

Sol. $x^2 - (2-2i)x - (2i-2) = 0$

$$x = \frac{(2-2i) \pm \sqrt{(2-2i)^2 + 4(2i-2)}}{2}$$

$$= \frac{(2-2i) \pm \sqrt{4-8i+4+8-8i-8}}{2}$$

$$= \frac{(2-2i) \pm \sqrt{4-8i}}{2}$$

$$= \frac{(2-2i) \pm \sqrt{4(1-2i)}}{2}$$

$$= \frac{(2-2i) \pm 2\sqrt{1-2i}}{2}$$

$$= (1-i) \pm \sqrt{1-2i}$$

$(1-i)$ or $(1+i)$

So $1 + i = 2(1) + (-2)(0) = 2$

∴ If the midpoint of a chord of the ellipse

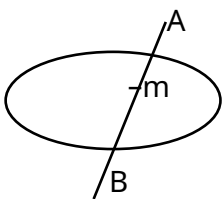
$\frac{x^2}{9} + \frac{y^2}{4} = 1$ is $(\sqrt{2}, \frac{2}{3})$, and the length of the

chord is $\frac{2\sqrt{10}}{3}$, then m is :

- (1) 1/8
- (2) 2/2
- (3) 2/6
- (4) 2/0

Ans. (2)

Sol.



If $m = (\sqrt{2}, \frac{2}{3})$ then equation of AB is

$T = S$

$$\frac{x\sqrt{2}}{9} + \frac{y \cdot \frac{2}{3}}{4} = \frac{2}{9} + \frac{\frac{2}{3} \cdot \frac{2}{3}}{4}$$

$$\frac{\sqrt{2}x}{9} + \frac{y}{6} = \frac{2}{9} + \frac{1}{6}$$

$\sqrt{2}x + 2y = 6$ put in ellipse

So, $\frac{x^2}{9} + \frac{y^2}{4} = 1$

$2x^2 + 3y^2 = 18$

$2x^2 + 3y^2 = 18$

$2x^2 + 3y^2 = 18$

$x = \sqrt{2}$ or $y = \frac{2}{3}$

So $y = 2$ or $y = \frac{2}{3}$

Length of chord = $\sqrt{(2-2)^2 + (2-\frac{2}{3})^2}$

$$= \sqrt{8 \cdot \frac{16}{9}}$$

$$= \sqrt{\frac{128}{9}} = \frac{8\sqrt{2}}{3}$$

7. Let S be the set of all the words that can be formed by arranging all the letters of the word GARDEN. From the set S, one word is selected at random. The probability that the selected word will NOT have vowels in alphabetical order is :

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

Ans. (4)

Sol. A, E, G, R, D, N

Probability (P) = $\frac{\text{favourable case}}{\text{Total case}}$

(when A & E are in order)

Total case = $6!$

Favourable case = $C_2 \cdot 4!$

$P = \frac{2 \cdot 4!}{6!}$

Probability when not in order = $1 - \frac{1}{3} = \frac{2}{3}$

v. Let f be a real valued continuous function defined on the positive real axis such that $g(x) = \int_0^x f(t) dt$.

If $g(x) = x^2 + x$, then value of $\int_1^2 \frac{f(x)}{x} dx$ is

- (1) 320
- (2) 340
- (3) 270
- (4) 310

Ans. (4)

Sol. $g(x) = x^2 + x$

$g'(x) = 2x + 1$

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

$f(x) = 2 + \frac{1}{x}$

$f(x) = 2 + \frac{1}{x}$

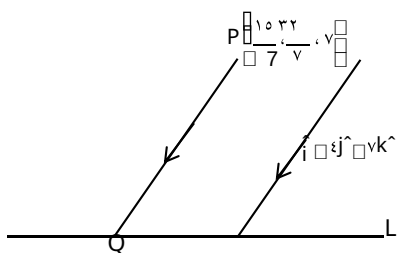
$\int_1^2 (2 + \frac{1}{x}) dx = [2x + \ln x]_1^2 = 4 + \ln 2 - 2 - \ln 1 = 2 + \ln 2$

8. The square of the distance of the point $(1, 2, 3)$ from the line $\frac{x-1}{3} = \frac{y-2}{4} = \frac{z-3}{5}$ in the direction of the vector $\hat{i} + \hat{j} + \hat{k}$ is:

- (1) 0.4
- (2) 0.1
- (3) 0.6
- (4) 0.8

Ans. (3)

Sol.



$L = \frac{x-1}{3} = \frac{y-2}{4} = \frac{z-3}{5}$

$PQ = \frac{|(1-1)\hat{i} + (2-2)\hat{j} + (3-3)\hat{k} \cdot (3\hat{i} + 4\hat{j} + 5\hat{k})|}{\sqrt{3^2 + 4^2 + 5^2}} = \frac{|0\hat{i} + 0\hat{j} + 0\hat{k} \cdot (3\hat{i} + 4\hat{j} + 5\hat{k})|}{\sqrt{50}} = \frac{|0|}{\sqrt{50}} = 0$

$Q = (1 + \frac{3}{\sqrt{50}}, 2 + \frac{4}{\sqrt{50}}, 3 + \frac{5}{\sqrt{50}})$

Since Q lies on line L

So, $\frac{1 + \frac{3}{\sqrt{50}} - 1}{3} = \frac{2 + \frac{4}{\sqrt{50}} - 2}{4} = \frac{3 + \frac{5}{\sqrt{50}} - 3}{5}$

$\frac{3}{3\sqrt{50}} = \frac{4}{4\sqrt{50}} = \frac{5}{5\sqrt{50}}$

$\frac{1}{\sqrt{50}} = \frac{1}{\sqrt{50}}$

Point Q $(\frac{8}{7}, \frac{10}{7}, \frac{17}{7})$

$PQ = \sqrt{(\frac{1}{7})^2 + (\frac{2}{7})^2 + (\frac{4}{7})^2} = \frac{\sqrt{1+4+16}}{7} = \frac{\sqrt{21}}{7}$

$(PQ)^2 = \frac{21}{49} = \frac{3}{7}$

9. The area of the region bounded by the curves $x(1+y) = 1$ and $y = 2x$ is:

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

Ans.

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

$y = 2x$

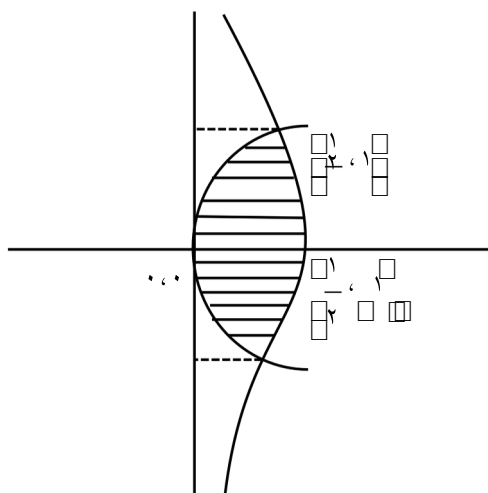
From equation (1) & (2)

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

$x = \frac{1}{2}, x = -1$ (Reject)

$y = 2$

$y = \pm 1$



Area bounded = $\int_0^1 \tan^{-1} y \, dy$
 $= \int_0^1 \tan^{-1} y \, dy$
 $= \left[y \tan^{-1} y - \frac{1}{2} \ln|1+y^2| \right]_0^1$
 $= \frac{1}{2} \ln 2$

10. Let $A = \begin{bmatrix} 1 & 1 \\ \sqrt{x} & 2 \end{bmatrix}$ and $P = \begin{bmatrix} \cos \theta & -\sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$.

If $B = PAP^T$, $C = PBP^T$ and the sum of the diagonal elements of C is $\frac{m}{n}$, where $\gcd(m, n) = 1$, then $m+n$ is:

- (1) 60
 (2) 127
 (3) 208
 (4) 2049

Ans.

