28/12/2025

SS_Set-2_ONLINE

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MM : 180

AIATS For One Year JEE(Advanced)-2026 (XII Studying)_Test-3A_Paper-2_ONLINE

Time : 180 Min.

MATHEMATICS

Section-I

1. (2)
2. (3)
3. (5)
4. (6)
5. (1)
6. (3)
7. (2)
8. (9)

Section-II

9. (A)
10. (A,B)
11. (C,D)
12. (B,C)
13. (A,D)
14. (A,B,C,D)

Section-III

15. (B)
16. (A)
17. (C)
18. (D)

PHYSICS

Section-I

19. (6)
20. (2)
21. (8)
22. (2)
23. (4)
24. (3)
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Section-II

27. (B,D)
28. (A,B,C)
29. (A,B)
30. (A,C,D)
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Section-III

33. (C)
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CHEMISTRY

Section-I

37. (5)

38. (8)

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40. (3)

41. (0)

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Section-II

45. (A,B)

46. (B,C,D)

47. (A,B,C,D)

48. (B,D)

49. (A,B,C)

50. (A,C)

Section-III

51. (A)

52. (B)

53. (C)

54. (C)

Hints and Solutions

MATHEMATICS

Section-I

(1) **Answer :** 2

Hint:

Solve for $\vec{a}$ and $\vec{b}$ and then take dot with $\vec{a}$.

Solution:

$\vec{a} + \vec{b} = 5\hat{i} + 5\hat{j} + \hat{k}$

$\vec{a} - \vec{b} = 3\hat{i} + \hat{j} + 9\hat{k}$

$\Rightarrow \vec{a} = 4\hat{i} + 3\hat{j} + 5\hat{k}$

$\vec{b} = \hat{i} + 2\hat{j} - 4\hat{k}$

$\vec{b} = \vec{c} + \vec{d}$

$\vec{b} \cdot \vec{a} = \vec{c} \cdot \vec{a} + \vec{d} \cdot \vec{a}$

= 4 + 6 – 20 = $\vec{c} \cdot \vec{a}$

⇒ –10 = $k(a^2)$

$\Rightarrow k = \frac{-1}{5}$

$\therefore \vec{b} = \frac{-1}{5}\vec{a} + \vec{d}$

$\Rightarrow \vec{d} = \frac{1}{5}\vec{a} + \vec{d} = \frac{9\hat{i} + 13\hat{j} - 15\hat{k}}{5}$

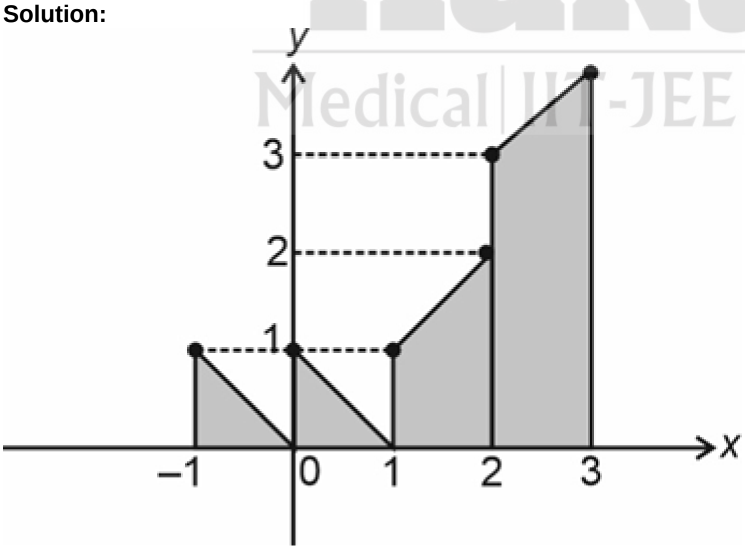
$\left|5\vec{d} \cdot \left(\hat{k} + \hat{j}\right)\right| = |13 - 15| = 2$

(2) **Answer :** 3

Hint:

Make the graph.

