26/04/2026

Code-B

Corporate Office : AESL, 3rd Floor, Incuspaze Campus-2, Plot No. 13, Sector-18, Udyog Vihar, Gurugram, Haryana - 122015, ***Ph.***+91-1244168300

MM : 180

AIATS For One Year JEE(Advanced)-2026 (XII Studying & XII Passed)_Test-6A_Paper-2_ONLINE

Time : 180 Min.

MATHEMATICS

Section-I

1. (B)

2. (A)

3. (D)

4. (C)

Section-II

5. (A,B,D)

6. (A,B,C)

7. (A,D)

Section-III

8. (5)

9. (103)

10. (9)

11. (8)

12. (0)

13. (2)

Section-IV

14. (08.00)

15. (04.00)

16. (04.00)

17. (00.00)

PHYSICS

Section-I

18. (C)

19. (B)

20. (B)

21. (B)

Section-II

22. (B,D)

23. (A,C)

24. (B,D)

Section-III

25. (1)

26. (11)

27. (3)

28. (22)

29. (74)

30. (99)

Section-IV

31. (00.00)

32. (17.70)

33. (02.00)

34. (06.00)

CHEMISTRY

Section-I

35. (D)

36. (C)

37. (B)

38. (B)

Section-II

39. (B,D)

40. (B,D)

41. (A,C,D)

Section-III

42. (9)

43. (6)

44. (21)

45. (36)

46. (44)

47. (5)

Section-IV

48. (03.00)

49. (00.05)

50. (08.00)

51. (03.00)

Hints and Solutions

MATHEMATICS

Section-I

(1) **Answer :** (B)

Hint:

$$S=\sum_{n=1}^{\infty}\sin^{-1}\left(\frac{\sqrt{n}-\sqrt{n-1}}{\sqrt{n\,(n+1)}}\right)$$

Solution:

$$S=\sum_{n=1}^{\infty}\sin^{-1}\left(\frac{\sqrt{n}-\sqrt{n-1}}{\sqrt{n\,(n+1)}}\right)$$

$\sin^{-1}\left(\frac{\sqrt{n}-\sqrt{n-1}}{\sqrt{n(n+1)}}\right)=\tan^{-1}\left(\sqrt{n}\right)-\tan^{-1}\left(\sqrt{n-1}\right)$

Take limit as $N\to\infty$

$S=\frac{\pi}{2}$

(2) **Answer :** (A)

Hint:

Variance = $\sum\frac{\alpha_i^2}{n}-\left(\overline{X}\right)^2$

Solution:

Mean $\overline{X}=6.8$

$\sum_{i=1}^{10}\alpha_i=6.8\times10=68$, $\sum_{i=1}^{10}\alpha_i^2=480$

$\left(\sum\alpha_i\right)_{new}=68-4-5+7+8=74$

Correct $\sum_{i=1}^{10}\alpha_i^2=480-\left(4^2+5^2\right)+\left(7^2+8^2\right)$

= 552

Corrected mean = $\frac{74}{10}=7.4$

∴ Variance = $\sum\frac{\alpha_i^2}{n}-\left(\overline{X}\right)^2$

= $\frac{552}{10}-(7.4)^2$

= $\frac{44}{100}=0.44$

(3) **Answer :** (D)

Hint:

$h(x)=e^x\cdot e^{e^x}$

Solution:

$\ln(g(x+y))=\ln(g(x))\cdot\ln(g(y))$

Differentiating both sides w.r.t. x

$\frac{1}{g(x+y)}\cdot g'(x+y)=\frac{1}{g(x)}\cdot g'(x)\cdot\ln(g(y))$

Put x = 0

$\frac{g'(y)}{g(y)}=\frac{g'(0)}{g(0)}\ln(g(y))$

$\frac{g'(y)}{g(y)\ln(g(y))}=1$

Integrating both sides,

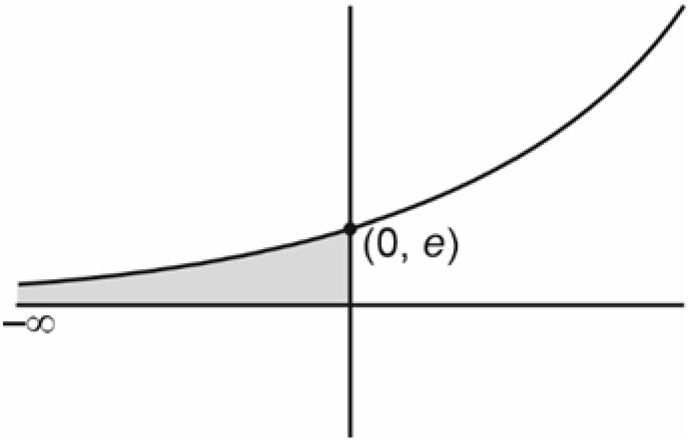
$\ln(\ln(g(y)))=y+c$

As $g(0)=e$, $g'(0)=e$

$\Rightarrow c=0$

$g(y)=e^{e^y}$ or $g(x)=e^{e^x}$

Now $h(x)=e^x\cdot e^{e^x}$



$\therefore\ A = \int_{-1}^{1} e^x e^{e^x} \cdot dx$

Put $e^x = t$

$e^x\, dx = dt$

$A = \int_{1/e}^{e} e^t\, dt$

$A = e^e - e^{1/e}$

(4) **Answer :** (C)

Hint:

$T_{r+1} = {}^{15}C_r\ \alpha^{15-r} \beta^r \left(x^{1/8}\right)^{15-r} \left(x^{-1/4}\right)^r$

Solution:

$T_{r+1} = {}^{15}C_r\ \alpha^{15-r} \beta^r \left(x^{1/8}\right)^{15-r} \left(x^{-1/4}\right)^r$

$= {}^{15}C_r\ \alpha^{15-r} \beta^r x^{\frac{15-3r}{8}}$

$\Rightarrow\ \frac{15-3r}{8} = 0\ \Rightarrow = r = 5$

$\therefore$ Term independent of x is ${}^{15}C_5\ \alpha^{10}\ \beta^5$

Now $\frac{5\left(\frac{\alpha^2}{5}\right) + 5\left(\frac{\beta}{5}\right)}{10} \geq \left(\frac{\alpha^{10} \cdot \beta^5}{5^{10}}\right)^{\frac{1}{10}}$

$\frac{1}{5^2} \geq \alpha \beta^{1/2}$

$\therefore\ \left(\alpha^{10}\ \beta^5\right)_{\max} = \frac{1}{5^{10}}$

$\therefore$ Maximum value of term independent of x is ${}^{15}C_5 \times \frac{1}{5^{10}}$

Section-II

(5) **Answer :** (A,B,D)

Hint:

$n(C \cup T \cup B) + n(C) + n(T) + n(B) - n(C \cap T) - n(C \cap B) - n(T \cap B) + n(C \cap T \cap B)$

Solution:

$n(C) = 320$, $n(T) = 210$, $n(B) = 130$

$n(C \cap B) = 55$, $n(C \cap T) = 80$, $n(T \cap B) = 60$

$n(\text{None}) = 110$

Number of people watching atleast one game = 600 – 110 = 490

$n(C \cup T \cup B) + n(C) + n(T) + n(B) - n(C \cap T) - n(C \cap B) - n(T \cap B) + n(C \cap T \cap B)$

$490 = 320 + 210 + 130 - 80 - 55 - 60 + n(C \cap T \cap B)$

$\Rightarrow n(C \cap T \cap B) = 25$

Only Tennis = $n(T) - n(C \cap T) - n(T \cap B) + n(C \cap T \cap B)$

$= 210 - 80 - 60 + 25 = 95$

Only cricket $\Rightarrow n(C) - n(C \cap T) - n(C \cap B) + n(C \cap T \cap B)$

$= 320 - 80 - 55 + 25 = 210$

Only Basketball = $n(B) - n(B \cap C) - n(B \cap T) + n(B \cap T \cap C)$

$= 130 - 55 - 60 + 25$

$= 40$

Exactly one = n(only C) + n(only B) + n(only T)
= 210 + 95 + 40 = 345

(6) **Answer :** (A,B,C)
Hint:
P^2 – (Trace P). P + $|P| \cdot I = 0$
Solution:
$P^2 + 2025\, I = 0$
As P^2 – (Trace P). P + $|P| \cdot I = 0$
∴ Trace (P) = 0 and $|P|$ = 2025

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix}\begin{bmatrix} a & b \\ c & d \end{bmatrix} = \begin{bmatrix} -k & 0 \\ 0 & -k \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} a^2+bc & ab+bd \\ ac+dc & bc+d^2 \end{bmatrix} = \begin{bmatrix} -k & 0 \\ 0 & -k \end{bmatrix}$$

Now $ab + bd = 0$ … (1)
$ac + dc = 0$
from (1), $b(a + d) = 0$
⇒ $a = -d$
⇒ $\frac{a}{d} = -1 < 0$
⇒ $ad < 0$

(7) **Answer :** (A,D)
Hint:
$\lim\limits_{x\to 2^-} g(x) = \lim\limits_{x\to 2^+} g(x) = g(2)$
Solution:
As $g(x)$ is continuous at $x = 2$
$\lim\limits_{x\to 2^-} g(x) = \lim\limits_{x\to 2^+} g(x) = g(2)$
When $x < 2$
Let $x = 2 - h$

$$\lim_{x\to 2^-} g(x) = \lim_{x\to 2^-} = \frac{e^{\left(\log_{13}\left(e^{x+2}\right)\right)\frac{[x+1]}{4}} - 169}{13^x - 169}$$

$$\lim_{h\to 0} g(x) = \lim_{h\to 0} = \frac{13^{(4-h)\cdot\frac{[3-h]}{4}} - 169}{13^2\cdot 13^{-h} - 13^2}$$

$$= \lim_{h\to 0} = \frac{13^{2-\frac{h}{2}} - 13^2}{13^2\left(13^{-h}-1\right)}$$

$$= \lim_{h\to 0} = \frac{13^{-\frac{h}{2}} - 1}{13^{-h}-1} = \lim_{h\to 0} = \frac{13^{-\frac{h}{2}} - 1}{\left(-\frac{h}{2}\right)}\frac{\left(-\frac{h}{2}\right)}{13^{-h}-1}$$

$$= \frac{\ln 13}{\ln 13}\cdot\frac{1}{2}$$

$= \frac{1}{2}$ … (1)
When $x > 2$

$$\lim_{x\to 2^+} g(x) = \beta \lim_{x\to 2^+} \frac{1-\cos\left(\sin\left(e^{x-2}-1\right)\right)}{(x-2)\cdot\sin(\tan(x-2))} \cdot \frac{1}{(x-2)\sin^2\left(e^{x-2}-1\right)} \cdot \frac{\sin^2\left(e^{x-2}-1\right)}{\frac{\sin(\tan(x-2))}{\tan(x-2)}\cdot\tan(x-2)}$$

$$= \beta\lim_{h\to 0}\frac{1-\cos\left(\sin e^h - 1\right)}{\sin^2\left(e^h-1\right)}\cdot\frac{\sin^2\left(e^h-1\right)}{h\cdot h^2}\cdot\frac{h^2}{\tan h}$$

⇒ $\beta \cdot \frac{1}{2} \cdot 1 \cdot 1$
⇒ $\frac{\beta}{2}$ … (2)
∴ from (1) and (2)
$\frac{\beta}{2} = \frac{1}{2}$ ⇒ β = 1
∴ Also $g(2) = \alpha$
∴ $\frac{1}{2} = \alpha$
6α + β = 4, $\alpha + \beta = \frac{3}{2}$

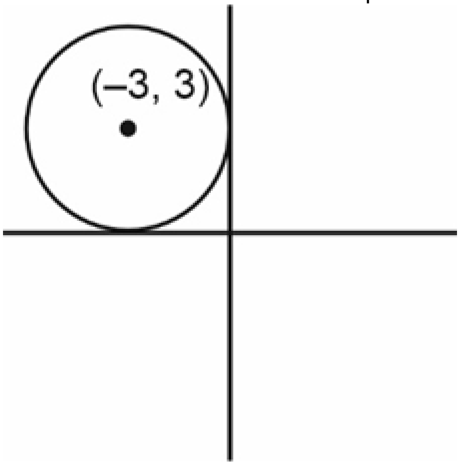
Section-III

(8) **Answer :** 5
Hint:
$|r_1 - r_2| < c_1c_2 < r_1 + r_2$
Solution:

$S_1 : (x + 3)^2 + (y - 3)^2 = 3^2$

$S_2 : (x - 2)^2 + (y - 15)^2 = r^2$

Since both circle intersects at two points



$\therefore |r_1 - r_2| < c_1c_2 < r_1 + r_2$ … (1)

Now $c_1c_2 = \sqrt{(2+3)^2 + (15-3)^2}$

$\Rightarrow \sqrt{(5)^2 + (12)^2}$

$c_1c_2 = 13$

$\Rightarrow r_1 = 3, r_2 = r$

From (1), $|3 - r| < 13 < 3 + r$

$\Rightarrow |r - 3| < 13 < r + 3$

$\Rightarrow -13 < 3 - r < 13, r + 3 > 13$

$\Rightarrow r \in (10, 16)$

(9) **Answer :** 103

Hint:

Baye's theorem

Solution:

Probability that yellow ball comes from Box I

$$P\left(\frac{B_1}{Y}\right) = \frac{\frac{1}{3}\cdot\frac{4}{10}}{\frac{1}{3}\cdot\left(\frac{4}{10}\right)+\frac{1}{3}\left(\frac{5}{10}\right)+\frac{1}{3}\cdot\frac{2}{10}}$$

$$P\left(\frac{B_1}{Y}\right) = \frac{4}{11} = \alpha$$

Similarly, $P\left(\frac{B_3}{W}\right) = \frac{\frac{1}{3}\cdot\frac{5}{10}}{\frac{1}{3}\left(\frac{4}{10}+\frac{3}{10}+\frac{5}{10}\right)}$