Sol. $P = \begin{bmatrix} \cos \theta & \sin \theta \\ \sin \theta & \cos \theta \end{bmatrix}$

$\therefore PP^T = I$

$B = PAP^T$

Pre multiply by P (Given)

$PB = PP^TAP = AP^T$

Now post multiply by P

$PBP = APP^T = A$

$\underbrace{BPPT}_{I} = BP$

$A = PBP$

Similarly $A = PB^T P^T = C$

$A = \begin{bmatrix} 1 & 1 \\ \sqrt{x} & 2 \end{bmatrix}$ (Given)

$A = \begin{bmatrix} 1 & 1 \\ \sqrt{x} & 2 \end{bmatrix}$

Similarly check A and so on since $C = A$

Sum of diagonal elements of C is $\frac{1}{\sqrt{x}}$

$= \frac{1}{\sqrt{x}} \frac{m}{n}$

$\gcd(m, n) = 1$ (Given)

$m+n = 60$

11. If $f(x) = \int \frac{1}{x \sqrt{\xi(1-x)/\xi}} dx$, $f(0) = -1$, then $f(1)$ is equal to:

- (1) $\log_2 2$
 (2) $\xi(\log_2 2)$
 (3) $2 - \log_2 2$
 (4) $\xi(\log_2 2)$

Ans. (2)

Sol. let $x = t$

$dx = \xi t \, dt$

then $\int \frac{1}{x \sqrt{\xi(1-x)/\xi}} dx = \int \frac{\xi t \, dt}{t \sqrt{1-t}}$

$= \int \frac{\xi t}{\sqrt{1-t}} dt = \xi \int \frac{(1-t)}{\sqrt{1-t}} dt$

$= \xi \int \sqrt{1-t} \, dt$

$= \xi \left[\frac{2}{3} (1-t)^{3/2} \right]_0^1 = \frac{2\xi}{3}$

hence $f(x) = \frac{2}{3} \xi \ln \left| \frac{1-x}{1} \right| + C$

$f(0) = -1 = \frac{2}{3} \xi \ln 1 + C = -1 \implies C = -1$

now $f(1) = \frac{2}{3} \xi \ln 2 - 1$

$= \frac{2}{3} \xi \ln 2 - 1$

12. Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be a twice differentiable function such that $f(x) = 1$. If $F(x) = \int x f(x) dx$ for all $x \in \mathbb{R}$.

$\int x f'(x) dx$ and $\int F(x) dx = \xi$, then

$F'(x) + \int F(x) dx$ is equal to:

- (1) 11
 (2) 10
 (3) 9
 (4) 13

Ans. (1)

Sol. $\int x F'(x) dx$

$= x F(x) - \int f(x) dx$

$= \int x F(x) dx - \int f(x) dx$ [$f(x) = x F(x) = x^2$]

$\int x F(x) dx \dots (1)$

$\int F(x) dx \dots (2)$

Also

$\int x^2 F'(x) dx + \int x^2 F'(x) dx + \int x^2 F'(x) dx$

$= 3 F'(x) - 2 \times 6 = 6$

$F'(x) = 12$

$\int F'(x) + \int F(x) dx$

12. For positive integers n, if $a_n = (n^2 + 1) \sin \frac{1}{n}$ and

$S_n = \sum_{k=1}^n \frac{1}{a_k}$, then the value of $\lim_{n \rightarrow \infty} S_n$

- (1) 0.5
- (2) 1.35
- (3) 1.75
- (4) 1.3

Ans. (3)

Sol. $a_n = \frac{n^2 + 1}{\sin \frac{1}{n}}$

$S_n = \sum_{k=1}^n \frac{1}{a_k} = \sum_{k=1}^n \frac{\sin \frac{1}{k}}{k^2 + 1}$

$= 4 \sum_{k=1}^n \frac{1}{k^2 + 1}$

$= 4 \sum_{k=1}^n \frac{1}{k^2 + 1}$

$= 4 \left(\frac{1}{3} + \frac{1}{5} + \frac{1}{7} + \dots \right)$

$\sum_{k=1}^n \frac{1}{k^2 + 1}$

$= 4 \sum_{k=1}^n \frac{1}{k^2 + 1}$

$= \frac{4}{3} \sum_{k=1}^n \frac{1}{k^2 + 1}$

$\lim_{n \rightarrow \infty} S_n = \frac{4}{3} \sum_{k=1}^{\infty} \frac{1}{k^2 + 1} = 1.75$

13. Let $f : A \rightarrow B$ be defined by $f(x) = 2x^2 - 10x + 16x + 7$ and $g : B \rightarrow C$ be

defined by $g(x) = \frac{x^2 + 25}{x^2 + 25}$. If both the functions

are onto and $S = \{x \in Z : x \in A \text{ or } x \in B\}$, then $n(S)$ is equal to :

- (1) 30
- (2) 36
- (3) 29
- (4) 31

Ans. (1)

Sol. as $f(x)$ is onto hence A is range of $f(x)$

now $f'(x) = 4x - 10x + 32$
 $= 6(x-2)(x-3)$

$f(2) = 16 - 20 + 32 + 7 = 35$

$f(3) = 18 - 30 + 36 + 7 = 31$

$f(0) = 7$

hence range $A = \{7, 31, 35\}$

also for range of $g(x)$

$g(x) = \frac{x^2 + 25}{x^2 + 25} \in B$

$S = \{7, 31, 35, \dots, 35\}$ hence $n(S) = 30$

14. Let X denote the greatest integer less than or equal to x . Then domain of $f(x) = \sec(\frac{1}{2}X + 1)$ is :

- (1) $(-\frac{1}{2}, -\frac{1}{2}) \cup (\frac{1}{2}, \frac{1}{2})$
- (2) $(-\frac{1}{2}, -\frac{1}{2})$
- (3) $(-\frac{1}{2}, -\frac{1}{2}) \cup (\frac{1}{2}, \frac{1}{2})$
- (4) $(-\frac{1}{2}, \frac{1}{2}) \cup (\frac{1}{2}, \frac{1}{2})$

Ans. (2)

Sol. $\frac{1}{2}X + 1 \neq \frac{\pi}{2} + n\pi$ or $\frac{1}{2}X + 1 \neq \frac{3\pi}{2} + n\pi$

$X \neq \pi - 2$ or $X \neq 3\pi - 2$

$X \neq \pi - 2 + 2n\pi$ or $X \neq 3\pi - 2 + 2n\pi$

$X \neq \pi - 2, \pi - 2 + 2\pi, \dots$

16. If $\sin^{-1} \frac{r}{6} + \sin^{-1} \frac{r}{4} = \frac{\pi}{2}$, then $a + b$ is equal to :

$a, b \in \mathbb{Z}$

- (1) 10
- (2) 2
- (3) 8
- (4) 5

Ans. (3)

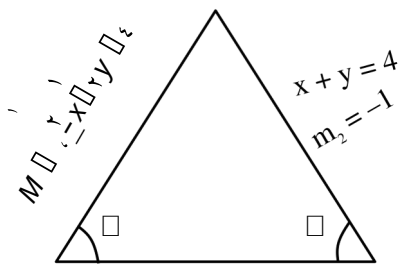
Sol. $\sin^{-1} \frac{r}{6} + \sin^{-1} \frac{r}{4} = \frac{\pi}{2}$
 $\sin^{-1} \frac{r}{6} = \frac{\pi}{2} - \sin^{-1} \frac{r}{4}$
 $\sin \left(\frac{\pi}{2} - \sin^{-1} \frac{r}{4} \right) = \frac{r}{6}$
 $\cos \left(\sin^{-1} \frac{r}{4} \right) = \frac{r}{6}$
 $\sqrt{1 - \left(\frac{r}{4} \right)^2} = \frac{r}{6}$
 $1 - \frac{r^2}{16} = \frac{r^2}{36}$
 $1 = \frac{r^2}{36} + \frac{r^2}{16} = \frac{4r^2 + 9r^2}{144} = \frac{13r^2}{144}$
 $144 = 13r^2$
 $r^2 = \frac{144}{13}$
 $r = \frac{12}{\sqrt{13}}$
 $a = 12, b = \sqrt{13}$
 $a + b = 12 + \sqrt{13}$

17. Two equal sides of an isosceles triangle are along $-x + y = 4$ and $x + y = 4$. If m is the slope of its third side, then the sum of all possible distinct values of m is :

- (1) -6
- (2) 12
- (3) 6
- (4) $2\sqrt{3}$

Ans. (3)

Sol.



$$\tan \theta = \frac{m_1 - m_2}{1 + m_1 m_2}$$

$$\tan \theta = \frac{m - (-1)}{1 + m(-1)}$$

$$\frac{m+1}{1-m} = \frac{m}{m-1}$$

$$(m+1)(m-1) = m(1-m)$$

$$m^2 - 1 = m - m^2$$

$$2m^2 - m - 1 = 0$$

$$2m^2 - 2m + m - 1 = 0$$

$$2m(m-1) + (m-1) = 0$$

$$(m-1)(2m+1) = 0$$

$$m = 1, -\frac{1}{2}$$

$m^2 - 2m - 1 = 0$
 sum of root = 2
 sum is 6

18. Let the coefficients of three consecutive terms T_{r-1} , T_r and T_{r+1} in the binomial expansion of $(a + b)^n$ be in a G.P. and let p be the number of all possible values of r . Let q be the sum of all rational terms in the binomial expansion of $(a + b)^n$.

