\left({}^{10}C_r\right)^2$ ...(1)

$={}^{20}C_{10}\left({}^{30}C_{20}-1\right)-{}^{30}C_{10}\left({}^{20}C_{10}-1\right)$

$={}^{30}C_{10}-{}^{20}C_{10}$

23. A signal which can be green or red with probability $\frac{4}{5}$ and $\frac{1}{5}$ respectivley, is received by station A and then transmitted to station B. The probability of each station receiving the signal correctly is $\frac{3}{4}$. If the signal received at station B is green then the probability that the original signal was green is

(a) $\frac{3}{5}$ (b) $\frac{6}{7}$

(c) $\frac{20}{23}$ (d) $\frac{9}{20}$

Sol.(c)

24. Let $S-\{1,2,3,4\}$. The total number of unordered pairs of disjoint subsets of S is equal to

(a) 25 (b) 34

(c) 42 (d) 41

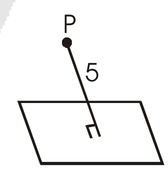
Sol.(d)

25. If the distance of the point $P(1,-2,1)$ from the plane $x+2y-2z=\alpha$, where $\alpha>0$, is 5, then the foot of the perpendicular from P to the plane is

(a) $\left(\frac{8}{3},\frac{4}{3},-\frac{7}{3}\right)$ (b) $\left(\frac{4}{3},-\frac{4}{3},\frac{1}{3}\right)$

(c) $\left(\frac{1}{3},\frac{2}{3},\frac{10}{3}\right)$ (d) $\left(\frac{2}{3},-\frac{1}{3},\frac{5}{2}\right)$

Sol.(a) The equation of $\perp^r$ from P on plane is



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

its distance form is

$\frac{x-1}{1/3}=\frac{y+2}{2/3}=\frac{z-1}{-2/3}=d$

A point at distance $|d|$ can be taken

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

When $d=5$ | when $d=-5$

$\left(\frac{8}{3},\frac{4}{3},\frac{-7}{3}\right)$ | $\left(\frac{-2}{3},\frac{-16}{3},\frac{13}{3}\right)$

Section - II
Integer Type

26. Let $a_1, a_2, a_3, ..., a_{11}$ be real numbers satisfying $a_1 = 15, 27 - 2a_2 > 0,$ and $a_k = 2a_{k-1} - a_{k-2}$ for $k = 3, 4, ..., 11$.

If $\frac{a_1^2 + a_2^2 + ... + a_{11}^2}{11} = 90$, then the value of $\frac{a_1 + a_2 + ... + a_{11}}{11}$ is equal to

Sol.(0) $a_1, a_2, a_3 ....a_{11}$ are in A. P.

Let common difference $= 'd'$

$a_2 = a_1 + d, a_3 = a_1 + 2d ...., a_{11} = a_1 + 10d$

Given $\sum_{r=0}^{10} (a_1 + rd)^2 = 90 \times 11$

$\Rightarrow a_1^2 \sum_{r=0}^{10} 1 + d^2 \sum_{r=0}^{10} r^2 + 2a_1 d \sum_{r=0}^{10} r = 990$

$\Rightarrow 11a_1^2 + d^2 \left(\frac{1}{6} \times 10 \times 11 \times 21 \right) + 2a_1 d \left(10 \times \frac{11}{2} \right)$

$= 990$

$\Rightarrow a_1^2 + 35d^2 + 10a_1 d = 90$

$\Rightarrow 225 + 35d^2 + 150d = 90$

$\Rightarrow 35d^2 + 150d + 135 = 0$

$\Rightarrow 7d^2 + 21d + 9d + 27 = 0$

$\Rightarrow 7d(d+3) + 9(d+3) = 0$

$\Rightarrow d = -3, \frac{-9}{7}$

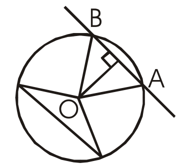
$\because \quad d < \frac{-3}{2} \Rightarrow d = -3$

27. Two parallel chords of a circle of radius 2 are at a distance $\sqrt{3} + 1$ apart. If the chords subtend at the centre, angles of $\frac{\pi}{k}$ and $\frac{2\pi}{k}$, where $k > 0$. then the value of $[k]$ is

[Note : $[k]$ denotes the largest integer less than or equal to k]

Sol.(3) Angle subtended by a chord at the centre

$\theta = 2\cos^{-1}\left(\frac{p}{r}\right)$



$\therefore p = r\cos\frac{\theta}{2}$

Given $p_2 \pm p_1 = \sqrt{3} + 1, \quad r = 2$

$2\left(\cos\frac{\pi}{2k} + \cos\frac{2\pi}{2k} \right) = \sqrt{3} + 1$

$\left(\cos\frac{\pi}{2k} + \cos\frac{2\pi}{2k} \right) = \frac{\sqrt{3}}{2} + \frac{1}{2}$

