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MATHEMATICS **Max Marks: 100**

SECTION-I
(SINGLE CORRECT ANSWER TYPE)

This section contains **20 Multiple Choice Questions.** Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

1. Two distinct numbers a and b are selected at random from 1,2,3,…..,50. The probability, that their product ab is divisible by 3, is

1) $\frac{664}{1225}$ 2) $\frac{272}{1225}$ 3) $\frac{561}{1225}$ 4) $\frac{8}{25}$

Key : 1

Sol : $3k \to 16$

$$\left.\begin{matrix}3k+1\\3k+2\end{matrix}\right\} \to 34$$

$$n(E) = 16 \times 34 + {}^{16}C_2$$

$$= 664$$

$$n(S) = {}^{50}C_2 = 1225$$

$$P(E) = \frac{664}{1225}$$

2. Let the solution curve of the differential equation

$xdy - ydx = \sqrt{x^2+y^2}\,dx, x > 0, y(1) = 0$, *be* $y = y(x)$. Then $y(3)$ is equal to

1)1 2)2 3)4 4)6

Key : 3

Sol : $xdy - ydx = \sqrt{x^2+y^2}\,dx$

$$\frac{xdy - ydx}{x^2} = \frac{\sqrt{x^2+y^2}}{x^2}dx$$

$$\int \frac{d(y/x)}{\sqrt{1+(y/x)^2}} = \int \frac{1}{x}dx$$

$$\log\left(\frac{y}{x}+\sqrt{1+\left(\frac{y}{x}\right)^2}\right) = \log x + \log C$$

$$y+\sqrt{x^2+y^2} = x^2$$

$$y-\sqrt{x^2+y^2} = -1$$

$$2y = x^2-1$$

$$y(3) = 4$$

3. The value of $\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}} \left(\frac{1}{[x]+4}\right)dx,$ where [.] denotes the greatest integer function, is

1) $\frac{1}{60}(\pi-7)$ 2) $\frac{7}{60}(3\pi-1)$ 3) $\frac{7}{60}(\pi-3)$ 4) $\frac{1}{60}(21\pi-1)$

Key :2

Sol : $\int_{-\frac{\pi}{2}}^{-1} \frac{1}{2}dx + \int_{-1}^{0} \frac{1}{3}dx + \int_{0}^{1} \frac{1}{4}dx + \int_{1}^{\frac{\pi}{2}} \frac{1}{5}dx$

$$= \frac{21\pi-7}{60} = \frac{7}{60}(3\pi-1)$$

4. Let $P(\alpha,\beta,\gamma)$ be the point on the line $\frac{x-1}{2} = \frac{y+1}{-3} = z$ at distance $4\sqrt{14}$ from the point $(1,-1,0)$ and nearer to the origin. Then the shortest distance, between the line $\frac{x-\alpha}{1} = \frac{y-\beta}{2} = \frac{z-\gamma}{3}$ and $\frac{x+5}{2} = \frac{y-10}{1} = \frac{z-3}{1}$, is equal to

1) $4\sqrt{\frac{5}{7}}$ 2) $7\sqrt{\frac{5}{4}}$ 3) $2\sqrt{\frac{7}{4}}$ 4) $4\sqrt{\frac{7}{5}}$

Key : 4

Sol : $\frac{x-1}{2}=\frac{y+1}{-3}=\frac{z}{1}=t$

$(1+2t,-1-3t,t)$

$4t^2+9t^2+t^2=16\times14$

$t=\pm4$

Points are $(9,-13,4),(-7,11,-4)$

$(\alpha,\beta,\gamma)=(-7,11,-4)$

$\bar{a}=(-7,11,-4),\bar{c}=(-5,10,3)$

$\bar{c}-\bar{a}=(2,-1,7)$

$b\times d=(-1,5,-3)$

$S.D=\left|\frac{-2-5-21}{\sqrt{1+25+9}}\right|=\frac{28}{\sqrt{35}}$

5. Let $f(x)=x^{2025}-x^{2000},x\in[0,1]$ and the minimum value of the function $f(x)$ in the interval $[0,1]$ be $(80)^{80}(n)^{-81}$. Then n is equal to

1) -80 2) -40 3) -81 4) -41

Key :3

Sol : $f(x)=x^{2025}-x^{2000};x\in[0,1]$

$f'(x)=2025x^{2024}-200x^{1999}$

$=x^{1999}\left(2025x^5-2000\right)$

$f'(x)=0\Rightarrow x^5=\frac{80}{81}$

$f(x)=\left(x^5\right)^{81}-\left(x^5\right)^{80}$

$=\left(\frac{80}{81}\right)^{81}-\left(\frac{80}{81}\right)^{80}$ $=\left(\frac{80}{81}\right)^{80}\left(-\frac{1}{81}\right)$

$=(80)^{80}(-81)^{-81}$

6. The number of distinct real solutions of the equation $x|x+4|+3|x+2|+10=0$ is

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

Key : 1

Sol : If

$x<-4:$

$-x(x+4)-3(x+2)+10=0$

$x^2+7x-4=0$

$x=\frac{-7\pm\sqrt{65}}{2}$

$-4<x<-2:$

$x(x+4)-3(x+2)+10=0$

$x^2+x+4=0$

$\Delta<0$

$x>-2$

$x(x+4)+3(x+2)+10=0$

$x^2+7x+16=0$

$\Delta<0$

7. The coefficient of x^{48} in $(1+x)+2(1+x)^2+3(1+x)^3+...+100(1+x)^{100}$ is equal to

1) ${}^{100}C_{50}+{}^{101}C_{49}$ 2) $100.{}^{100}C_{49}-{}^{101}C_{50}$

3) $100.{}^{101}C_{49}-{}^{100}C_{50}$ 4) $100.{}^{100}C_{49}-{}^{100}C_{48}$

Key : 3

Sol : $S=(1+x)+2(1+x)^2+3(1+x)^3+...+100(1+x)^{100}$

$(1+x)S=(1+x)^2+...+99(1+x)^{100}+100(1+x)^{101}$

$-xS=(1+x)\left(\frac{(1+x)^{100}-1}{x}\right)-100(1+x)^{101}$

$S=\left(\frac{(1+x)-(1+x)^{101}}{x^2}\right)+\frac{100(1+x)^{101}}{x}$

Coeff of $x^{48}=-{}^{101}C_{50}+100\times{}^{(101)}C_{49}$

8. If the image of the points $P(1,2,a)$ in the line $\frac{x-6}{3}=\frac{y-7}{2}=\frac{7-z}{2}$ is $Q(5,b,c)$, then $a^2+b^2+c^2$ is equal to

1)264 2)298 3)283 4)293

Key : 2

Sol : $P(1,2,a)$, $Q(5,b,c)$ $\frac{x-6}{3}=\frac{y-7}{2}=\frac{7-z}{2}$

$PQ \perp line$

$PQ(4,b-2,c-a)$

$3(4)+2(b-2)-2(c-a)=0$

$a-c=-12$

$a=3, c=15, b=8$

$a^2+b^2+c^2=9+64+225=298$

9. Let relation R on the set $M=\{1,2,3,....,16\}$ be given by $R=\{(x,y):4y=5x-3, x,y\in M\}$ Then the minimum number of elements required to be added in R, in order to make the relation symmetric, is equal to

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

Key : 4

Sol : $M=\{1,2,3....16\}$

$R=\{(x,y)/4y=5x-3, x,y\in N\}$

$4y=5x-3$

$y=\frac{5x-3}{4}$

No of order pairs =4

10. If the line $\alpha x+2y=1$, where $\alpha\in R$, does not meet the hyperbola $x^2-9y^2=9$, then a possible value of α is :

