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5 STUDENTS IN TOP 10 IN JEE-ADVANCED 2024 OPEN CATEGORY

1 AIR	4 AIR	5 AIR	6 AIR	9 AIR	10 AIR
RAGHAV SHARMA Ht. No. 242053073*	RHYTHM KEDIA Ht. No. 247025176*	P KUSHAL KUMAR Ht. No. 246150349	RAJDEEP MISHRA Ht. No. 241016176*	DHRUVIN H DOSHI Ht. No. 241106162	A SIDHVIK SUHAS Ht. No. 246119101

HIGHLIGHTS

- BELOW 100 ALL INDIA OPEN CATEGORY RANKS: 30
- BELOW 500 ALL INDIA OPEN CATEGORY RANKS: 122
- BELOW 1000 ALL INDIA OPEN CATEGORY RANKS: 203
- BELOW 100 ALL INDIA CATEGORY RANKS COUNT: 146
- BELOW 1000 ALL INDIA CATEGORY RANKS COUNT: 721
- NUMBER OF QUALIFIED RANKS: 4187+

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JEE MAIN (JAN) 2025 - SHIFT 2

28-01-2025

Sri Chaitanya IIT Academy., India.

A.P, TELANGANA, KARNATAKA, TAMILNADU, MAHARASHTRA, DELHI, RANCHI

A right Choice for the Real Aspirant

ICON Central Office – Madhapur – Hyderabad

2025_Jee-Main_28-Jan-2025_Shift-02

MATHS **Max Marks: 100**

(SINGLE CORRECT ANSWER TYPE)

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

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

1. Let $f:R-\{0\}\to(-\infty,1)$ be a polynomial of degree 2, satisfying $f(x)f\left(\frac{1}{x}\right)=f(x)+f\left(\frac{1}{x}\right)$. If $f(K)=-2K$, then the sum of squares of all possible values of K is:

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

Key:1

Sol:

$f:R-\{0\}\to(-\infty,1)$

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

$f(x)=1\pm x^n$

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

$given\ f(k)=-2k$

$1-x^2=f(x)\ because\ co-domain\ is\ (-\infty,1)$

$1-k^2=2k$

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

$k_1^2+k_2^2=(k_1+k_2)^2-2k_1k_2$

$=4+2$

6

$\therefore k_1^2+k_2^2=6$

2. Let $A=\begin{bmatrix}\frac{1}{\sqrt{2}} & -2\\ 0 & 1\end{bmatrix}$ and $P=\begin{bmatrix}\cos\theta & -\sin\theta\\ \sin\theta & \cos\theta\end{bmatrix}$, $\theta>0$. If $B=PAP^T$, $C=P^TB^{10}P$ and the sum of the diagonal elements of C is $\frac{m}{n}$, where gcd(m, n) = 1, then m + n is:

1) 2049 2) 258 3) 65 4) 127

Key: 3

SOL: Given

$$A=\begin{bmatrix}\frac{1}{\sqrt{2}} & -2\\ 0 & 1\end{bmatrix}\quad p=\begin{bmatrix}\cos\theta & -\sin\theta\\ \sin\theta & \cos\theta\end{bmatrix}$$

$B=PAP^T, P^TP=I$

$C=P^TB^{10}P$

$C=A^{10}$ (*by induction*)

$$C=\begin{bmatrix}\frac{1}{2^5} & -\sqrt{2}-10\\ 0 & 1\end{bmatrix}$$

$$\therefore T_r(C)=\frac{1}{2^5}+1=\frac{33}{32}=\frac{m}{n}, m+n=65$$

3. Let f be a real valued continuous function defined on the positive real axis such that $g(x)=\int_0^x tf(t)\,dt$. If $g(x^3)=x^6+x^7$, then value of $\sum_{r=1}^{15} f(r^3)$ is :

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

Key: 4

SOL:

$$g(x)=\int_0^x t\ f(t)dt \Rightarrow g(0)$$

$$g\left(x^3\right)=x^6+x^7$$

$$g^1\left(x^3\right)\left(3x^2\right)=6x^5+7x^6$$

$$g^1\left(x^3\right)=\frac{6x^3+7x^4}{3}$$

$$x^3 f\left(x^3\right) = x^3\left(2+\frac{7}{3}x\right)$$

$$f\left(x^3\right) = 2+\frac{7}{3}x$$

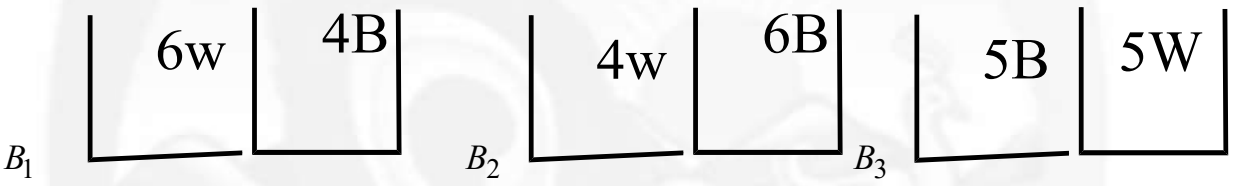
$$\sum_{r=1}^{15} f\left(r^3\right) = 2(15)+\frac{7}{3}\left(\frac{15\times 16}{2}\right) \qquad = 30+280 = 310$$

4. Bag B_1 contains 6 while and 4 blue balls, Bag B_2 contains 4 white and 6 blue balls, and Bag B_3 contains 5 white and 5 blue balls. One of the bags is selected at random and a ball is drawn from it. If the ball is white, then the probability, that the ball is drawn from Bag B_2, is :

1) $\frac{2}{5}$ (2) $\frac{4}{15}$ (3) $\frac{2}{3}$ (4) $\frac{1}{3}$

ANS:2

SOL:



$$P(B_2 / B_E) = \frac{p(B_2 n\, B_W)}{P(B_1 \cap B_W) + p(B_2 \cap B_W) + p(B_3 \cap B_W)}$$

$$= \frac{\frac{4}{10}}{\frac{6}{10}+\frac{4}{10}+\frac{5}{10}}$$

$$= \frac{4}{15}$$

05. If the midpoint of a chord of the ellipse $\frac{x^2}{9}+\frac{y^2}{4}=1$ is $\left(\sqrt{2}, 4/3\right)$, and the length of the chord is $\frac{2\sqrt{\alpha}}{3}$, then α is :

(1) 20 (2) 26 (3) 22 (4) 18

Key: 3

SOL:3

Given $S = \frac{x^2}{9}+\frac{y^2}{4}=1 \quad and \quad mid-point = (\sqrt{2},\frac{4}{3})$ $S_1 = S_{11}$

$$\frac{x\sqrt{2}}{9}+\frac{y.\frac{4}{3}}{4}-1=\frac{\left(\sqrt{2}\right)^2}{9}+\frac{\left(\frac{4}{3}\right)^2}{4}-1$$

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

$$=\sqrt{2}x+3y=6$$

$$y==2+\left(\frac{-y\sqrt{2}}{3}\right)x$$

$$Now\ \frac{x^2}{9}+\left(\frac{6-\sqrt{2x}}{3}\right)^2=1$$

$$6x^2-12\sqrt{2x}=0$$

$$6x\left(x-2\sqrt{2}\right)=0\ \Rightarrow x=0\ \ or\ \ 2\sqrt{2}$$

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

The length of chord = $\sqrt{\left(2\sqrt{2}\right)^2+\left(2-\frac{2}{3}\right)^2}=\sqrt{\frac{88}{9}}=\frac{2\sqrt{22}}{3}\ \ \alpha=22$

06. Let $[x]$ denot the greates integer less than or equal to x. Then the domain of

$$f(x)=\sec^{-1}(2[x]+1)$$

(1) $(-\infty,\infty)-\{0\}$ (2) $(-\infty,-1]\cup[0,\infty)$

(3) $(-\infty,-1]\cup[1,\infty)$ (4) $(-\infty,\infty)$

ANS:4

SOL:

$$Given\quad f(x)=\sec^{-1}\left(2[x]+1\right)$$

$$2[x]+1\le -1\quad or\quad 2[x]+1\ge 1$$

$$[x]\le -1\qquad or\quad [x]\ge 0$$

$$x\in(-\infty,0)\qquad x\in[0,\infty]$$

$$\Rightarrow x\in R\ \ or\ \ (-\infty,\infty)$$

07. If $\sum_{r=1}^{13}\left\{\frac{1}{\sin\left(\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right)\sin\left(\frac{\pi}{4}+\frac{r\pi}{6}\right)}\right\}=a\sqrt{3}+b, a,b\in Z,$ then a^2+b^2

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

ANS: 2

$$\sum_{r=1}^{13}\frac{1}{\sin\left(\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right)\sin\left(\frac{\pi}{4}+\frac{r\pi}{6}\right)}$$

SOL:

$$=\frac{1}{\sin\frac{\pi}{6}}\sum_{r=1}^{13}\frac{\sin\left[\left(\frac{\pi}{4}+\frac{r\pi}{6}\right)\right]-\left\{\frac{\pi}{4}+(r-1)\left(\frac{\pi}{6}\right)\right\}}{\sin\left[\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right]\sin\left[\frac{\pi}{4}+\frac{r\pi}{6}\right]}$$

$$\frac{1}{\sin\frac{\pi}{6}}\sum_{r=1}^{13}\cot\left(\frac{\pi}{4}+(r-1)\frac{\pi}{6}\right)-\cot\left(\frac{\pi}{4}+\frac{r\pi}{6}\right)$$

$$\Rightarrow\frac{1}{\frac{1}{2}}\left[\cot\frac{\pi}{4}-\cot\left(\frac{5\pi}{12}\right)\right]$$

$$\Rightarrow 2[1-\left(2-\sqrt{3}\right)=2\sqrt{3}-2$$

$$=a\sqrt{3}+b$$

$$\therefore a^2+b^2=8$$

08. Let $f:R\to R$ be a twice differentiable function such that $f(2)=1$. If $F(x)=xf(x)$ for all $x\in R$, $\int_0^2 xF(x)dx=6$ and $\int_0^2 x^2F^n(x)dx=40$, then $F(2)+\int_0^2 F(x)dx$ is equal to :