$k = 3$ satisfies

$\cos\frac{\pi}{6} + \cos\frac{\pi}{3} = \frac{\sqrt{3}}{2} + \frac{1}{2}$

28. Let k be a positive real number and let

$$A = \begin{bmatrix} 2k-1 & 2\sqrt{k} & 2\sqrt{k} \\ 2\sqrt{k} & 1 & -2k \\ -2\sqrt{k} & 2k & -1 \end{bmatrix}$$ and

$$B = \begin{bmatrix} 0 & 2k-1 & \sqrt{k} \\ 1-2k & 0 & 2\sqrt{k} \\ -\sqrt{k} & -2\sqrt{k} & 0 \end{bmatrix}$$

If $\det(adj\ A) + \det(adj\ B) = 10^6$, then $[k]$ is equal to

[Note : $adj\ M$ denotes the adjoint of a square matrix M and $[k]$ denotes the largest integer less than or equal to k]

Sol.(4) $\det(adjA) = (\det A)^{n-1}$

Where n is order

$\therefore \det(adjA)) = (\det A)^2$

$\det(adjB) = (\det B)^2 = 0$

$\because B$ is skew symmetric matrix of odd order

Given, $\det(adjA)+\det(adjB)=10^6$

$\Rightarrow (\det A)^2 = 10^6$ ....(1)

Expanding $\det A$, we get

$\det A = (2k+1)^3$

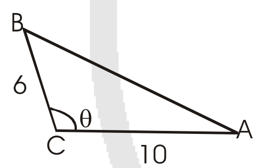
$\therefore \left((2k+1)^3\right)^2 = 10^6$

$\Rightarrow \quad k = 9/2$

$\therefore [k] = 4$

29. Consider a triangle ABC and let a, b and c denote the lengths of the sides opposite to vertices A, B and C respectively. Suppose $a=6, b=10$ and the area of the triangle is $15\sqrt{3}$. If $\angle ACB$ is obtuse and if r denotes the radius of the incircle of the triangle, then r^2 is equal to

Sol.(3)



Area $=\dfrac{1}{2}ab\sin C$

$15\sqrt{3} = \dfrac{1}{2}\times 6\times 10\times \sin C$

$SinC = \dfrac{\sqrt{3}}{2}$

$\angle C = 120^0$

$\because \cos C = \dfrac{a^2+b^2-c^2}{2ab}$

$-\dfrac{1}{2} = \dfrac{6^2+10^2-c^2}{2\cdot 6\cdot 10}$

$c = 14$

$r = \dfrac{\Delta}{s} = \dfrac{15\sqrt{3}}{15} \Rightarrow r^2 = 3$

30. Let f be a function defined on R (the set of all real numbers) such that $f'(x) = 2010(x-2009)(x-2010)^2(x-2011)^3(x-2012)^4$, for all $x \in R$.

If g is a function defined on R with values in the interval $(0, \infty)$ such that $f(x) = \ell n(g(x))$, for all $x \in R$, then the number of points in R at which g has a local maximum is

Sol.(1)

Section - III
Paragraph Type

Paragraph -1

Tangents are drawn from the point $P(3, 4)$ to the ellipse $\dfrac{x^2}{9}+\dfrac{y^2}{4}=1$ touching the ellipse at points A and B.

31. The coordinates of A and B are

(a) $(3,0)$ and $(0,2)$

(b) $\left(-\dfrac{8}{5}, \dfrac{2\sqrt{161}}{15}\right)$ and $\left(-\dfrac{9}{5}, \dfrac{8}{5}\right)$

(c) $\left(-\dfrac{8}{5}, \dfrac{2\sqrt{161}}{15}\right)$ and $(0,2)$

(d) $(3,0)$ and $\left(-\dfrac{9}{5}, \dfrac{8}{5}\right)$

Sol.(d)

32. The orthocenter of the triangle PAB is

(a) $\left(5, \dfrac{8}{7}\right)$ (b) $\left(\dfrac{7}{5}, \dfrac{25}{8}\right)$

(c) $\left(\dfrac{11}{5}, \dfrac{8}{5}\right)$ (d) $\left(\dfrac{8}{25}, \dfrac{7}{5}\right)$

Sol.(c)

33. The equation of the locus of the point whose distances from the point P and the line AB are equal, is

(a) $9x^2 + y^2 - 6xy - 54x - 62y + 241 = 0$

(b) $x^2 + 9y^2 + 6xy - 54x + 62y - 241 = 0$

(c) $9x^2 + 9y^2 - 6xy - 54x - 62y - 241 = 0$

(d) $x^2 + y^2 - 2xy + 27x + 31y - 120 = 0$

Sol.(a)

Paragraph -2

Consider the polynomial

$f(x) = 1 + 2x + 3x^2 + 4x^3$

Let s be the sum of all distinct real roots of $f(x)$ and let $t = |s|$.