- (1) 283
- (2) 290
- (3) 287
- (4) 299

Ans. (1)

Sol. $a, b \in \mathbb{Z}$
 T_{r-1}, T_r, T_{r+1} in G.P.

$$\frac{T_{r-1}}{T_r} = \frac{T_r}{T_{r+1}}$$

$$\frac{{}^{12}C_{r-1} a^{12-r+1} b^{r-1}}{{}^{12}C_r a^{12-r} b^r} = \frac{{}^{12}C_r a^{12-r} b^r}{{}^{12}C_{r+1} a^{12-r-1} b^{r+1}}$$

$$\frac{12-r+1}{r} \cdot \frac{a}{b} = \frac{r}{12-r} \cdot \frac{a}{b}$$

$$(12-r)(r+1) = (12-r)(r)$$

$$-r + 12r + 12 = 12r - r^2$$

$$r^2 = 0$$

No value of r possible
 So $P = 0$

No value of r possible

So $P = 0$

$$\frac{{}^{12}C_r a^{12-r} b^r}{(a+b)^{12}}$$

Exponent of a is $12-r$, exponent of b is r

- 12
- 0
- 27
- 0
- 12
- 206

$$q = 27 + 206 = 283$$

$$p + q = 0 + 283 = 283$$

19. If A and B are the points of intersection of the circle $x^2 + y^2 - 4x = 0$ and the hyperbola

$$\frac{x^2}{9} - \frac{y^2}{4} = 1$$

and a point P moves on the line $2x - 3y + \lambda = 0$, then the centroid of ΔPAB lies on the line :

- (1) $4x - 9y = 12$
- (2) $x + 9y = 36$
- (3) $9x - 9y = 32$
- (4) $6x - 9y = 20$

Ans. (4)

Sol. $x^2 + y^2 - 4x = 0$ $\frac{x^2}{9} - \frac{y^2}{4} = 1$ (1)

$4x^2 - 9y^2 = 36$ (2)

Solve (1) & (2)

$4x^2 - 9(4x - 4x) = 36$

$12x^2 - 36x - 36 = 0$

$(12x + 6)(x - 6) = 0$

$x = \frac{6}{12}, x = 6$

$x = \frac{6}{12}$ (rejected)

y is Imaginary

$n = 6, \frac{36}{9} - \frac{y^2}{4} = 1$

$y = 12, y = 1\sqrt{12}$

$A(6, 12), B(6, 1\sqrt{12})$

P lies on $\frac{x^2}{9} - \frac{y^2}{4} = 1$

centroid (h, k) $2x - 3y + \lambda = 0$

$h = \frac{12}{3}, \lambda = 3h - 12$

$k = \frac{2}{3} \Rightarrow 2 \Rightarrow 4 \Rightarrow 9k$

$9k = \lambda$

$6h - 3y = 9k - \lambda$

$6x - 9y = 20$

20. Let $f : \mathbb{R} \rightarrow \mathbb{R}$ be a polynomial of

degree 2, satisfying $f(x) = \frac{1}{x} f(x) + f(\frac{1}{x})$

$f(k) = -2k$, then the sum of squares of all possible values of k is :

- (1) 1 (2) 6
- (3) 7 (4) 9

Ans. (2)

Sol. as $f(x)$ is a polynomial of degree two let it be $f(x) = ax^2 + bx + c$

on satisfying given conditions we get

$c = 1$ & $a = \pm 1$

hence $f(x) = 1 \pm x^2$

also range $(-\infty, \infty)$ hence

$f(x) = 1 - x^2$

now $f(k) = -2k$

$1 - k^2 = -2k \Rightarrow k^2 - 2k - 1 = 0$

let roots of this equation be α & β

then $\alpha + \beta = (\alpha + \beta) - 2 = 2$
 $= 2 - 2(-1) = 4$

SECTION-B

21. The number of natural numbers, between 112 and 999, such that the sum of their digits is 10, is

Ans. (14)

Sol.

x	y	z
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Let $x = 2 \Rightarrow y + z = 13$

$(2, 9), (0, 13), (1, 12), (3, 10), (4, 9), (5, 8), (6, 7), (7, 6), (8, 5), (9, 4), (10, 3), (11, 2), (12, 1), (13, 0)$

Let $x = 3 \Rightarrow y + z = 12$

$(3, 9), (4, 8), \dots, (9, 3)$

Let $x = 4 \Rightarrow y + z = 11$

$(4, 9), (3, 8), \dots, (9, 1)$

Let $x = 5 \Rightarrow y + z = 10$

$(5, 9), (4, 8), \dots, (9, 1)$

Let $x = 6 \Rightarrow y + z = 9$

$(6, 9), (1, 8), \dots, (9, 0)$

Let $x = 7 \Rightarrow y + z = 8$

$(7, 9), (1, 7), \dots, (8, 0)$

Let $x = 8 \Rightarrow y + z = 7$

$(8, 7), (1, 6), \dots, (7, 0)$

Let $x = 9 \Rightarrow y + z = 6$

$(9, 6), (1, 5), \dots, (6, 0)$

Total = 6 + 7 + 8 + 9 + 10 + 9 + 8 + 7 = 64

22. Let $f(x) = \lim_{n \rightarrow \infty} \frac{\tan(x/\sqrt{n})}{\tan(x/\sqrt{n})}$.

Then $\lim_{x \rightarrow 0} \frac{e^x e^{f(x)}}{f(x)}$ is equal to _____.

Ans. (1)

Sol. $f(x) = \lim_{n \rightarrow \infty} \frac{\tan(x/\sqrt{n})}{\tan(x/\sqrt{n})} = \tan x$

$\lim_{x \rightarrow 0} \frac{e^x e^{\tan x}}{\tan x} = \lim_{x \rightarrow 0} \frac{e^{x+\tan x}}{\tan x} = \frac{1}{0}$

= 1 The interior angles of a polygon with n

23. sides are in an A.P. with common difference 1° . If the largest interior angle of the polygon is 119° , then n

Ans. is equal to _____.

Sol. $a + (n-1)1 = 119$

$a + (n-1)1 = 119 \dots (1)$

Now according to question

$a + (n-1)1 = 119$

$a = 120 - n \dots (2)$

Putting value of a from equation (2) in (1)

We get

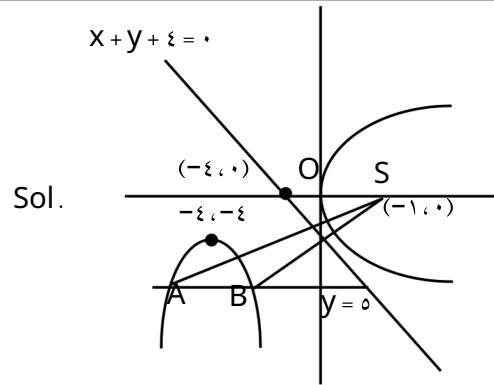
$(120 - n) + (n-1)1 = 119$

$120 - n + n - 1 = 119$

$n = 1, -1$ (rejected)

24. Let A and B be the two points of intersection of the line $y = 0$ and the mirror image of the parabola $y = \epsilon x$ with respect to the line $x + y + \epsilon = 0$. If d denotes the distance between A and B, and a denotes the area of ΔSAB , where S is the focus of the parabola $y = \epsilon x$, then the value of $(a + d)$ is _____.

Ans. (1/2)



Sol.