(1) 9 (2) 15 (3) 13 (4) 11

ANS: 4

SOL:

$f:R\to R$ be a twice differentiable f_n $f(2)=1, F(x)=xf(x),\ \forall x\in R$

Now

$$\int_0^2 x\,F'(x)dx=6,2\,F(x)]_0^2-\int_0^2 F(x)dx=6,xF(2)-\int_0^2 x\,F(x)dx=6$$

$$\Rightarrow\int_0^2 x\,F(x)dx=-2\ \&\int_0^2 F(x)dx=-2$$

$$And\ \int_0^2 x^2F''(x)dx=\ x^2F'(x)]_0^2-2\int_0^2 xF'(x)dx=40$$

$$4F'(2)-2\times 6=40$$

$$\Rightarrow F'(2)=13$$

09. Let A, B, C be three points in xy – plane, whose position vector are given by $\sqrt{3}\hat{i}+\hat{j},\hat{i}+\sqrt{3}\hat{j}$ and $a\hat{i}+(1-a)\hat{j}$ respectively with respect to the origin O. If the distance of the point C from the line bisecting the angle between the vectors $\overline{OA}$ and $\overline{OB}$ is $\frac{9}{\sqrt{2}}$, then the sum of all the possible value of a is:

(1) 2 (2) 0 (3) 1 (4) 9/2

ANS: 3

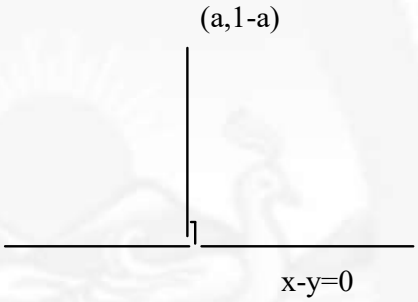
SOL:

$A(\sqrt{3},1)$

$B(1,\sqrt{3})$

$C(a,1-a)$

y=x is one bisector



$$\left|\frac{a-(1-a)}{\sqrt{1^2+1^2}}\right|=\frac{|2a-1|}{\sqrt{2}}=\frac{9}{\sqrt{2}}$$

$\Rightarrow 2a-1=9 \ or \ 2a-1=-9$

$a_1=5 \qquad a_1=-4$

$\therefore a_1+a_2=1$

10. If the components of $\vec{a}=\alpha\hat{i}+\beta\hat{j}+\gamma\hat{k}$ along and perpendicular to $\vec{b}=3\hat{i}+\hat{j}-\hat{k}$ respectively, are $\frac{16}{11}\left(3\hat{i}+\hat{j}-\hat{k}\right)$ and $\frac{1}{11}\left(-4\hat{i}-5\hat{j}-17\hat{k}\right)$ then $\alpha^2+\beta^2+\gamma^2$ is equal to :

(1) 26 (2) 16 (3) 23 (4) 18

ANS: 3

SOL:

$\bar{a}=\alpha\bar{i}+\beta\bar{j}+\gamma\bar{k}$

$\bar{b}=3\bar{i}+\bar{j}-\bar{k}$

Component along $\bar{b}$ is

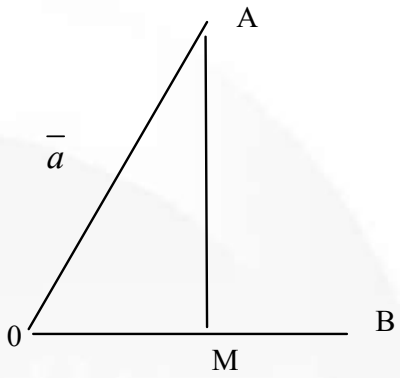
$a_{parallelcomponent}=\frac{16}{11}\left(3\bar{i}+\bar{j}-\bar{k}\right)$

Component perpendicular to $\bar{b}$ *is*

$$a_{perpendicular\ component} = \frac{1}{11}\left(-4\bar{i} - 5\bar{j} - 17\bar{k}\right)$$

$$\therefore \bar{a} = a_{11} + a_1$$

$$\bar{a} = \frac{16}{11}\left(3\bar{i} + \bar{j} - \bar{k}\right) + \frac{1}{11}\left(-4\bar{i} - 5\bar{j} - 17\bar{k}\right)$$



$$\alpha = \frac{48}{11} - \frac{4}{11} = 4$$

$$\beta = \frac{16}{11} - \frac{5}{11} = 1$$

$$\gamma = \frac{-16}{11} - \frac{17}{11} = -3$$

$$\therefore \alpha^2 + \beta^2 + \gamma^2 = 16 + 1 + 9$$

$$= 26$$

11. Let $f:[0,3] \to$ A be defined by $f(x) = 2x^3 - 15x^2 + 36x + 7$ and $g:(0,\infty] \to B$ be defined by $g(x) = \frac{x^{2025}}{x^{2025}+1}$. If both the functions are onto and $S = \{x \in Z : x \in A or x \in B\}$, then n (S) is equal to :

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

ANS: 2

SOL:

$$f:[0,3] \to A$$

$$f(x) = 2x^3 - 15x^2 + 36x + 7$$

$$g:[0,\infty) \to B$$

$$g(x) = \frac{x^{2025}}{1 + x^{2025}}$$

Both f, g are onto

$$f'(x) = 6x^2 - 30x + 36 = 6(x^2 - 5x + 6)$$

$$= 6(x-2)(x-3), f(2) = 35, f(3) = 34$$

$$g(x) = \frac{x^{2025}}{1 + x^{2025}} \in [0,1] \therefore S = \{0,7,8,.....35\} n(S) = 30$$

12. Let the coefficients of three consecutive terms T_r, T_{r+1} and T_{r+2} in the binomial expansion of $(a+b)^{12}$ 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 $\left(\sqrt[4]{3}+\sqrt[3]{4}\right)^{12}$. Then p + q is equal to :

(1) 299 (2) 295 (3) 283 (4) 287

ANS:3

SOL:

Clearly no value of r satisfies G.P $\therefore p=0$

$q=$ Sum of all rational terms $(3^{\frac{1}{4}}+4^{\frac{1}{3}})^{12}$

Exponent of $3^{\frac{1}{4}}$	exponent of $4^{\frac{1}{3}}$	terms
12	0	27
0	12	256

p+q=283

13. If $f(x)=\int \frac{1}{x^{1/4}(1+x^{1/4})}dx, f(0)=-6$, then f(1) is equal to :

(1) $\log_e 2+2$ (2) $4(\log_e 2-2)$ (3) $2-\log_e 2$ (4) $4(\log_e 2+2)$

ANS: 2

SOL:

$$f(x)=\int \frac{dx}{x^{\frac{1}{4}}\left(x^{\frac{1}{4}}+1\right)}, Let\ x=t^4$$

$$f(x)=4\int \frac{t^2-1+1}{t+1}$$

$$=4[\int (t-1)dt+\int \frac{dt}{t+1}]$$

$$f(x)=4\left[\frac{t^2}{2}-t+\ln(1+t)\right]+C$$

$$f(0)=-6 \Rightarrow C=-6$$

$$F(1)=4\left[\frac{1}{2}-1+\ln 2\right]-6$$

$$=4\left[\frac{-1}{2}+\ln 2\right]-6$$

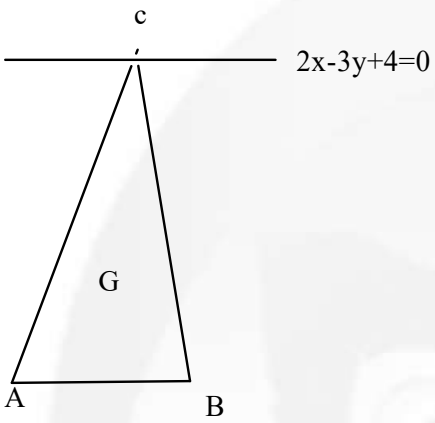
$$=4(\ln 2-2)$$

14. If A and B are the points of intersection of the circle $x^2+y^2-8x=0$ and the hyperbola $\frac{x^2}{9}-\frac{y^2}{4}=1$ and a point P moves on the line $2x-3y+4=0$, then the centroid of ΔPAB lies on the line:

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

ANS:2

SOL:



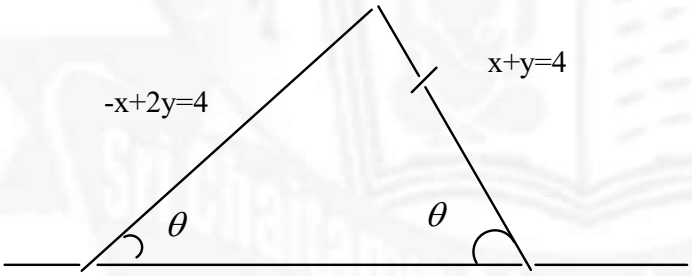
Locus of centroid is parallel to given line so Is 6x-9y=20

15. Two equal sides of an isosceles triangle are along $-x+2y=4$ 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) 12 (2) -6 (3) 6 (4) $-2\sqrt{10}$

ANS:3

SOL:



$$Tan\theta=\left|\frac{m+1}{1-m}\right|=\left|\frac{m-\frac{1}{2}}{1+m\left(\frac{1}{2}\right)}\right|\Rightarrow\left|\frac{m+1}{1-m}\right|=\left|\frac{2m-1}{2+m}\right|$$

$$m^2+3m+2=2m^2-3m+1$$

$$m^2-6m-1=0$$

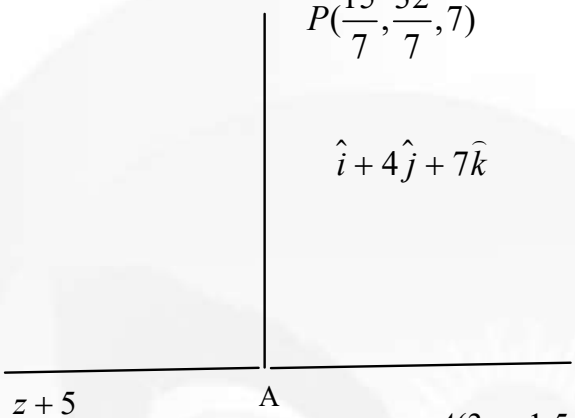
$$m_1+m_2=6$$

16. The square of the distance of the point $\left(\frac{15}{7},\frac{32}{7},7\right)$ from the line $\frac{x+1}{3}=\frac{y+3}{5}=\frac{z+5}{7}$ in the direction of the vector $\hat{i}+4\hat{j}+7\hat{k}$ is :