$= \frac{5}{12} = \beta$

$\therefore 132(\alpha + \beta) = 103$

(10) **Answer :** 9

Hint:

$a_{2027} - (t^2 - 13t + 30)\, a_{2026} + a_{2025} = 0$

Solution:

$x^2 - (t^2 - 13t + 30)x + 1 = 0$

$a_{2027} - (t^2 - 13t + 30)\, a_{2026} + a_{2025} = 0$

$\Rightarrow \frac{a_{2027}+a_{2025}}{a_{2026}} = t^2 - 13t + 30$

$= \frac{a_{2027}+a_{2025}}{a_{2026}} = \left(t - \frac{13}{2}\right)^2 - \frac{49}{4}$

$\Rightarrow \left(\frac{a_{2027}+a_{2025}}{a_{2026}}\right)_{\min} = -\left(\frac{7}{2}\right)^2$

$\therefore m + n = 9$

(11) **Answer :** 8

Hint:

$$d = \left|\frac{\left(\vec{a}_2 - \vec{a}_1\right)\cdot\left(\vec{b}_1 \times \vec{b}_2\right)}{\left|\vec{b}_1 \times \vec{b}_2\right|}\right|$$

Solution:

Let $\vec{a}_1 = (2,\ 3,\ -6),\ \vec{a}_2 = (-2,\ 0,\ 6)$

$\therefore\ \vec{a}_2 - \vec{a}_1 = (-4, -3, 12)$

$\therefore$ Also $\vec{b}_1 = \langle 2, -7, 5\rangle,\ \vec{b}_2 = \langle 2,\ 1, -3\rangle$

$$\therefore\ \vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 2 & -7 & 5 \\ 2 & 1 & -3 \end{vmatrix}$$

$= 16\hat{i} + 16\hat{j} + 16\hat{k}$

$$\therefore\ d = \left|\frac{\left(\vec{a}_2 - \vec{a}_1\right)\cdot\left(\vec{b}_1 \times \vec{b}_2\right)}{\left|\vec{b}_1 \times \vec{b}_2\right|}\right|$$

$$d = \frac{\langle -4, -3, 12\rangle\langle 16, 16, 16\rangle}{16\sqrt{3}}$$

$d = \frac{80}{16\sqrt{3}} = \frac{5}{\sqrt{3}}$

$\therefore\ m + n = 8$

(12) Answer : 0

Hint:

Let $y = h(x)$

$36 + \frac{d^2y}{dx^2} + \frac{dy}{dx} = x^2 + y^2$

Solution:

$36 + h''(x) + h'(x) = x^2 + h^2(x)$

$36 + \frac{d^2y}{dx^2} + \frac{dy}{dx} = x^2 + y^2$ … (1)

Now as Q be point of maxima of $h(x)$ so

$\frac{dy}{dx} = 0$ and $\frac{d^2y}{dx^2} < 0$

From (1), $36 + \frac{d^2y}{dx^2} = x^2 + y^2$

$\Rightarrow\ x^2 + y^2 = 36 + \frac{d^2y}{dx^2}$ … (2)

$x^2 + y^2 < 36$ means Q lies inside.

$\therefore$ No tangents are possible

(13) Answer : 2

Hint:

$g(x + y) = g(x) + g(y)$

$\Rightarrow g(x) = Kx$

Solution:

$g(x + y) = g(x) + g(y)$

$\Rightarrow g(x) = Kx$

Given $g\left(\frac{7}{2}\right) = 49$

$\Rightarrow\ 49 = K \cdot \frac{7}{2}$

$\Rightarrow K = 14$

$\therefore g(x) = 14x$

Also $h(x + y) = h(x)h(y) \Rightarrow h(x) = a^x$

$\Rightarrow\ 3 = a^{-1/4}$

$\Rightarrow 3^4 = a^{-1}$

$\Rightarrow\ \frac{1}{81} = a$

$\therefore\ h(x) = \left(\frac{1}{81}\right)^x$

$\therefore\ g\left(\frac{1}{9}\right) = \frac{14}{9},\ h\left(\frac{1}{2}\right) = \frac{1}{9}$

$\therefore\ g\left(\frac{1}{9}\right) + h\left(\frac{1}{2}\right) + \frac{1}{3} = \frac{14}{9} + \frac{1}{9} + \frac{1}{3}$

$= \frac{15}{9} + \frac{1}{3} = \frac{15+3}{9} = 2$

Section-IV

(14) **Answer :** 08.00
Hint:
Let $z = x + iy$
Solution:
$13z\bar{z} - 7i\left(z^2 - (\bar{z})^2\right) - 216 = 0$
Let $z = x + iy$
$13(x + iy)(x - iy) - 7i((x + iy)^2 - (x - iy)^2) - 216 = 0$
$\Rightarrow 13(x^2 + y^2) - 7i(x^2 - y^2 + 2ixy - x^2 + y^2 + 2ixy) = 216$
$\Rightarrow 13(x^2 + y^2) - 7i(4ixy) = 216$
$\Rightarrow 13(x^2 + y^2) + 28xy = 216$
Put $x = r\cos\theta$, $y = r\sin\theta$
$\Rightarrow 13r^2 + r^2 \cdot 28\cos\theta\sin\theta = 216$
$\Rightarrow 13r^2 + 14r^2\sin 2\theta = 216$
$\Rightarrow r^2 = \frac{216}{13 + 14\sin 2\theta}$
For minimum value of,
$r^2 \Rightarrow \theta = \frac{\pi}{4}, \frac{5\pi}{4}$
$r^2 = 8$
$x_1 = r\cos\theta = \pm 2$
$y_1 = r\sin\theta = \pm 2$

(15) **Answer :** 04.00
Hint:
Let $z = x + iy$
Solution:
$13z\bar{z} - 7i\left(z^2 - (\bar{z})^2\right) - 216 = 0$
Let $z = x + iy$
$13(x + iy)(x - iy) - 7i((x + iy)^2 - (x - iy)^2) - 216 = 0$
$\Rightarrow 13(x^2 + y^2) - 7i(x^2 - y^2 + 2ixy - x^2 + y^2 + 2ixy) = 216$
$\Rightarrow 13(x^2 + y^2) - 7i(4ixy) = 216$
$\Rightarrow 13(x^2 + y^2) + 28xy = 216$
Put $x = r\cos\theta$, $y = r\sin\theta$
$\Rightarrow 13r^2 + r^2 \cdot 28\cos\theta\sin\theta = 216$
$\Rightarrow 13r^2 + 14r^2\sin 2\theta = 216$
$\Rightarrow r^2 = \frac{216}{13 + 14\sin 2\theta}$
For minimum value of,
$r^2 \Rightarrow \theta = \frac{\pi}{4}, \frac{5\pi}{4}$
$r^2 = 8$
$x_1 = r\cos\theta = \pm 2$
$y_1 = r\sin\theta = \pm 2$