Area = $\frac{1}{2} \times \epsilon \times \epsilon = \frac{\epsilon^2}{2}$

$\epsilon = \epsilon$

So $a + d = \frac{\epsilon^2}{2}$

25. If $y = y(x)$ is the solution of the differential equation,

$\sqrt{x} \frac{dy}{dx} = \sin \frac{x}{\sqrt{y}} - y \sin \frac{x}{\sqrt{y}}$

$-2x \frac{dy}{dx} = \frac{2}{\epsilon} y$, then $y(\cdot)$ is equal to _____.

Ans. (2)

Sol. $\frac{d}{dx} \left(\frac{\sin \frac{x}{\sqrt{y}}}{\sqrt{x}} \right) = \frac{\sin \frac{x}{\sqrt{y}}}{\sqrt{x}}$

$x \frac{d}{dx} \left(\frac{\sin \frac{x}{\sqrt{y}}}{\sqrt{x}} \right) = \sin \frac{x}{\sqrt{y}} - \frac{\sin \frac{x}{\sqrt{y}}}{2\sqrt{x}}$

$y = \frac{\sin \frac{x}{\sqrt{y}}}{\sqrt{x}} = 2c \cdot e^{-\frac{x}{2\sqrt{y}}}$

$y = 2 \frac{2}{\epsilon} = \frac{4}{\epsilon} = 2c = \dots$

$y(\cdot) = -2$

JEE-MAIN EXAMINATION – JANUARY 2025

(HELD ON TUESDAY 28th JANUARY 2025)

TIME : 3 : 00PM TO 6 : 00 PM

PHYSICS	TEST PAPER WITH SOLUTION												
SECTION-A													
<p>26. A uniform magnetic field of 0.5 T acts perpendicular to a circular copper disc 20 cm in radius. The disc is having a uniform angular velocity of 100 rad/s about an axis through its centre and perpendicular to the disc. What is the potential difference developed between the axis of the disc and the rim ($\epsilon = 3.14$)</p> <p>(1) 0.628 V (2) 0.5024 V (3) 0.2012 V (4) 0.1206 V</p> <p>Ans. (3) Sol. $B = 0.5 \text{ T}$ $r = 20 \text{ cm}$ $\omega = 100 \text{ rad/s}$ $E = \int_0^r B \omega R \gamma$ $= 0.2012 \text{ V}$ A parallel plate capacitor of capacitance $1 \mu\text{F}$ is charged to a potential difference of 20 V. The distance between plates is 1 cm. The energy density between plates of capacitor is :</p> <p>(1) $1.8 \times 10^{-4} \text{ J/m}^3$ (2) $2 \times 10^{-4} \text{ J/m}^3$ (3) $2 \times 10^{-3} \text{ J/m}^3$ (4) $1.8 \times 10^{-3} \text{ J/m}^3$</p> <p>Ans. (1) Sol. $C = 1 \mu\text{F}$ $V = 20 \text{ V}$ $d = 1 \text{ cm}$ Energy density = $\frac{1}{2} \epsilon_0 E^2$ $E = \frac{V}{d} = 2000 \text{ V/m}$ $U = 1.88 \times 10^{-4} \text{ J/m}^3$</p>	<p>28. Match List-I with List-II</p> <table style="width: 100%; border: none;"> <tr> <td style="width: 50%; text-align: center;">List-I</td> <td style="width: 50%; text-align: center;">List-II</td> </tr> <tr> <td>(A) Angular Impulse</td> <td>(I) $M L T^{-2}$</td> </tr> <tr> <td>(B) Latent Heat</td> <td>(II) $M L^2 T^{-2}$</td> </tr> <tr> <td>resistivity</td> <td>(III) $M L^2 T^{-2} A^{-2}$</td> </tr> <tr> <td>Electromotive force</td> <td>(IV) $M L T^{-2} A^{-1}$</td> </tr> <tr> <td>(D)</td> <td></td> </tr> </table> <p>Choose the correct answer from the options given below :</p> <p>(1) (A)-(III), (B)-(I), (C)-(IV), (D)-(II) (2) (A)-(I), (B)-(III), (C)-(IV), (D)-(II) (3) (A)-(III), (B)-(I), (C)-(II), (D)-(IV) (4) (A)-(II), (B)-(I), (C)-(IV), (D)-(III)</p> <p>Ans. (1) Sol. Angular impulse = $M L T^2$ Latent Heat = $M L T^2$ Electrical resistivity = $M L T A^{-2}$ Electromotive force = $M L T A^{-1}$</p> <p>29. The ratio of vapour densities of two gases at the same temperature is $\frac{1}{9}$, then the ratio of r.m.s. velocities will be :</p> <p>(1) $\frac{20}{2}$ (2) $\frac{2}{20}$ (3) $\frac{0}{2}$ (4) $\frac{2}{20}$</p> <p>Ans. (3) Sol. $\frac{v_1}{v_2} = \frac{\sqrt{\frac{3P}{2d_1}}}{\sqrt{\frac{3P}{2d_2}}}$ Ratio of r.m.s velocities = $\sqrt{\frac{d_2}{d_1}}$</p> <p>30. The kinetic energy of translation of the molecules in 50 g of CO gas at 17°C is :</p> <p>(1) 3987.3 J (2) 4102.8 J (3) 4205.0 J (4) 3582.7 J</p> <p>Ans. (2)</p>	List-I	List-II	(A) Angular Impulse	(I) $M L T^{-2}$	(B) Latent Heat	(II) $M L^2 T^{-2}$	resistivity	(III) $M L^2 T^{-2} A^{-2}$	Electromotive force	(IV) $M L T^{-2} A^{-1}$	(D)	
List-I	List-II												
(A) Angular Impulse	(I) $M L T^{-2}$												
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resistivity	(III) $M L^2 T^{-2} A^{-2}$												
Electromotive force	(IV) $M L T^{-2} A^{-1}$												
(D)													

Sol. $(KE)_{\text{Translational}} = \frac{3}{2} kT \times \text{no. of molecule}$

$$\text{No. of molecule} = \frac{1.5 \times 10^{-17}}{1.5 \times 10^{-21}} = 10^4$$

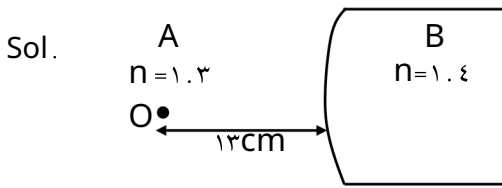
$$(KE)_{\text{Translational}} = 1.5 \times 10^{-17} \text{ J}$$

31. In a long glass tube, mixture of two liquids A and B with refractive indices μ_1 and μ_2 respectively,

forms a convex refractive meniscus towards A. If an object placed at μ_1 cm from the vertex of the meniscus in A forms an image with a magnification of $-\mu_2$ then the radius of curvature of meniscus is :

- (1) μ_1 cm (2) $\frac{\mu_1}{\mu_2}$ cm
 (3) $\frac{\mu_2}{\mu_1}$ cm (4) $-\mu_2$ cm

Ans. (3)



$$\frac{n_2}{v} = \frac{n_1}{u} - \frac{n_1}{R}$$

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

$$\frac{\mu_2}{v} = \frac{1}{\mu_1 R} - \frac{\mu_1}{R}$$

$$\frac{\mu_2}{v} = \frac{1 - \mu_1^2}{\mu_1 R}$$

$$m = \frac{v}{u} = \frac{1 - \mu_1^2}{\mu_1 R} \times \frac{R}{\mu_1}$$

$$2 = \frac{1 - \mu_1^2}{\mu_1^2} \Rightarrow \mu_1^2 = \frac{1 - 2\mu_1^2}{\mu_1^2} \Rightarrow \mu_1^4 = 1 - 2\mu_1^2$$

$$R = \frac{\mu_2}{\mu_1} \text{ cm}$$

32. The frequency of revolution of the electron in Bohr's orbit varies with n , the principal quantum number as

- (1) $\frac{1}{n}$ (2) $\frac{1}{n^2}$
 (3) $\frac{1}{n^3}$ (4) $\frac{1}{n^4}$

Ans. (2)

Sol. Frequency of revolution $\propto \frac{1}{n^3}$

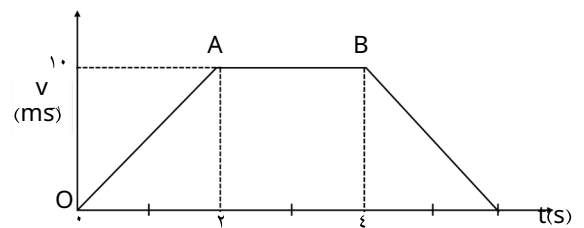
33. Which of the following phenomena can not be explained by wave theory of light :

- (1) Reflection of light
 (2) Diffraction of light
 (3) Refraction of light
 (4) Compton effect

Ans. (4)

Sol. Compton effect is based on particle nature of light.

