FIITJEE

Solutions to JEE(Main) -2024

Test Date: 8^{th} April 2024 (Second Shift)

MATHEMATICS, PHYSICS & CHEMISTRY

Paper – 1

Time Allotted: 3 Hours **Maximum Marks: 300**

- Please read the instructions carefully. You are allotted 5 minutes specifically for this purpose.

Important Instructions:

1. The test is of 3 hours duration.
2. This test paper consists of 90 questions. Each subject (MPC) has 30 questions. The maximum marks are 300.
3. This question paper contains three parts**. Part-A** is Mathematics, **Part-B** is Physics and **Part-C** is Chemistry. Each part has only two sections: **Section-A and Section-B**.
4. **Section – A** : Attempt all questions.
5. **Section – B :** Do any 5 questions out of 10 Questions.
6. **Section-A (01 – 20, 31 – 50, 61 – 80)** contains 60 multiple choice questions which have **only one correct answer**. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.
7. **Section-B (21 – 30, 51 – 60, 81 – 90)** contains 30 Numerical based questions. The answer to each question is rounded off to the nearest integer value. Each question carries **+4 marks** for correct answer and **–1 mark** for wrong answer.

Note: For the benefit of the students, specially the aspiring ones, the question of JEE(Main), 2024 are also given in this booklet. Keeping the interest of students studying in class XI, the questions based on topics from class XI have been marked with '*', which can be attempted as a test.

PART – A (MATHEMATICS)

SECTION - A

(One Options Correct Type)

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

Q1. If the line segment joining the points (5, 2) and (2, a) subtends an angle $\frac{\pi}{4}$ at the origin, then the absolute value of the product of all possible values of a is

(A) 6 (B) 8
(C) 2 (D) 4

Ans. D

Sol.

$$\left|\frac{\frac{a}{2}-\frac{2}{5}}{1+\frac{a}{2}.\frac{2}{5}}\right|=1$$

$$\Rightarrow \left|\frac{5a-4}{10+2a}\right|=1$$

assuming $a \neq 5$

$\Rightarrow |5a-4|=|10+2a|$

$\Rightarrow 5a-4=\pm(10+2a)$

$$a=-\frac{6}{7} \text{ or } \frac{14}{3}$$

A/Q $\left|\frac{-6}{7}.\frac{14}{3}\right|=4$

Q2. Let $\int_{\alpha}^{\log_e 4}\frac{dx}{\sqrt{e^x-1}}=\frac{\pi}{6}$. Then e^{α} and $e^{-\alpha}$ are the roots of the equation

(A) $x^2-2x-8=0$ (B) $2x^2-5x-2=0$
(C) $2x^2-5x+2=0$ (D) $x^2+2x-8=0$

Ans. C

Sol. $\int\frac{dx}{\sqrt{e^x-1}}=\int\frac{e^x}{e^x\sqrt{e^x-1}}dx$

Let $e^x-1=t^2 \Rightarrow e^x\,dx=2t\,dt$

$$=2\int\frac{dt}{t^2+1}=2\tan^{-1}t+C$$

$$\text{A / Q }\int_{\alpha}^{\ell n4}\frac{dx}{\sqrt{e^x-1}}=2\tan^{-1}\sqrt{e^x-1}\Big|_{\alpha}^{\ell n4}=\frac{\pi}{6}$$

$$\Rightarrow 2\tan^{-1}\sqrt{3}-2\tan^{-1}\sqrt{e^{\alpha}-1}=\frac{\pi}{2}$$

$$\Rightarrow 2\tan^{-1}\sqrt{e^{\alpha}-1}=1 \Rightarrow e^{\alpha}=2$$

now find a equation whose roots are $e^{\alpha}, e^{-\alpha}$ I.e 2 & $\frac{1}{2}$

Option 3 $2x^2-5x+2=0$

Q3. Let y = y(x) be the solution curve of the differential equation $\sec y\frac{dy}{dx}+2x\sin y=x^3\cos y$, y(1) = 0. Then $y(\sqrt{3})$ is equal to

(A) $\frac{\pi}{3}$
(B) $\frac{\pi}{12}$
(C) $\frac{\pi}{4}$
(D) $\frac{\pi}{6}$

Ans. **C**

Sol. $\sec y\frac{dy}{dx}+2x.\sin y=x^3.\cos y$

$\Rightarrow \sec^2 y\frac{dy}{dx}+2x\tan y=x^3$

Let $\tan y=t\Rightarrow \sec^2 y\frac{dy}{dx}=\frac{dt}{dx}$

$\Rightarrow \frac{dt}{dx}+2x.t=x^3$

IF = $3^{\int 2x dx}=e^{x^2}$

$t.e^{x^2}=\int x^3.e^{x^2}dx+c$

$t.e^{x^2}=\frac{1}{2}e^{x^2}(x^2-1)+c$

$\tan y.e^{x^2}=\frac{1}{2}e^{x^2}(x^2-1)+c$

for $x=1, y=1\Rightarrow c=0$

$\tan y=\frac{x^2-1}{2}$

for $x=\sqrt{3}, y=\frac{\pi}{4}$

Q4. Let $\vec{a}=4\hat{i}-\hat{j}+\hat{k}, \vec{b}=11\hat{i}-\hat{j}+\hat{k}$ and $\vec{c}$ -be a vector such that $(\vec{a}+\vec{b})\times\vec{c}=\vec{c}\times(-2\vec{a}+3\vec{b})$. If $(2\vec{a}+3\vec{b}).\vec{c}=1670$, then $|\vec{c}|^2$ is equal to

(A) 1600
(B) 1627
(C) 1618
(D) 1609

Ans. **C**

Sol. Given $(\vec{a}+\vec{b})\times\vec{c}=\vec{c}\times(-2\vec{a}+3\vec{b})$

$=-(-2\vec{a}+3\vec{b})\times\vec{c}$

$\Rightarrow (\vec{a}+\vec{b}-2\vec{a}+3\vec{b})\times\vec{c}=0$

$\Rightarrow (4\vec{b}-\vec{a})\times\vec{c}=0$

i.e $\vec{c}=\lambda(4\vec{b}-\vec{a})$

also given $(2\vec{a}+3\vec{b}).\vec{c}=1670$

$\Rightarrow (2\vec{a}+\vec{b}).\lambda(4\vec{b}-\vec{a})=1670$

$\Rightarrow \lambda(5\vec{a}.\vec{b}-2|\vec{a}|^2+12|\vec{b}|^2)=1670$

$\Rightarrow \lambda(5(46)-2(18)+12(123))=1670$

$\Rightarrow \lambda=1$

$\vec{c} = \lambda(4\vec{b} - \vec{a}) - = 40\hat{i} - 3\hat{j} + 3\hat{k}$

$|\vec{c}| = \sqrt{1618}$

Q5. The number of ways five alphabets can be chosen from the alphabets of the word MATHEMATICS, where the chosen alphabets are not necessarily distinct, is equal to

(A) 177 (B) 175

(C) 181 (D) 179

Ans. **D**

Sol. Letters M A T H E I C S

Repetition 2 2 2

Five letter words,

Type aabbc

ways ${}^3C_2.{}^6C_1 = 18$

Type aabcd

ways ${}^3C_1 . {}^7C_3 = 105$

Type abcde

ways = ${}^8C_3 = 56$

Required ways = 18 + 105 + 56

= 179

Q6. In an increasing geometric progression of positive terms, the sum of the second and sixth terms is $\frac{70}{3}$ and the product of the third and fifth terms is 49. Then the sum of the 4th, 6th and 8th terms is equal to

(A) 96 (B) 84

(C) 78 (D) 91

Ans. **D**

Sol. Let third term be $\frac{a}{r}$

fourth term a

fifth term = ar

A/Q $\frac{a}{r}.ar = 49 \Rightarrow a = 7$

So sequence is $\frac{a}{r^3}, \frac{a}{r^2}, \frac{a}{r}, a, ar, ar^2, ...$

sum of 2nd & 6th term = $\frac{70}{3}$

$\frac{a}{r^2} + ar^2 = \frac{70}{3}$

$\Rightarrow$ use $a = 7 \Rightarrow \frac{(r^4+1)7}{r^2} = \frac{70}{3}$

$r^2 = 3, \frac{1}{3}$

Since it is increasing so $r = \sqrt{3}$

A/Q $t_4 + t_6 + t_8$

$= a + ar^2 + ar^4$

$= 7(1 + 3 + 9)$

$= 91$

Q7. There are three bags X, Y and Z. Bag X contains 5 one-rupee coins and 4 five-rupee coins; Bag Y contains 4 one-rupee coins and 5 five-rupee coins and Bag Z contains 3 one-rupee coins and 6 five-rupee coins. A bag is selected at random and a coin drawn from it at random is found to be a one-rupee coin. Then the probability, that it came from bag Y, is

(A) $\frac{1}{4}$ (B) $\frac{5}{12}$

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

Ans. **D**

Sol.

Bag	**No. of Rs. 1**	**Coin of Rs. 5**
X	5	4
Y	4	5
Z	3	6

Probability of drawing Rs.1 coin from y bag

$$= \frac{\frac{1}{3}\times\frac{4}{9}}{\frac{1}{3}.\frac{5}{9}+\frac{1}{3}.\frac{4}{9}+\frac{1}{3}.\frac{3}{9}} = \frac{1}{3}$$

Q8. The area of the region in the first quadrant inside the circle $x^2 + y^2 = 8$ and outside the parabola $y^2 = 2x$ is equal to

(A) $\frac{\pi}{2}-\frac{1}{3}$ (B) $\pi-\frac{1}{3}$

(C) $\pi-\frac{2}{3}$ (D) $\frac{\pi}{2}-\frac{2}{3}$

Ans. **C**

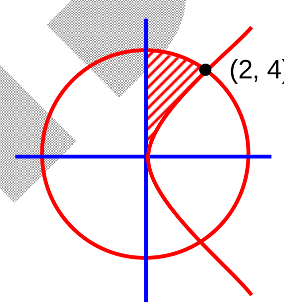
Sol. Solve $x^2 + y^2 = 8$ & $y^2 = 2x$

$x^2 + 2x - 8 = 0 \Rightarrow (x + y)(x - 2) = 0$

$\Rightarrow x = 2, -4$

Required Area $= \int_0^2 \left(\sqrt{8-x^2}-\sqrt{2x}\right) dx$

$= \pi-\frac{2}{3}$



Q9. If $\alpha \neq a, \beta \neq b, \gamma \neq c$ and $\begin{vmatrix} \alpha & b & c \\ a & \beta & c \\ a & b & \gamma \end{vmatrix} = 0$, then $\frac{a}{\alpha-a}+\frac{b}{\beta-b}+\frac{\gamma}{\gamma-c}$ is equal to

(A) 2 (B) 3

(C) 1 (D) 0

Ans. **D**

Sol.

$$\begin{vmatrix} \alpha & b & c \\ a & \beta & c \\ a & b & \gamma \end{vmatrix} = 0$$

$R_1 \to R_1 - R_3$; $R_2 \to R_2 - R_3$

$$\begin{vmatrix} \alpha-a & 0 & c-\gamma \\ 0 & \beta-b & c-\gamma \\ a & b & \gamma \end{vmatrix} = 0$$

Expand along 3^{rd} row

$-a(\beta - b)(c - \gamma) - b(\alpha - a)(c - \gamma) + \gamma(\alpha - a)(\beta - b) = 0$

divide by $(\alpha - a)(\beta - b).(\gamma - c)$

$$\frac{a}{\alpha - a} + \frac{b}{b - b} + \frac{\gamma}{\gamma - c} = 0$$

Q10. If the system of equations $x + 4y - z = \lambda$, $7x + 9y + \mu z = -3$, $5x + y + 2z = -1$ has infinitely many solutions, then $(2\mu + 3\lambda)$ is equal to :