(1) 66 (2) 54 (3) 44 (4) 41

ANS:1

SOL:



$\frac{x+1}{3}=\frac{y+3}{5}=\frac{z+5}{7}=s$ $A(3s-1,5s-3,7s-5)=(\frac{8}{7},\frac{4}{7},0)$

Equation of PA is

$\frac{x-\frac{15}{7}}{1}=\frac{y-\frac{32}{7}}{4}=\frac{Z=7}{7}=t$

$(t+\frac{15}{7},4t+\frac{32}{7},7t+7)$

$(\frac{8}{7},\frac{4}{7},0)$

$t+\frac{15}{7}=35-1$

$3s-t=\frac{15}{7}+1$

$3s-t=\frac{22}{7}$

$7s-5=7t+7$

$7s-7t=12$

$s-t=\frac{12}{7}$

From 1 and 2

$S=\frac{5}{7}$

$t=-1$

$PA^2 = 1^2 + 4^2 + 7^2 = 66$

17. If $\alpha + i\beta$ and $\gamma + i\delta$ are the roots of $x^2 - (3-2i)x - (2i-2) = 0$, $i = \sqrt{-1}$, then $\alpha\gamma + \beta\delta$ =

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

ANS:3

SOL:

$x^2 - (3-2i)x - (2i-2) = 0$

By observations $1, 2-2i$ *are roots*

$\alpha\gamma + \beta\delta = 2$

18. 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) $\frac{1}{2}$ (2) $\frac{1}{4}$ (3) $\frac{2}{3}$ (4) $\frac{1}{3}$

ANS: 1

SOL:

No of ways in which vowels come in E A order $= \frac{6!}{2}$

Total no.of ways =6!

P (E)= $\frac{1}{2}$

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

(1) $\frac{\pi}{2} - \frac{1}{3}$ (2) $\frac{\pi}{4} - \frac{1}{3}$ (3) $\frac{1}{2}\left(\frac{\pi}{2} - \frac{1}{3}\right)$ (4) $2\left(\frac{\pi}{2} - \frac{1}{3}\right)$

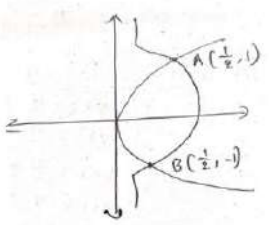
ANS:1

SOL: Given curves

$x(y^2+1) = 1 \; and \;\; y^2 = 2x, y^2 = \frac{1}{x} - 1$

$2x = \frac{1}{x} - 1 \Rightarrow x = \frac{1}{2}, -1(\text{Re } jected), y = \pm 1$

Required Area $= \int_{-1}^{1}\left(\frac{1}{1+y^2} - \frac{y^2}{2}\right)dy = \tan^{-1} y - \frac{y^3}{6}\Big|_{-1}^{1} = \frac{\pi}{2} - \frac{1}{3}$



20. For positive integers n, if $4a_n = \left(n^2 + 5n + 6\right)$ and $S_n = \sum_{k=1}^{n}\left(\frac{1}{a_k}\right)$, then the value of 507 S_{2025} is:

(1) 540 (2) 675 (3) 1350 (4) 135

ANS:2

SOL:

$$4\,a_n = n^2 + 5n + 6$$

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

$$a_n = \frac{n^2+5n+6}{4} = \frac{(n+2)(n+3)}{4}$$

$$\frac{1}{a_n} = \frac{4}{(n+2)(n+3)}$$

$$S_{2025} = 4\sum_{n=1}^{2025}\left(\frac{1}{n+2}\right) - \left(\frac{1}{n+3}\right), S_{2025} = 4\left[\frac{1}{3} - \frac{1}{2028}\right]$$

$$= 4\left[\frac{675}{2028}\right], = \frac{675}{507}, 507\ S_{2025=675}$$

(NUMERICAL VALUE TYPE)

This section contains 10 questions. Each question is numerical value type. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to second decimal place. (e.g. 6.25, 7.00, 0.33, 30, 30.27, 127.30). Attempt any five questions out of 10.

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

21. Let $f(x) = \lim_{x\to 0}\sum_{r=0}^{n}\left(\frac{\tan\left(x/2^{r+1}\right) + \tan^3\left(x/2^{r+1}\right)}{1 - \tan^2\left(x/2^{r+1}\right)}\right)$ Then $\lim_{x\to 0}\frac{e^x - e^{f(x)}}{\left(x - f(x)\right)}$ =

ANS: 1

SOL:

$$f(x) = \lim_{n\to\infty}\sum_{r=0}^{n}\left[\frac{\tan\left(\frac{x}{2^{r+1}}\right) + \tan^3\left(\frac{x}{2^{r+1}}\right)}{1 - \tan^2\left(\frac{x}{2^{r+1}}\right)}\right]$$

$$g = \frac{x}{2^{r+1}} = \Rightarrow \tan\theta\left(\frac{1-\tan^2\theta}{1-\tan^2\theta}\right) \qquad \Rightarrow \tan\theta \times \frac{1}{2\cos 2\theta} = \frac{\sin\theta}{\cos\theta\cos 2\theta} = \frac{\sin(2\theta-\theta)}{\cos\theta\cos 2\theta}$$

$$\tan 2\theta - \tan\theta \qquad r = 0 \Rightarrow \tan\frac{2x}{2} - \tan\frac{x}{2}$$

$$r = 1 \Rightarrow \tan\frac{x}{2} - \tan\frac{x}{4} \qquad r = 2 \Rightarrow \tan\frac{x}{4} - \tan\frac{x}{8}$$

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$r=n \Rightarrow \tan\frac{2x}{2^{n+1}}-\tan\frac{x}{2^{n+1}}$

$f(x)=\lim_{n\to\infty}\tan x-\tan\frac{x}{2^{n+1}}$ $\qquad f(x)=\tan x$

Now $\lim_{x\to 0} e^{f(x)}\left[\frac{e^{\left(x-f(x)\right)}-1}{\left(x-f(x)\right)}\right]=1$

22. The number of natural numbers, between 212 and 999, such that the sum of their digits is 15, is _____

ANS:64

SOL:

$x+y=z=15 \quad \& x\geq 2, y\geq 0 And \;\; Z\geq 0$

Let

$x=2 \Rightarrow y+z=13 \Rightarrow 6$

$x=3 \Rightarrow y+z=12 \Rightarrow 7$

$x=4 \Rightarrow y+z=11 \Rightarrow 8$

$x=5 \Rightarrow y+z=10 \Rightarrow 9$

$x=6 \Rightarrow y+z=9 \Rightarrow 10$

$x=7 \Rightarrow y+z=8 \Rightarrow 9$

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

$x=9 \Rightarrow y+z=6 \Rightarrow 7$

Total 64

23. The interior angles of a polygon with n sides, are in an A.P with common difference 6^0. If the largest interior angle of the polygon is 219^0, then n is equal to _____

ANS:20

SOL: $\frac{n}{2}\left(2a+(n-1)6\right)$

$=(n-2).180^0, a_n+3n^2-3n=(n-2).180^0, From \;\; given \;\; a+(n-1)6^0=219^0$

$a=225-6n$

1 and 2

$n^2-14n-120=0$

$n=20,-6 \;\; (\text{Re } jected)$

n=20

24. Let A and B be the two points of intersection of the line y + 5 = 0 and the mirror image of the parabola $y^2 = 4x$ with respect to the line $x + y + 4 = 0$. If d denotes the distance A and B, and a denotes the area of ΔSAB, where S is the focus of the parabola $y^2 = 4x$, then the value of (a + d) is _____

ANS:14

SOL:

$y^2 = 4x$

$P(t^2, 2t)$

$$\frac{x - t^2}{1} = \frac{y - 2t}{1} = \frac{-2\left[t^{2+2t+4}\right]}{1^1 + 1^1}$$

$x - t^2 = -t^2 - 2t - 4$

$x = -2t - 4$

$y - 2t = -t^2 - 2t - 4$

$y = -t^2 - 4$

$$\frac{x+4}{2} = -t$$

$$y + 4 = -\left(\frac{x+4}{2}\right)^2$$

Mirror image $(x+4)^2 = -4.1(y+4)$

$(x+4)^2 = -4(-5+4)$

$(x+4)^2 = 4$

$x + 4 = 2 \quad or \quad x + 4 = -2$

$x = -2 \quad or \quad x = -6$

$A(-2,-5) \quad and \quad B(-6,-5) \quad and \quad S = (0,0)$

AB=d=4

Area of SAB =

$$\frac{1}{2}|x_1 y_2 - x_2 y_1|$$

$$= \frac{1}{2}|10 - 30|$$

$= 10$

$a = 10$

a+d=14

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

$$\sqrt{4-x^2}\,\frac{dy}{dx} = \left(\left(\sin^{-1}\left(\frac{x}{2}\right)\right)^2 - y\right)\sin^{-1}\left(\frac{x}{2}\right), -2 \le x \le 2, y(2) = \frac{\pi^2-8}{4}$$, then $y^2(0)$ is

equal to

ANS:4

SOL: $$\frac{dy}{dx} + y.\frac{1}{2}\left(\frac{\sin^{-1}\left(\frac{x}{2}\right)}{\sqrt{1-\left(\frac{x}{2}\right)^2}}\right) = \frac{1}{2}.\left(\frac{(\sin^{-1}\left(\frac{x}{2}\right)^3}{\sqrt{1-\left(\frac{x}{2}\right)^2}}\right)$$

$$\sin^{-1}\left(\frac{x}{2}\right) = t, \frac{1}{\sqrt{1-\left(\frac{x}{2}\right)^2}}.\frac{1}{2}.dx = dt$$