1)0.6 2)0.7 3)0.5 4)0.8

Key : 4

Sol : $\alpha x+2y=1, \alpha\in R$

$x^2-9y^2=9$

$y=\frac{1-\alpha x}{2}$

$4x^2-9\left(1+\alpha^2x^2-2\alpha x\right)=36$

$\Delta<0$

$1620\alpha^2-720>0$

$\alpha^2>0.55$

$\alpha=0.8$

11. If the domain of the function $f(x)=\sin^{-1}\left[\frac{5-x}{3+2x}\right]+\frac{1}{\log_e(10-x)}$ is $(-\infty,\alpha]\cup[\beta,\gamma)-\{\delta\}$, then $6(\alpha+\beta+\gamma+\delta)$ is equal to

1)66 2)67 3)68 4)70

Key : 4

Sol : $f(x)=\sin^{-1}\left[\frac{5-x}{3+2x}\right]+\frac{1}{\log_e(10-x)}$

$-1\le\frac{5-x}{3+2x}\le1$

$\frac{2-3x}{3+2x}\le0$

$(3x-2)(2x+3)\ge0$

$(3x-2)(2x+3)\ge0 x\in\left(-\infty,-\frac{3}{2}\right]\cup\left[\frac{2}{3},\infty\right)$

$\frac{8+x}{3+2x}\ge0$

$x\in\left(-\infty,-8\right]\cup\left[\frac{-3}{2},\infty\right)$

$x\in\left(-\infty,-8\right]\cup\left[\frac{2}{3},10\right)-\{9\}=6(\alpha+\beta+\gamma+\delta)=70$

12. Let the line $x=-1$ divided the area of the region $\{(x,y):1+x^2\le y\le3-x\}$ in the ratio $m:n$, $\gcd(m,n)=1$. Then $m+n$ is equal to

1) 28 2) 25 3) 26 4) 27

Key : 4

Sol : $m=\int_{-2}^{-1}(3-x)-\left(1+x^2\right)dx$

$m = 2 + \frac{3}{2} - \frac{7}{3} = \frac{7}{6}$ $M = \int_{-1}^{1} (3-x) - \left(1+x^2\right) dx = 4 - \frac{1}{2}(0) - \frac{1}{3}(1+1) = 4 - \frac{2}{3} = \frac{10}{3}$

$m : M = \frac{7}{6} : \frac{10}{3} = \frac{7}{20}$

$m + n = 27$

13. Let $\overline{AB} = 2i + 4j - 5k$ and $\overline{AD} = i + 2j + \lambda k, \lambda \in R$. Let the projection of the vector $\bar{v} = i + j + k$ on the diagonal $\overline{AC}$ of the parallelogram $ABCD$ be of length one unit .If α, β ,where $\alpha > \beta$, be the roots of equation $\lambda^2 x^2 - 6\lambda x + 5 = 0$ then $2\alpha - \beta$ is equal to

1) 4 2) 3 3) 6 4) 1

Key : 2

Sol : $\overline{AB} = 2\bar{i} + 4\bar{j} - 5\bar{k}$

$\overline{AD} = \bar{i} + 2\bar{j} + \lambda\bar{k}$

$\bar{V} = \bar{i} + \bar{j} + \bar{k}$

$\frac{\bar{V}.\overline{AC}}{\left|\overline{AC}\right|} = 1$

$\overline{AC} = \overline{AB} + \overline{BC}$

$18\lambda = 54$

$18\lambda = 54$

14. If the sum of the first term of an A.P. is 6 and the sum of its first six terms is 4, then the sum of its first twelve terms is

1)-26 2)-24 3)-20 4)-22

Key : 4

Sol : $a + (a+d) + (a+2d) + (a+3d) = 6$

$2a + 3d = 3$

$6a + 15d = 4$

$d = -5/6$

$a = 11/4$

$S_{12} = \frac{12}{2}\left[2\left(\frac{11}{4}\right) + 11 \times (-5/6)\right] = -22$

15. If random variable x has the probability distribution

x	0	1	2	3	4	5	6	7

$P(x)$	0	$2k$	k	$3k$	$2k^2$	$2k$	k^2+k	$7k^2$

Then $P(3<x\le 6)$ is equal to

1) 0.22 2) 0.33 3) 0.64 4) 0.34

Key :2

Sol : $2K+K+3K+2K^2+2K+K^2+K+7K^2=1$

$(K+1)(10K-1)=0$

$K=-1 \text{ or } K=\frac{1}{10}$

$P(3<x\le 6)=\frac{2}{100}+\frac{2}{10}+\frac{1}{100}+\frac{1}{10}=0.33$

16. Let the set of all values of r, for which the circle $(x+1)^2+(y+4)^2=r^2$ and $x^2+y^2-4y-2y-4=0$ intersect at two distinct points be the interval (α,β). Then $\alpha\beta$ is equal to

1) 20 2) 25 3) 24 4) 21

Key : 2

Sol : $|r_1-r_2|<c_1c_2<r_1+r_2$

$r-3<\sqrt{9+25}<r+3$

$r\in\left(\sqrt{34}-3,\sqrt{34}+3\right)$

$\alpha\beta=25$

17. If the chord joining the points $P_1(x_1,y_1)$ and $P_2(x_2,y_2)$ on the parabola $y^2=12x$ subtends a right angle at the vertex of the parabola , then $x_1x_2-y_1y_2$ is equal to

1) 284 2) 280 3) 292 4) 288

Key : 4

Sol : $P\left(at_1^2,2at_1\right),Q\left(at_2^2,2at_2\right)$

$\therefore t_1t_2=-4, a=3$

$x_1x_2-y_1y_2=a^2\times(t_1t_2)^2-4a^2t_1t_2=288$

18. The number of solutions of $\tan^{-1}4x+\tan^{-1}6x=\frac{\pi}{6}$, where $-\frac{1}{2\sqrt{6}}<x<\frac{1}{2\sqrt{6}}$, equal to

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

Key : 1

Sol : $\tan^{-1}4x+\tan^{-1}6x=\frac{\pi}{6}$

$$\tan^{-1}\left(\frac{10x}{1-24x^2}\right)=\frac{\pi}{6}$$

$$24x^2+10\sqrt{3}x-1=0$$

$$x=\frac{-5\sqrt{3}\pm 3\sqrt{14}}{24}$$

19. If $A=\begin{pmatrix}2 & 3\\ 3 & 5\end{pmatrix}$ then the determinant of the matrix $(A^{2025}-3A^{2024}+A^{2023})$ is

1)28 2)12 3)16 4)24

Key : 3

Sol : $A=\begin{pmatrix}2 & 3\\ 3 & 5\end{pmatrix}, |A|=1$

$$\left|A^{2025}-3A^{2024}+A^{2023}\right|=\left|A^{2023}\right|\left|A^2-3A+I\right|=16$$

20. Let $f:[1,\infty)\to R$ be a differentiable function . *If* $6\int_1^x f(t)dt=3xf(x)+x^3-4$

For all $x\geq 1$, then the value of $f(2)-f(3)$ is

1) -4 2) -3 3) 3 4) 4

Key : 3

Sol : $6\int_1^x f(t)dt=3xf(x)+x^2-4$

By using leibnz rule

$$6f(x)=3f(x)+3xf'(x)+3x^2$$

$$\frac{f(x)-xf'(x)}{x^2}=1$$

$$\frac{d}{dx}\left(\frac{f(x)}{x}\right)=-1 \; f(x)=-x^2+kx$$

$1=-1+k$ (since $f(1)=1$)

$f(x)=-x^2+2x$

$f(2)-f(3)=3$

SECTION-II
(NUMERICAL VALUE TYPE

This section contains 5 Numerical Value Type Questions. The Answer should be within 0 to 9999. If the Answer is in Decimal then round off to the Nearest Integer value (Example i,e. If answer is above 10 and less than 10.5 round off is 10 and If answer is from 10.5 and less than 11 round off is 11).

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases.