(A) –2 (B) 2

(C) –3 (D) 3

Ans. **C**

Sol. for infinite solution, by cramers rule

$\Delta = 0 \quad \& \quad \Delta_1 = \Delta_2 = \Delta_3 = 0$

$$\Delta = \begin{vmatrix} 1 & 4 & -1 \\ 7 & 9 & \mu \\ 5 & 1 & 2 \end{vmatrix} = 0 \Rightarrow \mu = 0$$

$$\Delta_3 = \begin{vmatrix} 1 & 4 & \lambda \\ 7 & 9 & -3 \\ 5 & 1 & -1 \end{vmatrix} = 0 \Rightarrow \lambda = -1$$

A/Q $\quad 2\mu + 3\lambda = -3$

Q11. If the term independent of x in the expansion of $\left(\sqrt{a}x^2 + \frac{1}{2x^3}\right)^{10}$ is 105, then a^2 is equal to

(A) 2 (B) 9

(C) 4 (D) 6

Ans. **C**

Sol. $T_{r+1} = {}^{10}C_r.(\sqrt{a}x^2)^{10-r}.\left(\frac{1}{2x^3}\right)^r$

$= {}^{10}C_r.\frac{(\sqrt{a})^{10-r}}{2^r}.x^{20-5r}$

For independent r = 4

A/Q $\frac{{}^{10}C_4.(\sqrt{a})^6}{2^4} = 105 \Rightarrow a = 2$

Q12. Let $f(x) = \begin{cases} -a & \text{if } -a \le x \le 0 \\ x + a & \text{if } 0 < x \le a \end{cases}$ where a > 0 g(x) = (f(|x|) – |f(x)|)/2

Then the function g : [–a, a] $\to$ [–a, a] is

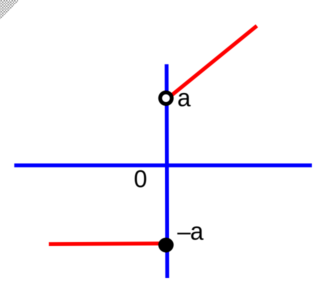
(A) one-one (B) both one-one and onto

(C) onto (D) neither one-one nor onto

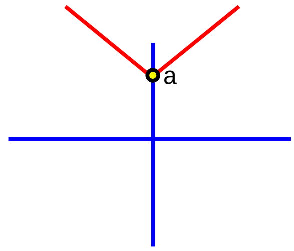
Ans. **D**

Sol.

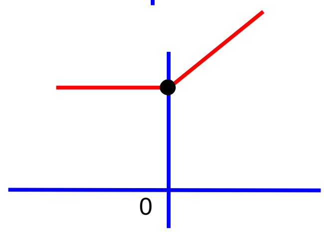
f(x)



f(|x|)



|f(x)|



So $g(x) = \begin{cases} 0 & x > 0 \\ \dfrac{-x}{2} & ; x < 0 \end{cases}$

Many-one as for x > 0 it is '0' and into as it will not cover [–a, 0)

Q13. If the function $f(x) = 2x^3 - 9ax^2 + 12a^2x + 1$, $a > 0$ has a local maximum at $x = \alpha$ and a local minimum at $x = \alpha^2$, then α and α^2 are the roots of the equation

(A) $x^2 + 6x + 8 = 0$
(B) $x^2 - 6x + 8 = 0$
(C) $8x^2 - 6x + 1 = 0$
(D) $8x^2 + 6x - 1 = 0$

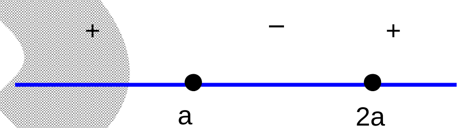
Ans. B

Sol. $f(x) = 2x^3 - 9ax^2 + 12a^2x + 1$

$f(x) = 6x^2 - 18ax + 12a^2$

$= 6(x - a)(x - 2a)$

sign scheme of f'(x)



maxima at $x = a = \alpha$

minima at $x = 2a = \alpha^2$

$\Rightarrow \alpha^2 = 2\alpha \Rightarrow \alpha = \underbrace{0}_{\text{rejected}},\ 2$

A/Q Equation whose roots are α, α^2 i.e 2 & 4

Q14. If the image of the point (–4, 5) in the line x + 2y = 2 lies on the circle $(x + 4)^2 + (y - 3)^2 = r^2$, then r is equal to :

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

Ans. C

Sol. Image of (–4, 5) about x + 2y = 2

$$\frac{x+4}{1} = \frac{y-5}{2} = \frac{-2(-4+10-2)}{5}$$

$$(x, y) = \left(\frac{-28}{5}, \frac{9}{5}\right)$$

this point lies on circle

$$\left(\frac{-28}{5} + 4\right)^2 + \left(\frac{9}{5} - 3\right)^2 = r^2 \Rightarrow r^2 = 4$$

Q15. If the value of $\frac{3\cos 36^\circ + 5\sin 18^\circ}{5\cos 36^\circ - 3\sin 18^\circ}$ is $\frac{a\sqrt{5}-b}{c}$ where a, b, c are natural numbers and gcd(a, c) = 1, then a + b + c is equal to
(A) 40 (B) 54
(C) 52 (D) 50

Ans. **C**

Sol. Use $\cos 36^\circ = \frac{\sqrt{5}+1}{4}$

$\sin 18^\circ = \frac{\sqrt{5}-1}{4}$

$$\frac{3\cos 36^\circ + 5\sin 18^\circ}{5\cos 36^\circ - 3\sin 18^\circ} = \frac{2\sqrt{5}-\frac{1}{2}}{\frac{\sqrt{5}}{2}+2} = \frac{4\sqrt{5}-1}{4+\sqrt{5}}$$

$$\frac{a\sqrt{5}-b}{c} = \frac{17\sqrt{5}-24}{11}$$

a + b + c = 52

Q16. Let A = {2, 3, 6, 8, 9, 11} and B = {1, 4, 5, 10, 15}. Let R be a relation on A × B defined by (a, b) R (c, d) if and only if 3ad – 7bc is an even integer. Then the relation R is
(A) an equivalence relation
(B) reflexive but not symmetric
(C) reflexive and symmetric but not transitive
(D) transitive but not symmetric

Ans. **C**

Sol. (a, b) R(c, d) $\Leftrightarrow$ 3ad – 7bc is an even integer
For reflexive
(a, g) $R_{c,d} \Leftrightarrow$ 3ab – 7ab = –4ab is an even no.
For symmetric modify the term
$3ad - 7bc = 3(ad - bc) - \underbrace{4bc}_{\text{even}}$
So we require to check first term only
If (a, b) R(c,d) be true
i.e 3(ad – bc) is an even number
= –3(cb – da) will also be even no.
For transitive,
i.e (c, d) R (a, b) is true
consider (3, 1) R (2, 4) & (2, 4) R (2, 5) be true
but (3, 1) R (2, 5) is false

Q17. The sum of all possible values of $\theta \in [-\pi, 2\pi]$, for which $\frac{1+i\cos\theta}{1-2i\cos\theta}$ is purely imaginary, is equal to:
(A) 5π (B) 2π
(C) 4π (D) 3π

Ans. **D**

Sol. $\frac{(1+i\cos\theta)}{1-2i\cos\theta} = \frac{1-4\cos^2\theta + i(3\cos\theta)}{1+4\cos^2\theta}$

Purely imaginary if $\cos\theta = \pm\frac{1}{2}$

since $\theta \in [-\pi, 2\pi]$

$\theta = \left\{\frac{-2\pi}{3}, \frac{-\pi}{3}, \frac{\pi}{3}, \frac{2\pi}{3}, \pi + \frac{\pi}{3}, 2\pi - \frac{\pi}{3}\right\}$

sum = 3π

Q18. For $a, b > 0$, let $f(x) = \begin{cases} \frac{\tan((a+1)x) + b\tan x}{x}, & x < 0 \\ 3 & x = 0 \\ \frac{\sqrt{ax + b^2x^2} - \sqrt{ax}}{b\sqrt{a}\ x\ \sqrt{x}}, & x < 0 \end{cases}$

be a continous function at x = 0. Then $\frac{b}{a}$ is equal to

(A) 8
(B) 6
(C) 4
(D) 5

Ans. B

Sol. $\lim\limits_{x\to 0^-} f(x) = \lim\limits_{x\to 0}\left(\frac{\tan(a+1)x}{(a+1)x}.(a+1) + b.\frac{\tan x}{x}\right)$

$= a + 1 + b$

$\lim\limits_{x\to 0^+} f(x) = \lim\limits_{x\to 0}\frac{\sqrt{ax + b^2x^2} - \sqrt{ax}}{b\sqrt{a}.x^{3/2}}$

$\lim\limits_{x\to 0}\frac{ax + b^2x^2 - ax}{b\sqrt{a}.x^{3/2}(\sqrt{ax + b^2x^2} + \sqrt{ax})}$

$= \frac{b}{2a}$

Since it is continuous at x = 0

$\lim\limits_{x\to o^-} f(x) = f(0) = \lim\limits_{x\to o^+} f(x)$

$\frac{b}{2a} = 3 = a + b + 1$

A/Q $\frac{b}{a} = 6$

Q19. If the shortest distance between the lines $\frac{x-\lambda}{2} = \frac{y-4}{3} = \frac{z-3}{4}$ and $\frac{x-2}{4} = \frac{y-4}{6} = \frac{z-7}{8}$ is $\frac{13}{\sqrt{29}}$, then a value of λ is :

(A) 1
(B) $-\frac{13}{25}$
(C) $\frac{13}{25}$
(D) –1

Ans. A

Sol. Since lines are parallel so shortest distance

b/w $\vec{r} = \vec{a}_1 + \lambda\vec{b}$ & $\vec{r} = \vec{a}_2 + \lambda\vec{b}$ is

$= |(\vec{a}_2 - \vec{a}_1)\times\hat{b}|$

here $\vec{a}_2\vec{a}_1 = <\lambda - 2, 0, 4>$

$= (\vec{a}_2 - \vec{a}_1)\times\vec{b} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \lambda-2 & 0 & -4 \\ 2 & 3 & 4 \end{vmatrix}$

$$\frac{13}{\sqrt{29}} = \left|\frac{-12\hat{i} - 4\lambda\hat{j} + (3\lambda - 6)\hat{k}}{\sqrt{29}}\right|$$

$$\Rightarrow \ 169 = 144 + 16\lambda^2 + 9(\lambda - 2)^2 \Rightarrow \lambda = 1, \frac{11}{25}$$

Q20. Let $\vec{a} = \hat{i} + 2\hat{j} + 3\hat{k}$, $\vec{b} = 2\hat{i} + 3\hat{j} - 5\hat{k}$ and $\vec{c} = 3\hat{i} - \hat{j} + \lambda\hat{k}$ be three vectors. Let $\vec{r}$ be a unit vector along $\vec{b} + \vec{c}$. If $\vec{r} \cdot \vec{a} = 3$, then 3λ is equal to

(A) 30 (B) 25
(C) 21 (D) 27

Ans. **B**

Sol. Let $\vec{r} = k(\vec{b} + \vec{c})$

Given $\vec{r}.\vec{a} = 3$

$k(\vec{b} + \vec{c}).\vec{a} = 3$

$\Rightarrow k(3\lambda - 6) = 3 \Rightarrow k = \frac{1}{\lambda - 2}$

$|\vec{r}| = 1 \Rightarrow |k(\vec{b} + \vec{c})| = 1$

$\Rightarrow \sqrt{25 + 4 + (\lambda - 5)^2} = (\lambda - 2)^2$

$\Rightarrow 3\lambda = 25$

SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

Q21. If $\int \frac{1}{5\sqrt{(x-1)^4\ (x+3)^6}} dx = A\left(\frac{\alpha x - 1}{\beta x + 3}\right)^B + C$, where C is the constant of integration, then the value of $\alpha + \beta + 20\ AB$ is_____.