34. The real number s lies in the interval

(a) $\left(-\frac{1}{4}, 0\right)$ (b) $\left(-11, -\frac{3}{4}\right)$

(c) $\left(-\frac{3}{4}, -\frac{1}{2}\right)$ (d) $\left(0, \frac{1}{4}\right)$

Sol.(c)

35. The area bounded by the curve $y = f(x)$ and the lines $x = 0, y = 0$ and $x = t$, lies in the interval

(a) $\left(\frac{3}{4}, 3\right)$ (b) $\left(\frac{21}{64}, \frac{11}{16}\right)$

(c) $(9, 10)$ (d) $\left(0, \frac{21}{64}\right)$

Sol.(a)

36. The function $f'(x)$ is

(a) increasing in $\left(-t, -\frac{1}{4}\right)$ and decreasing in $\left(-\frac{1}{4}, t\right)$

(b) decreasing in $\left(-t, -\frac{1}{4}\right)$ and increasing in $\left(-\frac{1}{4}, t\right)$

(c) increasing in $(-t, t)$

(d) decreasing in $(-t, t)$

Sol.(b)

Section- IV
Matrix -Match Type

37. Match the statements in Column-I with those in Column - II.

Column - I

(A) A line from the origin meets the lines $\frac{x-2}{1} = \frac{y-1}{-2} = \frac{z+1}{1}$ and $\frac{x-\frac{8}{3}}{2} = \frac{y+3}{-1} = \frac{z-1}{1}$ at P and Q respectively. If length $PQ = d$, then d^2 is

(B) The values of x satisfying $\tan^{-1}(x+3) - \tan^{-1}(x-3) = \sin^{-1}\left(\frac{3}{5}\right)$ are

(C) None-zero vectors $\vec{a}, \vec{b}$ and $\vec{c}$ satisfy $\vec{a} \cdot \vec{b} = 0$, $(\vec{b} - \vec{a}) \cdot (\vec{b} + \vec{c}) = 0$ and $2|\vec{b} + \vec{c}| = |\vec{b} - \vec{a}|$.

If $\vec{a} = \mu\vec{b} + 4\vec{c}$, then the possible values of μ are

(D) Let f be the function on $[-\pi, \pi]$ given by $f(0) = 9$ and $f(x) = \frac{\sin\left(\frac{9x}{2}\right)}{\sin\left(\frac{x}{2}\right)}$ for $x \neq 0$.

The value of $\frac{2}{\pi}\int_{-\pi}^{\pi} f(x)\,dx$ is

Column - II

(p) -4

(q) 0

(r) 4

(s) 5

(t) 6

37.Sol. (A) Let the equation of line be

$$\frac{x}{a}=\frac{y}{b}=\frac{z}{c} \quad ......(1)$$

Given lines are

$$\frac{x-2}{1}=\frac{y-1}{-2}=\frac{z+1}{1} \quad .....(2)$$

$$\& \ \frac{x-8/3}{2}=\frac{y+3}{-1}=\frac{z-1}{1} \quad ......(3)$$

Equations (1) & (2) are coplaner

$$\begin{vmatrix} 2 & 1 & -1 \\ a & b & c \\ 1 & -2 & 1 \end{vmatrix}=0$$

$\Rightarrow a+3b+5c=0$ ...(4)

Equations (1) & (3) are also coplaner

$$\begin{vmatrix} 8/3 & -3 & 1 \\ a & b & c \\ 2 & -1 & 1 \end{vmatrix}=0$$

$\Rightarrow 3a+b-5c=0$ ......(5)

Solving (4) & (5) by cross multiplication

$$\Rightarrow \frac{a}{-20}=\frac{b}{20}=\frac{c}{-8} \Rightarrow (a,b,c)=(5,-5,2)$$

Let a point on this line be $(5k,-5k,2k)$

If it is on (2)

$$\frac{5k-2}{1}=\frac{-5k-1}{-2}=\frac{2k+1}{1} \Rightarrow k=1$$

$\therefore P(5,-5,2)$

If it is on (3)

$$\frac{-5k+3}{-1}=\frac{2k-1}{1} \Rightarrow 3k=2 \qquad \therefore Q\left(\frac{10}{3},\frac{-10}{3},\frac{4}{3}\right)$$

distance

$$PQ^2=\left(5-\frac{10}{3}\right)^2+\left(-5+\frac{10}{3}\right)^2+\left(2-\frac{4}{3}\right)^2$$

$$=\frac{50}{9}+\frac{4}{9}=6$$

$\therefore (A)\to(t)$

38.(B) $\tan^{-1}(x+3)-\tan^{-1}(x-3)=\sin^{-1}\frac{3}{5}$

$$\tan^{-1}\left(\frac{(x+3)-(x-3)}{1+(x+3)(x-3)}\right)=\tan^{-1}\left(\frac{3}{4}\right)$$

$$\Rightarrow \frac{6}{x^2-8}=\frac{3}{4} \Rightarrow x^2=16 \Rightarrow x=4,-4$$