21. Let $\alpha=\frac{-1+i\sqrt{3}}{2}$ and $\beta=\frac{-1-i\sqrt{3}}{2}, i=\sqrt{-1}$. If

$(7-7\alpha+9\beta)^{20}+(9+7\alpha-7\beta)^{20}+(-7+9\alpha+7\beta)^{20}+(14+7\alpha+7\beta)^{20}=m^{10}$,

Then m is_____

Key :49

Sol : $Z=(7-7\alpha+9\beta)^{20}+(9+7\alpha-7\beta)^{20}+(-7-9\alpha+7\beta)^{20}+(14+7\alpha+7\beta)^{20}$

$=\alpha^{20}(7\beta-7+9\alpha)^{20}+\beta^{20}(-7+9\alpha+7\beta)^{20}+(-7+9\alpha+7\beta)^{20}+7^{20}$

$=(-7+9\alpha+7\beta)^{20}(0)+7^{20}$

$m^{10}=7^{20}$

$m=49$

22. Let A be a 3×3 matrix such that $A+A^T=0$. If $A\begin{bmatrix}1\\-1\\0\end{bmatrix}=\begin{bmatrix}3\\3\\2\end{bmatrix}, A^2\begin{bmatrix}1\\-1\\0\end{bmatrix}=\begin{bmatrix}-3\\19\\24\end{bmatrix}$

and $\det(adj(2adj(A+I)))=(2)^{\alpha}.(3)^{\beta}.(11)^{\gamma}, \alpha,\beta,\gamma$ are nonnegative integers, then $\alpha+\beta+\gamma$ is equal to _____

Key : 18

Sol : $A=-A^T$

$$A=\begin{bmatrix}0 & \alpha & \beta\\ -\alpha & 0 & \gamma\\ -\beta & -\gamma & 0\end{bmatrix}$$

$$\begin{bmatrix}0 & \alpha & \beta\\ -\alpha & 0 & \gamma\\ -\beta & -\gamma & 0\end{bmatrix}\begin{bmatrix}1\\ -1\\ 0\end{bmatrix}=\begin{bmatrix}3\\ 3\\ 2\end{bmatrix}$$

$\alpha=-3,-\beta+\gamma=2$

$$\begin{bmatrix}0 & \alpha & \beta\\ -\alpha & 0 & \gamma\\ -\beta & -\gamma & 0\end{bmatrix}\begin{bmatrix}3\\ 3\\ 2\end{bmatrix}=\begin{bmatrix}-3\\ 19\\ -24\end{bmatrix}$$

$\beta=3$

$$|A+I|=\begin{vmatrix}1 & -3 & 3\\ 3 & 1 & 5\\ -3 & -5 & 1\end{vmatrix}=44$$

$$\det(adj(2adj(A+I)))=2^6\det\left(adj\left(adj\left(A+I\right)\right)\right)=2^6\left(44\right)^4=2^{14}\times11^4$$

23. Let ABC be a triangle .Consider four points $p_1,p_2,p_{3,}p_4$ on the side AB, five points $p_{5,}p_6,p_7,p_{8,}p_9$ on the side BC, and four points $p_{10},p_{11},p_{12},p_{13}$ on the side AC, None of these points is a vertex of the triangle ABC.Then the total number of pentagons , that can be formed by taking all the vertices from the points $p_1,p_2,..,p_{13,}$

is_____

Key : 660

Sol : ${}^4C_2.{}^5C_2.{}^4C_1+{}^4C_2.{}^5C_2.{}^4C_1+{}^4C_2.{}^4C_2.{}^5C_1=240+240+180=660$

24. If $\dfrac{\cos^2 48^0-\sin^2 12^0}{\sin^2 24^0-\sin^2 6^0}=\dfrac{\alpha+\beta\sqrt{5}}{2}$,where $\alpha,\beta\in N,$ then $\alpha+\beta$ is equal to

_____

Key :4

Sol : $\dfrac{\cos60^0\cos36^0}{\sin30^0.\sin18^0}=\dfrac{\sqrt{5}+1}{4}.\dfrac{4}{\sqrt{5}-1}=\dfrac{3+\sqrt{5}}{2}$

$\alpha+\beta=4$

25. If $\int (\sin x)^{\frac{-11}{2}} (\cos x)^{\frac{-5}{2}} dx = -\frac{p_1}{q_1}(\cot x)^{\frac{9}{2}} - \frac{p_2}{q_2}(\cot x)^{\frac{5}{2}} - \frac{p_3}{q_3}(\cot x)^{\frac{1}{2}} + \frac{p_4}{q_4}(\cot x)^{\frac{-3}{2}} + C$, where p_i and q_j are positive integers with gcd $(p_i, q_i) = 1$ for $i = 1,2,3,4$ and C is the constant of integration, then $\frac{15 p_1 p_2 p_3 p_4}{q_1 q_2 q_3 q_4}$ is equal to_____

Key : 16

Sol : $\int (\sin x)^{\frac{-11}{2}} (\cos x)^{\frac{-5}{2}} dx = \int \frac{1}{Tan^{11/2} x}.\sec^8 x dx = \int \frac{\left(1+Tan^2 x\right)^3 \sec^2 x}{Tan^{11/2} x} dx$

$put\, Tanx = t$

$\frac{15 p_1 p_2 p_3 p_4}{q_1 q_2 q_3 q_4} = \frac{15(2\times 6\times 6\times 2)}{9\times 5\times 1\times 3} = 16$

PHYSICS

Max Marks: 100

SECTION-I
(SINGLE CORRECT ANSWER TYPE)

This section contains 20 Multiple Choice Questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

26. The volume of an ideal gas increases 8 times and temperature becomes $(1/4)^{th}$ of initial temperature during a reversible change. If there is no exchange of heat in this process $(\Delta Q = 0)$ then identify the gas from the following options (Assuming the gases given in the options are ideal gases):

1) NH_3 2) He 3) O_2 4) CO_2

Key : 2

Sol : $TV^{\gamma-1} = const;$

$\gamma = 1 + \frac{2}{f};$

$f = 3$

27. A solid sphere of mass 5 kg and radius 10 cm is kept in contact with another solid sphere of mass 10 kg and radius 20 cm. The moment of inertia of this pair of spheres about the tangent passing through the point of contact is ____ kgm^2.

1) 0.18 2) 0.36 3) 0.63 4) 0.72

Key : 3

Sol : $I = \frac{7}{5}\left(M_1R_1^2 + M_2R_2^2\right)$

28. A Projectile is thrown upward at an angle 60° with the horizontal. The speed of the projectile is 20 m/s when its direction of motion is 45° with the horizontal. The initial speed of the projectile is ------ m/s

1) $20\sqrt{3}$ 2) $40\sqrt{2}$ 3) 40 4) $20\sqrt{2}$

Key : 4

Sol : $\frac{u}{2} = \frac{20}{\sqrt{2}}$

$u = 20\sqrt{2}$

29. Given below are two statements:

Statement I: Pressure of fluid is exerted only on a solid surface in contact as the fluid-Pressure does not exist everywhere in a still fluid .

Statement II: Excess potential energy of the molecules on the surface of a liquid. When compared to interior, results in surface tension.

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

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

Key : 3

Sol : Conceptual

30. Match the LIST-I with LIST-II

	List -I	**List-II**
A	Spring constant	I. $ML^2T^{-2}K^{-1}$
B	Thermal conductivity	II. $ML^\circ T^{-2}$
C	Boltzmann constant	III. $ML^2T^{-3}A^{-2}$
D.	Inductive reactance	IV. $MLT^{-3}K^{-1}$

Choose the correct answer from the options given below:

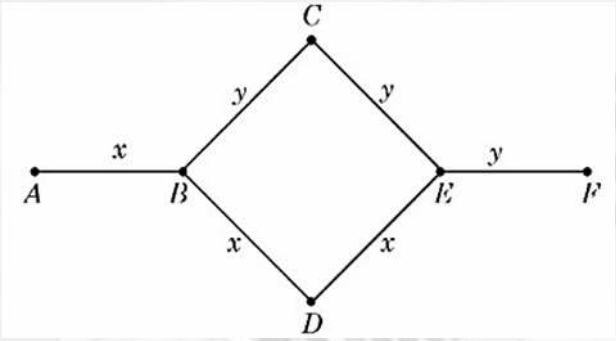
1) A-II,B-IV,C-I,D-III 2) A-III,B-II,C-IV,D-I

3) A-II, B-I,C-IV,D-III 4) A-I,B-IV,C-II,D-III

Key : 1

Sol : dimensional formula

31. Rods x and y of equal dimensions but of different materials are joined as shown in figure, Temperatures of end points A and F are maintained at $100^{\circ}C$ and $40^{\circ}C$ respectively . Given the thermal conductivity of rod x is three times of that of rod y, the temperature at junction points B and E are (close to):



1) $80^{\circ}C$ and $60^{\circ}C$ respectively 2) $80^{\circ}C$ and $70^{\circ}C$ respectively

3) $89^{\circ}C$ and $73^{\circ}C$ respectively 4) $60^{\circ}C$ and $45^{\circ}C$ respectively

Key : 3

Sol : $R=\frac{l}{KA}$

32. 7.9 MeV $\alpha-$particle scatters from a target material of atomic number 79. From the given data the estimated diameter of nuclei of the target material is (approximately) _____m.