34. The velocity-time graph of an object moving along a straight line is shown in figure. What is the distance covered by the object between $t = 0$ to $t = 5$ s :



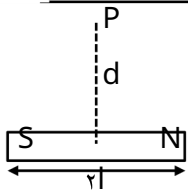
- (1) 30 m (2) 10 m
 (3) 13 m (4) 11 m

Ans. (1)

Sol. Distance = Area under v vs t graph

$$\text{Distance} = \frac{1}{2} \times 2 \times 10 + 10 \times 2 = 30 \text{ m}$$

30.



A bar magnet has total length $2r = 2$ units and the field point P is at a distance $d = 1$ units from the centre of the magnet. If the relative uncertainty of length measurement is 1% , then uncertainty of the magnetic field at point P is:

- (1) 1% (2) 2%
 (3) 3% (4) 5%

Ans. (2, 3)

Sol. Method-1 :

Without considering uncertainty in μ .

$$B \propto \frac{\mu \cdot m}{r^3}$$

$$B \propto \frac{1}{r^3}$$

$$\frac{\Delta B}{B} \propto 3 \frac{\Delta r}{r}$$

% uncertainty in $B = 3\%$

Method-2 :

With considering uncertainty in μ

$$B \propto \frac{1}{r^3}$$

$$\frac{\Delta B}{B} \propto \frac{\Delta \mu}{\mu} + 3 \frac{\Delta r}{r} = 1\% + 3 \times 1\% = 4\%$$

% uncertainty in $B = 4\%$

31.

Earth has mass λ times and radius γ times that of a planet. If the escape velocity from the earth is 11.2 km/s, the escape velocity in km/s from the planet will be :

- (1) 11.2 (2) 0.7
 (3) 2.8 (4) 1.4

Ans. (2)

Sol. $V_{\text{escape}} = \sqrt{\frac{2GM}{R}}$

$$\frac{(V_{\text{escape}})_{\text{Planet}}}{(V_{\text{escape}})_{\text{Earth}}} = \sqrt{\frac{M_p R_E}{M_E R_p}} = \sqrt{\frac{\lambda R_E}{R_E \gamma}} = \sqrt{\frac{\lambda}{\gamma}}$$

$$(V_{\text{escape}})_{\text{Planet}} = (V_{\text{escape}})_{\text{Earth}} \sqrt{\frac{\lambda}{\gamma}} \text{ km/s}$$

37.

Given below are two statements. One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) : Knowing initial position x and initial momentum p is enough to determine the position and momentum at any time t for a simple harmonic motion with a given angular frequency ω .

Reason (R) : The amplitude and phase can be expressed in terms of x and p .

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

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

(2) (A) is false but (R) is true.

(3) (A) is true but (R) is false.

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

Ans. (4)

Sol. $x = A \sin(\omega t + \phi)$

$$x = A \sin \phi \quad \dots (1)$$

$$p = m A \omega \cos(\omega t + \phi)$$

$$p = m A \omega \cos \phi \quad \dots (2)$$

$$(2)/(1) \Rightarrow \tan \phi = \frac{x \cdot m \omega}{p}$$

$$\sin \phi = \frac{x \cdot m \omega}{\sqrt{(m \omega x)^2 + p^2}}$$

From (1), $A = \frac{x_0}{\sin \phi} = \frac{\sqrt{(m \omega x)^2 + p^2}}{m \omega}$

This means we can explain assertion with the given reason.

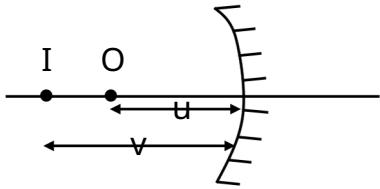
38.

A concave mirror produces an image of an object such that the distance between the object and image is 30 cm. If the magnification of the image is -3 , then the magnitude of the radius of curvature of the mirror is :

- (1) 20 cm (2) 30 cm
 (3) 10 cm (4) 15 cm

Ans. (4)

Sol.



$$m = -\frac{v}{u} \text{ and } v - u = r \cdot \text{cm}$$

$$f = \frac{vu}{v-u} = \frac{(r \cdot \text{cm})(\dots)}{r \cdot \text{cm}}$$

39.

-

$$(2) 1: 13$$

$$(3) 1: 3$$

Ans.

Sol. $\frac{P_{out}}{P_{in}} = \frac{(\hat{r}_i \cdot \hat{r}_j) \cdot (\hat{r}_i \cdot \hat{r}_j)}{\dots}$

$$\vec{a} = F \cdot \hat{i} - j$$

$$v \text{ at } t = \xi \text{ sec} = \frac{1}{2} \hat{i} + \frac{1}{2} \hat{j} + 4 \hat{k} \quad (\hat{r}_i \cdot \hat{r}_j)$$

$$P_{ins} = (\hat{r}_i \cdot \hat{r}_j) (\hat{r}_i \cdot \hat{r}_j)$$

$$\frac{P_{out}}{P_{ins}} = \frac{1}{2}$$

Note : Given data is not matching.

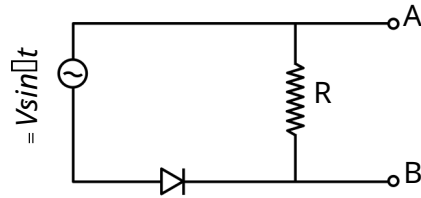
$$S_{out} = \dots$$

$$S = \frac{1}{r} (\hat{r}_i \cdot \hat{r}_j) (\xi) r \hat{i} \cdot \hat{j}$$

If $r_i \cdot r_j = \dots$ then $r_f = \dots$

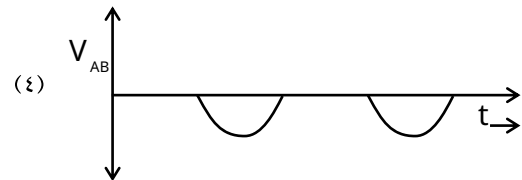
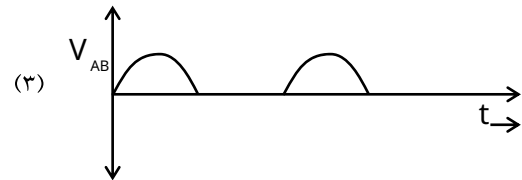
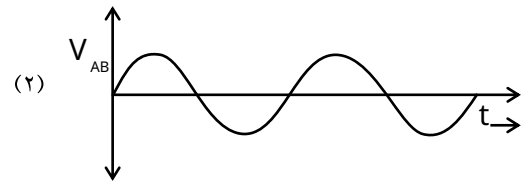
But Final position given in the question is $(1, 1)$.

39.



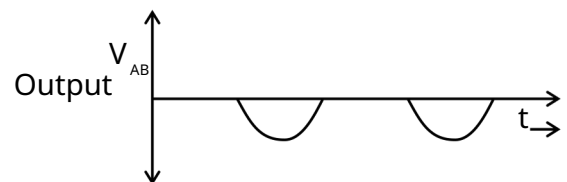
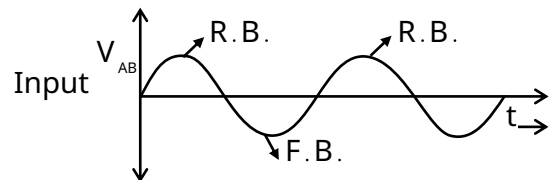
In the circuit shown here, assuming threshold voltage of diode is negligibly small, then voltage V_{AB} is correctly represented by :

(1) V_{AB} would be zero at all times

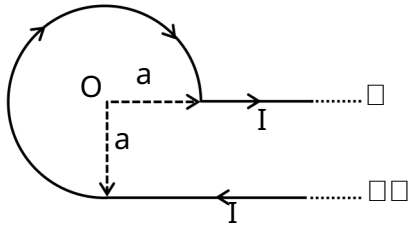


Ans. (3)

Sol. $V = V \sin \omega t$



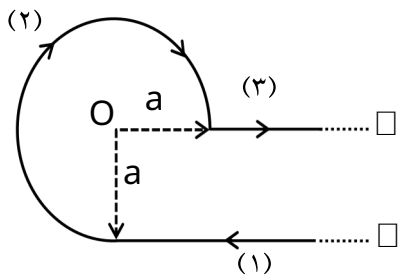
ε1.