I.F= $e^{+2/2}$

$$e\frac{-x}{2} = \int e^{\frac{t^2}{2}}.t^3.dt, y.e\frac{t^2}{2} = 2\int e^{\frac{t^2}{2}}.\frac{t^2}{2}.t.dt, y.e\theta = 2\int e^{\theta}.\theta, d\theta$$

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

$$y = 2(\theta - 1) + c \qquad y = 2\left(\frac{t^2}{2} - 1\right) + C.e^{-\theta}$$

$$y = 2\left[\frac{\sin^{-1}\left(\frac{x^2}{2}\right)}{2} - 1\right] + c.e^{-}\left[\frac{\sin^{-1}\left(\frac{x}{2}\right)^2}{2}\right]$$

$$x = 2\ \frac{\pi^2-8}{4} = 2\left[\frac{\pi^2}{8} - 1\right] + C.e^{-\frac{\pi^2}{8}}$$

$$c = 0$$

$$y = \left(\sin^{-1}\left(\frac{x}{2}\right)\right)^2 - 2$$

$$y(0) = -2$$

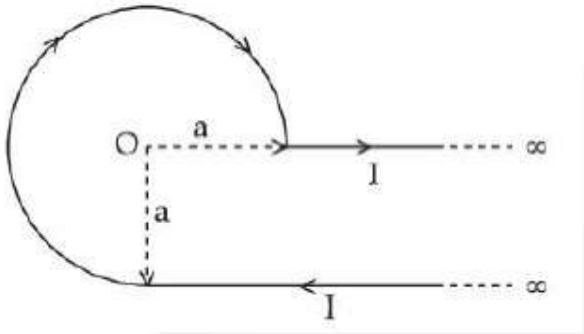
$$y(0)^2 = 4$$

PHYSICS **Max Marks: 100**

(SINGLE CORRECT ANSWER TYPE)

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

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

26. 

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) $\frac{\mu_o}{2\pi}\frac{I}{a}\left[\frac{\pi}{2}+2\right]$ **2)** $\frac{\mu_o}{4\pi}\frac{I}{a}\left[\frac{\pi}{2}+1\right]$ **3)** $\frac{\mu_o}{4\pi}\frac{I}{a}\left[\frac{3\pi}{2}+2\right]$ **4)** $\frac{\mu_o}{4\pi}\frac{I}{a}\left[\frac{3\pi}{2}+1\right]$

ANS: 4

SOL: $B_{RTng\ at\ centre}=\frac{\mu_o I}{2r}$

$$B_{finite\ wire}=\frac{\mu_{oI}}{4\pi r}\left(\sin\theta_1+\sin\theta_2\right)$$

$$B_1=\frac{\mu_{oI}}{4\pi a}\left(\sin 90+\sin 0\right)=\frac{\mu_0 I}{4\pi a}$$

$$B_2=\frac{\mu_{oI}}{2a}.\frac{3}{4}=\frac{3\mu_0 I}{8a}$$

$$\therefore B_{net}=\frac{\mu_o I}{4\pi a}\left(1+\frac{3\pi}{2}\right)$$

27. Earth has mass 8 times and radius 2 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) 2.8 2) 11.2 3) 8.4 4) 5.6

ANS: 4

Sol: $\frac{escape\ velocity}{v_e=\sqrt{Rg_sR}}=\sqrt{\frac{RGM}{R}}=\sqrt{\frac{2G8M_p}{2R_p}}$

$$v_e=2v_p\ \therefore V_p=\frac{v_e}{2}=\frac{11.2}{2}=5.6\frac{km}{S}$$

28. A uniform rod of mass 250 g having length 100 cm is balanced on a sharp edge at 40 cm mark. A mass of 400 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) 300 g 2) 290 g 3) 200 g 4) 190 g

ANS: 4

SOL $400g(30) = 250g \times 10 + mg50 \quad \frac{1200-250}{5} = \frac{950}{5} = 190$

29. The kinetic energy of translation of the molecules in 50 g of CO_2 gas at 17^0C is

1) 3582.7J 2) 4205.5J 3) 3986.3J 4) 4102.8J

ANS: 4

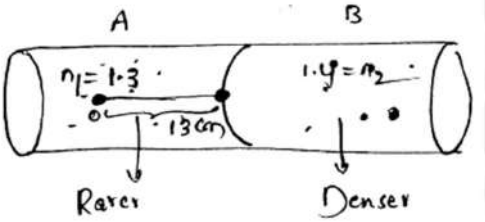
SOL: $K_T = \frac{3}{2}PV = \frac{3}{2}nRT = \frac{3}{2} \times \frac{50}{44} \times 8.314 \times \underset{\underset{273+17}{\downarrow}}{T} \quad K_T = 4109.7J$

30. In a long glass tube, mixture of two liquids A and B with refractive indices 1.3 and 1.4 respectively, forms a convex refractive meniscus towards A. If an object placed at 13 cm from the vertex of the meniscus in A forms an image with a magnification of '-2' then the radius of curvature of meniscus is:

1) $\frac{1}{3}$ cm 2) $\frac{2}{3}$ cm 3) $\frac{4}{3}$ cm 4) 1 cm

ANS:2

SOL:



$m = -2 = \frac{v\mu_1}{u\mu_2} = \frac{V1.3}{1.4(-13)} \quad \therefore V = 28$

$\frac{\mu_2}{V} - \frac{\mu_1}{u} = \frac{\mu_1 - \mu_2}{R} \qquad \frac{1.4}{28} + \frac{1.3}{13} = \frac{0.1}{x} = \frac{1}{10x} \qquad \therefore x = \frac{2}{3}$

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

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

ANS: 1

Sol:

$mvr = \frac{nh}{2\pi} \quad \therefore r\ \alpha\ \underset{\underset{r\alpha n^2}{\downarrow}}{\frac{n}{v}}$

$vr\alpha n$

$$\frac{mv^2}{r}=\frac{ke^2}{r^2}$$

$$mv^2=\frac{ke^2}{r}$$

$$V^2r=cons\tan t$$

$$Vr.v=cons\tan t$$

$$n.v=cons\tan t$$

$$v\,\alpha\,\frac{1}{n}$$

Time period

$$T=\frac{2\pi r}{V}=\frac{1}{f}$$

$$f\,\alpha\,\frac{1}{n}\times\frac{1}{n^2}$$

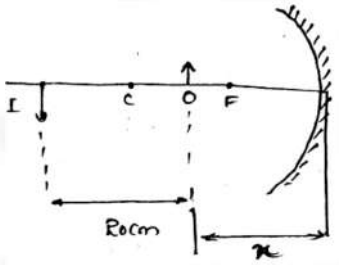
$$f\,\alpha\,\frac{1}{n^3}$$

32. A concave mirror produces an image of an object such that the distance between the object and image is 20 cm. If the magnification of the image is '-3', then the magnitude of the radius of curvature of the mirror is:

1) 3.75 cm 2) 15 cm 3) 30 cm 4) 7.5 cm

ANS: 2

SOL:



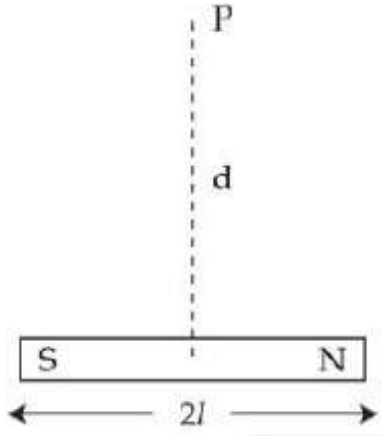
$$m=\frac{-v}{u}\,\frac{20+x}{x}=3\quad x\Rightarrow 10$$

$$\frac{1}{-30}+\frac{1}{-10}=\frac{1}{f}$$

$$f=-\frac{15}{2}$$

$$R=2f=-15$$

$$|R|=15\ cm$$



33. A bar magnet has total length $2l = 20$ units and the field point P is at a distance $d = 10$ 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) 5% 2) 10% 3) 4% 4) 3%

ANS: given 3 or 4 no option

SOL:

Given 3 & 4 Both options

$$B = \frac{\mu_o}{4\pi}.\frac{2.l.m}{\left(l^2+\lambda^2\right)^{3/2}}$$

In the given data uncertainty in the length measurements is 1:1

Here l and r are length based measures and equal in magnitude to short bar magnet consideration can't b' used both by using short bar magnet approx.

B= k. $\frac{l}{n}$ $\frac{\Delta B}{B} = \frac{\Delta l}{l} + \frac{3\Delta}{r}$

Or if M values is fixed $\Delta = \frac{K}{r^3}$

$$\frac{\Delta B}{\Delta} = 3\frac{\Delta^2}{r} \Rightarrow \frac{\Delta B}{B}\% = 3\%$$

By using B= $\frac{\mu_0}{4\pi}.\frac{2lm}{\left(l^2+r^2\right)^{\frac{3}{2}}}$ $\frac{\mu_0}{4\pi}.\frac{2lm}{\left(l^2+r^2\right)^{\frac{3}{2}}}\frac{\Delta B}{B}\% = 1.5\%$

34. A 400 g 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) 400 cm^3 2) 1400 cm^3 3) 600 cm^3 4) 4000 cm^3

Ans: 3

Sol:

$F_b = mg$

$V_b S_L g = V_b \int^{b} g$

$400 = (1) v_{in}$

$v_{in} = 400 cm^3$

$v_b = 10^3 = 1000 cc$

$v_{out} = v_6 - v_{in}$

$= 1000 cc - 400 cc$

$v_{out=600 cm^3}$

35. Which of the following phenomena can not be explained by wave theory of light?

1) Diffraction of light 2) Refraction of light

3) Reflection of light 4) Compton effect

Ans:4

Sol: Theory ; Theory based on wave nature of light

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

Assertion (A) : Knowing initial position x_0 and initial momentum p_0 is enough to determine the position and momentum at any time t for a simple harmonic motion with a given angular frequency to