$\therefore (B)\to(p),(r)$

38.(C) $\bar{a}\cdot\bar{b}=0$

$(\bar{b}-\bar{a})\cdot(\bar{b}+\bar{c})=0$

$\Rightarrow \bar{b}^2-\bar{a}\cdot\bar{b}+\bar{b}\cdot\bar{c}-\bar{a}\cdot\bar{c}=0$

$\Rightarrow \bar{b}^2+\bar{b}\cdot\bar{c}-\bar{a}\cdot\bar{c}=0$ ...(1)

Also, $2^2(\bar{b}+\bar{c})^2=(\bar{b}-\bar{a})^2$

$\Rightarrow 4(\bar{b}^2+\bar{c}^2+2\bar{b}\cdot\bar{c})=\bar{b}^2+\bar{a}^2-2\bar{a}\cdot\bar{b}$

$\Rightarrow 3\bar{b}^2+4\bar{c}^2-\bar{a}^2+8\bar{b}\cdot\bar{c}=0$ ......(2)

If $\bar{a}=\mu\bar{b}+4\bar{c}$ then

$\bar{a}^2=\mu^2\bar{b}^2+16\bar{c}^2+8\mu\bar{b}\cdot\bar{c}$

$\bar{a}\cdot\bar{c}=\mu\bar{b}\cdot\bar{c}+4\bar{c}^2$

$\bar{a}\cdot\bar{b}=\mu\bar{b}^2+4\bar{b}\cdot\bar{c}=0$

$\bar{b}^2+\bar{b}\cdot\bar{c}-\mu\bar{b}\cdot\bar{c}-4\bar{c}^2=0$

(A) $\to$ t (B) $\to$ p,r (C) $\to$ q (D) $\to$ r

38. Match the statements in Column-I with those in Column - II.
[Note : Here z takes values in the complex plane and $\text{Im } z$ and $\text{Re } z$ denote, respectively, the imaginary part and the real part of z.]

Column - I

(A) the set of points z satisfying $|z-i|z||=|z+i|z||$ is contained in or equal to

(B) The set of points z satisfying $|z+4|+|z-4|=10$ is contained in or equal to

(C) If $|w|=2$, then the set of points $z=w-\frac{1}{w}$, is contained in or equal to

(D) If $|w| = 1$, then the set of points $z = w + \frac{1}{w}$ is contained in or equal to

Column - II

(p) an ellipse with eccentricity $\frac{4}{5}$

(q) the set of points z satisfying $\text{Im } z = 0$

(r) the set of points z satisfying $|\text{Im } z| \le 1$

(s) the set of points z satisfying $|\text{Re } z| \le 2$

(t) the set of points z satisfying $|z| \le 3$

38.Sol.

(A). $\left|z - i|z|\right| = \left|z + i|z|\right| = \left|z - \left(-i|z|\right)\right|$

$\Rightarrow$ 'z' will lie on $\perp^r$ bisector of line joining

$i|z|$ & $-i|z|$

$\Rightarrow$ 'z' will lie on Real axis.

$\Rightarrow \Rightarrow Im\ z = 0$

(B). $|z+4| + |z-4| = 10$

'z' will lie on an ellipse with

$2a = 10$ & $2ae = 8 \Rightarrow e = 4/5$

(C) Let $w = 2e^{i\theta}$

$$z = w - \frac{1}{w} = 2e^{i\theta} - \frac{1}{2e^{i\theta}} = 2e^{i\theta} - \frac{e^{-i\theta}}{2}$$

$$= \frac{3}{2}\cos\theta + \frac{5}{2} i \sin\theta$$

$$|\text{Re } z| \le \frac{3}{2} \ \& \ |\text{Im } z| \le \frac{5}{2} \ \& \ |z| \le \sqrt{5}$$

(D) $|\omega| = 1 \Rightarrow \omega = \overline{\omega}$

$$z = \omega + \frac{1}{\omega} = \omega + \overline{\omega}$$

$$\Rightarrow \text{Im } z = 0 \ \& \ |\text{Re } z| \le 1$$

(A) $\rightarrow$ q,r, (B) $\rightarrow$ p, (C) $\rightarrow$ s,t, (D) $\rightarrow$ q,s,r,t

PAPER - II
[PHYSICS]

QUESTIONS WITH ONLY ONE CORRECT ANSWERS

39. A tiny spherical oil drop carrying a net charge q is balanced in still air with a vertical uniform electric field of strength $\frac{81\pi}{7} \times 10^5\ Vm^{-1}$. When the field is switched off, the drop is observed to fall with terminal velocity $2 \times 10^{-3}\ ms^{-1}$. Given $g = 9.8 ms^{-2}$, viscosity of the air $= 1.8 \times 10^{-5}\ Nsm^{-2}$ and the density of oil $= 900 mgm^{-3}$, the magnitude of q is :