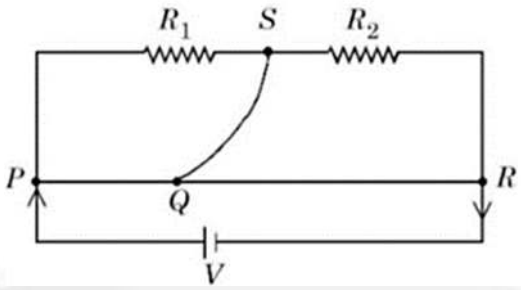
$\left|\frac{1}{4x\in_0}-9\times10^9\,Nm^2/C^2 and\ electron\ ch\arg e=1.6\times10^{-19}C\right|$

1) 1.69×10^{-12} 2) 2.88×10^{-14} 3) 5.76×10^{-14} 4) 1.44×10^{-13}

Key : 2

Sol : $\frac{Ze^2}{4\pi\in_0 R}=KE$

33. A meter bridge with two resistance $R_1 and\ R_2$ as shown in figure was balanced (null point) At $40\,cm$ from the point P. The null point changed to 50 cm from the point P, when 16Ω resistance is connected in parallel to R_2. The values of resistances R_1 and R_2 are_____



1) $R_2 = 4\Omega, R_1 = \frac{4}{3}\Omega$ 2) $R_2 = 8\Omega, R_1 = \frac{16}{3}\Omega$

3) $R_2 = 12\Omega, R_1 = \frac{12}{3}\Omega$ 4) $R_2 = 16\Omega, R_1 = \frac{16}{3}\Omega$

Key : 2

Sol : Meter bridge

34. The escape velocity from a spherical planet A is 10 km/s. The escape velocity from another planet B whose density and radius are 10% of those of planet A. Is _____ m/s.

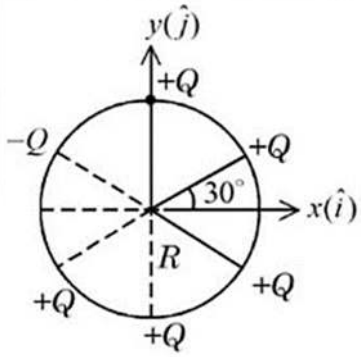
1) $1000\sqrt{2}$ 2) $100\sqrt{10}$ 3) $200\sqrt{5}$ 4) 1000

Key : 2

Sol : $\rho^1 = \frac{\rho}{10}$

$R^1 = \frac{R}{10}$

35. Six point charges are kept 60° apart from each other on the circumference of a circle of radius R as shown in figure. The net electric field at the center of the circle is _____



. ($\in_0$ *is permittivity of free space*)

1) $-\frac{Q}{4\pi \in_0 R^2}\left(\sqrt{3}\hat{i} - \hat{j}\right)$ 2) $\frac{Q}{4\pi \in_0 R^2}\left(\sqrt{3}\hat{i} - \hat{j}\right)$

3) $-\frac{5Q}{8\pi \in_0 R^2}\left(\hat{i} + \sqrt{3}\hat{j}\right)$ 4) $-\left(\frac{5Q}{8\pi \in_\circ R^2}\right)\left(\hat{i} - 3\hat{j}\right)$

Key : 2

Sol : $E=\dfrac{2Q}{4\pi\in_0 R^2}\left\{\cos 30^0 i-\sin 30^0 j\right\}$

36. Three identical coils C_1, C_2 and C_3 are closely placed such that they share a common axis, C_2 is exactly midway. C_1 carries current I in anti-clockwise direction while C_3 carries current I in clockwise direction . An induced current flows though C_2 will be in clockwise direction when

1) C_1 moves away from C_2 and C_3 moves towards C_2
2) C_1 moves towards C_2 and C_3 moves away from C_2
3) C_1 and C_3 move with equal speeds away from C_2
4) C_1 and C_3 move with equal speeds towards C_2

Key : 2

Sol : Conceptual

37. The minimum frequency of photon required to break a particle of mas 15.348 amu into $4\,\alpha$ particles is _____ kHz

$\left[mass\ \ of\ He\ nucleus=4.002\ amu, 1amu=1.66\times10^{-27}\ kg.h=6.6\times10^{-34}\ J.s\ \ and\ c=3\times10^{g}\ m/s\right]$

1) 14.94×10^{19} 2) 9×10^{19} 3) 14.94×10^{20} 4) 9×10^{20}

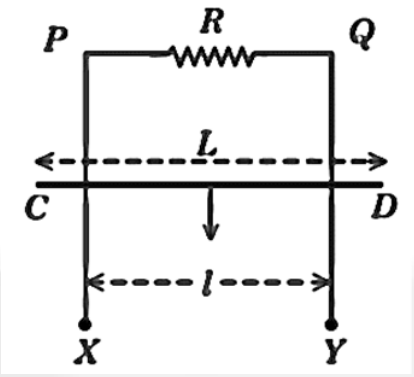
Key : 3

Sol : $\vartheta=\dfrac{149.04\times10^{-13}}{10^{-34}}$

$\vartheta=149.04\times10^{21}$

38. $XPQY$ is a vertical smooth long loop having a total resistance R where PX is parallel to QY and separation between them is $l.A$ constant magnetic field B perpendicular to the plane of the loop exists in the entire space.

A rod CD of length $L(L>l)$ and mass m is made to slide down from rest under the gravity as shown in figure. The terminal speed acquired by the rod is _____ $m/s.(g=acceleration\ due\ to\ gravity)$



1) $\frac{8mgR}{B^2l^2}$ 2) $\frac{mgR}{B^2l^2}$ 3) $\frac{2mgR}{B^2l^2}$ 4) $\frac{2mgR}{B^2l^2}$

Key : 2

Sol : $Mg = Bil$

39. A thin convex lens of focal length 5 cm and a thin concave lens of focal length 4 cm are combined together (without any gap) and this combination has magnification m_1 when an object is placed 10 cm before the convex lens. Keeping the positions of convex lens and object undisturbed a gap of 1 cm is introduced between the lenses by moving the concave lens away. Which lead to a change in magnification of total lens system to m_2.The value of $\left|\frac{m_1}{m_2}\right|$ is _____

1) $\frac{5}{27}$ 2) $\frac{25}{27}$ 3) $\frac{3}{2}$ 4) $\frac{5}{9}$

Key : $\frac{5}{6}$ not available in options

Sol : $m_2' = \frac{f_1}{u_2 + f_1}$

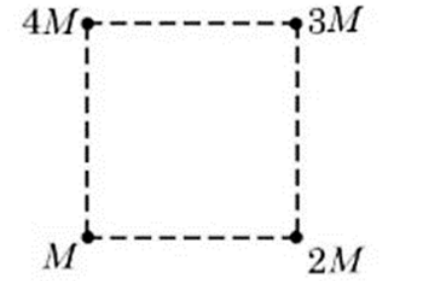
$m_2'' = \frac{f_2}{u_2' + f_2}$

$m_2 = m_2' \times m_2''$

$u_2 = -10cm, f_1 = +5cm, u_2' = 9cm, f_2 = -4cm$

40. Net gravitational force at the center of a square is found to be F_1 when four particles having mass M,2M,3M and 4M are placed at the four corners of the square as shown in

figure and it is F_2 when the positions of 3M and 4M are interchanged. The ratio $\frac{F_1}{F_2}$ is $\frac{a}{\sqrt{5}}$, The value of a is _____