Ans. **7**

Sol. $\int \frac{dx}{\sqrt[5]{(x-1)^4\ (x+3)^6}} = \int \frac{dx}{\sqrt[5]{\left(\frac{x-1}{x+3}\right)^4 .(x+3)^{10}}}$

$= \int \frac{1}{(x+3)^2 \left(\frac{x-1}{x+3}\right)^{4/5}}$

Let $\left(\frac{x-1}{x+3}\right) = t \Rightarrow \frac{4dx}{(x+3)^2} = dt$

$= \frac{1}{4}\int \frac{dt}{t^{4/5}} = \frac{5}{2}\left(t^{1/5}\right) + c = \frac{5}{4}\left(\frac{x-1}{x+3}\right)^{1/5} + c$

Compare $A = \frac{5}{4}$, $\alpha = 1$, $\beta = 1$, $B = \frac{1}{5}$

A/Q $\alpha + \beta + 20AB = 7$

Q22. Let $P(\alpha,\beta,\gamma)$ be the image of the point Q(1, 6, 4) in the line $\frac{x}{1}=\frac{y-1}{2}=\frac{z-2}{3}$. Then $2\alpha+\beta+\gamma$ is equal to_____.

Ans. **11**

Sol. General pt on $\frac{x}{1}=\frac{y-1}{2}=\frac{z-2}{3}=\lambda$

be $(\lambda, 2\lambda + 1, 3\lambda + 2)$

DR of PQ = $<\lambda - 1, 2\lambda - 5, 3\lambda - 2>$

PQ & line is $\perp$

$1(\lambda - 1) + 2(2\lambda - 5) + 3(3\lambda - 2) = 0$

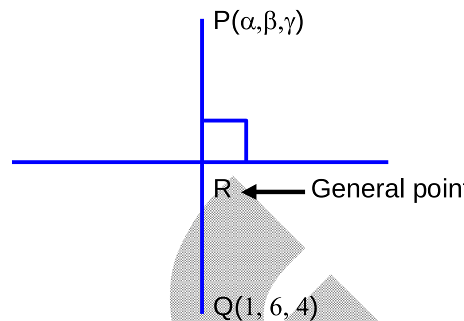
$\Rightarrow \lambda = \frac{17}{14}$

R is mid pt. $\lambda = \frac{\alpha+1}{2} \Rightarrow \alpha = 2\lambda - 1$

Similarly $\beta = 4\lambda - 4$

$\gamma = 6\lambda$

A/Q $2\alpha + \beta + \gamma = 4\lambda - 2 + 4\lambda - 4 + 6\lambda$



Q23. Let $\alpha|x| = |y|e^{xy-\beta}$, $\alpha,\beta \in N$ be the solution of the differential equation xdy – ydx + xy (xdy + ydx) = 0, y(1) = 2. Then $\alpha+\beta$ is equal to_____.

Ans. **4**

Sol. $xdy - ydx + xy(xdy + ydx) = 0$

$x^2\left(d\left(\frac{y}{x}\right)\right) + xy.d(xy) = 0$

$\Rightarrow \frac{d\left(\frac{y}{x}\right)}{\frac{y}{x}} + d(xy) = 0$

Integrate

$\int \frac{d\left(\frac{y}{x}\right)}{\frac{y}{x}} + \int d(xy) = c$

$\ln \frac{y}{x} + xy = c$

$x = 1, y = 2 \Rightarrow c = 2 + \ln 2$

$\ln \frac{y}{x} = 2 + \ln 2 - xy$

$\left|\frac{y}{x}\right| = e^{2+\ln 2 - xy} = 2e^{2-xy}$

$\Rightarrow 2|x| = |y|.e^{xy-2}$

Compare $\alpha = 2, \beta = 2$

Q24. Let a ray of light passing through the point (3, 10) reflects on the line 2x + y = 6 and the reflected ray passes through the point (7, 2). If the equation of the incident ray is ax + by + 1 = 0, then $a^2 + b^2 + 3ab$ is equal to_____.

Ans. **1**

Sol. Image of (7, 2) about the line will be, on the incident Ray

$\frac{x-7}{2}=\frac{y-2}{1}=\frac{-2(14+2-6)}{5}$

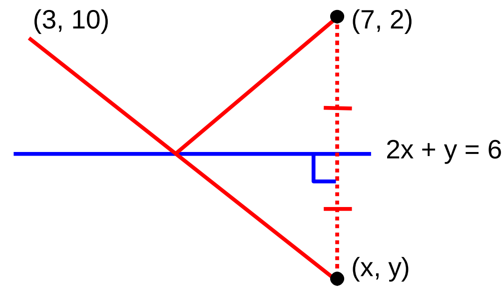
$x = -1, y = -2$

line through (3, 10) & (–1, –2)

$\frac{y+2}{x+1}=\frac{12}{4} \Rightarrow 3x-y+1=0$

A/Q $a^2 + b^2 + 3ab = 9 + 1 + 3.3(-1)$

$= 1$



Q25. Let a, b, c $\in$ N and a < b < c. Let the mean, the mean deviation about the mean and the variance of the 5 observations 9, 25, a, b, c be 18, 4 and $\frac{136}{5}$, respectively. Then 2a + b – C is equal to_____.

Ans. **33**

Sol. $AM \Rightarrow \frac{9+25+a+b+c}{5}=18 \Rightarrow a+b+c=56$

Mean deviation

$\frac{|9-18|+|25-18|+|a-18|+|b-18|+|c-18|}{5}=4$

$|a-18| + |b-18| + |c-18| = 4$

Variance $\frac{\sum(x_i-\bar{x})^2}{N}=\frac{136}{5}$

$\Rightarrow \frac{(9-18)^2+(25-18)^2+(a-18)^2+(b-18)^2+(c-18)^2}{5}=\frac{136}{5}$

$\Rightarrow (a-18)^2+(b-18)^2+(c-18)^2=6$

Since $a,b,c \in N$

sum of squares $= 6 \Rightarrow 1, 1, 2$

so a = 17, b = 19, c = 20

A/Q 2a + b – c = 33

Q26. If $\alpha=\lim_{x\to 0^+}\left(\frac{e^{\sqrt{\tan x}}-e^{\sqrt{x}}}{\sqrt{\tan x}-\sqrt{x}}\right)$ and $\beta=\lim_{x\to 0}(1+\sin x)^{\frac{1}{2}\cot x}$ are the roots of the quadratic equation $ax^2+bx-\sqrt{e}=0$, then 12 $\log_e$(a + b) is equal to_____.

Ans. **6**

Sol. $\alpha = \lim_{x\to o^+}\left(\frac{e^{\sqrt{\tan x}}-e^{\sqrt{x}}}{\sqrt{\tan x}-\sqrt{x}}\right)$

$= \lim_{x\to o^+} e^{\sqrt{x}}\frac{\left(e^{\sqrt{\tan x}-\sqrt{x}}-1\right)}{\sqrt{\tan x}-\sqrt{x}}$

$= 1$

$\beta = \lim_{x\to o}(1+\sin x)^{\frac{\cot x}{2}}$

$= e^{\lim_{x\to 0}} \cot x.\sin x = e^{1/2}$

α, β as root

$\Rightarrow (x-1)(x-\sqrt{e})=0$

$\Rightarrow (x^2 - x(1+\sqrt{e}) + \sqrt{e}) = 0$

$-x^2 + (1+\sqrt{e})x - \sqrt{e} = 0$

A/Q $a = -1,\ b = 1+\sqrt{e}$

12 ln (a + b) = 6

Q27. Let S be the focus of the hyperbola $\frac{x^2}{3} - \frac{y^2}{5} = 1$, on the positive x-axis. Let C be the circle with its centre at $A(\sqrt{6}, \sqrt{5})$ and passing through the point S. If O is the origin and SAB is a diameter of C, then the square of the area of the triangle OSB is equal to_____.

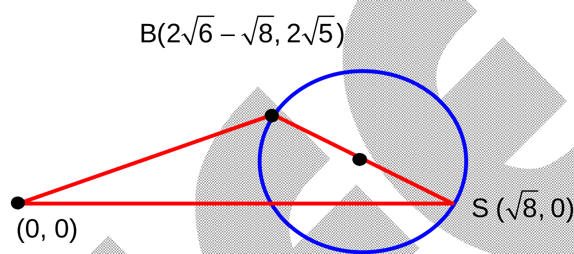
Ans. **1505**

So. $\frac{x^2}{3} - \frac{y^2}{5} = 1$

Focus $(\sqrt{8}, 0)$

area = $\frac{1}{2}\sqrt{8}.2\sqrt{5}$

= $\sqrt{40}$



Q28. An arithmetic progression is written in the following way

2
5 8
11 14 17
20 23 26 29
- - - - - - - - - - - - -
- - - - - - - - - - - - - - - -

The sum of all the terms of the 10^{th} row is_____.

Ans. **40**

Sol. 10^{th} row will have 10 elements first elements of every row

Let $S = 2 + 5 + 11 + 20 + \ldots + t_{10}$

$\underline{S = \quad 2 + 5 + 11 + \ldots\ldots + t_{10}}$

$0 = 2 + \underbrace{3 + 6 + 9 + \ldots\ldots}_{9 \text{ terms in AP}} - t_{10}$

$t_{10} = 2 + 3(1 + 2 + 3 + \ldots 9)$

$= 2 + 3.\frac{9.10}{2}$

= 137

so sum of terms n = 10

a = 137

d = 3

$S = \frac{10}{2}(2.137 + 9.3)$

= 1505

Q29. The number of distinct real roots of the equation $|x + 1|\,|x + 3| - 4|x + 2| + 5 = 0$, is_____.

Ans. **2**

Sol. **Case-I**

$x > -1$

$x^2 + 4x + 3 - 4x - 8 + 5 = 0$

$x^2 = 0$

so, $x = 0$

Case-II

$-1 \geq x \geq -2$
$-x^2 - 4x - 3 - 4x - 8 + 5 = 0$
$x^2 + 8x + 6 = 0$
$x = -4 \pm \sqrt{40}$
False

Case-III
$-3 \leq x < -2$
$-x^2 - 4x - 3 + 4x + 2 + 5 = 0$
$x^2 = 4$
$x = 2, -2$
No Solution.

Case-IV
$x < -3$
$+ (x^2 + 4x + 3) + 4x + 8 + 5 = 0$
$x^2 + 8x + 16 = 0 \Rightarrow x = -4$

Q30. Let A be the region enclosed by the parabola $y^2 = 2x$ and the line $x = 24$. Then the maximum area of the rectangle inscribed in the region A is ____.