Reason (R) : The amplitude and phase can be expressed in terms of x_0 and p_0. In the light of the above statements, choose the correct answer from the options given below:

1)(A) is true but (R) is false

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

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

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

Ans:4

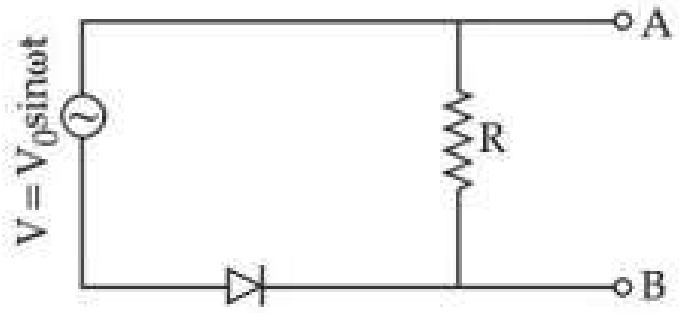
Sol:

$x_0 = A\cos(\omega t + \varnothing)$

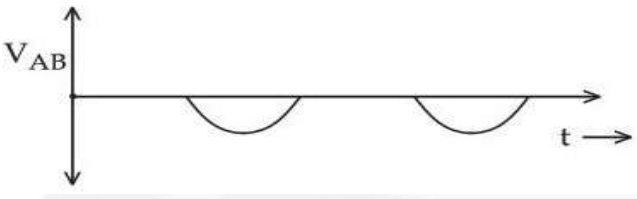
$P_0 = mv = -m\omega A \sin(\omega t + \varnothing)$

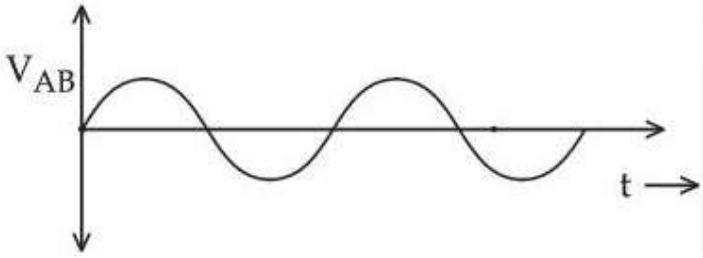
$A^2[\sin^2(\omega t + \varnothing) + \cos^2(\omega t + \varnothing) = {x_0}^2 + \left(\frac{p_0}{m\omega}\right)^2$

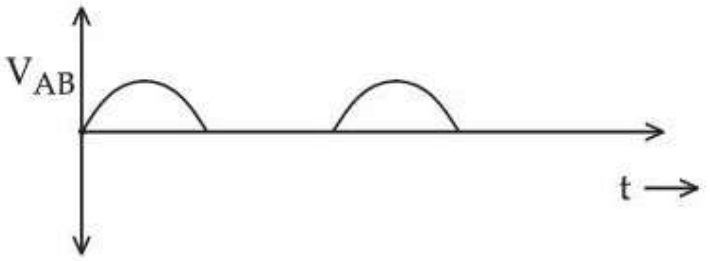
$\cos\varnothing = \frac{x_0}{A} = \frac{x_0}{\sqrt{x_0^2 + \left(\frac{P_0}{m\omega}\right)}}$

37. 

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

1) 

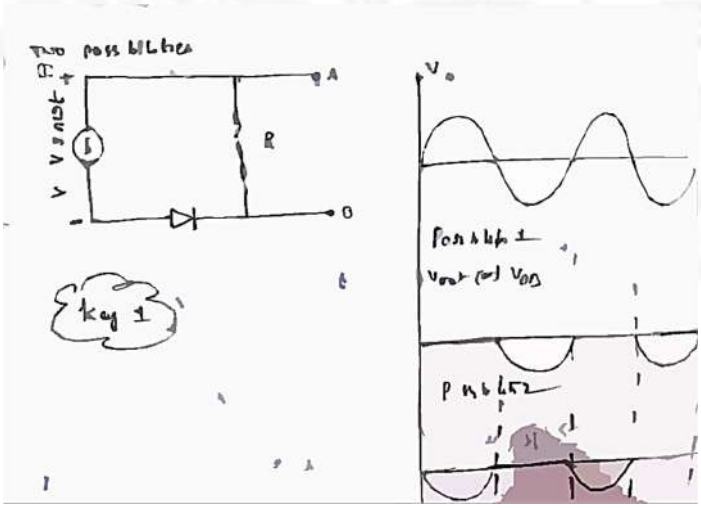
2) 

3) 

4) V_{AB} Would be zero at all times

ANS:1

SOL:

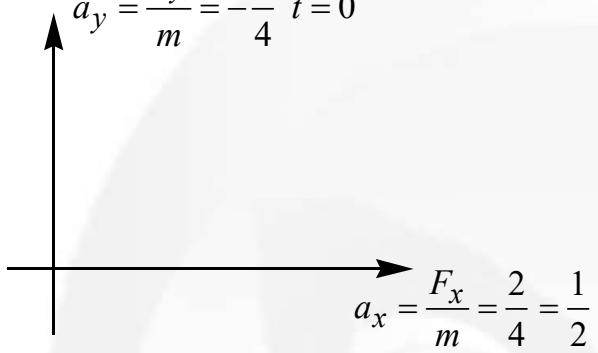


38. A body of mass 4 kg is placed on a plane at a point P having coordinate (3, 4) m. Under the action of force $\vec{F}=\left(2\hat{i}+3\hat{j}\right)N$, it moves to a new point Q having coordinates (6, 10) m in 4 sec. The average power and instanteous power at the end of 4 sec are in the ratio of:

(1) 1 : 2 (2) 4 : 3 (3) 13 : 6 (4) 6 : 13

ANS:4

SOL:



$$\bar{V}_x=0+\frac{1}{2}\times 4=2\hat{i}$$

$$\bar{V}_y=0+\frac{3}{4}\times 4=3\hat{j}$$

$$\bar{V}=V_x\hat{i}+V_y\hat{j}=2\hat{i}+3\hat{j}$$

Trastantaneous power: $P_{inst}=\bar{F}.\bar{V}$

$$=\left(2\hat{i}+3\hat{j}\right).\left(2\hat{i}+3\hat{j}\right)=4+9, P_{inst}=13W$$

Average power:

$$dw=\left(2\hat{i}+3\hat{j}\right).\left(dx\hat{i}+dy\hat{j}\right)$$

$$\Delta w=\int_3^6 2dx+\int_4^{10}3dy$$

$$\Delta w=24$$

$$P_{Avg}=\frac{\Delta w}{\Delta t}=\frac{24}{4}=6W\ \therefore P_{Avg}:P_{inst}=6:13$$

39. A uniform magnetic field of 0.4 T acts perpendicular to a circular copper disc 20 cm in radius. The disc is having a uniform angular velocity of 10 π rad s^{-1} about anaxis through its centre and perpendicular to the disc. What is the potential difference developed between the axis of the disc and the rim? $(\pi=3.14)$

(1) 0.2512 V 2) 0.1256 V 3) 0.5024 V 4) 0.0628 V

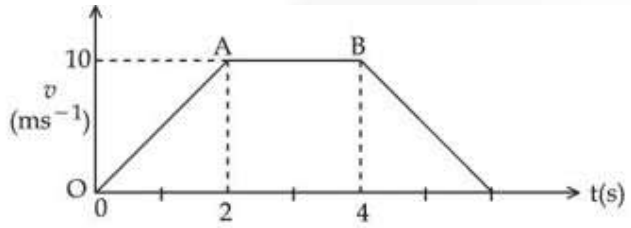
ANS:1

SOL:

$$V_x - V_y = \frac{Bwd^2}{2} = \frac{0.4 \times 10\pi \times \left(\frac{1}{5}\right)^2}{2}$$

$$V_x - V_y = 0.2512V$$

40. 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 = 4s?



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

ANS:4

SOL: Area given us displacement

ma straight line distance and displacement both are same.

$$\therefore Area = d = \frac{1}{2} \times 2 \times 10 + 2 \times 10 = 30m$$

Sol:

41. A ballon 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 '3a' will be (Take 'g' as acceleration due to gravity)

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

ANS:1

SOL:

$$B - mg = ma$$

$$B - (m-x)g = (m-x)3a$$

$$B = m(g+a) = (m-x)(g+3a)$$

$$m - x = \frac{m(a+g)}{g+3a}$$

$$= m\left[\frac{g+3a-a-g}{g+3a}\right] \qquad x = \frac{2ma}{2+3a}$$

42. The ration of vapour densities of two gases at the same temperature is $\frac{4}{25}$, then the ratio of r.m.s velocities will be :

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

ANS:3

SOL: Molecular weight = 2 x vapor density

$$\frac{v_1}{v_2}=\sqrt{\frac{\frac{3RT}{M_1}}{\frac{3RT}{M_2}}}=\sqrt{\frac{M_2}{M_1}}=\sqrt{\frac{(V.D)_2}{(V.D)_1}}=\sqrt{\frac{25}{4}}=\frac{5}{2}$$

43. Match List-I with List -II

List -I	List-II
A)Angular Impulse	I) $[M^0L^2T^{-2}]$
B) Latent Heat	II) $[M\ L^2\ T^{-3}A^{-1}]$
C) Electrical resistivity	III) $[M\ L^2T^{-1}]$
D) Electromotive force	IV) $\left[M\ L^3\ T^{-3}A^{-2}\right]$

1) $(A)-(I),(B)-(III),(C)-(IV),(D)-(II)$
2) $(A)-(II),(B)-(I),(C)-(IV),(D)-(III)$
3) $(A)-(III),(B)-(I),(C)-(II),(D)-(IV)$
4) $(A)-(III),(B)-(I),(C)-(IV),(D)-(II)$