An infinite wire has a circular bend of radius a and carrying a current I as shown in figure. The magnitude of magnetic field at the origin O of the arc is given by :

- (1) $\frac{\mu_0 I}{4a}$ (2) $\frac{\mu_0 I}{4a\sqrt{2}}$
 (3) $\frac{\mu_0 I}{2a\sqrt{2}}$ (4) $\frac{\mu_0 I}{2a}$

Ans. (2)



Sol.

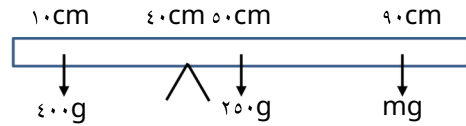
$B_1 = \frac{\mu_0 I}{4a}$
 $B_2 = \frac{\mu_0 I}{4a\sqrt{2}}$
 $B_{\text{net}} = \frac{\mu_0 I}{4a\sqrt{2}}$

ε2. A uniform rod of mass 20 g having length 100 cm is balanced on a sharp edge at 40 cm mark. A mass of 50 g is suspended at 10 cm mark. To maintain the balance of the rod, the mass to be suspended at 90 cm mark, is

- (1) 30 g (2) 19 g
 (3) 20 g (4) 29 g

Ans. (2)

Sol.



$\Sigma \tau_{\text{Net}} = 0 \Rightarrow (50 \times 10) = (20 \times 10) + (m \times 50)$
 $m = \frac{1200}{50} = 24\text{ g}$

ε3.

A solid cube having an edge of length 10 cm floats in water. How much volume of the cube is outside the water?

(Given : density of water = 1000 kg m^{-3})

- (1) 1500 cm^3 (2) 4000 cm^3
 (3) 5000 cm^3 (4) 6000 cm^3

Ans. (4)

$Mg = F_B \Rightarrow (1000 \times 10^3) = 1000 V$
 $V_{\text{submerged}} = 1000 \times 10^3\text{ m}^3$
 $(V_{\text{outside}}) = (1000 \times 10^3) - 1000 \times 10^3$
 $= 6000 \times 10^3\text{ m}^3 = 6000\text{ cm}^3$

ε4.

The magnetic field of an E.M. wave is given by

$B = \frac{\sqrt{2}}{2} i \hat{j} \sin \left(\frac{z}{c} - t \right)$ (S.I. Units)

The corresponding electric field in S.I. units is :

- (1) $E = \frac{\sqrt{2}}{2} i \hat{j} \sin \left(\frac{z}{c} - t \right)$
 (2) $E = -i \hat{j} \sin \left(\frac{z}{c} - t \right)$
 (3) $E = -i \hat{j} \sin \left(\frac{z}{c} - t \right)$
 (4) $E = \frac{\sqrt{2}}{2} i \hat{j} \sin \left(\frac{z}{c} - t \right)$

Ans. (1)

$B = \frac{\sqrt{2}}{2} i \hat{j} \sin \left(\frac{z}{c} - t \right)$
 $E = B \cdot c$ and $E = Bc$

Here $E = \frac{\sqrt{2}}{2} (i \hat{j}) \sin \left(\frac{z}{c} - t \right)$

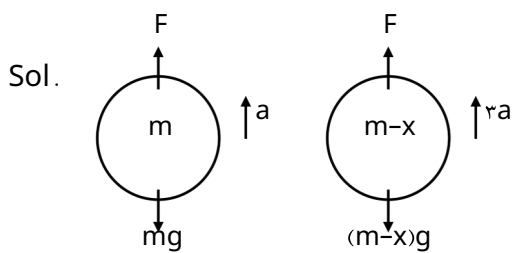
$E = \frac{\sqrt{2}}{2} c$

$E = \frac{\sqrt{2}}{2} i \hat{j} \sin \left(\frac{z}{c} - t \right)$

ε 6. A balloon and its content having mass M is moving up with an acceleration ' a '. The mass that must be released from the content so that the balloon starts moving up with an acceleration ' $\frac{a}{2}$ ' will be : (Take ' g ' as acceleration due to gravity)

- (1) $\frac{2Ma}{g}$ (2) $\frac{Ma}{2g}$
 (3) $\frac{2Ma}{g+2a}$ (4) $\frac{Ma}{g+2a}$

Ans. (3)



$$F - mg = ma$$

$$F = ma + mg$$

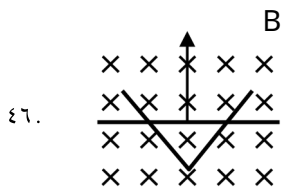
$$F - (m-x)g = (m-x)\frac{a}{2}$$

$$mg - xg = \frac{a}{2}(m-x)$$

$$mg - xg = \frac{a}{2}m - \frac{a}{2}x$$

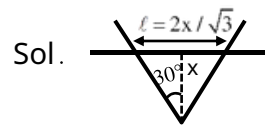
$$x = \frac{2ma}{g+2a}$$

SECTION-B



A conducting bar moves on two conducting rails as shown in the figure. A constant magnetic field B exists into the page. The bar starts to move from the vertex at time $t = 0$ with a constant velocity. If n the induced EMF is $E = \frac{1}{2} n t^2$, then value of n is

Ans. (1)



$$E = \frac{d\phi}{dt}$$

$$E = \frac{d}{dt} (B \cdot l \cdot x) \text{ and } x = vt$$

$$E = \frac{d}{dt} (B \cdot l \cdot vt) = B \cdot l \cdot v$$

ε 8. An electric dipole of dipole moment $1.6 \times 10^{-29} \text{ Cm}$ is placed in uniform electric field of magnitude 10^6 V/m . Initially, the dipole moment is parallel to electric field. The work that needs to be done on the dipole to make its dipole moment opposite to the field, will be _____ J.

Ans. (12)

Sol. $p = 1.6 \times 10^{-29} \text{ Cm}$

$$E = 10^6 \text{ V/m}$$

$$W = \Delta U = -pE(\cos\theta_1 - \cos\theta_2)$$

$$W = 2pE = 12 \text{ J}$$

ε 9. The volume contraction of a solid copper cube of edge length 10 cm , when subjected to a hydraulic pressure of $7 \times 10^6 \text{ Pa}$, would be _____ mm.
 (Given bulk modulus of copper = $1.4 \times 10^{11} \text{ Nm}^{-2}$)

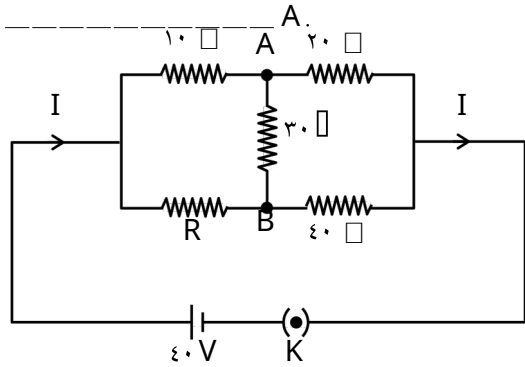
Ans. (50)

Sol. $B = \frac{P}{\Delta V/V}$

$$\Delta V/V = \frac{P}{B} = \frac{7 \times 10^6}{1.4 \times 10^{11}} = 5 \times 10^{-5}$$

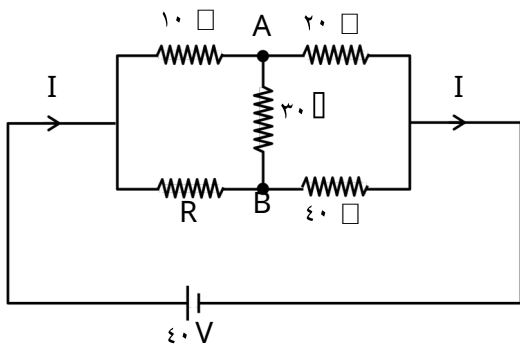
$$\Delta V = 50 \text{ mm}^3$$

49. The value of current I in the electrical circuit as given below, when potential at A is equal to the potential at B , will be



Ans. (2)

Sol.