Ans. **128**

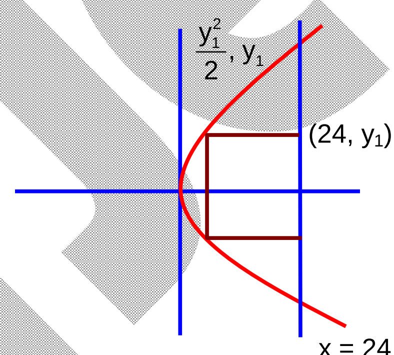
Sol. Area $= 2\left(24 - \frac{y_1^2}{2}\right)y_1$

$A = 48y_1 - y_1^3$

for maximum, $\frac{dA}{dy_1} = 0$

$48 - 3y_1^2 = 0 \Rightarrow y_1 = 4$

So area $= 48.4 - 4^3$
$= 128$



PART – B (PHYSICS)

SECTION - A

(One Options Correct Type)

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

Q31. Least count of a vernier caliper is $\frac{1}{20N}$cm. The value of one division on the main scale is 1 mm. Then the number of divisions of main scale that coincide with N divisions of vernier scale is:

(A) $(2N-1)$
(B) $\left(\frac{2N-1}{2}\right)$
(C) $\left(\frac{2N-1}{2N}\right)$
(D) $\left[\frac{2N-1}{20N}\right]$

Ans. B

Sol. Let 'n' number of divisions of main scale coincide with N divisions of varies scale, then

$N.(1VSD) = n.(1MSD)$

Least. count $LC = \frac{1}{20N}cm = \frac{1}{2N}mm$

$LC = 1MSD - 1VSD$

$\frac{1}{2N}mm = 1mm - \frac{n(1mm)}{N}$

$n = \left(1 - \frac{1}{2N}\right)N$

$n = \frac{2N-1}{2}$

Q32. A thin circular disc of mass M and radius R is rotating in a horizontal plane about an axis passing through its centre and perpendicular to its plane with angular velocity ω. If another disc of same dimensions but of mass $\frac{M}{2}$ is placed gently on the first disc co-axially, then the new angular velocity of the system is:

(A) $\frac{2}{3}\omega$
(B) $\frac{3}{2}\omega$
(C) $\frac{5}{4}\omega$
(D) $\frac{4}{5}\omega$

Ans. A

Sol. Conservation of angular momentum

$I_1\omega_1 = I_2\omega_2$

$\frac{MR^2}{2}\omega = \frac{3}{2}\left(\frac{MR^2}{2}\right)\omega_2$

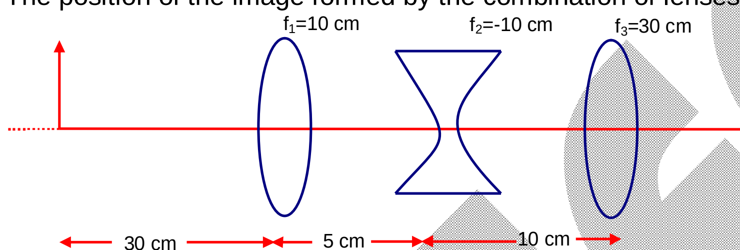
$\omega_2 = \frac{2}{3}\omega$

Q33. A plane progressive wave is given by $y = 2\cos 2\pi(330t - x)\,m$. The frequency of the wave is:
(A) 165 Hz
(B) 660 Hz
(C) 330 Hz
(D) 340 Hz

Ans. C

Sol. $y = 2\cos 2\pi(330t - x)$
By comparing standard equation
$y = A\cos(\omega t - kx)$
$\omega = 2\pi \times 330$
$2\pi f = 2\pi \times 330$
$f = 330\,Hz$

Q34. The position of the image formed by the combination of lenses is:



(A) 30 cm (left of third lens)
(B) 30 cm (right of third lens)
(C) 15 cm (right of second lens)
(D) 15 cm (left of second lens)

Ans. B

Sol. For lens1 ; $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

$v = \frac{uf}{u+f} = \frac{-30 \times 10}{-30+10} = 15cm$

for lens2 ; $u = +(15-5)cm = +10cm$

$v = \frac{uf}{u+f} = \frac{10 \times (-10)}{10-10} = -\infty$

For lens3 ; object at infinity $(u = -\infty)$ so image will be formed at focus i.e 30cm (right of third lens)

Q35. If ϵ_0 is the permittivity of free space and E is the electric field, $\epsilon_0 E^2$ has the dimensions:
(A) $\left[M^{-1} L^{-3} T^4 A^2\right]$
(B) $\left[M^0 L^{-2} T A\right]$
(C) $\left[M L^2 T^{-2}\right]$
(D) $\left[M L^{-1} T^{-2}\right]$

Ans. D

Sol. Electrostatic energy density

$\frac{\text{Energy}}{\text{Volume}} = \frac{1}{2}\varepsilon_0 E^2$

$\left[\varepsilon_0 E^2\right] = \frac{ML^2T^{-2}}{L^3} = ML^{-1}T^{-2}$

Q36. If M_0 is the mass of isotope ${}^{12}_{5}B$, M_P and M_n are the masses of proton and neutron, then nuclear binding energy of isotope is:
(A) $(5M_p + 7M_n - M_0)C^2$
(B) $(M_0 - 5M_p)C^2$
(C) $(M_0 - 5M_p - 7M_n)C^2$
(D) $(M_0 - 12M_n)C^2$

Ans. A

Sol. Binding energy

$$BE = (\Delta m)c^2$$

$$= (5M_P + 7M_n - M_0)c^2$$

Q37. The angle of projection for a projectile to have same horizontal range and maximum height is:

(A) $\tan^{-1}\left(\frac{1}{2}\right)$ (B) $\tan^{-1}\left(\frac{1}{4}\right)$

(C) $\tan^{-1}(2)$ (D) $\tan^{-1}(4)$

Ans. D

Sol. $\tan\theta = \frac{4H}{R}$

for H = R

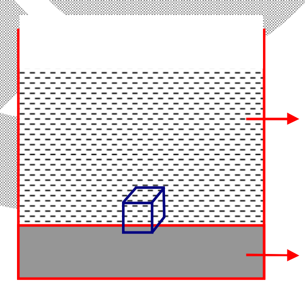
$\tan\theta = 4$

$\theta = \tan^{-1}(4)$

Q38. A cube of ice floats party in water and partly in kerosene oil. The ratio of volume of ice immersed in water to that in kerosene oil (specific gravity of Kerosene oil = 0.8, specific gravity of ice = 0.9).

(A) 9 : 10 (B) 1 : 1

(C) 8 : 9 (D) 5 : 4



Ans. B

Sol. Let v_1 = volume of Ice immersed in water

v_2 = volume of Ice immersed in oil

$$(f_B)_1 + (f_B)_2 = Mg$$

$$\rho_\omega v_1 g + \rho_{oil} v_2 g = \rho_{ice}(v_1 + v_2)g$$

$$v_1 + \frac{\rho_{oil} v_2}{\rho_\omega} = \frac{\rho_{ice}}{\rho_\omega}(v_1 + v_2)$$

$$v_1 + 0.8v_2 = 0.9(v_1 + v_2)$$

$$\frac{v_1}{v_2} = 1$$

Q39. A coil of negligible resistance is connected in series with 90Ω resistor across 120 V, 60 Hz supply. A voltmeter reads 36 V across resistance. Inductance of the coil is:

(A) 0.286 H (B) 2.86 H

(C) 0.91 H (D 0.76 H

Ans. D

Sol. $V_R = I_{rms}.R = \frac{V_{rms}}{z}.R$

$$36 = \frac{120}{\sqrt{x_L^2 + R^2}}.R$$

$$36 = \frac{120}{\sqrt{x_L^2 + 90^2}} \times 90$$

$$x_L \simeq 286.2$$

$\omega.L = 286.2$
$(2\pi.60)L = 286.2$
$L \simeq 0.76\text{Hz}$

Q40. Water boils in an electric kettle in 20 minutes after being switched on. Using the same main supply, he length of the heating element should be……to……. times of its initial length if the water is to be boiled in 15 minutes.

(A) increased, $\frac{4}{3}$
(B) decreased, $\frac{4}{3}$
(C) decreased, $\frac{3}{4}$
(D) inreased, $\frac{3}{4}$

Ans. **C**

Sol. $H = P_1t_1 = P_2t_2$

$$\frac{v^2}{\rho\frac{\ell_1}{A}}t_1 = \frac{v^2}{\rho\frac{\ell_2}{A}}t_2$$

$$\frac{\ell_2}{\ell_1} = \frac{t_2}{t_1} = \frac{15}{20} = \frac{3}{4}$$

$$\ell_2 = \frac{3}{4}\ell_1$$

Decreased, 3/4

Q41. A proton and an electron have the same de Broglie wavelength. If K_p and K_e be the kinetic energies of proton and electron respectively, then choose the correct relation:

(A) $K_p = K_e$
(B) $K_p = K_e{}^2$
(C) $K_p > K_e$
(D) $K_p < K_e$

Ans. **D**

Sol. $\lambda = \frac{h}{P} = \frac{\ell}{\sqrt{2mk}}$

$\lambda_P = \lambda_e$
$m_Pk_P = m_ek_e$
$k_P < k_e \qquad (\because m_P > m_e)$

Q42. In a hypothetical fission reaction

${}_{92}X^{236} \rightarrow {}_{56}Y^{141} + {}_{36}Z^{92} + 3R$

The identity of emitted particles (R) is :

(A) $\gamma-$radiations
(B) Electron
(C) Neutron
(D) Proton

Ans. **C**

Sol. ${}_{92}X^{236} \longrightarrow {}_{56}Y^{141} + {}_{36}Z^{92} + 3{}_0^1R$

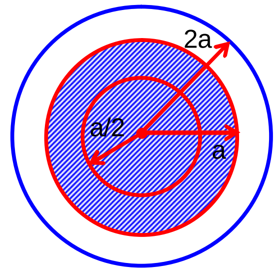
$R \Rightarrow$ Neutron.

Q43. A long straight wire of radius a carries a steady current 1. The current is uniformly distributed across its cross section. The ratio of the magnetic field at $\frac{a}{2}$ and 2a from axis of the wire is:

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

Ans. **A**

Sol. $\Rightarrow$ Magnetic field at r = a/2
Using ampere's law



$$B_1 2\pi\left(\frac{a}{2}\right)=\mu_0\frac{1}{\pi a^2}\cdot\left(\frac{a}{2}\right)^2$$

$$B_1=\frac{\mu_0 I}{4\pi a}$$

$\Rightarrow$ Magnetic field at r = 2a

Using Ampere's caw

$$B_2\cdot 2\pi(2a)=\mu_0 I$$

$$B_2=\frac{\mu_0 I}{4\pi a}$$

i.e. $\frac{B_1}{B_2}=1$

Q44. A capacitor has air as dielectric medium and two conducting plates of area 12 cm^2 and they are 0.6 cm apart. When a slab of dielectric having area 12 cm^2 and 0.6 cm thickness is inserted between the plates, one of the conducting plates has to be moved by 0.2 cm to keep the capacitance same as in previous case. The dielectric constant of the slab is :
(Given $\in_0=8.834\times10^{-12}F/m$)

(A) 1 (B) 0.66
(C) 1.50 (D) 1.33

Ans. **C**

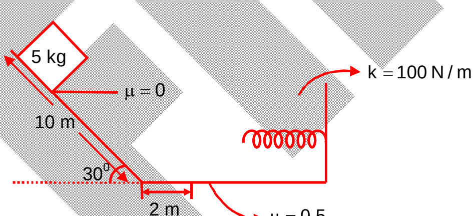
Sol. $$\frac{\varepsilon_0 A}{d}=\frac{\varepsilon_0 A}{0.2+\frac{d}{k}}$$

$$d=0.2+\frac{d}{k}$$

$$0.6=0.2+\frac{0.6}{k}$$

$$k=\frac{0.6}{0.4}=\frac{3}{2}=1.50$$

Q45.