(a) $1.6 \times 10^{-19} C$ (b) $3.2 \times 10^{-19} C$

(c) $4.8 \times 10^{-19} C$ (d) $8.0 \times 10^{-19} C$

Sol. d)

$$qE = mg \qquad ....(1)$$

$$6\pi\eta rV = mg = \frac{4}{3}\pi r^3 d.g \qquad ....(2)$$

$$\Rightarrow 6\pi\eta rV = qE$$

$$\Rightarrow 6\pi \times 1.8 \times 10^{-5} \times r \times 2 \times 10^{-3} = q \times \frac{81\pi}{7} \times 10^{-5}$$

$$q\eta V = 2r^2 dg$$

$$\Rightarrow r^2 = \frac{9 \times 2 \times 10^{-3} \times 1.8 \times 10^{-5}}{2 \times 900 \times 9.8} = \frac{18}{98} \times 10^{-10}$$

$$= \frac{9}{79} \times 10^{-10}$$

$$\Rightarrow r = \frac{3}{7} \times 10^{-5} m$$

$$Now\ \ 9E = 6\pi\eta rV$$

$$q = \frac{6\pi \times 1.8 \times 10^{-5}}{\frac{81\pi}{7} \times 10^5} \times \frac{3 \times 10^{-5}}{7} \times 2 \times 10^{-3}$$

$$= \frac{6 \times 1.8 \times 3 \times 2}{81} \times 10^{-18}$$

$= \frac{4\times1.8}{9}\times10^{-18} = 0.8\times10^{-18} = 8\times10^{-19}$

40. A biconvex lens of focal length 15 cm is in front of a plane mirror. The distance between the lens and the mirror is 10 cm. A small object is kept at a distance of 30 cm from the lens. The final image is :

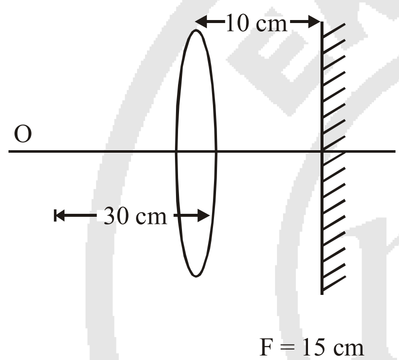
(a) virtual and at a distance of 16 cm from the mirror

(b) real and at a distance of 16 cm from the mirror

(c) virtual and at a distance of 20 cm from the mirror

(d) real and at a distance of 20 cm from the mirror

Sol. (b)



Lens

$$\frac{1}{v}+\frac{1}{30}=\frac{1}{15}$$

$$\frac{1}{v}=\frac{1}{15}-\frac{1}{30}=\frac{1}{30}$$

$$v = 30\,cm$$

$\therefore$ virton object for mirror. Image will be at 20 cm from mirror toward left. i.e. virtnd object for lens at 10 cm

$$\frac{1}{v}-\frac{1}{10}=\frac{1}{15}$$

$$\frac{1}{v}=\frac{1}{10}+\frac{1}{15}=\frac{3+2}{30}$$

$$\Rightarrow v = 6\,cm$$

41. A Vernier calipers has 1 mm marks on the main scale. It has 20 equal divisions on the Vernier scale which match with 16 main scale divisions. For this Vernier calipers, the least count is :

(a) 0.02 mm (b) 0.05 mm

(c) 0.1 mm (d) 0.2 mm

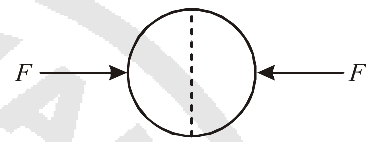
Sol. (d)

$$LC = 1MSD - 1VSD$$

$$= 1mm - \frac{16}{20}mm$$

$$= 1 - 0.8 = 0.2mm$$

42. A uniformly charged thin spherical shell of radius R carries uniform surface charge density of σ per unit area. It is made of two hemispherical shells, held together by pressing them with force F (see figure). F is proportional to



(a) $\frac{1}{\varepsilon_o}\sigma^2R^2$ (b) $\frac{1}{\varepsilon_o}\sigma^2R$

(c) $\frac{1}{\varepsilon_o}\frac{\sigma^2}{R}$ (d) $\frac{1}{\varepsilon_o}\frac{\sigma^2}{R^2}$

Sol. (a) $F\alpha\frac{Q_1Q_2}{\in_0 R^2} = \frac{(\sigma4\pi R^2)^2}{\in_0 R^2} = \frac{\sigma^2R^2}{\in_0}$

[check dimensions]

43. A hollow pipe of length 0.8 m is closed at one end. At its open end a 0.5 m long uniform string is vibrating in its second harmonic and it resonates with the fundamental frequency of the pipe. If the tension in the wire is 50 N and the speed of sound is 320 ms^{-1}, the mass of the string is :