1) 3 2) 2 3) 1 4) $2\sqrt{5}$

Key : 2

Sol : $F_2 = \sqrt{10}$

$$\frac{F_1}{F_2} = \frac{2}{\sqrt{5}}$$

41. Consider an equilateral prism $\left(refractive\ \ index\sqrt{2}\right)$ A ray of light is incident on its one surface at a certain angle i. If the emergent ray is found to graze along the other surface then the angle of refraction at the incident surface is close to

1) 20° 2) 40° 3) 15° 4) 30°

Key : 3

Sol : $r_1 + r_2 = A$

42. A simple pendulum has a bob with mass m and charge q. The pendulum string has negligible mass. When a uniform and horizontal electric field E is applied. The tension in the string changes. The final tension in the string when pendulum attains an equilibrium position is _____
(g acceleration due to gravity)

1) $\sqrt{m^2g^2 + q^2E^2}$ 2) $mg + qE$ 3) $mg - qE$ 4) $\sqrt{m^2g^2 - q^2E^2}$

Key : 1

Sol : $T = \sqrt{q^2E^2 + m^2g^2}$

43. Electric field in a region is given by $E = Ax\hat{i} + By\hat{j}$, where $A = 10V/m^2$ and $B = 5V/m^2$ If the electric potential at a point $(10, 20)$ is $500V$, then the electric potential at origin

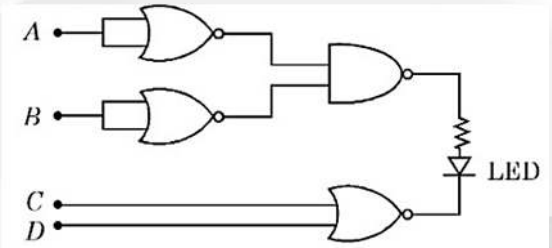
is _____V.

1) 500 2) 0 3) 1000 4) 2000

Key :

Sol : $V_p - V_0 = -\int_0^p E.dl$

44. Find the correct combination of A,B,C and D inputs which can cause the LED to glow.

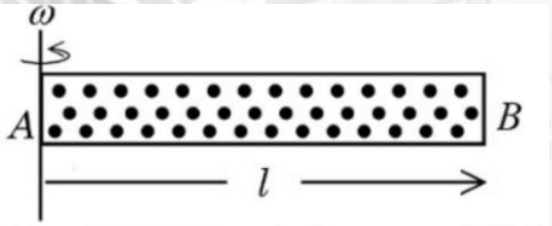


1) 0011 2) 1000 3) 1101 4) 0100

Key : 3

Sol : Conceptual

45. A cylindrical tube AB of length l, closed at both ends contains an ideal gas of 1 mol having molecular weight M. The tube is rotated in a horizontal plane with constant angular velocity ω about an axis perpendicular AB and passing through the edge at end A as shown in the figure. If P_A and P_B are the pressures at A and B respectively. Then (Consider the temperature is same at all points in the tube)



1) $P_B = P_A \exp\left(M\omega^2 l^2 / 2RT\right)$ 2) $P_B = P_A \exp\left(M\omega^2 l^2 / RT\right)$

3) $P_B = P_A$ 4) $P_B = P_A \exp\left(M\omega^2 l^2 / 3RT\right)$

Key : 1

Sol : $\int_{P_A}^{P_B} \frac{dP}{P} = \frac{M}{RT}\omega^2 \int_0^L x dx$

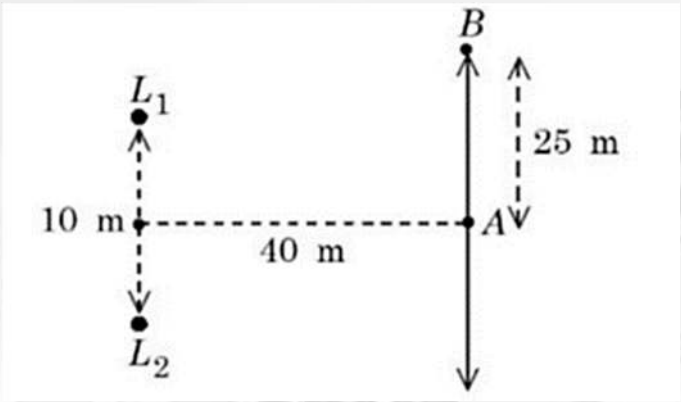
$P_B = P_A \exp\left(M\omega^2 l^2 / 2RT\right)$

SECTION-II
(NUMERICAL VALUE TYPE

This section contains 5 Numerical Value Type Questions. The Answer should be within 0 to 9999. If the Answer is in Decimal then round off to the Nearest Integer value (Example I,e. If answer is above 10 and less than 10.5 round off is 10 and If answer is from 10.5 and less than 11 round off is 11).

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases

46. Two loudspeakers $(L_1 \text{ and } L_2)$ are placed with a separation of 10 m. as shown in figure. Both speakers are fed with an audio input signal of same frequency with constant volume A voice recorder, initially at point A at equidistance to both loud speakers is moved by 25m along the line AB while monitoring the audio signal The measured signal was found to undergo 10 cycles of minima and maxima during the movement. The frequency of the input signal is ____ Hz (Speed of sound in air is 324 m/s and $\sqrt{5} = 2.23$)



Key : 348

Sol : path difference$= L_2B - L_1B = 10\lambda = 10\dfrac{C}{f}$

47. A circular disc has radius R_1 and thickness T_1. Another circular disc made of the same material has radius R_2 and thickness T_2 If the moment of inertia of both discs are same and $\dfrac{R_1}{R_2} = 2$ then $\dfrac{T_1}{T_2} = \dfrac{1}{\alpha}$, The value of α is _____

Key : 16

Sol : $I_1 = I_2$

$$\left(\frac{R_2}{R_1}\right)^4 = \frac{T_1}{T_2}$$

48. Inductance of a coil with 10^4 turns is 10 mH and it is connected to a dc source of 10 V with internal resistance of 10Ω. The energy density in the inductor when the current reaches $\left(\dfrac{1}{e}\right)$ of its maximum value is $\alpha\pi \times \dfrac{1}{e^2} J/m^3$. The value of α is $\left(\mu_0 = 4\pi \times 10^{-7} Tm/A\right)$

Key : data insufficient add or delete

Sol : If $n=\frac{N}{l}=10^4$ then energy density $\frac{B^2}{2\mu_0}$

$B=\mu_0 ni$

49. The electric field of a plane electromagnetic wave, travelling in an unknown non-magnetic medium is given by . $E_y=20\sin\left(3\times10^6 x-4.5\times10^{14}t\right)V/m$

(where x,t and other values have S.I. units).The dielectric constant of the medium is____

(Speed of light in free space is 3×10^8m/s)

Key : 4

Sol : $C=\frac{\omega}{k}=\frac{C_0}{\sqrt{\mu_r \in_r}}$

$\mu_r=1$

50. A parallel beam of light travelling in air (refractive index 1.0) is incident on a convex spherical glass surface of radius of curvature 50 cm. Refractive index of glass is 1.5. The rays converge to a point at a distance x cm from the centre of the curvature of the spherical surface . The value of x is _____cm.

Key : 100

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

CHEMISTRY **Max Marks: 100**

SECTION-I
(SINGLE CORRECT ANSWER TYPE)

This section contains 20 Multiple Choice Questions. Each question has 4 options (1), (2), (3) and (4) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

51. As compared with chlorocyclohexane, which of the following statements correctly apply to chlorobenzene ?

A. The magnitude of negative charge is more on chlorine atom

B. The C-C*l* bond has partial double bond character

C. C – C*l* bond is less polar

D. C-C*l* bond is longer due to repulsion between delocalised electrons of the aromatic ring and lone pairs of electrons of chlorine.