ANS:4

SOL: Angular Cupules = $\Delta L = Iw = ML^2T^{-1}$

EMF $=V=\frac{W}{q}=\frac{ML^2T^{-2}}{AJ}=ML^2T^3T^{-1}$

Q = ML

Latent heat = $\frac{Q}{M}=\frac{ML^2T^{-2}}{M}=\left[L^2T^{-2}\right]$

Resistivity = $S=\frac{E}{J}=\frac{F.A}{q.I}=\frac{ML^{-2}T.L^2}{ATA}=\left[M^1L^3T^{-3}A^{-2}\right]$

44. The magnetic field of an E.M wave is given by $\overline{B}$

$\vec{B}=\left(\frac{\sqrt{3}}{2}\hat{i}+\frac{1}{2}\hat{j}\right)30\sin\left[\omega\left(t-\frac{z}{c}\right)\right]$(*S.Iinits*). the corresponding electrical field in S.I units is:

1) $\vec{E}=\left(\frac{3}{4}\hat{i}+\frac{1}{4}\hat{j}\right)30\ c\cos\left[\omega\left(t-\frac{z}{c}\right)\right]$

2) $\vec{E}=\left(\frac{1}{2}\hat{i}+\frac{\sqrt{3}}{2}\hat{j}\right)30\ c\ \mathrm{c}\sin\left[\omega\left(t+\frac{z}{c}\right)\right]$

3) $\vec{E}=\left(\frac{\sqrt{3}}{2}\hat{i}-\frac{1}{2}\hat{j}\right)30\,\mathrm{csin}\left[\omega\left(t+\frac{z}{c}\right)\right]$

4) $\vec{E}=\left(\frac{1}{2}\hat{i}-\frac{\sqrt{3}}{2}\hat{j}\right)30\,\mathrm{csin}\left[\omega\left(t-\frac{z}{c}\right)\right]$

ANS:4

SOL:

$$\vec{B}=\left(\frac{\sqrt{3}}{2}\hat{i}+\frac{1}{2}\hat{j}\right)30\sin\left[\sin\left(t-\frac{3}{c}\right)\right]$$

Electric and magnetic fields are in same place

(NUMERICAL VALUE TYPE)

This section contains 10 questions. Each question is numerical value type. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to second decimal place. (e.g. 6.25, 7.00, 0.33, 30, 30.27, 127.30). Attempt any five questions out of 10.

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

45. A parallel plate capacitor of capacitance $1\,\mu\mathrm{F}$ is charged to a potential difference of 20 V. The distance between plates is $1\,\mu\mathrm{m}$. The energy density between plated of capacitor is.

$1.2\times10^{-4}\,\mathrm{J/m^3}$ 2. $1.8\times10^{3}\,\mathrm{J/m^3}$ 3. $1.8\times10^{5}\,\mathrm{J/m^5}$ 4. $2\times10^{2}\,\mathrm{J/m^3}$

ANS:2

SOL: Energy stored $"U"=\frac{\frac{1}{2}CV^2}{Ad}=\frac{\frac{1}{2}\times10^{-6}\times400}{A\times10^{-6}}$ $U=\frac{200}{A}=\frac{200}{\frac{10^{-6}d}{0}}$

$$U=\frac{200\times8.854\times10^{-12}}{10^{-12}} \qquad U\cong1.7\times10^{3}\,\frac{J}{m^3}$$

46. An electric dipole of dipole moment 6×10^{-6} 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 make to make its dipole moment opposite to the field, will be _____J.

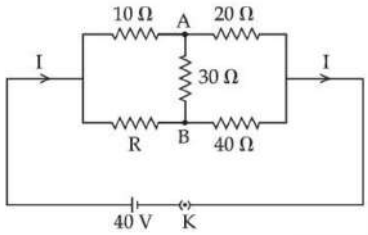
ANS: 12

SOL: $\Delta w=U_j-U_i=PE\left(\cos\theta_i-\cos\theta_j\right)$

$\Delta w=6\times10^{-6}\times10^{6}\left(\cos0-\cos180\right)$

$\Delta w=2\times6=12$

47. 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 _____A.



ANS:2

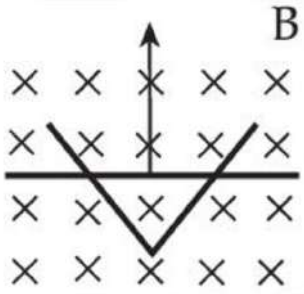
SOL: Wheatstone bridge

$$\frac{R}{40}=\frac{10}{20}\Rightarrow R=20$$

$$R_e=\frac{30\times 60}{90}=20$$

$$I=\frac{40}{R_e}=\frac{40}{20}=2A$$

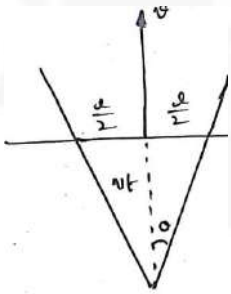
48.



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 the induced EMF is $E\propto t^n$, then value of n is _____.

ANS: 1

SOL:



$$\tan\theta=\frac{\frac{l}{2}}{vt}\Rightarrow v=2xt-\tan\theta$$

$E = Blv$

$E = Bv\,2vt\,\tan\theta$

$E = 2Bv^2t\,\tan\theta$

49. A thin transparent film with refractive index 1.4, 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 _____ $\pi\times10^{-13}\,m^3/s$.

ANS: 54

SOL:

$2\mu\,\Delta t = \lambda$

$$\Delta t = \frac{\lambda}{2\mu} = \frac{560\times10^{-9}}{2\times1.4} = 2\times10^{-7}$$

$$\frac{\Delta Q}{\Delta t} = \frac{\pi e^2\Delta t}{12} = \frac{\pi\times\left(18\times10^{-3}\right)^2\times2\times10^{-7}}{12}$$

$$\frac{\Delta Q}{\Delta t} = 54\times\pi\times10^{-13}$$

50. The volume contraction of a solid copper cube of edge length 10 cm, when subject to a hydraulic pressure of 7×10^6 Pa, would be _____ mm^3.

(Given bulk modulus of copper $1.4\times10^{11}\,Nm^{-2}$)

ANS: 50

SOL:

$$\beta = \frac{\frac{\Delta p}{\Delta v}}{v}$$

$$\Delta v = \frac{\Delta p v}{\beta} = \frac{7\times10^5\times10^{-3}}{14\times10^{10}} = 50mm^3$$

CHEMISTRY **Max Marks: 100**

(SINGLE CORRECT ANSWER TYPE)

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

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

51. Concentrated nitric acid is labelled as 75% by mass. The volume in mL of the solution which contains 30 g of nitric acid is_____.
Given :Density of nitric acid solution is 1.25 g/mL.
1. 40 2. 32 3. 55 4. 45

Key : 2

Sol : $M=\frac{10\times\%w/w\times d}{M.Wt}$ $M=\frac{10\times75\times1.25}{63}$

$$M=\frac{Wt}{G.M.W}\times\frac{1000}{V(ml)},\frac{10\times75\times1.25}{63}=\frac{30}{63\times V_{mL}}\times1000$$

VmL = 32 mL

52. 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. Show no change in volume since solution is 0.9% (w/w)
2. Shrink since solution is 0.45% (w/w) as a result of association of glucose molecules (due to hydrogen bonding)
3. Swell up since solution is 1%(w/w)
4. Shrink since solution is 0.5%(w/w)

Key: BONUS

Sol: living cell=0.9 gm in 100 gm of solutions
% (w/w)=0.9
Solution is having equal moles of glucose and water= 0.5
Weight of solution = $0.5\times180+0.5\times18=99gm$
% (W/W) =90% concentrated solutions
=cell will shrink

53. Identify product [A], [B] and [C] in the following reaction sequence.

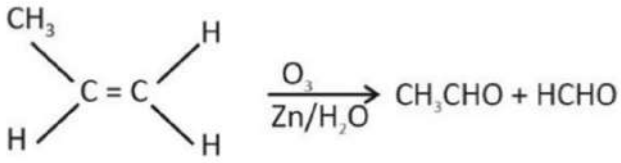
$$CH_3-C\equiv CH\xrightarrow[H_2]{Pd/c}[A]\xrightarrow[(ii)Zn,\ H_2O]{(i)\ O_3}[B]+[C]$$

1. [A] : $CH_3CH_2CH_3$, [B] : CH_3CHO, [C] : HCHO
2. [A] : CH_3-CH=CH_2, [B] : CH_3CHO, [C] : HCHO
3. [A] : CH2=CH2, [B] : $H_3C-\overset{\overset{O}{\|}}{C}-CH_3$, [C] : HCHO
4. [A] : CH_3-CH=CH_2, [B] : CH_3CHO, [C] : CH_3CH_2OH

Key: 2

Sol:

$$CH_3-C\equiv CH \xrightarrow[\text{hydrogenation}]{\text{Partial}}$$



54. Match List-I with List – II

List-I (Complex)	List – II(hybridization of central metal ion)
(A) $[CoF_6]^{3-}$	(I) d^2sp^3
(B) $[NiCl_4]^{2-}$	(II) sp^3
(C) $[Co(NH_3)_6]^{3+}$	(III) $sp^3\,d^2$
(C) $[Ni(CN)_4]^{2-}$	(IV) dsp^2

Choose the correct answer from the options given below:

1. (A)-(III), (B)-(II), (C)-(I), (D)-(IV)
2. (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
3. (A)-(I), (B)-(IV), (C)-(III), (D)-(II)
4. (A)-(I), (B)-(II), (C)-(III), (D)-(IV)

Key: 1

Sol: (A) $[CoF_6]^{3-} \Rightarrow$ cobalt in +3 O.S. with Flourine ligand. Here, F^- act as week field ligand

$Co^{3+} \Rightarrow d^6 \Rightarrow t_{2g}^4 e_g^2$ $\therefore [CoF_6]^{3-}$ has hybridisation $\Rightarrow d^2sp^3$

(B) $[NiCl_4]^{2-}$

$Ni^{2+} \Rightarrow d^8 \Rightarrow t_{2g}^6 e_g^2$ (No pairing by WFL Cl^-)

$\therefore$ $[NiCl_4]^{2-}$ has hybridisation sp^3

(C) $[Co(NH_3)_6]^{3+} \Rightarrow Co^{3+}$, NH_3 ligand act as SFL.