(a) 5 grams (b) 10 grams

(c) 20 grams (d) 40 grams

Sol. (b)

$$\frac{320}{4\times0.8}=\frac{2}{2\times0.5}\sqrt{\frac{50}{\mu}}$$

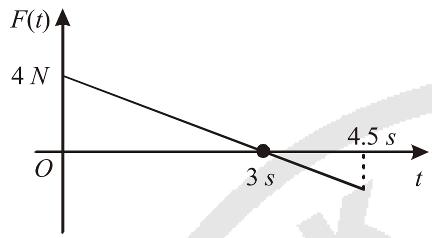
$$\Rightarrow 50 = \sqrt{\frac{50}{\mu}}$$

$$\Rightarrow \mu = \frac{1}{50}kg/m$$

$\therefore$ mass of string $= 0.5\times\frac{1}{50}\times100\,gm$

$= 10\, gm$

44. A block of mass 2 kg is free to move along the x-axis. It is at rest and from t = 0 onwards it is subjected to a time-dependent force F(t) in the x direction. The force F(t) varies with t as shown in the figure. The kinetic energy of the block after 4.5 seconds is :



(a) 4.50 J (b) 7.50 J
(c) 5.06 J (d) 14.06 J

Sol. (c) $\Delta P = \frac{1}{2}\times 3\times 4 - \frac{1}{2}\times 1.5\times 2$

$= 6 - 1.5 = 4.5\, kg\, m/s$

$\therefore P = 4.5\, kg\, m/s$

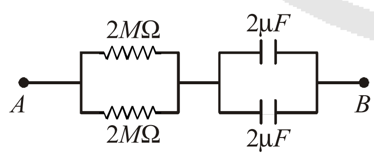
$K = \frac{P^2}{2m} = \frac{4.5\times 4.5}{2\times 2} = 5.06\, J$

Intege type

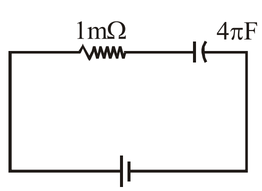
QUESTIONS WITH INTEGER TYPE

45. At time t = 0, a battery of 10 V is connected across points A and B in the given circuit. If the capacitors have no charge initially, at what time (in seconds) does the voltage across them become 4 V ?

[Take : $\ell n\ 5 = 1.6,\ \ell n\ 3 = 1.1$]



Sol. (2)



$q = q_0(1 - e^{-t/\tau})$

$\Rightarrow v = v_0(1 - e^{-t/\tau})$

$\Rightarrow 4 = 10\left[1 - e^{-t/4}\right]$

$\Rightarrow e^{-t/4} = 0.6$

$\Rightarrow \frac{t}{4} = \ln 5 - \ln 3 = 0.5$

$t = 2$

46. A diatomic ideal gas is compressed adiabatically to 1/32 of its initial volume. In the initial temperature of the gas is T_i (in Kelvin) and the final temperature is aT_i, the value of a is :

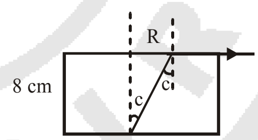
Sol. (4) $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$\Rightarrow T_1 = T_2\left(\frac{1}{32}\right)^{\frac{2}{5}}$

$\Rightarrow T_2 = 4T_1$

47. A large glass slab $(\mu = 5/3)$ of thickness 8 cm is placed over a point source of light on a plane surface. It is seen that light emerges out of the top surface of the slab from a circular area of radius R cm. What is the value of R ?

Sol. (6)



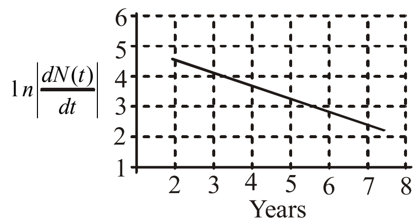
$\sin c = \frac{1}{\mu} = \frac{3}{5}$

$\Rightarrow \tan c = \frac{3}{4}$

$\Rightarrow \frac{R}{8} = \frac{3}{4}$

$\Rightarrow R = 6\, cm$

48. To determine the half life of a radioactive element, a student plots a graph of $\ell n\left|\frac{dN(t)}{dt}\right|$ versus t. Here $\frac{dN(t)}{dt}$ is the rate of radioactive decay at time t. If the number of radioactive nuclei of this element decreases by a factor of p after 4.16 years, the value of p is :



Sol. (8)

$$N = N_0 e^{-\lambda t} \Rightarrow -\frac{dN}{dt} = N_0 \lambda e^{-\lambda t}$$

$$\Rightarrow \ln\left|\frac{dN}{dt}\right| = \ln(N_0\lambda) - \lambda t$$

Slope of the graph is

$$-\lambda = -\frac{1}{2} \Rightarrow \lambda = 1/2\, yr^{-1}$$

$$\therefore \frac{N}{N_0} = e^{-\lambda t} = e^{-\frac{1}{2}\times 4.16} = e^{-2.08}$$

$$\therefore P = e^{2.08} = 8$$

49. Image of an object approaching a convex mirror of radius of curvature 20 m along its optical axis is observed to move from $\frac{25}{3}$ m to $\frac{50}{7}$ m in 30 seconds. What is the speed of the object in km per hour ?