E. The C-C*l* bond is formed using sp^2 hybridized orbital of carbon

Choose the correct answer from the options given below :

1) A, D and E Only 2) B, C and D Only

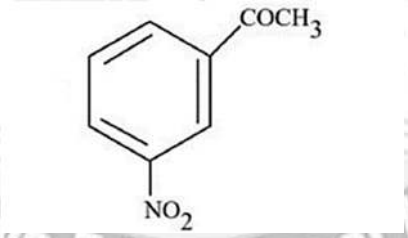
3) B, C and E Only 4) A, C and E Only

Key : 3

Sol : NCERT resonance effect

52. Given below are two statements :

Statement I : Benzene is nitrated to give nitrobenzene, which on further treatment with $CH_3COCl/AlCl_3$ will give



Statement II : $-NO_2$ group in a m-directing, and deactivating group

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

1) Statement I is correct but Statement II is incorrect

2) Statement I is incorrect but Statement II is correct

3) Both Statement I and Statement II are incorrect

4) Both Statement I and Statement II are correct

Key : 2

Sol : No FC reaction in nitro benzene

53. Given below are two statements:

Statement I : The Henry's law constant K_H is constant with respect to variations in solution's concentration over the range for which the solution is ideally dilute.

Statement II : K_H does not differ for the same solute in different solvents. In the light of the above statements, choose the correct answer from the options given below

1) Statement I is true and Statement II are false

2) Statement I is false but Statement II is true

3) Both Statement I and Statement II are false

4) Both Statement I and Statement II are true

Key : 1

Sol : NCERT

54. In the reaction

$$2Al(s) + 6HCl(aq) \rightarrow 2Al^{3+}(aq) + 6Cl^{-}(aq) + 3H_2(g)$$

1) 67.2 L $H_2(g)$ at STP is produced for every mole of Al that reacts

2) 12L HCl (aq) is consumed for every 6L $H_2(g)$ produced.

3) 33.6 L $H_2(g)$ is produced regardless of temperature and pressure for every mole of Al that reacts

4) 11.2 L $H_2(g)$ at STP is produced for every mole of HCl consumed

Key : 4

Sol : 6 mole $HCl \Leftrightarrow 3 mole H_2$

1 mole $HCl \Leftrightarrow ? \quad = 11.2 lit$

55. Given below are two statements :

Statement-I : The halogen that makes longest bond with hydrogen in HX, has the smallest covalent radius in its group.

Statement-II : A group 15 elements hybride EH_3 has the lowest boiling point among corresponding hybrids of other group 15 elements. The maximum covalency of that element E is 4

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

1) Both Statement I and Statement II are true

2) Both Statement I and Statement II are false

3) Statement I is true but Statement II is false

4) Statement I is false but Statement II is true

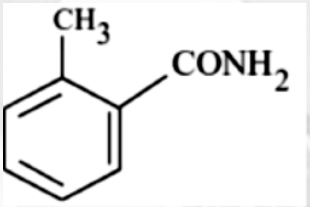
Key : 2

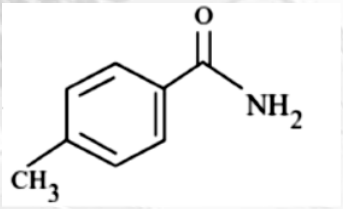
Sol : Boiling point order

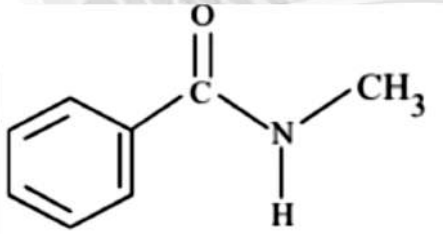
$PH_3 < AsH_3 < NH_3 < SbH_3$

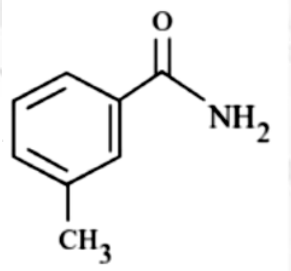
P=max valency =6

56. 'A' is a neutral organic compound (M. F: C_8H_9ON). On treatment with aqueous $Br_2 / HO^{(-)}$, 'A' forms a compound 'B' which is soluble in dilute acid. 'B' on treatment with aqueous $NaNO_2 / HCl(0-5°C)$ produces a compound 'C' which on treatment with CuCN/ NaCN produces 'D' . Hydrolysis of 'D' produces 'E' which is also obtainable from the hydrolysis of 'A'. 'E' on treatment with acidified $KMnO_4$ produces 'F'. 'F' contains two different types of hydrogen atoms. The structure of 'A' is

1) 

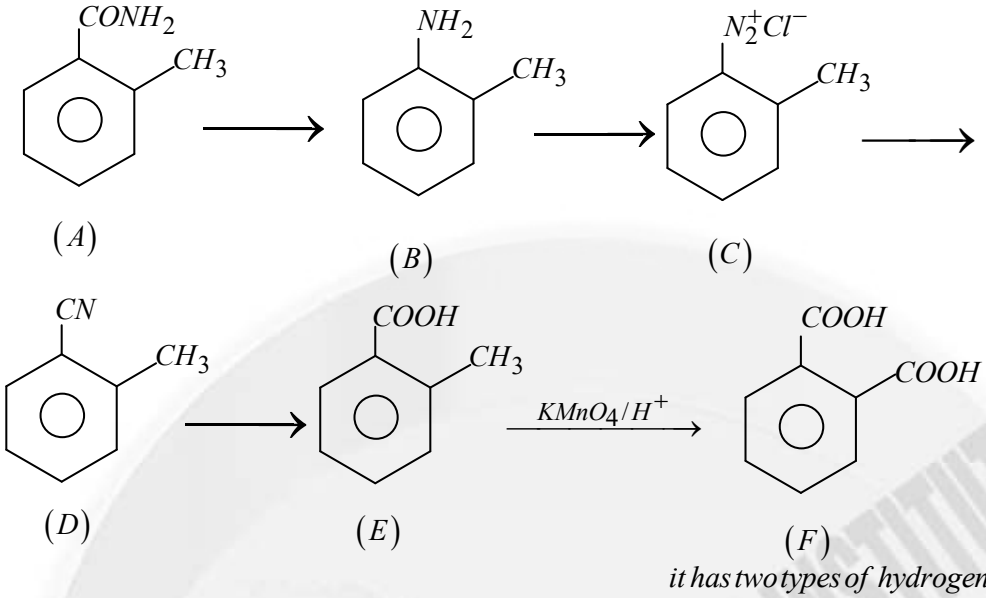
2) 

3) 

4) 

Key : 1

Sol :



57. TWO p – block elements X and Y form fluorides of the type EF_3. The fluoride compound XF_3 is a Lewis acid and YF_3 is a Lewis base. The hybridizations of the central atoms of XF_3 and YF_3 respectively are

1) sp^2 and sp^3 2) Both sp^3 3) Both sp^2 4) sp^3 and sp^2

Key : 1

Sol : X=III A element

Y=V A element

(Eg: BF_3)

58. Match the List-I with List – II

List-I (Reagents)	List-II (Name of Reaction involving carbonyl compounds)
A. $NH_2 - NH_2, KOH$	I. Tollen's Test
B. $Ag(NH_3)_2OH$	II. Clemmensen Reduction
C. Aq. $CuSO_4$, Sodium Potassium tartarate, KOH	III. Wolff – Kishner Reduction
D. $Zn - Hg, HCl$	IV. Fehling's Test