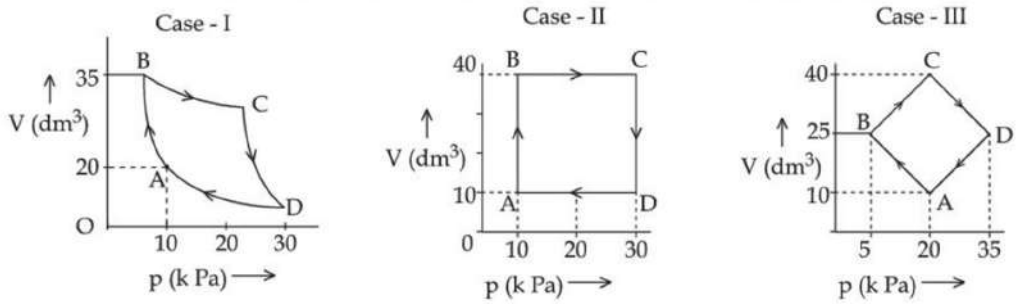
$Co^{3+} \Rightarrow d^6 \Rightarrow t_{2g}^6 e_g^0$

(D) $[Ni(CN)_4]^{2-} \Rightarrow Ni^{2+}$, CN^- act as strong field ligand.

$Ni^{2+} \Rightarrow d^8 \Rightarrow t_{2g}^6 e_g^2 \Rightarrow$ (pairing will occur)

$[Ni(CN)_4]^{2-}$ has hybridization dsp^2

55.



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

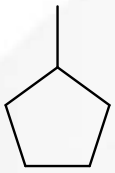
Choose the correct option regarding ΔU :

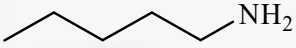
1. ΔU (Case-I) > ΔU (Case-III) > ΔU (Case-II)
2. ΔU (Case-I) = ΔU (Case-II) = ΔU (Case-III)
3. ΔU (Case-III) > ΔU (Case-II) > ΔU (Case-I)
4. ΔU (Case-I) > ΔU (Case-II) > ΔU (Case-III)

Key: 2

Sol: Internal energy is a state function. $\Delta U = 0$ in cyclic process.

56. Given below are statements :

Statement (I) :  and  isomeric compounds.

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

Key: 3

Sol: Ring chain isomers

1^{o} amine and 2^{o} amine are functional isomers.

57. The amphoteric oxide V_2O_3, V_2O_4 and V_2O_5, upon reaction with alkali leads to formation of an oxide anion. The oxidation state of V in the oxide anion is:

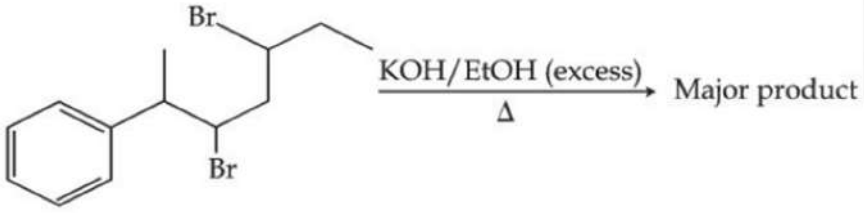
1) +3 2) +5 3) +4 4) +7

Key: 2

Sol: $V_2O_5 \rightarrow$ Amphoteric oxide when react with acid form $[VO_2]^+$

$$\overset{+5}{V_2O_5} \xrightarrow{\text{Acids}} \overset{+5}{[VO_2]^+}$$

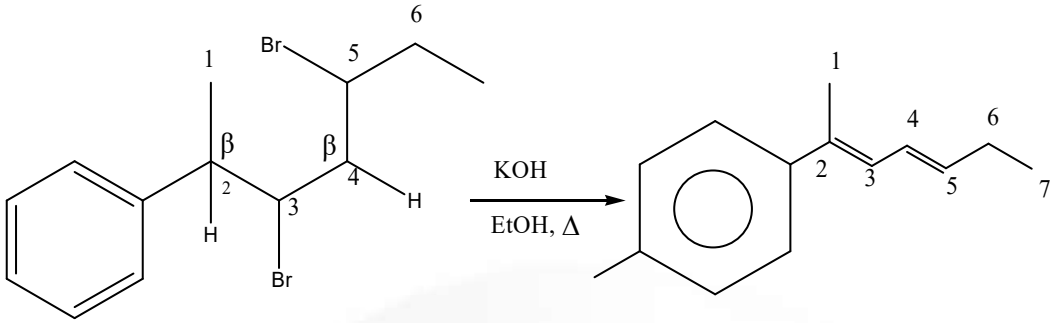
58. The major product of the following reaction is:



1) 2-Phenylhepta-2,4-diene 2) 2-Phenylhepta-2,5-diene

3) 6-Phenylhepta-3,5-diene 4) 6-Phenylhepta-2,4-diene

Key: 1



Sol:

It's an E_2 reaction and more stable conjugated alkane will be major product.

59. Given below are two statements :

Statement (I) : According to the law of Octaves, the elements were arranged in the increasing order of their atomic number.

Statement (II) : Meyer observed a periodically repeated pattern upon plotting physical properties of certain elements against their respective atomic numbers.

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

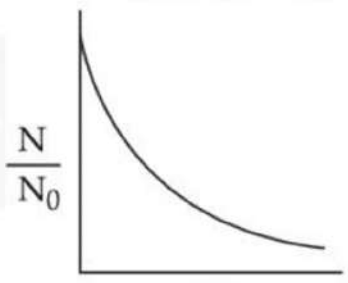
1. Statement I is false but Statement II is true
2. Both statement I and Statement II are false
3. Both statement I and Statement II are true
4. Statement I is true but Statement II is false

Key: 2

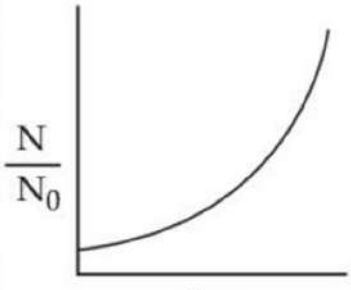
Sol: Law of octave $\rightarrow$ elements were arranged in increasing order of their atomic mass.

Lothar meyer Curve $\rightarrow$ plotted the atomic volume against atomic mass.

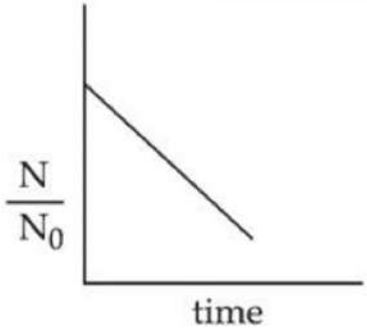
60. For bacterial growth in a cell culture, growth law is very similar to the law of radioactive decay. Which of the following graphs is most suitable to represent bacterial colony growth? Where N – Number of Bacteria at any time, N_0 – Initial number of Bacteria.



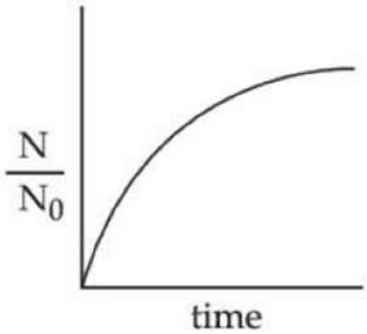
1.



2.



3.



4.

Key: 2

Sol: $\frac{dN}{dt} = kN$

$$\frac{dN}{N} = kdt$$

On integrating using proper limits

$$\int_{N_0}^{N} \frac{dN}{N} = k\int_{0}^{t} dt$$

$$[\ln N]_{N_0}^{N} = k[t]_0^t$$

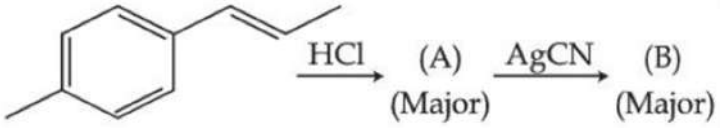
$$\ln N - \ln N_0 = kt$$

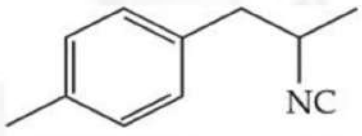
$$\ln \frac{N}{N_0} = kt$$

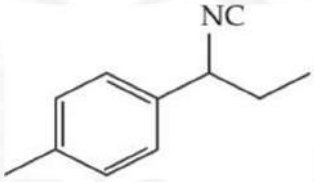
$$\frac{N}{N_0} = e^{kt}$$

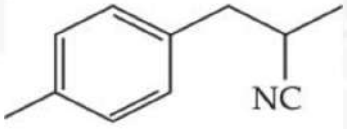
Value of $\frac{N}{N_0}$ increases expotentially.

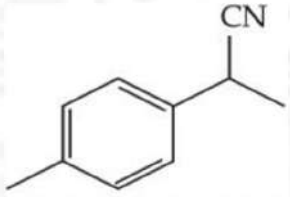
61. The product B formed in the following reaction sequence is:



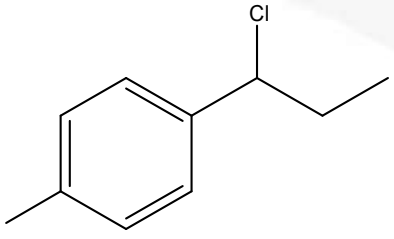
1. 

2. 

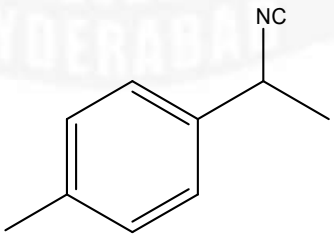
3. 

4. 