(16) **Answer :** 04.00
Hint:

$$\begin{vmatrix} \beta & \cos\beta & 1+\cos\beta \\ 1 & \sin\beta & \sin\beta \\ 0 & \cos\beta & \cos\beta \end{vmatrix} = 0$$

Solution:
As all are linearly dependent vectors for $x = \beta$

$$\therefore \begin{vmatrix} \beta & \cos\beta & 1+\cos\beta \\ 1 & \sin\beta & \sin\beta \\ 0 & \cos\beta & \cos\beta \end{vmatrix} = 0$$

$\Rightarrow \alpha(\cos\beta \cdot \cos\beta - \cos\beta \cdot \sin\beta) - \cos\beta(\cos\beta) + (1 + \cos\beta)(\cos\beta) = 0$
$\Rightarrow -\cos^2\beta + \cos\beta + \cos^2\beta = 0$
$\Rightarrow \cos\beta = 0$
$\Rightarrow \beta = \frac{\pi}{2}$ (considering principal values)
$\therefore \left(\frac{4\beta}{\pi}\right)^2 = 4$
$\therefore$ Remainder = 8 $\forall n \in Z$

(17) **Answer :** 00.00
Hint:

$$[P(x)Q(x)\,R(x)] = \begin{vmatrix} \cos 2021x & \sin 2021x & \cos 2024x \\ \tan 2023x & \sin 2023x & \cos 2026x \\ \cos 2025x & \sin 2025x & \cos 2028x \end{vmatrix}$$

Solution:

$$[P(x)Q(x)R(x)] = \begin{vmatrix} \cos 2021x & \sin 2021x & \cos 2024x \\ \tan 2023x & \sin 2023x & \cos 2026x \\ \cos 2025x & \sin 2025x & \cos 2028x \end{vmatrix}$$

$$\int_0^{3\pi} [PQR]x\ dx = \int_0^{3\pi} [PQR]\,(3\pi - x)dx$$

$$\int_0^{3\pi} [PQR]x\ dx = -\int_0^{3\pi} [PQR]dx$$ (∵ $C_1 \to -C_1$)

$$\Rightarrow \int_0^{3\pi} [PQR]dx = 0$$

PHYSICS

Section-I

(18) **Answer :** (C)
Hint:
sin *i* = μ sin *r*
Solution:
sin *i* = μ sin *r*

$\frac{i}{\mu} = r$

$\frac{i}{\mu^2}\Delta u = \Delta r$

$\frac{i}{a^2} \cdot \frac{3b}{4\lambda_0^2} = \Delta r$

(19) **Answer :** (B)
Hint:
dp.A = –*nAdhmg*
Solution:
dp.A = –*nAdhmg*

$P = \frac{n_0 N_0 RT}{N_0 V} = nkT$

dP = *dn*(*kT*)

$n = n_0 e^{-\frac{mgh}{kT}}$

$n' = n_0 e^{-\frac{mg_2h}{kT}}$

$\frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1} = \frac{e^{-\frac{2mgh}{kT}}}{e^{-\frac{mgh}{kT}}}$

$\lambda e^{\frac{mgh}{kT}} = \lambda'$

$\frac{mgh}{kT} = \ln\left(\frac{\lambda'}{\lambda}\right) \quad \frac{mgh}{kT} = \ln\left(\frac{\lambda''}{\lambda'}\right)$

$\frac{\lambda'}{\lambda} = \frac{\lambda''}{\lambda'}$

$\lambda'^2 = \lambda\lambda''$

(20) **Answer :** (B)
Hint:

$\frac{1}{2}Li^2 = \frac{1}{2}mv^2$

Solution:

$Blv = \frac{Ldi}{dt} \quad \frac{1}{2}Li^2 = \frac{1}{2}mv^2$

$ilB = -\frac{mdv}{dt}$ $\quad i = \sqrt{\frac{m}{L}}v_0$

$\frac{Ld^2i}{dt^2} = -\frac{Bldv}{dt}$ $\quad i = \sqrt{\frac{1}{0.01}} \cdot 4 = 40$

$iB^2l^2 = -mL\frac{d^2i}{dt^2}$

(21) Answer : (B)

Hint:

$\frac{dy}{D} = n\lambda$

Solution:

$\frac{dy}{D} = 20\lambda$

$n_1 = \frac{C}{\lambda}$ $\; n_2 = \frac{3C}{4\lambda}$ $\; n_3 = \frac{3C}{5\lambda}$ $\; n_4 = \frac{C}{2\lambda}$

$1 : \frac{3}{4} : \frac{3}{5} : \frac{1}{2}$

20 : 15 : 12 : 10

Section-II

(22) Answer : (B,D)

Hint:

$KE_{\text{w.r.t. com}} + U = 0$

Solution:

$KE_{\text{w.r.t. com}} + U = 0$

$\frac{1}{2}(4m)\left(\frac{v}{2}\right)^2 - \frac{2Gm^2}{l} - \frac{2Gm^2}{\sqrt{2}l} = 0$

$\frac{v^2}{2} - \frac{2Gm}{l} - \frac{2Gm}{\sqrt{2}l} = 0$

$v = \sqrt{\frac{2Gm}{l}\left(2 + \sqrt{2}\right)}$

$K = \frac{1}{2}4m\left(\frac{v}{2}\right)^2 = \frac{1}{2}mv^2$

(23) Answer : (A,C)

Hint:

$p\pi r^2 = \sigma^2\pi rt$

Solution:

For cylinder

$T\Delta\theta = pr\Delta\theta l$

$T = prt$

$\sigma tl = prl$

$p = \frac{\sigma t}{r}$

For sphere

$p\pi r^2 = \sigma^2\pi rt$

$p = \frac{2\sigma t}{r}$

(24) Answer : (B,D)

Hint:

$V_P = -V\frac{dy}{dx}$

Solution:

$V_P = -V\frac{dy}{dx} = V\frac{2x}{(1+x^2)^2} = \frac{40}{4} =$ 10 m/s

$\frac{\partial^2 y}{\partial x^2} = \frac{1}{c^2}\frac{\partial^2 y}{dt^2}$

$\frac{\partial y}{\partial x} = \frac{2x}{(1+x^2)^2}$

$\frac{\partial^2 y}{\partial x^2} = \frac{2-6x^2}{(1+x^2)^3} = \frac{1}{2}$

At $x = 1$, $\frac{\partial^2 y}{dx^2} = \frac{1}{2}$

$a_p = 400 \times \frac{1}{2}$ = 200 m/s^2

Section-III

(25) Answer : 1

Hint:

$C_1 = C_2 = \frac{\mu_0 i}{2}$

Solution:

$C_1 = C_2 = \frac{\mu_0 i}{2}$

(26) Answer : 11

Hint:

$N = N_0 e^{-\lambda t}$

Solution:

$N = N_0 e^{-\lambda t}$

$\frac{\ln 3}{\lambda} = \tau_1 = \tau_2$

$\frac{\ln 2}{\lambda} = \tau$

$\frac{\tau_1 + \tau_2}{\tau} = \frac{2 \ln 3}{\lambda \ln 2} = \frac{\ln 9}{\ln 2}$

(27) Answer : 3

Hint:

F = M L T^{-2}

Solution:

F = M L T^{-2}

$l = \sqrt{\frac{hG}{c^3}}$ $t = \frac{hG}{c^5}$ $m = \sqrt{\frac{hc}{G}}$

$F = \sqrt{\frac{c^8}{G^2}}$

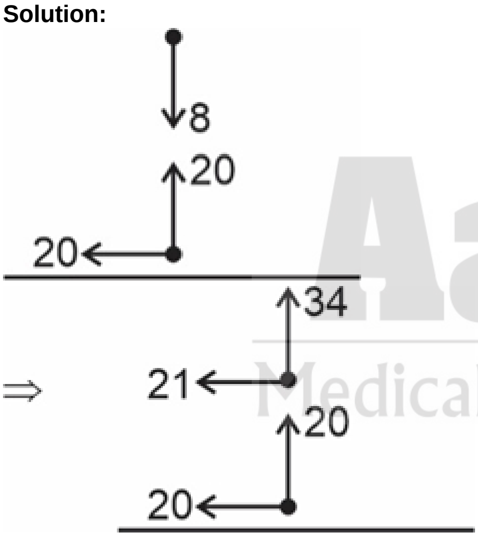
$F = \frac{c^4}{G}$

(28) Answer : 22

Hint:

$e = \frac{V_{sep}}{V_{app}}$

Solution:



(29) Answer : 74

Hint:

τ = *I*α

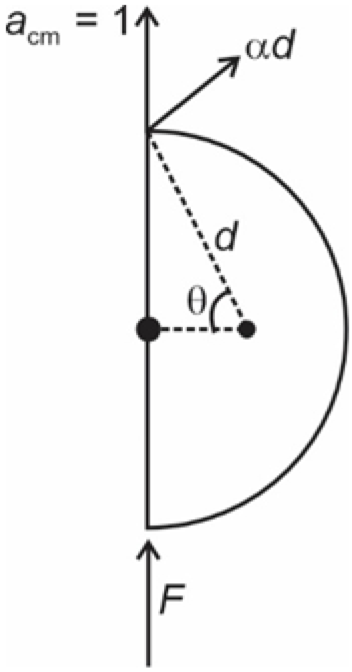
Solution:

$\alpha = \frac{\tau}{I}$ $I_e = I_{cm} + Md^2$

$\alpha = \frac{\frac{4}{3\pi}}{\frac{1}{2} - \frac{16}{9\pi^2}} = \frac{12\pi}{9\pi^2 - 16}$

$\left\{ \frac{MR^2}{2} - M\left(\frac{4R}{3\pi}\right)^2 = I_{cm} \right\}$

$\left(\frac{1}{2} - \frac{16}{9\pi^2}\right) = I_{cm}$



$a_{cm} = \frac{F}{m} = 1$ m/s^2

$\alpha d \cos\theta = a_r$

$d = \frac{R}{\sin\theta}$ and $a_r = \frac{16}{29}$

⇒ $a_{cm} + a_r = \frac{45}{29}$

∴ α = 45 and β = 29

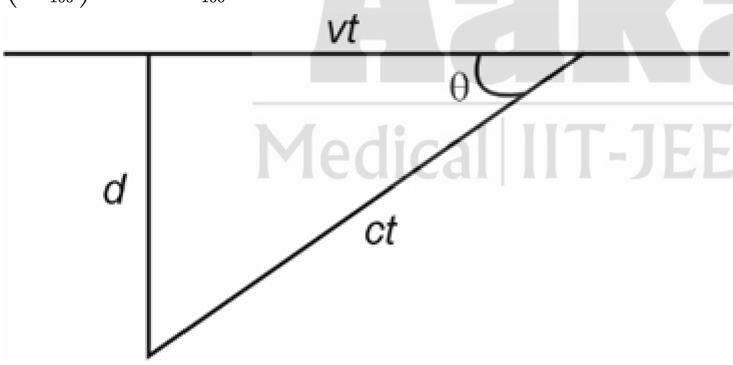
(30) **Answer :** 99

Hint:

$f = f_0\left(\frac{v \pm v_0}{v \pm v_s}\right)$

Solution:

$\left(1 - \frac{1}{100}\right) f' = f_0 = \frac{99}{100} \times 100 = 99\,Hz$



$v^2t^2 + d^2 = c^2t^2$

$\frac{d^2}{c^2 - v^2} = t^2 \Rightarrow \cos\theta = \frac{v}{c}$

$f' = f_0\left(\frac{c}{c - c\cos^2\theta}\right)$

$f_0 = f' \cdot \sin^2\theta = \frac{f' \cdot d^2}{c^2t^2}$

$= \frac{f' \cdot d^2}{c^2d^2}\left(c^2 - v^2\right) = f'\left(1 - \frac{v^2}{c^2}\right)$

Section-IV

(31) **Answer :** 00.00

Hint:

$\frac{\partial E}{\partial x} + \frac{\partial E}{\partial y} + \frac{\partial E}{\partial z} = \frac{\rho}{\epsilon_0}$

Solution:

$\frac{\partial E}{\partial x} + \frac{\partial E}{\partial y} + \frac{\partial E}{\partial z} = \frac{\rho}{\epsilon_0}$

(i) $\rho_1 = 0$

(ii) $2x - 2y + 27 = \frac{\rho}{\epsilon_0}$

$\rho = 2\epsilon_0$

$\rho = 2 \times 8.85 \times 10^{-12}$

$\rho_2 = 17.70 \times 10^{-12}$ C/m^3

(32) **Answer :** 17.70

Hint:

$\frac{\partial E}{\partial x} + \frac{\partial E}{\partial y} + \frac{\partial E}{\partial z} = \frac{\rho}{\epsilon_0}$

Solution:

$\frac{\partial E}{\partial x} + \frac{\partial E}{\partial y} + \frac{\partial E}{\partial z} = \frac{\rho}{\epsilon_0}$

(i) $\rho_1 = 0$

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$\rho = 2\epsilon_0$

$\rho = 2 \times 8.85 \times 10^{-12}$

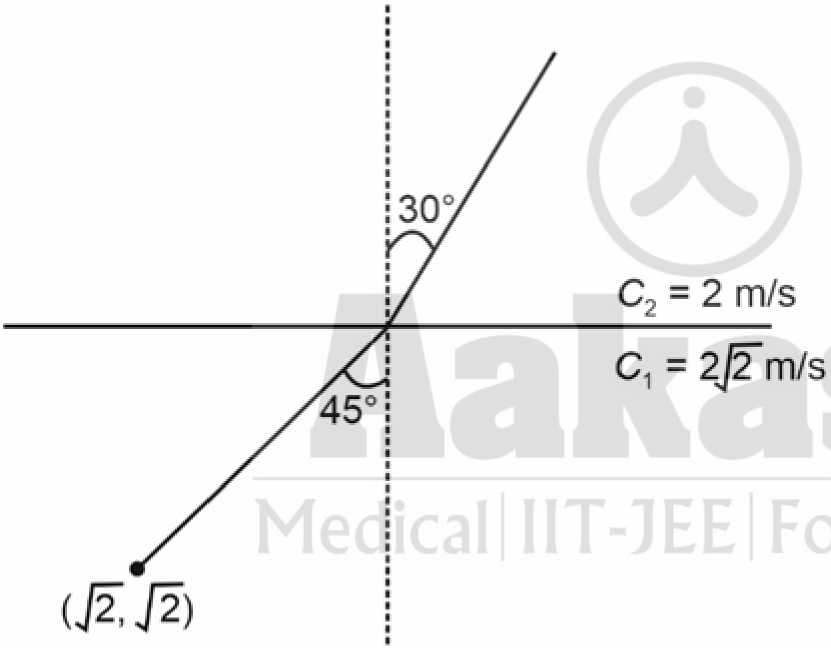
$\rho_2 = 17.70 \times 10^{-12}$ C/m^3

(33) **Answer :** 02.00

Hint:

$\mu_1 \sin i = \mu_2 \sin r$

Solution:



$\frac{\sin 45°}{C_1} = \frac{\sin 30}{C_2}$

C_1 = 2 m/s

$t_1 = \frac{2}{2\sqrt{2}} = \frac{1}{\sqrt{2}}$ $\quad$ $t = t_1 + t_2$

$\frac{3}{\sqrt{2}} \times 2 = d$ $\quad$ $y = 3\sqrt{2} \times \frac{\sqrt{3}}{2} = \frac{3}{2}\sqrt{6}$

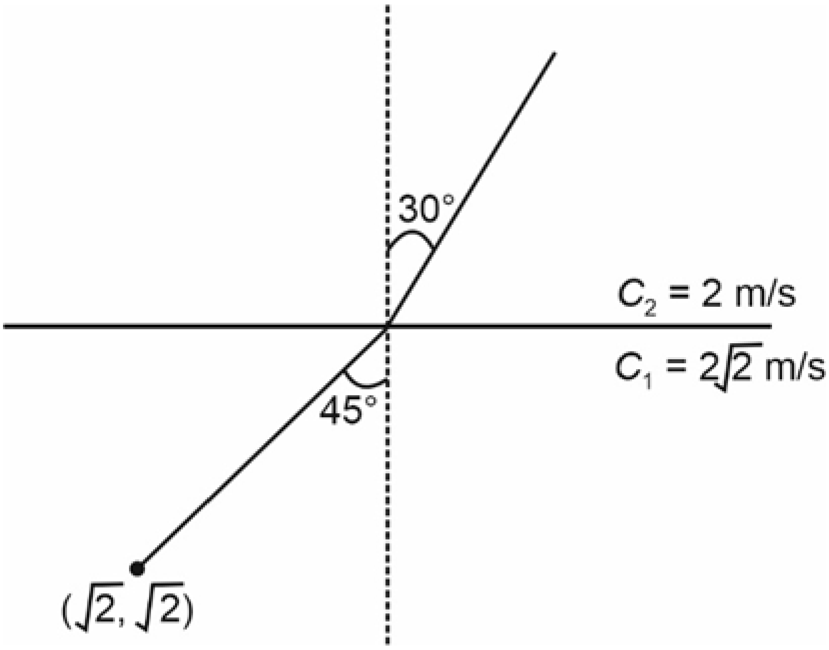
$d = 3\sqrt{2}\,m$

(34) **Answer :** 06.00

Hint:

$\mu_1 \sin i = \mu_2 \sin r$

Solution:



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$d = 3\sqrt{2}\,m$

CHEMISTRY

Section-I

(35) **Answer :** (D)

Hint:

Higher the electron density on metal higher will be M — C bond order

Solution:

In metal carbonyls, as the negative charge on central metal ion increases, its tendency to use its lone pair of electrons to overlap with the vacant antibonding molecular orbital of CO ligand increases and hence metal-carbon bond order increases. Therefore, the correct order of metal-carbon bond order of the given metal carbonyls is

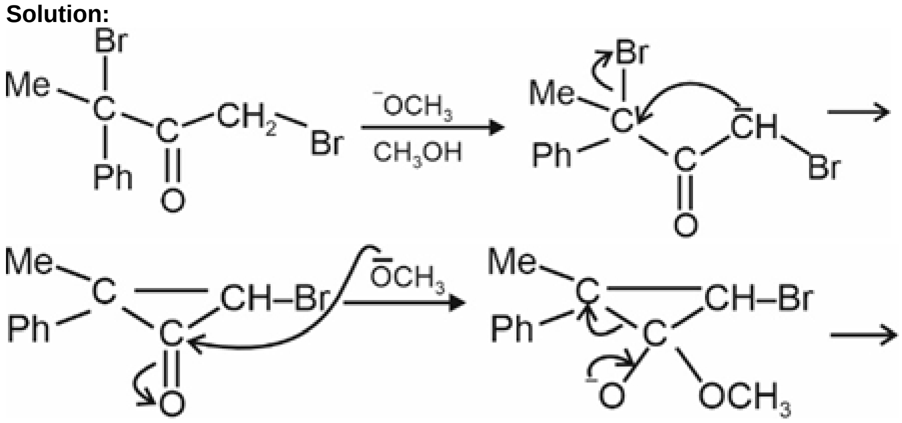
$[V(CO)_6]^-$ > $[Fe(CO)_5]$ > $[Mn(CO)_6]^+$ > $[Fe(CO)_6]^{2+}$

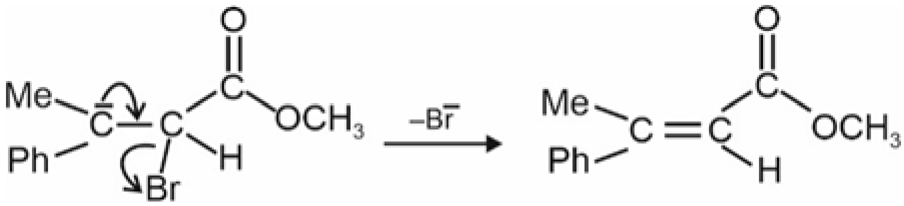
(36) **Answer :** (C)

Hint:

Favorskii rearrangement

Solution:





(37) **Answer :** (B)
Hint:
$\frac{r_{Cl_2O}}{r_X} = \sqrt{\frac{M_X}{M_{Cl_2O}}}$
Solution:
As the oxide of chlorine dissociates on heating, it is likely to be Cl_2O

	$Cl_2(g)$	+ $2Cl_2O(g)$ $\xrightarrow{\Delta}$	$3Cl_2(g)$ +	$O_2(g)$
Initial vol.	40 mL	40 mL	0	0
Final vol.	40 – 20 = 20 mL	–	60 mL	20 mL

Final volume of gaseous mixture = 100 mL
On treatment with aq. KOH solution, the volume is reduced to 20 mL only.
$Cl_2(g) + 2KOH(aq) \rightarrow KCl(aq) + KOCl(aq) + H_2O(l)$