A block is simply released from the top of an inclined plane as shown in the figure above. The maximum compression in the spring when the block hits the page is :

(A) $\sqrt{5}m$ (B) $\sqrt{6}m$
(C) 1 m (D) 2 m

Ans. **D**

Sol. Applying work-energy theorem

$$W_{Total}=\Delta KE$$

$W_{gravity}$ +W_{spring}+$W_{friction}$ = KE_{final} - $KE_{initial}$

$$mgh-\frac{1}{2}kx^2-\mu mgx=0-0$$

$$5\times10\times5-\frac{1}{2}100x^2-0.5\times5\times10\times x=0$$
$$50x^2+25x=250$$
x = 2

Q46. A diatomic gas $(\gamma=1.4)$ does 100 J of work in an isobaric expansion. The heat given to the gas is:

(A) 250 J (B) 490 J
(C) 350 J (D) 150 J

Ans. C

Sol. Isobaric expansion

$$Q=\Delta U+W$$
$$1=\frac{\Delta U}{Q}+\frac{W}{Q}$$
$$\frac{W}{Q}=\left(1-\frac{\Delta U}{Q}\right)=\left(1-\frac{nc_V\Delta T}{nc_P\Delta T}\right)$$
$$\frac{W}{Q}=\left(1-\frac{1}{r}\right)=\left(1-\frac{1}{1.4}\right)$$
$$\frac{100}{Q}=\frac{0.4}{1.4}$$
Q = 350J

Q47. There are 100 divisions on the circular scale of a screw gauge of pitch 1 mm. With no measuring quantity in between the jaws, the zero of the circular scale lies 5 divisions below the reference line. The diameter of a wire is then measured using this screw gauge. It is found that 4 linear scale divisions are clearly visible while 60 divisions on circular scale coincide with the reference line. The diameter of the wire is :

(A) 3.35 mm (B) 4.60 mm
(C) 4.65 mm (D) 4.55 mm

Ans. D

Sol. Least count

$$LC=\frac{\text{Pitch}}{\text{Total division on circular scode}}$$
$$LC=\frac{1mm}{100}=0.01mm$$
Also, Zero error $=+5\times(0.01)mm$

$=+0.05mm$

Reading = $4\times1mm+60\times0.01mm-0.05mm$

Reading = 4.55mm

Q48. Two satellite A and B go round a planet in circular orbits having radii 4R and R respectively. If the speed of A is 3v, the speed of B will be:

(A) 3v (B) 12v
(C) 6v (D) $\frac{4}{3}v$

Ans. C

Sol. Orbital speed

$$V_0=\sqrt{\frac{GM}{R}}$$ M $\rightarrow$ Mass of planet
R $\rightarrow$ Radius of orbit

$$V_0 \propto \frac{1}{R}$$
$$\frac{V_B}{V_A} = \sqrt{\frac{R_A}{R_A}} = \sqrt{\frac{4R}{R}} = 2$$
$$V_B = 2V_A = 2(3V)$$
$$V_B = 6V$$

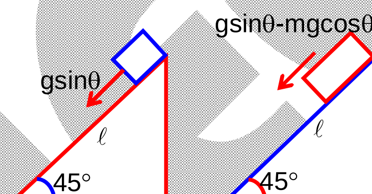
Q49. A given object takes n times the time to slide down 45^0 rough inclined plane as it takes the time to slide down an identical perfectly smooth 45^0 inclined plane. The coefficient of kinetic friction between the object and the surface of inclined plane is :

(A) $1-\frac{1}{n^2}$ (B) $\sqrt{1-n^2}$

(C) $\sqrt{1-\frac{1}{n^2}}$ (D) $1-n^2$

Ans. A

Sol. For smooth inclined plane



$$\ell = \frac{1}{2}(g\sin\theta)t_1^2$$
$$t_1 = \sqrt{\frac{2\ell}{g\sin\theta}}$$

For Rough inclined plane

$$\ell = \frac{1}{2}(g\sin\theta - \mu g\cos\theta)t_2^2$$
$$t_2 = \sqrt{\frac{2\ell}{g\sin\theta - \mu g\cos\theta}} \quad \text{-(ii)}$$

According to Question $t_2 = nt_1$

$$\sqrt{\frac{2\ell}{g\sin\theta - \mu g\cos\theta}} = n\sqrt{\frac{2\ell}{g\sin\theta}}$$
$$\frac{1}{\sin\theta - \mu\cos\theta} = \frac{n^2}{\sin\theta}$$
$$\theta = 45^\circ$$
$$\mu = 1-\frac{1}{n^2}$$

Q50. Given below are two statements :

Statement (I) : The mean free path of gas molecules is inversely proportional to square of molecular diameter.

Statement (II) : Average kinetic energy of gas molecules is directly proportional to absolute temperature of gas.

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

(A) Both **Statement I** and **Statement II** are false
(B) **Statement I** is true but **Statement II** is false
(C) Both **Statement I** and **Statement II** are true
(D) **Statement I** is false but **Statement II** is true

Ans. C

Sol. Mean free path

$$\lambda = \frac{RT}{\sqrt{2}\pi d^2 N_A P}$$

$\lambda \propto \frac{1}{d^2}$

$\text{Also, } KE = \frac{f}{2}nRT$

$KE \propto T$

SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

Q51. Two slits are 1 mm apart and the screen is located 1 m away from the slits. A light of wavelength 500 nm is used. The width of each slit to obtain 10 maxima of the double slit pattern within the central maximum of the single slit pattern is……….x 10^{-4} m.

Ans. **2**

Sol. $10\left(\frac{\lambda D}{d}\right) = \frac{2\lambda D}{a}$

$a = \frac{d}{5}$

$a = \frac{10^{-3}}{5} m = 2 \times 10^{-4} m$

Q52. Small water droplets of radius 0.01 mm are formed in the upper atmosphere and falling with a terminal velocity of 10 cm/s. Due to condensation. If 8 such droplets are coalesced and formed a larger drop, the new terminal velocity will be………cm/s.

Ans. **40**

Sol. Let radius of smaller drop is r and radius of bigger drop is R

$8\left(\frac{4}{3}\pi r^3\right) = \frac{4}{3}\pi R^3$

$R = 2r$

$\Rightarrow V_T = \frac{2r^2 g}{9\eta}(\rho - \sigma)$

$V_T \propto r^2$ -(i)

$\frac{V_T'}{V_T} = \frac{R^2}{r^2} = \frac{(2r)^2}{r^2} = 4$

$V_T^1 = 4V_T = 4 \times 10 cm/s$

$V_T^1 = 40 cm/s$

Q53. A body of mass M thrown horizontally with velocity v from the top of the tower of height H touches the ground at a distance of 100 m from the foot of the tower. A body of mass 2M thrown at a velocity $\frac{v}{2}$ from the top of the tower of height 4H will touch the ground at a distance of…….m.

Ans. **100**

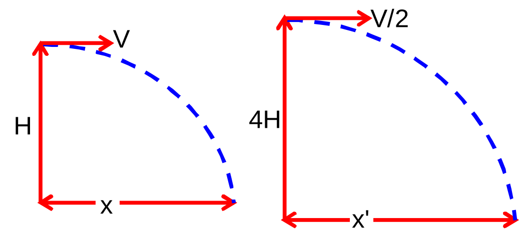
Sol. $x = V\sqrt{\frac{2H}{g}}$

$x' = \frac{v}{2}\sqrt{\frac{2(4H)}{g}}$

$x' = v\sqrt{\frac{2H}{g}}$

From equation (i) & (ii)

$x' = x = 100\text{m}$



Q54. The coercivity of a magnet is $5\times10^{3}\,\text{A/m}$. The amount of current required to be passed in a solenoid of length 30 cm and the number of turns 150, so that the magnet getse demagnetized when inside the solenoid is………A.

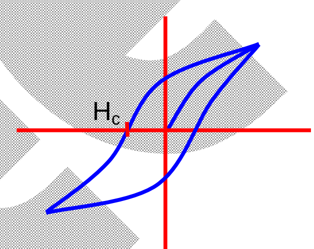
Ans. **10**

Sol. $\mu_0 H_C = \mu_0 n i$

$i = \frac{H_C}{n}$

$i = \frac{5\times10^{3}}{\left(\frac{150}{30\times10^{-2}}\right)}$

i = 10



Q55. An object of mass 0.2 kg executes simple harmonic motion along x axis with frequency of $\left(\frac{25}{\pi}\right)$Hz. At the position x = 0.04 m the object has kinetic energy 0.5 J and potential energy 0.4 J. The amplitude of oscillation is……..cm.

Ans. **6**

Sol. Total energy = KE + PE

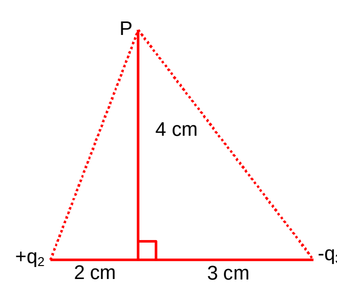
$\frac{1}{2}m\omega^{2}A^{2} = 0.5 + 0.4$

$\frac{1}{2}\times0.2\times\left(2\pi\times\frac{25}{\pi}\right)^{2}\cdot A^{2} = 0.9$

$A = 0.06\,\text{m}$

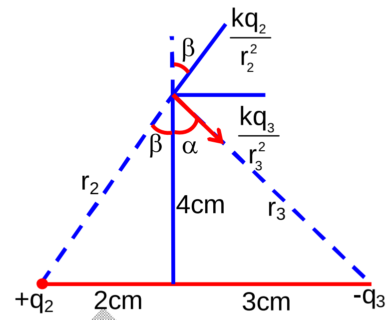
A = 6cm

Q56. If the net electric field at point P along Y axis is zero, then the ratio of $\left|\frac{q_2}{q_3}\right|$ is $\frac{8}{5\sqrt{x}}$, where x = ………………



Ans. **5**

Sol. $E_y = 0$



$$\frac{kq_2}{r_2^2}\cos\beta = \frac{kq_3}{r_3^2}\cos\alpha$$

$$\frac{q_2}{q_3} = \frac{\cos\alpha}{\cos\beta}\cdot\left(\frac{r_2}{r_3}\right)^2$$

$$\frac{q_2}{q_3} = \frac{4/5}{4/\sqrt{20}}\cdot\left(\frac{\sqrt{20}}{5}\right)^2$$

$$\frac{q_2}{q_3} = \frac{\sqrt{20}}{5}\times\frac{20}{25} = \frac{8\sqrt{5}}{25}$$

$$\frac{q_2}{q_3} = \frac{8}{5\sqrt{5}} = \frac{8}{5\sqrt{x}}$$

$$x = 5$$

Q57. An alternating emf $E = 110\sqrt{2}\,\sin 100t$ volt is applied to a capacitor of $2\mu F$, the rms value of current in the circuit is……….mA.