$V_A = V_B$ the bridge is balanced

$$1 \cdot I_1 = R \cdot I_2$$

$$R = 2 \cdot I_1$$

$$I = \frac{\xi}{3} = 2A$$

50. A thin transparent film with refractive index 1.5 is held on circular ring of radius 1.8 cm. The fluid in the film evaporates such that transmission through the film at wavelength 560 nm goes to a minimum every 12 seconds. Assuming that the film is flat on its two sides, the rate of evaporation is _____ $\times 10^{-3}$ m/s.

Ans. (0.8)

Sol. Maxima condition

$$2nt = n\lambda \quad \text{or} \quad t = \frac{n\lambda}{2} \quad \dots$$

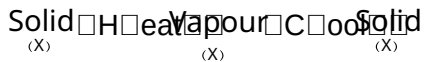
Minima condition $2t = (2n - 1) \frac{\lambda}{2}$

$$t = \frac{(2n - 1)\lambda}{4} \quad \dots$$

$$t = \frac{2\lambda}{4}$$

$$\text{Rate of evaporation} = \frac{\Delta t}{\text{time}} = 0.8 \times 10^{-3} \text{ m/s}$$

Q6. The purification method based on the following physical transformation is :



- (1) Sublimation (2) Distillation
(3) Crystallization (4) Extraction

Ans. (1)

Sol. Theory base

Q7. Identify correct conversion during acidic hydrolysis from the following : (A) starch gives galactose.

(B) cane sugar gives equal amount of glucose and fructose.

(C) milk sugar gives glucose and galactose.

(D) amylopectin gives glucose and fructose.

(E) amylose gives only glucose.

Choose the correct answer from the options given below :

(1) (C), (D) and (E) only

(2) (A), (B) and (C) only

(3) (B), (C) and (E) only

(4) (B), (C) and (D) only

Sol. (A) Starch $\xrightarrow{\text{H}^+/\text{H}_2\text{O}}$ Glucose

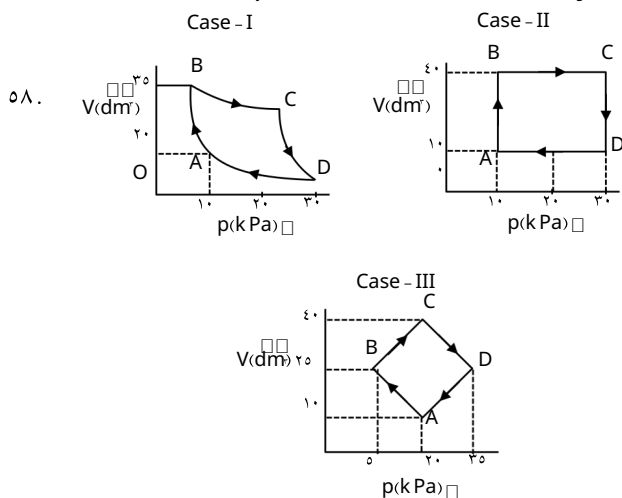
(B) Cane sugar $\xrightarrow{\text{H}^+/\text{H}_2\text{O}}$ 50% glucose + 50% fructose (Sucrose)

(C) Milk sugar $\xrightarrow{\text{H}^+/\text{H}_2\text{O}}$ glucose + galactose (Lactose)

(D) Amylopectin $\xrightarrow{\text{H}^+/\text{H}_2\text{O}}$ Glucose

(E) Amylose $\xrightarrow{\text{H}^+/\text{H}_2\text{O}}$ Glucose

So, correct options are B, C and E only



An ideal gas undergoes a cyclic transformation starting from the point A and coming back to the same point by tracing the path A-B-C-D-A as shown in the three cases above.

Choose the correct option regarding $\oint U$.

(1) $\oint U$ (Case-III) < $\oint U$ (Case-II) < $\oint U$ (Case-I)

(2) $\oint U$ (Case-I) < $\oint U$ (Case-II) < $\oint U$ (Case-III)

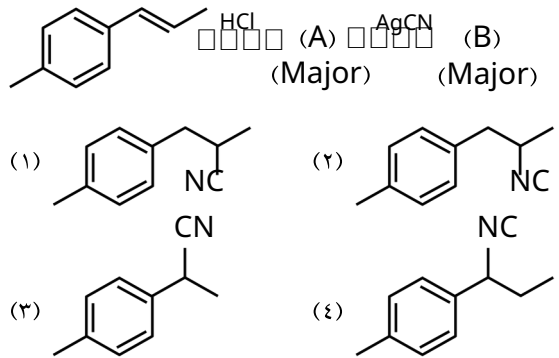
(3) $\oint U$ (Case-I) < $\oint U$ (Case-III) < $\oint U$ (Case-II)

(4) $\oint U$ (Case-I) = $\oint U$ (Case-II) = $\oint U$ (Case-III)

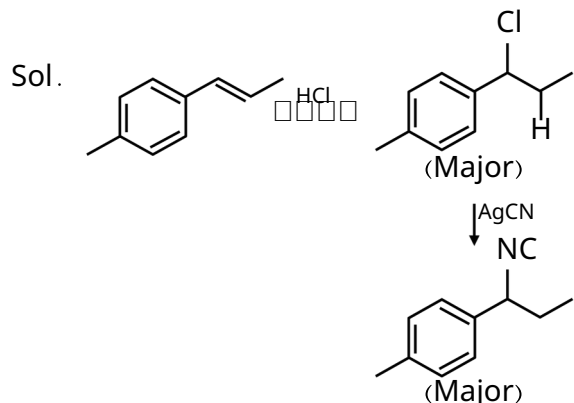
Ans. (4)

Sol. As internal energy 'U' is a state function, its cyclic integral must be zero in a cyclic process
 $\oint U$ case (I) = $\oint U$ case (II) = $\oint U$ case (III)

Q9. The product B formed in the following reaction sequence is :



Ans. (4)



Q10. Concentrated nitric acid is labelled as 70% by mass. The volume in mL of the solution which contains 30 g of nitric acid is _____.

Given : Density of nitric acid solution is 1.30 g/mL

(1) 32

(2) 40

Ans. (2)

Sol. % w/w of HNO₃ = 70%

means 100 gm of solution containing 70 g of HNO₃

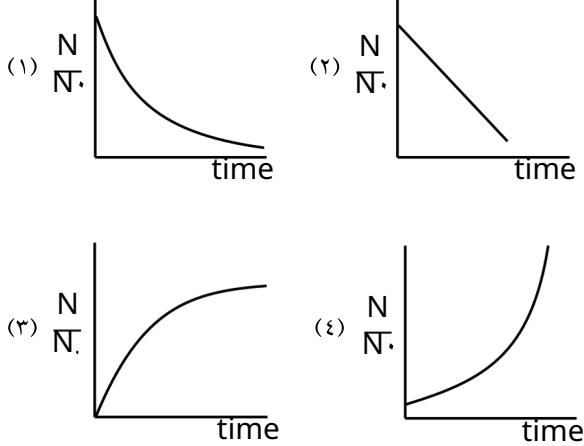
$\frac{100 \text{ gm}}{\text{solution}} \times \frac{70 \text{ gm}}{100} = \frac{70 \text{ gm}}{V}$

V ml of 100 gm solution = $\frac{100}{1.30}$ ml

70 gm of HNO₃ present in $\frac{100}{1.30}$ ml solution
30 gm of HNO₃ present in _____

$\frac{100}{1.30} \times \frac{30}{70} = 32 \text{ ml solution}$

70. For bacterial growth in a cell culture, growth law is very similar to the law of radioactive decay. Which of the following graphs is most suitable to represent bacterial colony growth :

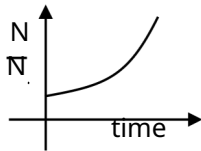


Ans. (3)

Sol. Because no. of bacteria initial = N_0 and No. of bacteria at any time $t = N$ Since bacterial growth is given as

$$N = N_0 \cdot e^{Kt}$$

Where $K =$ growth constant for bacterial growth



71. Which of the following is /are not correct with respect to energy of atomic orbitals of hydrogen atom:

- (A) $1s > 2p > 3d > 4s$
- (B) $1s > 2s = 2p > 3s = 3p$
- (C) $1s > 2s > 2p > 3s > 3p$
- (D) $1s > 2s > 3s > 3d$

Choose the correct answer from the options given below :

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

Ans. (3)

Sol. For single electron species energy only depends on

'n' (principal quantum number)
So energy of $2s = 2p$
and energy of $3d > 3s$

77. Assume a living cell with 0.9% (w/w) of glucose solution (aqueous). This cell is immersed in another solution having equal mole fraction of glucose and water.