$\frac{r_{Cl_2O}}{r_X} = \sqrt{\frac{M_X}{M_{Cl_2O}}}$

$\frac{225}{300} = \sqrt{\frac{M_X}{87}}$

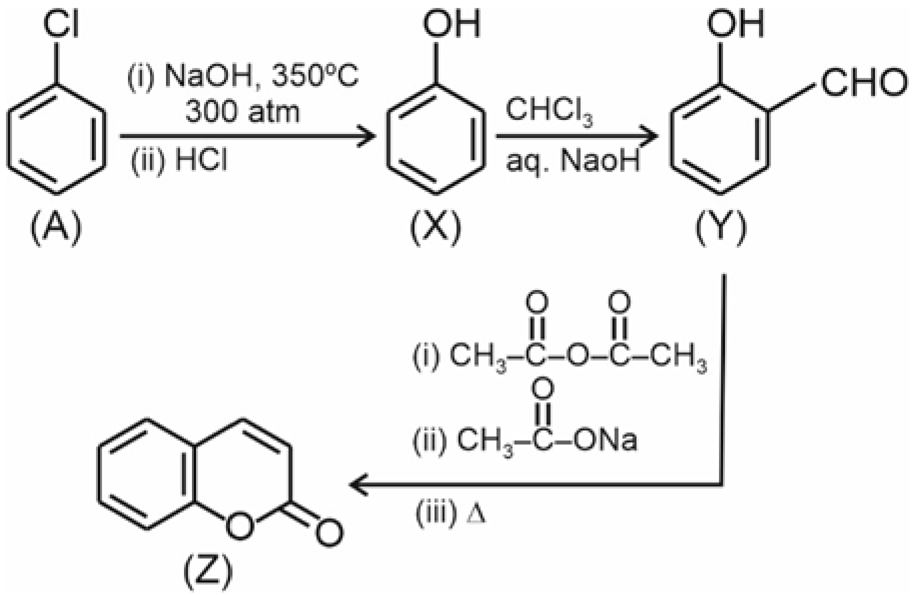
$\Rightarrow M_X = 49\ g\ mol^{-1}$

(38) **Answer :** (B)
Hint:
Most bulky group must be present at equatorial position.
Solution:
In alkyl substituted cyclohexanes, bulky alkyl groups preferably occupy equatorial position to avoid 1-3 and 1-5 axial repulsions. Therefore, (III) is more stable than (IV). In alkyl substituted 1, 3-dioxanes, the alkyl group at 2^{nd} position should preferably be at equatorial position. Therefore, (I) is more stable than (II). In 5-hydroxy-1, 3-dioxane, the OH group occupies axial position in order to have intramolecular H-bonding. Therefore, (VI) is more stable than (V).

Section-II

(39) **Answer :** (B,D)
Hint:
The lowest part of the blast furnace is known as combustion zone.
Solution:
Liquation process is employed when impurities have higher melting point than metal.

(40) **Answer :** (B,D)
Hint:
Compound X is phenol.
Solution:

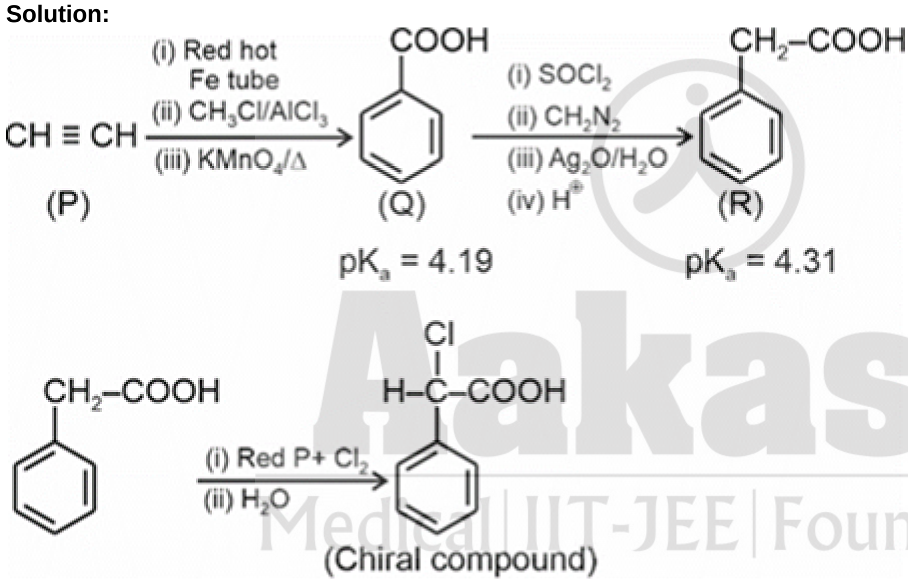


(41) Answer : (A,C,D)

Hint:

Compound Q on reaction with soda lime gives benzene.

Solution:



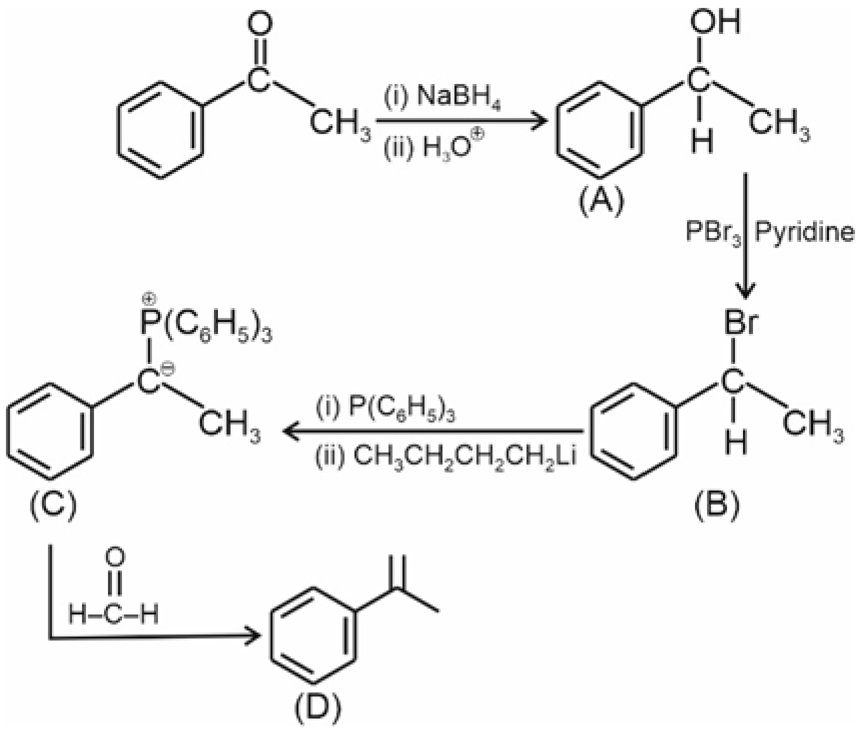
Section-III

(42) Answer : 9

Hint:

D is 2-phenyl propene

Solution:



(43) **Answer :** 6

Hint:

(i), (iv) and (ix) are non-aromatic. (x) is anti aromatic.