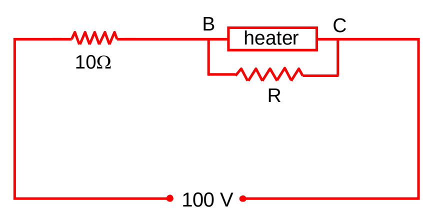
Ans. **22**

Sol.
$$i_{rms} = \frac{V_{rms}}{X_c} = \frac{\left(\frac{110\sqrt{2}}{\sqrt{2}}\right)}{(1/\omega c)}$$

$$i_{rms} = 110\times\left(100\times 2\times 10^{-6}\right)$$

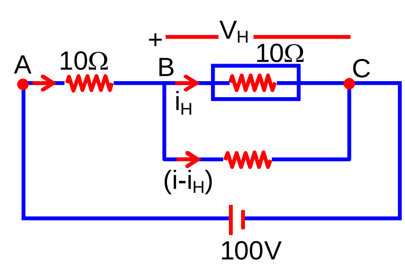
$$i_{rms} = 22\,mA$$

Q58. A heater is designed to operate with a power of 1000 W in a 100 V line. It is connected in combination with a resistance of 10Ω and a resistance R to a 100 V mains as shown in figure. For the heater to operate at 62.5 W, the value of R should be……….Ω .



Ans. **5**

Sol. Resistance of heater



$$R_H = \frac{v^2}{P} = \frac{(100)^2}{1000} = 10\,\Omega$$

Maximum potential across heater can be applieds

or $\dfrac{V_H^2}{R_H} = P = 62.5$

$$V_H = \sqrt{62.5\times 10} = 25V$$

i.e $V_{BC} = 25V$

Also $V_{AB} + V_{BC} = 100V$

$$V_{AB} = 75V$$

$$i = \frac{75}{10} = 7.5A$$

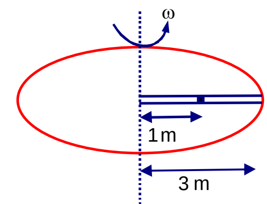
$$i_H = \frac{R}{R+10}(i) = \frac{R}{R+10}\times 7.5$$

$$\frac{25}{10}\frac{R}{R+10}\times 7.5$$

R + 10 = 3R

R = 5Ω

Q59. A circular table is rotating with an angular velocity of ω rad / s about its axis (see figure). There is a smooth groove along a radial direction on the table. A steel ball is gently placed at a distance of 1 m on the groove. All the surfaces are smooth. If the radius of the table is 3 m, the radial velocity of the ball w.r.t. the table at the time ball leaves the table is $x\sqrt{2}\omega$ m / s, where the value of x is...........



Ans. **2**

Ans. $a_c = w^2x$

$$v\frac{dv}{dx} = w^2x$$

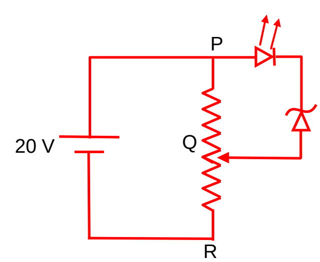
$$\int_0^v vdv = \int_1^3 w^2x\,dx$$

$$\frac{v^2}{2} = w^2\left[\frac{x^2}{2}\right]_1^3$$

$$v = 2\sqrt{2}\,w = x\sqrt{2}w$$

x = 2

Q60. A potential divide circuit is connected with a dc source of 20 V, a light emitting diode of glow in voltage 1.8 V and a zener diode of breakdown voltage of 3.2 V. The length (PR) of the resistive wire is 20 cm. The minimum length of PQ to just glow the LED is..........cm.



Ans. **5**

Sol. Potential graclient

$$x = \frac{20}{20}v/cm = 1v/cm$$

$$V_{PQ} = (1.8+3.2) = 5v$$

$$x(PQ) = 5v$$

$$PQ = \frac{5}{x} = \frac{5v}{1v/cm} = 5cm$$

PART – C (CHEMISTRY)

SECTION - A

(One Options Correct Type)

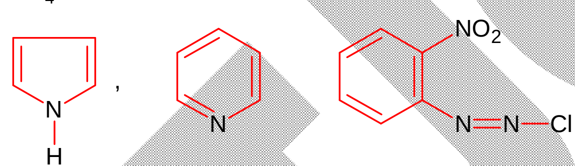
This section contains **20 multiple choice questions**. Each question has **four choices** (1), (2), (3) and (4), out of which **ONLY ONE** option is correct.

Q61. Given below are two statements:
Statement I : Kjeldahl method is applicable to estimate nitrogen in pyridine.
Statement II: The nitrogen present in pyridine can easily be converted into ammonium sulphate in Kjeldahal method.
In the light of the above statements, choose the **correct** answer from the options given below:
(A) **Statement I** is true but **Statement II** is false.
(B) **Statement I** is false but **Statement II** is true.
(C) Both **Statement I** and **Statement II** are true.
(D) Both **Statement I** and **Statement II** are false.

Ans. D

Sol. group, azo group or N present is rings because nitrogen of these compounds can't be converted to $(NH_4)_2SO_4$

e.g →



Q62. Identify the correct statements about p-block elements and their compounds.
(a) Non metals have higher electronegativity than metals.
(b) Non metals have lower ionisaiton enthalpy than metals.
(c) Compounds formed between highly reactive nonmetals and highly reactive metals are generally ionic.
(d) The non-metal oxides are generally basic in nature.
(e) The metal oxides are generally acidic or neutral in nature.
Choose the **correct** answer from the options given below:
(A) (b) and (d) only (B) (a) and (c) only
(C) (b) and (e) only (D) (d) and (e) only

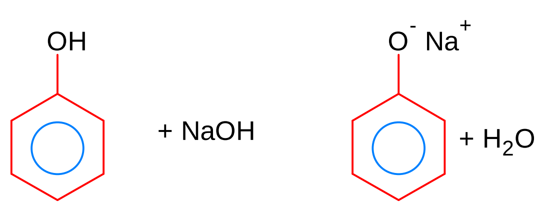
Ans. B

Sol.
- E_N of non- metal increases as non- metallic character increases
- Along period I.E increases, thus metals have lower I.E
- Metal oxides are basic and non- metal oxides are acidic or neutral

Q63. Which one the following compounds will readily react with dilute NaOH?
(A) C_2H_5OH (B) C_6H_5OH
(C) $C_6H_5CH_2OH$ (D) $(CH_3)_3COH$

Ans. B

Sol. $R-OH + NaOH \longrightarrow$ No reaction



Phenol is stronger acid than H_2O

Q64. Given below are two statements:
Statement I : S_N^2 reactions are stereospecific, indicating that they result in the formation of only one stereo-isomer as the product.
Statement II: S_N^1 reactions generally result in formation of product as racemic mixture.
In the light of the above statements, choose the **correct** answer from the options given below:
(A) Both **Statement I** and **Statement II** are true.
(B) Both **Statement I** and **Statement II** are false
(C) **Statement I** is false but **Statement II** is true.
(D) **Statement I** is true but **Statement II** is false.

Ans. A

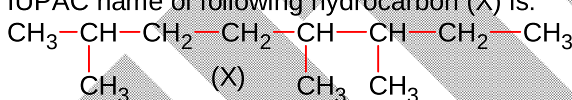
Sol. In S_N^2 reaction <u>Inversion</u> takes place
In S_N^1 reaction <u>Racemisation</u> takes place

Q65. Identify the **incorrect** statements abut group 15 elements:
(a) Dinitrogen is a diatomic gas which acts like an inert gas at room temperature
(b) The common oxidation states of these elements are -3,+3 and +5
(c) Nitrogen has unique ability to form $p\pi$- $p\pi$ multiple bonds.
(d) The stability of +5 oxidation states increases down the group.
(e) Nitrogen shows a maximum covalency of 6.
Choose the **correct** answer from the options given below:
(A) (d) and (e) only
(B) (a), (c), (e) only
(C) (b), (d), (e) only
(D) (a), (b), (d) only

Ans. A

Sol.
- N_2 is diatonic and inert at room temperature
- Common O.S are –3, +3 & +5
- Stability of (+3) oxidation state increases down the group due to inert pair effect
- Nitrogen present in 2nd period , it has no vacant d-orbital, so that it can expand its octet.

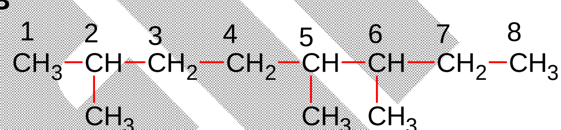
Q66. IUPAC name of following hydrocarbon (X) is:



(A) 2-Ethyl-3,6-dimethylheptane
(B) 2,5,6-Trimethyloctane
(C) 2-Ethy-2,6-diethylheptane
(D) 3,4,7-Trimethyloctane.

Ans. B

Sol.



(2,5,6) – Trimethyloctane.

Q67. The emf of cell $T\ell\,|\,T\ell^{+}\,(0.001M)\,||\,Cu^{2+}\,(0.01M)\,|$ Cu is 0.83 V at 298 K. It could be increased by:
(A) Decreasing concentration of both $T\ell^{+}$ and Cu^{2+} ions
(B) Increasing concentration of $T\ell^{+}$ ions
(C) Increasing concentration of Cu^{2+} ions
(D) Increasing concentration of both $T\ell^{+}$ and Cu^{2+} ions

Ans. C

Sol.
$T\ell\,|\,T\ell^{+}\,||\quad Cu^{+2}\,|\,Cu$
$(0.001M)\quad(0.01M)$

$$\left[T\ell(s)\longrightarrow T\ell^{+}_{(aq)}+e^{-}\right]\times 2$$

$$Cu^{+2}_{(aq)}+2e^{-}\longrightarrow Cu(s)$$

$$\overline{2T\ell(s) + Cu^{+2}_{(aq)} \longrightarrow 2T\ell^{+}_{(aq)} + Cu(s) \longrightarrow} \text{ cell reaction}$$

$$E_{cell} = E^0_{cell} - \frac{0.0591}{2}\log\frac{\left[T\ell^+\right]^2}{\left[Cu^{+2}\right]}$$

E_{cell} increases if $\left[Cu^{+2}\right]$ increases.

Q68. In qualitative test for identification of presence of phosphorous, the compound is heated with an oxidizing agent. Which is further treated with nitric acid and ammonium molybdate respectively. The yellow coloured precipitate obtained is:

(A) $(NH_4)_3PO_4 \cdot 12MoO_3$ (B) $MoPO_4 \cdot 21NH_4NO_3$

(C) $Na_3PO_4.12MoO_3$ (D) $(NH_4)_3PO_4.12(NH_4)_2MoO_4$

Ans. A

Sol. $PO_4^{-3} + (NH_4)_2MoO_4 \xrightarrow{H^{\oplus}} (NH_4)_3PO_4 \uparrow 2MoO_3 \downarrow$

Canary yellow ppt

(Ammonium phospho mohybdate)

This is the test of PO_4^{-3} radical in qualitative analysis.

Q69. Match **List – I** with **List – II**

List –I (Test)	**List – II (Identification)**
(a) Bayer's test	(I) Phenol
(b) Ceric ammonium nitrate test	(II) Aldehyde
(c) Phthalein dye test	(III) Alcoholic-OH group
(d) Schiff's test	(IV) Unsaturation

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

(A) (a) – (II), (b) – (III), (c) – (IV), (d) – (I) (B) (a) – (IV), (b) – (I), (c) – (II), (d) – (III)

(C) (a) – (IV), (b) – (III), (c) – (I), (d) – (II) (D) (a) – (III), (b) – (I), (c) - (IV), (d) – (II)

Ans. C

Sol. Bayer's Δ test $\rightarrow$ Test of unsatsuration

(alk. $KMnO_4$)

Ceric ammonium nitrate test $\rightarrow$ Test of (-OH) group

$(NH_4)_2\,[Ce(NO_3)_6]^{-2}$

Phthalein dye test $\rightarrow$ Phenol

Schiff's test $\rightarrow$ Aldehyde.