Key: 2



A



B

Sol:

62. Consider an elementary reaction

$A(g) + B(g) \rightarrow C(g) + D(g)$

If the volume of reaction mixture is suddenly reduced to $\frac{1}{3}$ of its initial volume, the reaction rate will become 'x' times of the original reaction rate. The value of 'x' is:

1. $\frac{1}{3}$ 2. 3 3. 9 4. $\frac{1}{9}$

Key: 3

Sol: r=K[A][B]

Because volume becomes (1/3)rd,

So concentration becomes 3 times.

r^1 = K[3A][3B]

r^1 = 9K[A][B]

r^1 = 9r

Hence rate becomes 9 times

63. Arrange the following in increasing order of solubility product :

$Ca(OH)_2$, AgBr, PbS, HgS

1. PbS < HgS < $Ca(OH)_2$ < AgBr
2. $Ca(OH)_2$ < AgBr < HgS < PbS
3. HgS < PbS < AgBr < $Ca(OH)_2$
4. HgS < AgBr < PbS < $Ca(OH)_2$

Key: 3

Sol: Based on K_{SP} values.

Salt	K_{SP}
HgS	4×10^{-53}
PbS	8×10^{-28}
AgBr	5×10^{-13}
$Ca(OH)_2$	5.5×10^{-6}

64. 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 < 4s < 3d

Choose the correct answer from the options given below :

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

Key: 2

Sol: For single electron species, energy depends on 'n' value only.

65. 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. (A) and (B) only
2. (B) and (C) only
3. (B) and (D) only
4. (D) and (E) only

Key: 3

Sol: (A) Aniline can form diazonium salt

(C) Only aliphatic and aromatic primary amines gives carbylamine test

(E) Tertiary amines do not react with bezene sulphonyl chloride.

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

$$\text{Solid (X)} \xrightarrow{\text{Heat}} \text{Vapour (X)} \xrightarrow{\text{Cool}} \text{Solid (X)}$$

1. Sublimation
2. Crystallization
3. Distillation
4. Extraction

Key: 1

Sol: Conversion of solid to vapour is known as sublimation.

Conversion of vapour to solid is known as Deposition or desublimation.

67. 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. (B),(C) and (E) only
2. (B),(C) and (D) only
3. (C),(D) and (E) only
4. (A),(B) and (C) only

Key: 1

Sol: (A)Starch gives glucose

(D) Amylopectin gives glucose only

68. Identify the inorganic sulphides that are yellow in colour:

(A) $(NH_4)_2S$ (B) PbS (C) CuS (D) As_2S_3 (E) As_2S_5

Choose the correct answer from the options given below :

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

Key: 3

Sol: PbS : Black

Cus : Black

69. Match List-I with List – II

List-I (Saccharides)	List – II (Glycosidic-linkages found)
(A) Sucrose	(I) α 1- 4
(B) Maltose	(II) α 1- 4 and α 1- 6
(C) Lactose	(III) α 1- β 2
(C) Amylopectin	(IV) β 1- 4

Choose the correct answer from the options given below :

1. (A)-(II), (B)-(IV), (C)-(III), (D)-(I)
2. (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
3. (A)-(IV), (B)-(II), (C)-(I), (D)-(III)
4. (A)-(III), (B)-(I), (C)-(IV), (D)-(II)

Key: 4

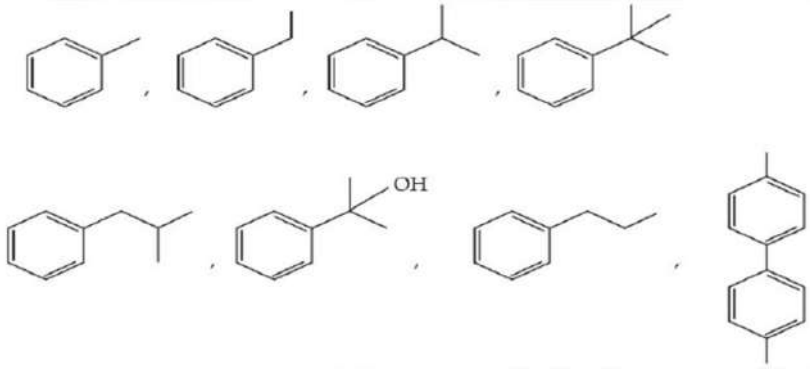
Sol: 1) Sucrose $\rightarrow$ C_1-C_2 glycosidic linkage

2) Maltose $\rightarrow$ C_1-C_4 glycosidic linkage

3) Lactose $\rightarrow$ C_1-C_4 glycosidic linkage

4) Amylopectin $\rightarrow$ branched chain polymer. The chain is formed by C_1-C_4 glycosidic linkage and C_1-C_6 glycosidic linkage

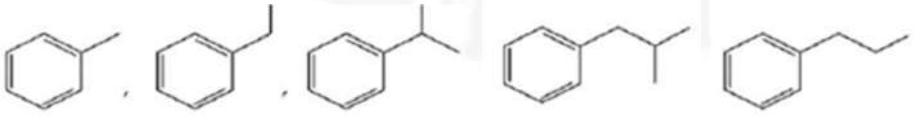
70. The total number of compounds from below when treated with hot $KMnO_4$ giving benzoic acid is:



1. 4 2. 3 3. 5 4. 6

Key: 3

Sol: Benzylic hydrogen containing species



,

(NUMERICAL VALUE TYPE)

This section contains 10 questions. Each question is numerical value type. For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to second decimal place. (e.g. 6.25, 7.00, 0.33, 30, 30.27, 127.30). Attempt any five questions out of 10.

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

71. The spin only magnetic moment (μ) value (B.M.) of the compound with strongest oxidizing power among Mn_2O_3, TiO and VO is _____B.M. (Nearest Integer).

ANS: 5

SOL: Mn_2O_3 is strong oxidizing agent among the given compounds because of E^0 values

$$E^0_{\frac{Mn^{+3}}{Mn^{+2}}} = +1.57V$$

Mn^{+3} has $3d^4$ configuration

$$\mu = \sqrt{4(4+2)} = 4.90$$

72. Consider the following data :
Heat of formation of $CO_2(g)$ = -393.5 kJ mol^{-1}
Heat of formation of $H_2O(l)$ = -286.0 kJ mol^{-1}
Heat of combustion of benzene is = -3267.0 kJ mol^{-1}
The heat of formation of benzene is _____ kJ mol^{-1} (Nearest integer)

ANS: 48

SOL :

$$C_6H_{6(l)} + \frac{15}{2}O_{2(g)} \Rightarrow 6CO_{2(g)} + 3H_2O_{(l)} : \Delta H = -3267\ KJ/mol$$

$$-3267 = 6(-393.5) + 3(-286) - x$$

$$x = -2361 - 858 + 3267$$

48

73. Electrolysis of 600 mL aqueous solution of NaCl for 5 min changes the pH of the solution to 12. The current in Amperes used for the given electrolysis is _____(Nearest integer)

ANS: 2

Sol: $P^{OH} = 2; [OH^-] = 10^{-2}$ $\quad 1000ml \rightarrow 10^{-2}$

$$600ml \rightarrow \frac{10^{-2}}{10^3} \times 600 = 6 \times 10^{-3}\ mole$$

$$= 3 \times 10^{-3}\ mole\ H_2$$

$$n_{H_2} = \frac{1}{n_f \times 96500} \times i \times t_{sec}$$

$$3 \times 10^{-3} = \frac{1}{2 \times 96500} \times i \times 5 \times 60$$

$$= 1930 \times 10^{-3} = 1.93 \quad nearly\ 2$$

74. A group 15 element forms $d\pi$ - $d\pi$ bond transition metals. It also forms hydride, which is a strongest base among the hydrides of other group members that form $d\pi$ - $d\pi$ bond. The atomic number of the element is_____.

Ans: 15

SOL : PH_3 is more basic than other group hydrides which can form $d\pi - d\pi$ bond 'N' cannot form $d\pi - d\pi$

75. Total number of molecules /species from following which will be paramagnetic is_____.

O_2, O_2^+, O_2^-, NO, NO_2, CO, $K_2[NiCl_4]$, $[Co(NH_3)_6]Cl_3$, $K_2[Ni(CN)_4]$

Ans: 6

SOL : $O_2, O_2^+, O_2^-, NO, NO_2, K_2[NiCl_4]$ *are paramagnetic*

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G N NIRMALKUMAR Appl.No. 240310385062*	REDDI ANIL Appl.No. 240310238514*	K C BASAVA REDDY Appl.No. 240310618179*	THOTAMSETTY NIKILESH Appl.No. 240310813888*	A V TANISH REDDY Appl.No. 240310807613	HIMANSHU THALOR Appl.No. 240310580429**	VEDANT SAINI Appl.No. 240310182830	P MEET VIKRAMBHAI Appl.No. 240310157524*	
34 RANK	40 RANK	43 RANK	46 RANK	49 RANK	52 RANK	53 RANK	57 RANK	
SANVI JAIN Appl.No. 240310150036*	VISHARAD SRIVASTAVA Appl.No. 240310046262*	T JAYADEV REDDY Appl.No. 240310167365	ISHAAN GUPTA Appl.No. 240310100229*	MAVURU JASWITH Appl.No. 240310542275*	DORISALA SRINIVASA REDDY Appl.No. 240310682440*	ARCHIT RAHUL PATIL Appl.No. 240310512311*	KRISHNA AGRAWAL Appl.No. 240310285850*	
60 RANK	68 RANK	70 RANK	76 RANK	92 RANK	93 RANK	95 RANK	96 RANK	98 RANK
AYUSH GANGAL Appl.No. 240310270709	PALAGIRI SATHISH REDDY Appl.No. 240310905497	MD K GHOUSE MOHIUDDIN Appl.No. 240310176352	T V S SAI NAGA BHUSHAN Appl.No. 240310868568	M M PRUTHVI RAJ Appl.No. 240311084545	M SAI SIVA LOCHAN Appl.No. 240310866829*	RAJDEEP MISHRA Appl.No. 240310265621*	MANOJ SOHAN GAJULA Appl.No. 240310529661	KRISH NARSARIA Appl.No. 240310028286*

Below 100 All-India Open Category Ranks **25**

Below 500 All-India Open Category Ranks **108**

Below 1000 All-India Open Category Ranks **222**

Below 100 All-India All Category Ranks **97**

Below 1000 All Category Ranks **888**

TOTAL QUALIFIED RANKS FOR JEE ADVANCED-2024 **21,987**

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