Choose the correct answer from the options given below L

1) A-III, B-IV, C-I, D-II 2) A-IV, B-III, C-II, D-I

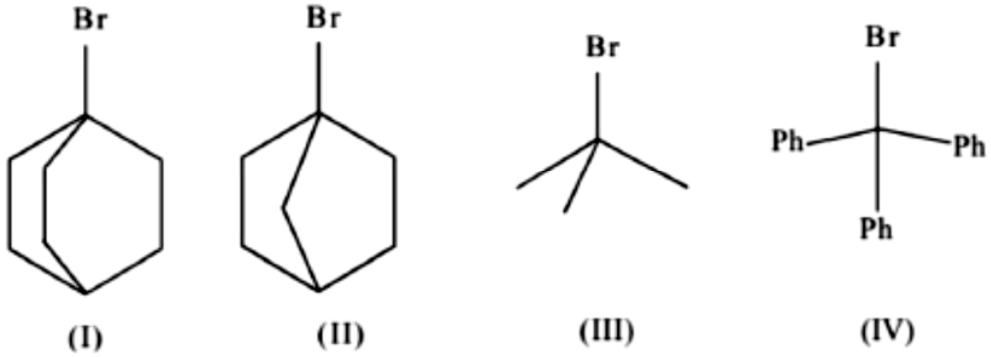
3) A-III, B-I, C-IV, D-II 4) A-II, B-I, C-IV, D-III

Key : 3

Sol : As per NCERT

59. The correct order of the rate of reaction of the following reactants with nucleophile by S_N1 mechanism is

(Given : Structures I and II are rigid)



1) I < II < III < IV
2) III < I < II < IV
3) II < I < III < IV
4) IV < III < II < I

Key : 3

Sol : Based on stability of carbocation. Intermediate

60. Given below are two statements :

Statement I : Phenol on treatment with $CHCl_3$ / aq.KOH under refluxing condition, followed by acidification produces p- hydroxy benzaldehyde as the major product and o-ohydroxy benzaldehyde as the minor product.

Statement II : The mixture of p-hydroxybenzaldehyde and o- hydroxybenzaldehyde can be easily separated through steam distillation.

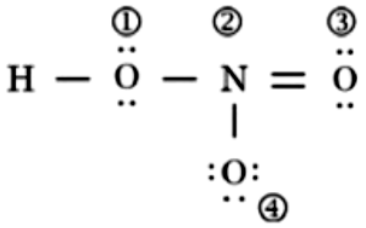
In the light of the above statements, choose the correct answer from the options given below

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

Key : 4

Sol : Due to steric factor of K^+ para product is major

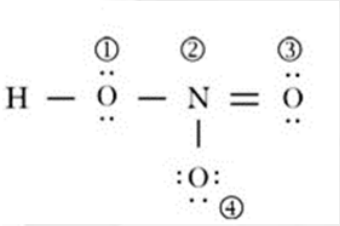
61. The formal charges on the atoms marked as (1) to (4) in the Lewis representation of HNO_3 molecule respectively are



1) 0, 0, -1, + 1 2) 0 , –1,0, + 1 3) 0, + 1, 0, -1 4) +1, 0, 0, -1

Key : 3

Sol :



$1 = 6 - 4 - \frac{1}{2}[4] = 0$

$2. 5 - 0 - \frac{1}{2}[8] = +1$

$3.\ 6 - 4 - \frac{1}{2}[4] = 0$

$4. 6 - 6 - \frac{1}{2}[2] = -1$

62. The energy required by electrons, present in the first Bohr orbit of hydrogen atom to be excited to second Bohr orbit is _____ J mol^{-1}

Given : $R_H = 2.18 \times 10^{-11}$ ergs

1) 9.835×10^5 2) 9.835×10^{12} 3) 1.635×10^{-11} 4) 1.635×10^{-18}

Key : 1

Sol : $E_2 - E_1 = R_H \left[\frac{1}{N_1^2} - \frac{1}{N_2^2} \right] \times 6 \times 10^{23} = 2.18 \times 10^{-18} \left[\frac{3}{4} \right] \times 6 \times 10^{23} = 9.81 \times 10^5 J / mol$

63. $A \rightarrow$ product (First order reaction)

Three sets of experiment were performed for a reaction under similar experimental conditions :

Run 1 $\Rightarrow$ 100 mL of 10 M solution of reactant A

Run 2 $\Rightarrow$ 200 mL of 10 M solution of reactant A

Run 3 $\Rightarrow$ 100 mL of 10 M solution of reactant A + 100 mL of H_2O added.

The correct variation of rate of reaction is

1) Run 1 < Run 2 < Run 3 2) Run 3 < Run 1 = Run 2

3) Run 1 = Run 2 = Run 3 4) Run 3 < Run 1 < Run 2

Key : 2

Sol : $r = K(C)^1$

64. A first row transition metal (M) does not liberate H_2 gas from dilute HCl. 1 mol of aqueous solution of MSO_4 is treated with excess of aqueous KCN and then $H_2S(g)$ is passed through the solution. The amount of MS (metal sulphide) formed from the above reaction is _____ mol

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

Key : 2

Sol : $M = Cu \rightarrow Cu^{+1}$ *in complex*

$$\underset{1mole}{CuSO_4} + KCN \rightarrow \underset{1mole}{Cu(CN)_2} \xrightarrow{KCN} \underset{0.5mole}{Cu_2(CN)_2}$$

$$Cu_2(CN)_2 \xrightarrow{KCN} 2K_3\left[Cu(CN)_4\right] + (CN)_2$$

NO, free Cu^+ ions are available

65. Consider the transition metal ions $Mn^{3+}, Cr^{3+}, Fe^{3+}$ and Co^{3+} and all form low spin octahedral complexes. The correct decreasing order of unpaired electrons in their respective d-orbitals of the complexes is

1) $Mn^{3+} > Fe^{3+} > Co^{3+} > Cr^{3+}$ 2) $Fe^{3+} > Co^{3+} > Mn^{3+} > Cr^{3+}$

3) $Cr^{3+} > Fe^{3+} > Co^{3+} > Mn^{3+}$ 4) $Cr^{3+} > Mn^{3+} > Fe^{3+} > Co^{3+}$

Key : 4

Sol :

Mn^{+3} Cr^{+3} Fe^{+3} Co^{+3}

d^4 d^3 d^5 d^6

$t_{2g}^3 e_g^1$ t_{2g}^3 $t_{2g}^5 e_g^0$ $t_{2g}^6 e_g^0$

$n=2$ $n=3$ $n=1$ $n=0$

$Cr^{+3} > Mn^{+3} > Fe^{+3} > Co^{+3}$

66. The correct order of reactivity of CH_3Br in methanol with the following nucleophiles is

$F^-, I^-, C_2H_5O^-$ and $C_6H_5O^-$

1) $I^- > C_2H_5O^- > F^- > C_6H_5O^-$ 2) $I^- > C_2H_5O^- > C_6H_5O^- > F^-$

3) $I^- > C_6H_5O^- > F^- > C_2H_5O^-$ 4) $I^- > F^- > C_6H_5O^- > C_2H_5O^-$

Key : 2

Sol : $I^- > EtO^- > PhO^- > F^-$

67. A 'p' block element (E) and hydrogen form a binary cation $(EH_x)^+$, while EH_3 on treatment with K_2HgI_4 in alkaline medium gives a precipitate of basic mercury (II) amido – iodine. Given below are first ionisation enthalpy values $\left(kJ\ mol^{-1}\right)$ for first element each from group 13, 14, 15 and 16. Identify the correct first ionisation enthalpy value for element E.

1) 1086 2) 1312 3) 1402 4) 801

Key : 3

Sol : I.P order $III_A < IV_A < VI_A < V_A$

68. Given below are two statements :

Statement I : Sucrose is dextrorotatory. However, sucrose upon hydrolysis gives a solution having mixture of products. This solution shows laevorotation.

Statement II : Hydrolysis of sucrose gives glucose and fructose. Since the laevorotation of glucose is more than the dextrorotation of fructose, the resulting solution becomes laevorotatory.