Q70. For reaction $A \xrightarrow{K_1} B \xrightarrow{K_2} C$

If the rate of formation of B is set to be zero then the concentration of B is given by:

(A) $(K_1 + K_2)[A]$ (B) $K_1K_2[A]$

(C) $(K_1 / K_2)[A]$ (D) $(K_1 - K_2)[A]$

Ans. C

Sol. $A \xrightarrow{K_1} B \xrightarrow{K_2} C$

Rate of formation of B is

$$\frac{-d[B]}{dt} = K_1[A] - K_2[B]$$

$$O = K_1[A] - K_2[B]$$

$$\frac{K_1}{K_2}[A] = [B]$$

Q71. The equilibrium $Cr_2O_7^{2-} \rightleftharpoons 2CrO_4^{2-}$ is shifted to the right in:

(A) a weakly acidic medium
(B) a neutral medium
(C) an acidic medium
(D) a basic medium

Ans. **D**

Sol. $Cr_2O_7^{--} \underset{H^{\oplus}}{\overset{OH^-}{\rightleftharpoons}} CrO_4^{--}$

In basic medium equilibrium shifted in right & in acidic medium shifted in left

Q72. Given below are two statements:

Statement I : All the following compounds react with p-toluenesulfonyl chloride.

$C_6H_5NH_2$ $(C_6H_5)_2NH$ $(C_6H_5)_3N$

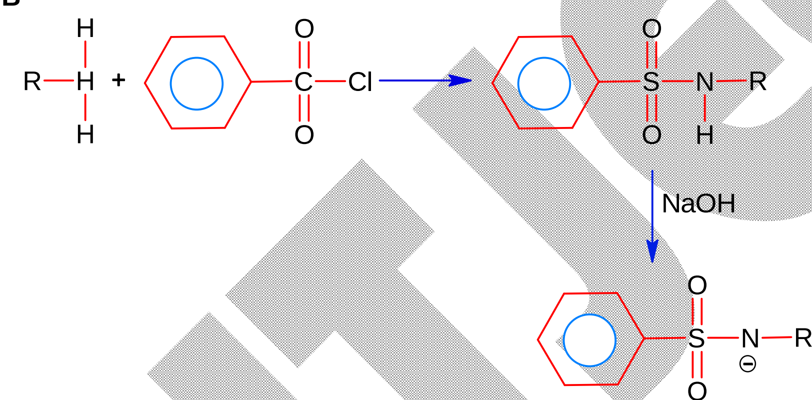
Statement II: Their products in the above reaction are soluble is aqueous NaOH.

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

(A) Both **Statement I** and **Statement II** are true.
(B) Both **Statement I** and **Statement II** are false.
(C) **Statement I** is true but **Statement II** is false.
(D) **Statement I** is false but **Statement II** is true.

Ans. **B**

Sol.



- 1^0 amine gives sulphonamide which is soluble in NaOH
- 2^0 amiry give sulphonamide which does not dissolve in NaOH
- 3^0 amine no reaction with benzene sulphonyl chloride

Q73. When ψ_A and ψ_B are the wave functions of atomic orbitals then σ^* is represented by:

(A) $\psi_A - 2\psi_B$
(B) $\psi_A - \psi_B$
(C) $\psi_A + \psi_B$
(D) $\psi_A + 2\psi_B$

Ans. **B**

Sol. Anti bonding molecular orbital $(\sigma^*) = \psi_A - \psi_B$ It is formed by the destructive overlapping interference of wave functions.

Q74. The reaction;

$\frac{1}{2}H_{2(g)} + AgCl_{(s)} \rightarrow H^+_{(aq)} + C^-_{(aq)} + Ag_{(s)}$

Occurs in which of the following galvanic cell:

(A) $Ag|AgCl_{(s)}|KCl_{(soln.)}|AgNO_{3(aq)}|Ag$
(B) $Pt|H_{2(g)}|HCl_{(soln.)}|AgNO_{3(aq)}|Ag$
(C) $Pt|H_{2(g)}|KCl_{(sol^n.)}|AgCl_{(s)}|Ag$
(D) $Pt|H_{2(g)}|HCl_{(soln.)}|AgNO_{(s)}|Ag$

Ans. **C**

Sol. $\frac{1}{2}H_2(g) + AgC\ell(s) \longrightarrow H^+_{aq} + C\ell^-_{aq} + Ag_{(s)}$.

Anode half-cell reaction

$\frac{1}{2}H_2(g) \longrightarrow H^+_{aq} + e^-$

Cathode half-cell reaction

$Ag^+_{(aq)} + e^- \longrightarrow Ag(s)$

$AgC\ell(s) \longrightarrow Ag^+_{(aq)} + C\ell^-_{(aq)}$

$\cancel{Ag^+_{aq}} + AgC\ell(s) \longrightarrow Ag(s) + \cancel{Ag^+_{aq}} + C\ell^-_{aq}$

∴ Cathode half cell reaction

$AgC\ell(s) + e^- \longrightarrow Ag(s) + C\ell^-_{(aq)}$

∴ overall cell reaction

$\frac{1}{2}H_2(g) + AgC\ell(s) \longrightarrow H^+_{(aq} + C\ell^-_{(aq)} + Ag(s)$

∴ cell representation

$Pt / H_2(g) / KC\ell_{solution} / AgC\ell(s) / Ag$

Q75. Given below are two statements:
Statement I : A Buffer solution is the mixture of a salt and an acid or a base mixed in any particular quantities.
Statement II: Blood is naturally occurring buffer solution whose pH is maintained by H_2CO_3 / HCO_3^- concentrations.
In the light of the above statements, choose the **correct** answer from the options given below:
(A) Both **Statement I** and **Statement II** are true.
(B) Both **Statement I** and **Statement II** are false.
(C) **Statement I** is false but **Statement II** is true.
(D) **Statement I** is true but **Statement II** is false.

Ans. **C**

Sol. • Buffer is a mixture of either
W.A + conjugate salt
W.B + conjugate salt
(CH_3COOH+ CH_3COONa) / (NH_4OH + NH_4Cl)
• Blood is a buffer solution of H_2CO_3 & HCO_3^-

Q76. The correct sequence of acidic strength of the following aliphatic acids in their decreasing order is:
$CH_3CH_2COOH, CH_3COOH, CH_3CH_2CH_2COOH, HCOOH$
(A) $CH_3COOH > CH_3CH_2COOH > CH_3CH_2CH_2COOH > HCOOH$
(B) $HCOOH > CH_3COOH > CH_3CH_2COOH > CH_3CH_2CH_2COOH$
(C) $CH_3CH_2CH_2COOH > CH_3CH_2COOH > CH_3COOH > HCOOH$
(D) $HCOOH > CH_3CH_2CH_2COOH > CH_3CH_2COOH > CH_3COOH$

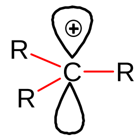
Ans. **B**

Sol. Number of carbon increases in alkyl chain acidic character decreses
$HCOOH > CH_3COOH > CH_3CH_2\text{-}COOH > CH_3\text{-}CH_2\text{-}CH_2\text{-}COOH$

Q77. The shape of carbocation is:
(A) Trigonal planar
(B) Tetrahderal
(C) Diagonal
(D) Diagonal pyramidal

Ans. **A**

Sol. The shape of carbocation



$\longrightarrow Sp^2 \longrightarrow$ Trigonal Planar

Q78. Match **List – I** with **List – II**

List –I (Complex ion)	**List – II (Spin only magnetic moment in B.M)**
(a) $[Cr(NH_3)_6]^{3+}$	(I) 4.90
(b) $[NiCl_4]^{2-}$	(II) 3.87
(c) $[CoF_6]^{3-}$	(III) 0.0
(d) $[Ni(CN)_4]^{2-}$	(IV) 2.83

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

(A) (a) – (IV), (b) – (III), (c) – (I), (d) – (II)
(B) (a) – (II), (b) – (III), (c) – (I), (d) – (IV)
(C) (a) – (I), (b) – (IV), (c) – (II), (d) – (III)
(D) (a) – (II), (b) – (IV), (c) – (I), (d) – (III)

Ans. D

Sol. (a) $\left[Cr(NH_3)_6\right]^{+3} \rightarrow Cr^{+3} = 4s^0 3d^3 \quad u.e = 3$

$\therefore \mu = \sqrt{3(3+2)}\,B.M = \sqrt{15}\,B.M = 3.87\,B.M$

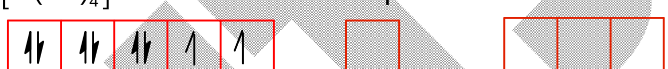
(b) $[NiCl_4]^{-2} \rightarrow Ni^{+2} = -4s^0 3d^8$ unpaired $e^- = 2$

$\therefore \mu = \sqrt{2(2+2)} = \sqrt{8} = 2.83\,B.M$

(c) $[CoF_6]^{-3} \rightarrow Co^{+3} = -4s^0 3d^6 \Rightarrow$ unpaired $e^- = 4$

$\therefore \mu = \sqrt{4(4+2)} = \sqrt{24} = 4.90\,B.M$

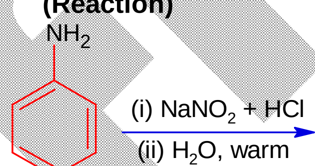
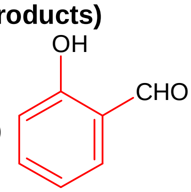
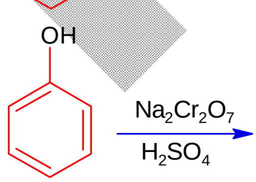
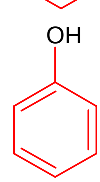
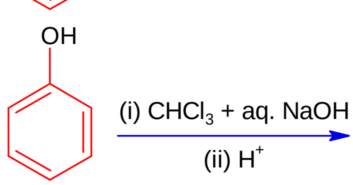
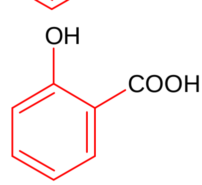
(d) $[Ni(CN)_4]^{-2} \rightarrow Ni^{+2} = -4s^0 3d^8$ unpaired $e^- = 0$

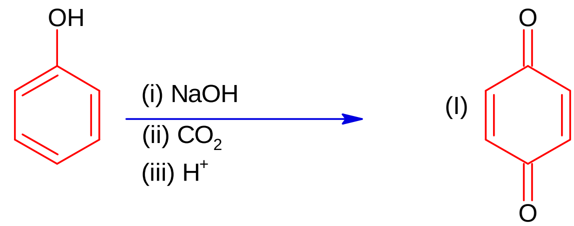


S.F.L $\longrightarrow$ 

$\therefore \mu = 0$

Q79. Match **List – I** with **List – II**

List –I (Reaction)	**List – II (Products)**
(a) 	(I) 
(b) 	(I) 
(c) 	(I) 

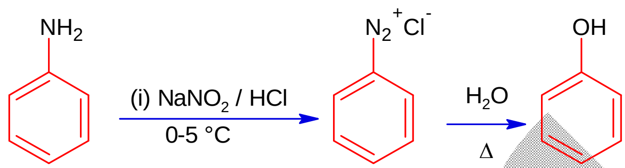
(d) 

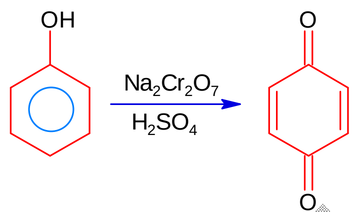
Choose the **correct** answer from the options given below:

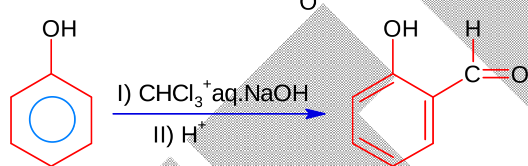
(A) (a)-(I), (b)-(IV), (c)-(II), (d)-(III)
(B) (a)-(IV), (b)-(II), (c)-(III), (d)-(I)
(C) (a)-(III), (b)-(II), (c)-(I), (d)-(IV)
(D) (a)-(II), (b)-(IV), (c)-(I), (d)-(III)

Ans. **D**

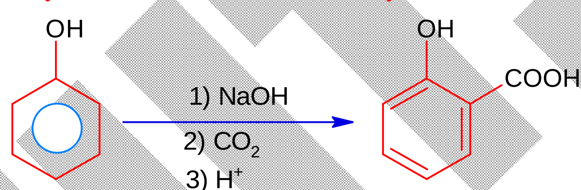
Sol.