Sol. (3)

For $v = \frac{25}{3} m, f = +10$

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

$$\frac{3}{25} + \frac{1}{u} = \frac{1}{10}$$

$$\frac{1}{u} - \frac{1}{10} - \frac{3}{25} = \frac{25-30}{10\times 25} = \frac{-5}{10\times 25} = -\frac{1}{50}$$

$$\Rightarrow u_1 = -50$$

Simillarly,

$$\frac{1}{u} = \frac{1}{10} - \frac{7}{50} - \frac{7}{50} = \frac{50-70}{10\times 50} = \frac{-20}{10\times 50} = -\frac{1}{25}$$

$$\Rightarrow u_2 = -25$$

Object distance $25m$ in $30\ \sec 80$ speed of object will be $\frac{25}{30}\times\frac{18}{5} = 3\, km/h$

QUESTIONS WITH COMPREHENSION TYPE

Paragraph For Questions 50 to 52

The key feature of Bohr's theory of spectrum of hydrogen atom is the quantization of angular momentum when an electron is revolving around a proton. We will extend this to a general rotational motion to find quantized rotational energy of a diatomic molecule assuming it to be rigid. The rule to be applied is Bohr's quantization condition.

50. A diatomic molecule has moment of inertia I. By Bohr's quantization condition its rotational energy in the nth level (n = 0 is not allowed) is

(a) $\frac{1}{n^2}\left(\frac{h^2}{8\pi^2 I}\right)$ (b) $\frac{1}{n}\left(\frac{h^2}{8\pi^2 I}\right)$

(c) $n\left(\frac{h^2}{8\pi^2 I}\right)$ (d) $n^2\left(\frac{h^2}{8\pi^2 I}\right)$

Sol. (d)

$$I\omega = n\frac{h}{2\pi}$$

$$\omega = \frac{nh}{2\pi I}$$

$$\therefore = \frac{1}{2} I\omega^2 = \frac{1}{2} I \frac{n^2h^2}{2\pi^2 I^2} = \frac{n^2h^2}{8\pi^2 I}$$

51. It is found that the excitation frequency from ground to the first excited state of rotation for the CO molecule is close to $\frac{4}{\pi}\times 10^{11} Hz$. Then the moment of inertia of CO molecule about its center of mass is close to (Take $h = 2\pi\times 10^{-34} J\, s$)

(a) $2.76\times 10^{-46} kg\, m^2$ (b) $1.87\times 10^{-46} kg\, m^2$

(c) $4.67\times 10^{-47} kg\, m^2$ (d) $1.17\times 10^{-47} kg\, m^2$

Sol. (b) $hv = (2^2 - 1^2)\,\dfrac{h^2}{8\pi^2 I}$

$$\Rightarrow I = \frac{3h}{8\pi v} = \frac{3\times 2\pi\times 10^{-34}}{8\times\pi^2\times\frac{4}{\pi}\times 10^{11}}$$

$$= \frac{3\times 10^{-45}}{16} = 0.187\times 10^{-45}$$

$$= 1.87\times 10^{-46}\ kgm^2$$

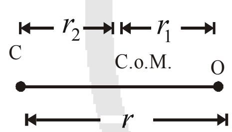
$$= 1.87\times 10^{-46}\ kgm^2$$

52. In a CO molecule, the distance between C (mass = 12 a.m.u.) and O (mass = 16 a.m.u.), where 1 a.m.u. $=\frac{5}{3}\times 10^{-27}\,kg$, is close to :

(a) $2.4\times 10^{-10}\,m$ (b) $1.9\times 10^{-10}\,m$

(c) $1.3\times 10^{-10}\,m$ (d) $4.4\times 10^{-10}\,m$

Sol. (c)



$$r_1 = \frac{12}{28}r = \frac{3}{7}r$$

$$r_2 = \frac{16}{28}r = \frac{7}{4}r$$

$$m_0 r_1^2 + m_c r_2^2 = I$$

$$\left[16\times\left(\frac{3}{7}\right)^2 + 12\times\left(\frac{4}{7}\right)^2\right] r^2\times\frac{5}{3}\times 10^{-27} = 1.87\times 10^{-46}$$

$$\Rightarrow r^2 = \frac{1.87\times 49\times 3\times 10^{-19}}{5\times 336}$$

$$= 0.163\times 10^{-19} = 1.63\times 10^{-20}$$

$$\Rightarrow r = 1.28\times 10^{-10}$$

Paragraph For Questions 53 to 55

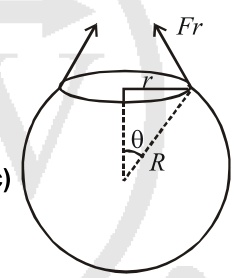
When liquid medicine of density ρ is to be put in the eye, it is done with the help of a dropper. As the bulb on the top of the dropper is pressed, a drop forms at the opening of the dropper. We wish to estimate the size of the drop. We first assume that the drop formed at the opening is spherical because that requires a minimum increase in its surface energy. To determine the size, we calculate the net vertical force due to the surface tension T when the radius of the drop is R. When this force becomes smaller than the weight of the drop, the drop gets detached from the dropper.