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

1) Both Statement I and Statement II are true

2) Statement I true but Statement II is false

3) Statement I is false but Statement II are true

4) Both Statement I and Statement II are fasle

Key : 2

Sol : laevo rotation of fructose is more than dextro rotation of glucose

69. Match the List-I with List – II

List-I	**List-II**
Thermodynamic Process	**Magnitude in kJ**
A. Work done in reversible, isothermal expansion of 2 mol of ideal gas from 2 dm^3 to 20 dm^3 at 300 K	I. 4
B. Work done in irreversible isothermal expansion of 1 mol ideal gas form 1m^3 to 3m^3 at 300 K against a Constant pressure of 3kPa	II. 11.5
C. Change in internal energy for adiabatic expansion of a 1 mol ideal gas with change of temperature = 320 K and $\bar{C}_v = \frac{3}{2}R$	III. 6
D. Change in enthalpy at constant pressure of 1 mol ideal gas With change of temperature = 337 K and $\bar{C}_p = \frac{5}{2}R$	IV. 7

Choose the correct answer from the options given below :

1) A-II,B- III, C-I, D-IV 2) A-I,B- II, C-III, D-IV

3) A-II,B- I, C-III, D-IV 4) A-III,B- II, C-IV, D-I

Key : 1

Sol : $W_{it,rev} = 2.303 \times 2 \times 8.314 \times 10^{-3} \times 300 \log \frac{20}{2} = 11.5$

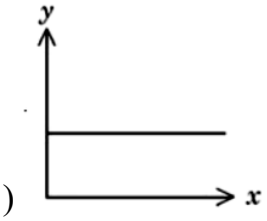
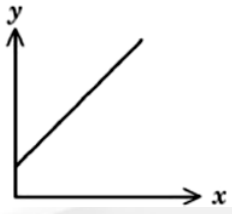
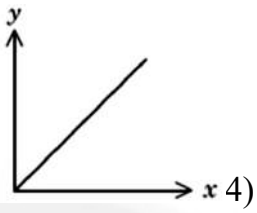
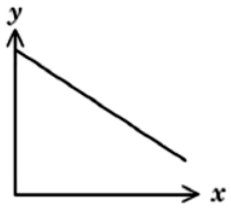
$(W) = P\Delta V = 3 \times 10^3 (3-1) = 6 \times 10^3 T$

$\Delta U = {}^{n} C_r dt = 1 \times \frac{3R}{2} \times 320 = 4$

70. Consider a solution $CO_2(g)$ dissolved in water in a closed container

Which one of the following plots correctly represents variation of log (partial pressure of CO_2 in vapour phase above water) [y-axis] with log (mole fraction of CO_2 in water)

[x-axis] at 25°C ?

1)  2)  3)  4) 

Key : 2

Sol : $P_{CO_2} = K_H . X_{CO_2}$

$\log P_{CO_2} = \log K_H + \log X_{CO_2}$

SECTION-II
(NUMERICAL VALUE TYPE

This section contains 5 Numerical Value Type Questions. The Answer should be within 0 to 9999. If the Answer is in Decimal then round off to the Nearest Integer value (Example i,e. If answer is above 10 and less than 10.5 round off is 10 and If answer is from 10.5 and less than 11 round off is 11).

Marking scheme: +4 for correct answer, 0 if not attempt and -1 in all other cases

71. Consider the following electrochemical cell at 298 K

$Pt\left|HSnO_2^-(aq)\right|Sn(OH)_6^{2-}(aq)\left|OH^-(aq)\right|Bi_2O_3(s)\,|\,Bi(s)$

If the reaction quotient at a given time is 10^6, then the cell EMF (E_{cell}) is _____ $\times 10^{-1}$ V (Nearest integer).

Given the standard half – cell reduction potential as

$E^o_{Bi_2O_3//Bi,OH^-} = -0.44\,V$ and $E^o_{Sn(OH)_6^{2-}/HSnO_2^-,OH^-} = -0.90\,V$

Key : 4

Sol : $HSnO_2^- \rightarrow Sn(OH)_6^{-2} + 2e^-$

$E = (-0.44 + 0.9) - \frac{0.06}{6}\log 10^6 = 0.4 = 4 \times 10^{-1}$

72. Dissociation of a gas A_2 takes place according to the following chemical reaction. At equilibrium, the total pressure is 1 bar at 300 K

$A_2(g) \quad 2A(g)$

The standard Gibbs energy of formation of the involved substances has been provided below :

Substance	ΔG_f° / kJ mol^{-1}
A_2	−100.00
A	−50.832

The degree of dissociation of $A_2(g)$ given by $\left(x\times10^{-2}\right)^{1/2}$ where x = _____ (Nearest integer)

[Given : R = 8 J mol^{-1}K^{-1}, log 2 = 0.3010, log 3 = 0.48]

Assume degree of dissociation is not negligible

Key : 33

Sol : $A_2 \rightleftarrows 2A$

$\Delta G_r = (-50.832)2 - (-100)$

$= 100 - 101.664$

$-1.664 = -2.303\times8\times10^{-3}\times300\log K$

$\log K = \log 2 \Rightarrow K = 2$

$A_2 \rightarrow 2A$

$k_P = \left(\frac{2\alpha}{1+\alpha}.P\right)^2$

$\left(\frac{1-\alpha}{1+\alpha}.P\right) = P = 1$

$3\alpha^2 = 1$

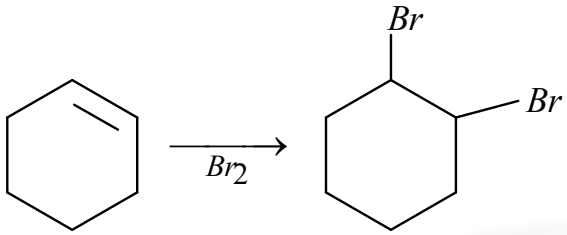
$\alpha = \left(\frac{1}{3}\right)^2 \quad = \left(33.3\times10^{-2}\right)^{1/2}$

73. The cycloalkene (X) on bromination consumes one mole of bromine per mole of (X) and gives the product (Y) in which C:Br ratio is 3 : 1. The percentage of bromine in the product (Y) is _____ % (Nearest integer)

(Given : molar mass in g mol^{-1} H:1, C : 12, O : 16, Br : 80)

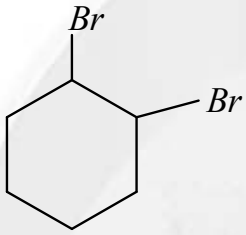
Key : 66

Sol : C:Br $\Rightarrow$ 3:2



1 mole 1 mole

C:Br $\Rightarrow$ 6:2 $\Rightarrow$ 3:1



Ml of

$C_6H_{10}Br_2 \Rightarrow 66.11$

74. The temperature at which rate constants of the given below two gaseous reactions become equal is _____ K (Nearest integer)

$$X \longrightarrow Y \qquad k_1 = 10^6 e^{\frac{-30000}{T}}$$

$$P \longrightarrow Q \qquad k_2 = 10^4 e^{\frac{-24000}{T}}$$

Given : ln 10 = 2.303)

Key : 1303

Sol :

$K_1 = K_2$

$$10^6.e^{-\frac{3\times10^4}{T}} = 10^4.e^{-\frac{2.4\times10^4}{T}}$$

$$2\times2.303 - \frac{3\times10^4}{T} = \frac{-2.4\times10^4}{T}$$

$$T = \frac{6\times10^3}{4.606}$$

75. Sodium fusion extract of an organic compound (Y) with $CHCl_3$ and chlorine water gives violet colour to the $CHCl_3$ layer. 0.15 g of (Y) gave 0.12 g of the silver halie precipitate in Carius method. Percentage of halogen in the compound (Y) is _____ (Nearest integer)
(Given : molar mass g mol^{-1} C: 12, H : 1, Cl : 35.5, Br : 80, I : 127)

Key : 43

Sol : $\frac{127}{235}\times\frac{0.12}{0.15}\times 100 = 43.23$

$$\frac{Awof\ I}{Mw\ of\ AgI}\times\frac{wof\ AgI}{wof\ O.C}\times 100$$

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