Solution:

The compounds which contain $(4n + 2)\pi$ electrons are aromatic, where n = 0, 1, 2, 3 ….

Compounds (ii), (iii), (v), (vi), (vii) and (viii) are aromatic.

(44) **Answer :** 21

Hint:

$\frac{dE^\circ}{dT} = \frac{\Delta S^\circ}{nF}$

Solution:

At T = 298 K, $E^o = 0.7131$ V

Now, $\Delta G^o = -nFE^o$

$= -1 \times (9.6485 \times 10^4 \text{ C mol}^{-1}) \times (0.07131 \text{ V})$

$= -6.88 \text{ kJ mol}^{-1}$

$\Delta S^\circ = nF\left(\frac{dE^\circ}{dT}\right)$ … (i)

Temperature coefficient-

$\left(\frac{dE^\circ}{dT}\right) = -4.99 \times 10^{-4} - 2(3.45 \times 10^{-6})(T - 298)$

At T = 298 K

$\left(\frac{dE^\circ}{dT}\right) = -4.99 \times 10^{-4} \text{ VK}^{-1}$

Equation (i) :-

$\Delta S^o = 1 \times 9.6485 \times 10^4 \text{ C mol}^{-1}$

$\times (-4.99 \times 10^{-4} \text{ VK}^{-1})$

$= -48.2 \text{ JK}^{-1} \text{ mol}^{-1}$

Now, $\Delta G^o = \Delta H^o - T\Delta S^o$,

$\Delta H^o = \Delta G^o + T\Delta S^o$

$= -6.88 \text{ kJ mol}^{-1} + 298 \text{ K} \times (-0.0482 \text{ kJ K}^{-1} \text{ mol}^{-1})$

$= -21.2$ kJ/mol

(45) **Answer :** 36

Hint:

In the mixture of NaCl and Na_2CO_3, only Na_2CO_3 is neutralised by H_2SO_4 solution.

Solution:

Let the mass of Na_2CO_3 be x. Milli equivalents of Na_2CO_3 = Milli equivalents of H_2SO_4

$\frac{x}{53} \times \frac{1000}{200} \times 10 = 60 \times \frac{1}{20}$

x = 3.18 g

Percentage of Na_2CO_3 = $\frac{3.18}{5.0} \times 100 = 63.6\%$

Percentage of NaCl = 100 – 63.6 = 36.40%

(46) **Answer :** 44

Hint:

Density (d) = $\frac{Z\times M}{a^3\cdot N_A}$

Solution:

$Z=\frac{1}{8}\times 8+\frac{1}{2}\times 6=4,$ d = 4.424 g/cm^3

$d=\frac{ZM}{N_A\,a.b.c}$

$\Rightarrow M=\frac{4.424\times 6.023\times 10^{23}\times 400\times 250\times 200\times 10^{-30}}{4}$

M = 13.32 g mol^{-1}

Therefore, 6.023 × 10^{23} atoms have = 13.32 g

∴ 2 × 10^{24} atoms will have

= $\frac{13.32}{6.023\times 10^{23}}\times 2\times 10^{24}$

= 44.23 g

(47) **Answer :** 5

Hint:

In acidic medium I_2 formed while in alkaline medium IO_3^- is formed.

Solution:

Iodine is liberated from KI in acidic medium

$10I^-+2\,MnO_4^-+16H^+\rightarrow 2\,Mn^{2+}+8H_2O+5I_2$

Oxidation of iodide to iodate in faintly alkaline medium

$2\,MnO_4^-+H_2O+I^-\rightarrow 2\,MnO_2+2\,OH^-+IO_3^-$

Oxidation number of iodine in I_2 = 0

Oxidation number of iodine in IO_3^- = +5

Section-IV

(48) **Answer :** 03.00

Hint:

R = K[A]^x [B]^y

Solution:

Let the order of reaction w.r.t A and B be x and y respectively. Therefore, R = K[A]^x [B]^y

1.25 × 10^{-3} = k(0.16)^x (0.40)^y …(i)

2.56 × 10^{-3} = k(0.08)^x (0.80)^y …(ii)

6.40 × 10^{-4} = k(0.08)^x (0.40)^y …(iii)

On solving, x = 1 and y = 2

Overall order of reaction = x + y = 3

Rate constant, k = 0.05 L^2 mol^{-2} s^{-1}

(49) **Answer :** 00.05

Hint:

R = K[A]^x [B]^y

Solution:

Let the order of reaction w.r.t A and B be x and y respectively. Therefore, R = K[A]^x [B]^y

1.25 × 10^{-3} = k(0.16)^x (0.40)^y …(i)

2.56 × 10^{-3} = k(0.08)^x (0.80)^y …(ii)

6.40 × 10^{-4} = k(0.08)^x (0.40)^y …(iii)

On solving, x = 1 and y = 2

Overall order of reaction = x + y = 3

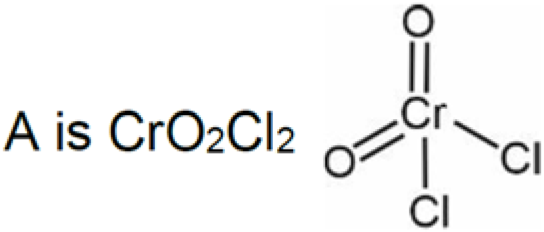
Rate constant, k = 0.05 L^2 mol^{-2} s^{-1}

(50) **Answer :** 08.00

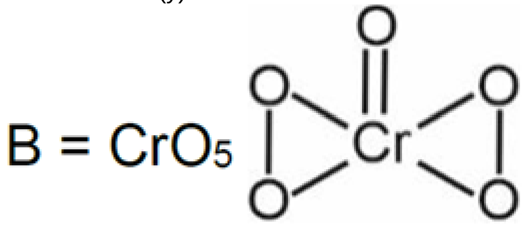
Hint:

Red orange vapour is chromyl chloride.

Solution:

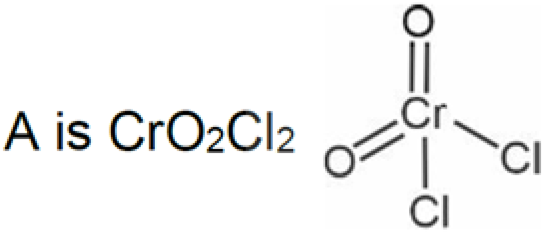


Cr = O bond (x) = 2
Oxidation state (y) = +6



x = 1, y = 2 ⇒ (x + y) = 3

(51) Answer : 03.00
Hint:
Red orange vapour is chromyl chloride.
Solution:



Cr = O bond (x) = 2
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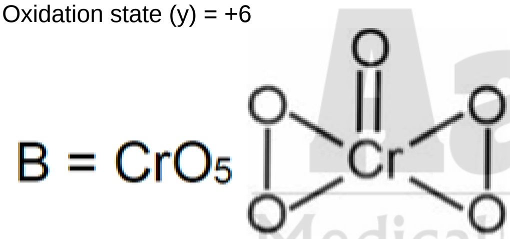

x = 1, y = 2 ⇒ (x + y) = 3