(a) 

(b) 

(c) 

(Reimer Tiemann reaction)

(d) 

Q80. Given below are two statements:

Statement I : Fusion of MnO_2 with KOH and an oxidizing agent gives dark green K_2MnO_4

Statement II: Manganate ion on electrolytic oxidation in alkaline medium gives permanganate ion.

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

(A) **Statement I** is false but **Statement II** is true
(B) Both **Statement I** and **Statement II** are true.
(C) **Statement I** is true but **Statement II** is false
(D) Both **Statement I** and **Statement II** are false.

Ans. **B**

Sol. $$MnO_2 + 4KOH + O_2 \longrightarrow \underset{\text{(dark green)}}{2K_2MnO_4} + 2H_2O$$

Electrolytic oxidation in alkaline medium

$$MnO_4^{-2} \longrightarrow MnO_4^- + e^-$$

SECTION - B

(Numerical Answer Type)

This section contains **10** Numerical based questions. The answer to each question is rounded off to the nearest integer value.

Q81. $\Delta_{vap}H^o$ for water is +40.79 kJ mol^{-1} at 1 bar and 100^{o}C. Change in internal energy for this vapourisation under same condition is ___________kJ mol^{-1}. (Integer answer)
(Given R = 8.3J K^{-1}mol^{-1})

Ans. **38**

Sol. $\Delta H^0_{vap} = 40.79\,kJ/mole$

$H_2O(\ell) \rightleftharpoons H_2O(g) \qquad \Delta H^0_{vap} = 40.79\,kJ/mole$

$\Delta H^0_{vap} = \Delta U^0_{vap} + \Delta n_g RT$

$40.79 = \Delta U^0_{vap} + \frac{1\times 8.3\times 373}{1000}$

$\Delta V^0_{vap} = 40.79 - 8.3\times 0.373$

$= 40.79 - 3.09$

$= 37.7 \approx 38\,kJ/mole$

Q82. Number of molecules having bond order 2 from the following molecules is_________.
$C_2, O_2, Be_2, Li_2, Ne_2, N_2, He_2$

Ans. **2**

Sol. B.O= 2

$C_2 = \sigma^2_{1s}\sigma^{x^2}_{1s}\sigma^2_{2s}\sigma^{*2}_{2s}, \pi^2_{2px} \equiv \pi^2_{2py}$

$B.O = \frac{8-4}{2} = 2$

$O_2 = \sigma^2_{1s}\sigma^{*2}_{1s}\sigma^2_{2s}\sigma^{*2}_{2s}\sigma^2_{2pz}\pi^2_{2px} \equiv \pi^2_{2py}, \pi^{*1}_{2px} \equiv \pi^{*1}_{2py}$

$B.O = \frac{10-6}{2} = 2$

$Be_2 = \sigma^2_{1s}\sigma^{*2}_{1s}\sigma^2_{2s}\sigma^{*2}_{2s}$ $\qquad \therefore B.O = \frac{4-4}{2} = 0$

$Li_2 = \sigma^2_{1s}\sigma^{*2}_{1s}\sigma^2_{2s}$ $\qquad B.O = \frac{4-2}{2} = 1$

$Ne_2 = \sigma^2_{1s}, \sigma^{*2}_{1s}, \sigma^2_{2s}, \sigma^{*2}_{2s}, \sigma^2_{2pz}, \pi^2_{2px} \equiv \pi^2_{2py}, \pi^{*2}_{2px} \equiv \pi^{*2}_{2py}\sigma^2_{2pz}$

$B.O = \frac{10-10}{2} = 0$

$N_2, \qquad B.O = \frac{10-4}{2} = 3$

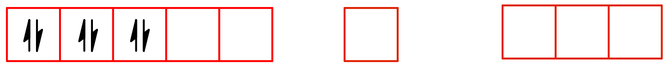
$He_2, \qquad B.O = \frac{2-2}{2} = 0$

C_2 & O_2 has B.O = 2

Q83. Total number of unpaired electrons in the complex ions $[Co(NH_3)_6]^{3+}$ and $[NiCl_4]^{2-}$ is_____

Ans. **2**

Sol. $\left[Co(NH_3)_6\right]^{+3}, \quad Co^{+3} = 4s^0 3d^6$



$3d^6$

S.F.L $\longrightarrow$ low spin complex $t_{2g}^{2,2,2} e_g^{0,0}$

$\therefore$ unpaired $e^- = 0$

$[NiCl_4]^{-2} \longrightarrow Ni^{+2} = -4s^0 3d^8$

W.F.L $\longrightarrow$  $e^{2,2}\ t_2^{2,1,1}$

Unpaired $e^- = 2$
2+0 = (2)

Q84. Wave number for a radiation having $5800\,\mathring{A}$ wavelength is $x \times 10\,cm^{-1}$. The value of x is ________ . (Integer answer)

Ans. **1724**

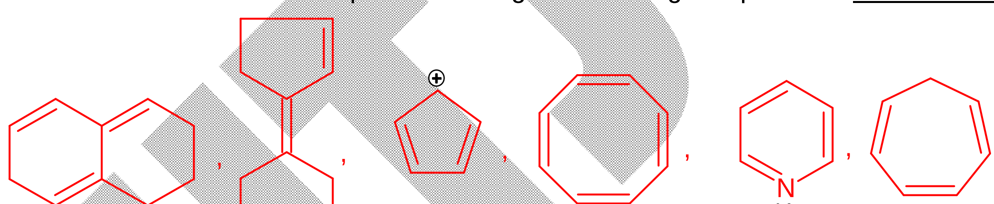
Sol. $\lambda = 5800\,\mathring{A} = 5800 \times 10^{-8}\,cm$

$\therefore$ Wave no $(\bar{\nu}) = \dfrac{1}{\lambda} = \dfrac{1}{5800 \times 10^{-8}} = 17241.38$

$x \times 10 = 1724 \times 10\,cm^{-1}$

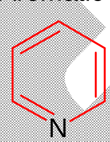
$\therefore \boxed{x = 1724}$

Q85. Total number of aromatic compounds among the following compounds is__________.



Ans. **1**

Sol. Aromatic compound is



Q86. Molality of an aqueous solution of urea is 4.44m, Mole fraction of urea in solution is $x \times 10^{-3}$. Value of x is______________(Integer answer)

Ans. **74**

Sol. Molality = 4.44
It means 4.44 mole urea present in 1 kg H_2O = 1000 g H_2O

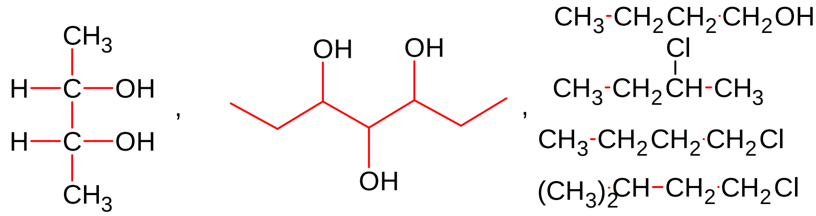
$\therefore n_{H_2O} = \dfrac{1000}{18}$

$\therefore X_{urea} = \dfrac{4.444}{4.44 + \dfrac{1000}{18}} = \dfrac{4.44}{4.44 + 55.55}$

$= \dfrac{4.44}{59.99} = 0.074$

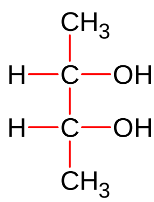
$\therefore x \times 10^{-3} = 0.074 = 74 \times 10^{-3}$

Q87. Total number of optically active compounds from the following is___________.

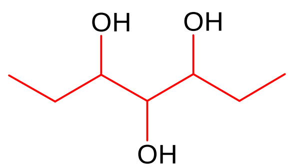


Ans. 1

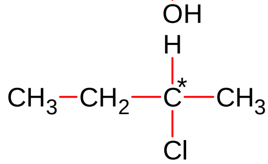
Sol.



P.O.S $\longrightarrow$ meso compound $\longrightarrow$ optically inactive



$\longrightarrow$ optically inactive



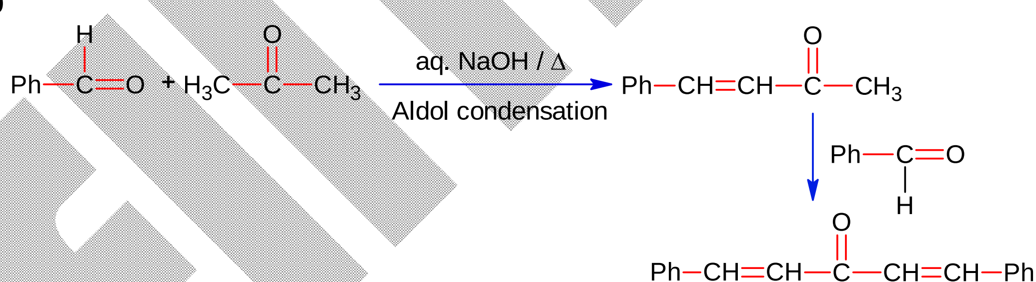
$\longrightarrow$ optically active

Rest all are optically inactive has not any chiral centre.

Q88. Two moles of benzaldehyde and one mole of acetone under alkaline condition using aqueous NaOH after heating gives x as the major product. The number of π bonds in the product x is__________________.

Ans. 9

Sol.



Number of π bonds = 9

Q89. A solution is prepared by adding 1 mole ethyl alcohol in 9 mole water. The mass percent of solute in the solution is_______(Integer answer)

(Given: Molar mass in g mol^{-1} Ethyl alcohol:46 water :18)

Ans. 22

Sol. $n_{C_2H_5OH} = 1$ $\qquad$ $n_{H_2O} = 9$

$\therefore m_{C_2H_5OH} = 1 \times 46 = 46g$ $\qquad$ $m_{H_2O} = 9 \times 18 = 162g$

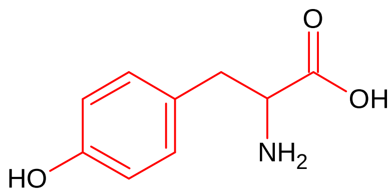
$$\therefore \text{mass\%} = \frac{\text{mass of } C_2H_5OH}{\text{Total mass of soln}} \times 100$$

$$= \frac{46}{46+162} \times 100 = \frac{4600}{208} = 22.11 \approx 22$$

Q90. The total number of carbon atoms present in tyrosine, an amino acid, is__________.

Ans. **9**

Sol.



(Tyrosine)

No. of C-atom = 9