53. If the radius of the opening of the dropper is r, the vertical force due to the surface tension on the drop of radius R (assuming r<<R) is :

(a) $2\pi rT$ (b) $2\pi RT$

(c) $\dfrac{2\pi r^2 T}{R}$ (d) $\dfrac{2\pi R^2 T}{r}$

Sol. (c)



Net vertically upward force

$$\Rightarrow 2\pi rT\left(\frac{r}{R}\right) = \frac{2\pi r^2 T}{R}$$

54. If $r = 5\times 10^{-4}\,m$, $\rho = 10^3\,kgm^{-3}$, $g = 10ms^{-2}$, $T = 0.11Nm^{-1}$, the radius of the drop when it detaches from the dropper is approximately

(a) $1.4\times 10^{-3}\,m$ (b) $3.3\times 10^{-3}\,m$

(c) $2.0\times 10^{-3}\,m$ (d) $4.1\times 10^{-3}\,m$

Sol. (a) $\dfrac{2\pi r^2 T}{R} = \dfrac{4}{3}\pi R^3\rho .g$

$$R^4 = \frac{3r^2 T}{2\rho g} = \frac{3\times 25\times 10^{-8}\times 0.11}{2\times 10^3\times 10}$$

$$\Rightarrow R \simeq 1.42\times 10^{-3}\,m$$

55. After the drop detaches, its surface energy is

(a) $1.4\times10^{-6}J$ (b) $2.7\times10^{-6}J$

(c) $5.4\times10^{-6}J$ (d) $8.1\times10^{-6}J$

Sol. (b)

$$E = 4\pi R^2T = 4\times3.14\times(1.42\times10^{-3})^2\times0.11$$
$$=2.7\times10^{-6}J$$

QUESTIONS WITH MATRIX MATCH TYPE

56. You are given may resistances, capacitors and inductors. These are connected to a variable DC voltage source (the first two circuits) or an AC voltage source of 50 Hz frequency (the next three circuits) in different ways as shown in **Column II**. When a current I (steady state for DC or rms for AC) flows through the circuit, the corresponding voltage V_1 and V_2. (indicated in circuits) are related as shown in **Column I**. Match the two

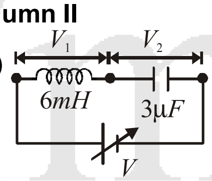
Column I / **Column II**

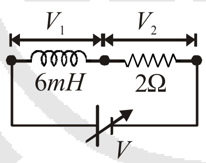
(A) $I\neq0, V_1$ is proportional to I

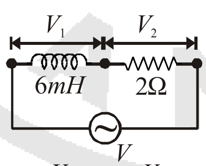
(B) $I\neq0, V_2>V_1$

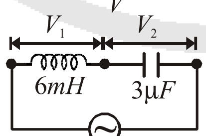
(C) $V_1=0, V_2=V$

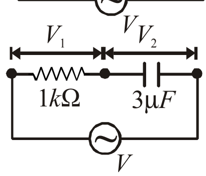
(D) $I\neq0, V_2$ is proportional to I

(p)


(q)


(r)


(s)


(t)


Sol.

(a) $\rightarrow$ r,s,t
(b) $\rightarrow$ q,r,s,t
(c) $\rightarrow$ p,q
(d) $\rightarrow$ q,r,s,t

57. Two transparent media of refractive indices μ_1 and μ_3 have a solid lens shaped transparent material of refractive index μ_2 between them as shown in figures in **Column II**. A ray traversing these media is also shown in the figures. In **Column I** different relationships between μ_1, μ_2 and μ_3 are given. Match them to the ray diagrams shown in **Column II**.

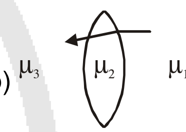
Column I / **Column II**

(A) $\mu_1<\mu_2$

(B) $\mu_1>\mu_2$

(C) $\mu_2=\mu_3$

(D) $\mu_2>\mu_3$

(p)


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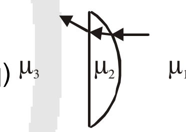

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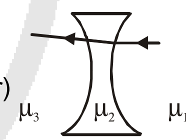

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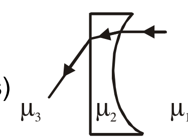
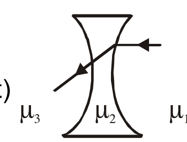


(t)


Sol.

(a) $\rightarrow$ p,r,
(b) $\rightarrow$ q,s,t
(c) $\rightarrow$ p,r,t
(d) $\rightarrow$ q,s