(Consider the data upto first decimal place only)

The cell will :

- (1) shrink since solution is 0.9% (w/w)
- (2) shrink since solution is 0.5% (w/w) as a result of association of glucose molecules (due to hydrogen bonding)
- (3) swell up since solution is 1% (w/w)
- (4) Show no change in volume since solution is 0.9% (w/w)

Ans. (BONUS)

NTA (3)

Sol. Living cell = 0.9 gm in 100 gm of solution

$$\%W/W = 0.9$$

Solution is have equal moles of glucose and water = 0.5

$$\text{Weight of solution} = 0.5 \times 180 + 0.5 \times 18 = 99 \text{ gm}$$

$$\%W/W \approx 0.9\%$$

Concentrated solution

= Cell will shrink.

78. Identify correct statements :

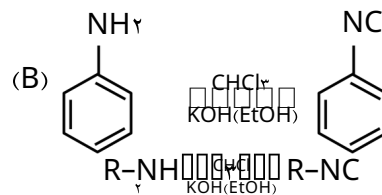
- (A) Primary amines do not give diazonium salts when treated with NaNO_2 in acidic condition.
- (B) Aliphatic and aromatic primary amines on heating with CHCl_3 and ethanolic KOH form carbylamines.
- (C) Secondary and tertiary amines also give carbylamine test.
- (D) Benzenesulfonyl chloride is known as Hinsberg's reagent.
- (E) Tertiary amines reacts with benzenesulfonyl chloride very easily.

Choose the correct answer from the options given below :

- (1) (B) and (D) only
- (2) (D) and (E) only
- (3) (A) and (B) only
- (4) (B) and (C) only

Ans. (1)

Sol. (A) $\text{R-NH}_2 \xrightarrow{\text{NaNO}_2/\text{H}^+} \text{R-N} \equiv \text{N}^+ \text{Cl}^-$



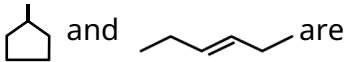

(C) Only primary amine gives carbyl amine test

(D) $\text{Ph-SO}_2\text{Cl}$ is Hinsberg reagent

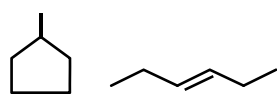
Benzene sulphonyl chloride

(E) Tertiary amine do not react with $\text{Ph-SO}_2\text{Cl}$

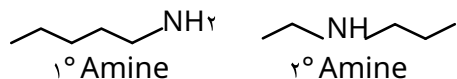
So correct options are (B) and (D) only

79. Given below are two statements :
 Statement (I) :  are isomeric compounds.
 Statement (II) :  are functional group isomers.
 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) Both Statement I and Statement II are true
 (3) Statement I is true but Statement II is false
 (4) Statement I is false but Statement II is true

Ans. (2)
 Sol. Statement-I True



Both are ring chain isomers
 Statement-II True



1° Amine and 2° Amine are different functional groups, hence both are functional group isomers.

80. Identify the inorganic sulphides that are yellow in colour :
 (A) $(\text{NH}_4)_2\text{S}$
 (B) PbS
 (C) CuS
 (D) As_2S_3
 (E) As_2S_5
 Choose the correct answer from the options given below :

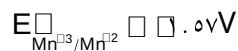
Ans. (A) (A) and (C) only
 NTA (B) (A) and (B) only

Sol. As_2S_3 and As_2S_5 are yellow colour sulphides. $(\text{NH}_4)_2\text{S}$ is colourless, PbS is black, CuS is black in colour

SECTION-B

81. The spin only magnetic moment (μ) value (B.M.) of the compound with strongest oxidising power among Mn^{2+} , TiO and VO is _____ B.M. (Nearest integer).

Ans. (5)
 Sol. Strongest oxidising power among the option is Mn^{2+} because of E° value



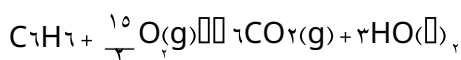
Mn^{2+} d⁵ configuration

$\mu = \sqrt{2 \times 5} \text{ BM}$
 $= 5.89 \text{ BM}$

5

82. Consider the following data : Heat of formation of $\text{CO}_2(\text{g}) = -393.5 \text{ kJ mol}^{-1}$
 Heat of formation of $\text{H}_2\text{O}(\text{l}) = -286.0 \text{ kJ mol}^{-1}$
 Heat of combustion of benzene is $-3267.0 \text{ kJ mol}^{-1}$
 The heat of formation of benzene is _____ kJ mol^{-1} (Nearest integer)

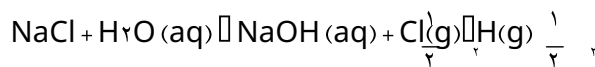
Ans. (48)
 Sol. $\Delta H_f^\circ(\text{CO}_2(\text{g})) = -393.5 \text{ kJ / mole}$
 $\Delta H_f^\circ(\text{H}_2\text{O}(\text{l})) = -286.0 \text{ kJ / mole}$
 $\Delta H_c^\circ(\text{C}_6\text{H}_6) = -3267.0 \text{ kJ / mole}$
 $\Delta H_f^\circ(\text{C}_6\text{H}_6) = ?$



$\Delta H_r = \Delta H_c = 6\Delta H_f(\text{P}) - \Delta H_f(\text{R})$
 $-3267 = 6 \times (-393.5) + 3(-286) - \Delta H_f(\text{C}_6\text{H}_6)$
 $\Delta H_f(\text{C}_6\text{H}_6) = 48 \text{ kJ / mole}$

83. Electrolysis of 100 mL aqueous solution of NaCl for 10 min changes the pH of the solution to 12. The current in Amperes used for the given electrolysis is _____ (Nearest integer).

Ans. (2)
 Sol. Electrolysis of NaCl is



Since during electrolysis pH changes to 12
 So $[\text{OH}^-] = 10^{-2}$ and $[\text{H}^+] = 10^{-12}$

So by Faraday law

Gram amount of substance deposited = Amount of electricity passed

$10 \times \frac{100}{1000} \times \frac{1}{96500} \times 96500 = I \times t$

$10 \times \frac{100}{1000} \times \frac{1}{96500} \times 96500 = I \times 60 \times 60$

$I = \frac{10 \times 100 \times 96500}{1000 \times 96500 \times 3600}$

$I = 1.93 \text{ ampere}$

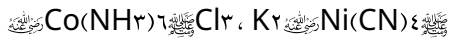
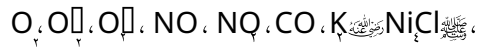
So, $I = 2 \text{ ampere}$ (nearest integer)

84. A group 15 element forms d^π-d^π bond with transition metals. It also forms hydride, which is a strongest base among the hydrides of other group members that form d^π-d^π bond. The atomic number of the element is _____.

Ans. (15)

Sol. Phosphorus belongs to 15 group and forms d^π-d^π bond with transition metal and PH_3 is strongest base among the other group members except NH_3 .

Q. Total number of molecules/species from following which will be paramagnetic is _____.



Ans. (6)

Sol. O_2 2 unpaired electrons according to MOT
 O_3 1 unpaired electrons according to MOT
 O_4 1 unpaired electrons according to MOT
 NO 1 odd electron species
 NO_2 1 odd electron species
 $K_2[NiCl_4]$ 2 unpaired Ni 3d weak Ligand. C.N. = 4
 Tetrahedral, Paramagnetic with 2 unpaired electrons