Solution:



R = area = $\left(\frac{1}{2} \times 1 \times 1 \times 2\right) + \frac{1}{2}(3) \times 1 + \frac{1}{2} \times 7 \times 1$

= 1 + 5 = 6

(3) **Answer :** 5

Hint:

Take the dot product to find α.

Solution:

$(\alpha - 2)\cdot 1 + (1 - 7)\cdot 2 + (8 - 4)\cdot 3 = 0$

$\Rightarrow \alpha - 2 - 12 + 12 = 0$

$\Rightarrow \alpha = 2$

Mid point of AB lies on line, i.e.,

(2, 4, 6) lies on line

$\frac{2-1}{1}=\frac{4-2}{2}=\frac{\alpha-\beta}{3}$

⇒ 6 – β = 3

⇒ β = 3

∴ α + β = 5

(4) **Answer :** 6

Hint:

Solve the D.E.

Solution:

$\frac{dy}{dx}=\sec^2 x$

$-\frac{dx}{dy}=\sec^2 x$

⇒ $-dy=\frac{dx}{\sec^2 x}$

⇒ $-dy = \cos^2 x\, dx$

⇒ $y=-\int\left(\frac{1+\cos 2x}{2}\right)dx$

⇒ $y=-\frac{x}{2}-\frac{1}{4}\sin 2x+c$

⇒ $4y + 2x + \sin 2x = c'$

(5) **Answer :** 1

Hint:

Use multiplication theorem.

Solution:

A : Raju falls sick

B_1 : Raju eats bread

B_2 : Raju eats oats

$P(B_1)=\frac{3}{4}$

$P(B_2)=\frac{1}{4}$

$P(A/B_1)=\frac{1}{3}$

$P(A/B_2)=\frac{2}{3}$

$P(A) = P(A \cap B_1) \cup P(A \cap B_2)$

= $\frac{3}{4}\times\frac{1}{3}+\frac{1}{4}\times\frac{2}{3}=\frac{5}{12}$

Required probability = $1-\frac{5}{12}\times\frac{5}{12}=\frac{119}{144}$

(6) **Answer :** 3

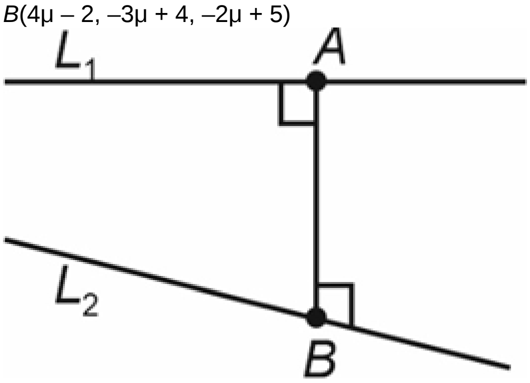
Hint:

Find $\overrightarrow{AB}$ in two different ways.

Solution:

$A(2\lambda, 3\lambda - 3, -10\lambda + 24)$

$B(4\mu - 2, -3\mu + 4, -2\mu + 5)$



$\overrightarrow{AB}=\langle 4\mu-2-2\lambda,-3\mu+4-3\lambda+3,-2\mu+5+10\lambda-24\rangle$

= $\langle 4\mu-2\lambda-2,-3\mu-3\lambda+7,-2\mu+10\lambda-19\rangle$

$\overrightarrow{AB}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2 & 3 & -10\\ 4 & -3 & -2\end{vmatrix}$ = $-36\hat{i}-36\hat{j}-18\hat{k}$

$\equiv 2\hat{i}+2\hat{j}+\hat{k}$

$\frac{4\mu-2\lambda-2}{2}=\frac{-3\mu-3\lambda+7}{2}=\frac{-2\mu+10\lambda-19}{1}$
⇒ μ = 1, λ = 2
∴ $A(4, 3, 4)$

(7) **Answer :** 2
Hint:
Find y' and y'' to compare.
Solution:
$y' = 4e^{4x}(\alpha + \beta x) + e^{4x}(\beta)$
$= e^{4x}(4\alpha + 4\beta x + \beta)$
$y'' = e^{4x}(4\beta) + 4\cdot e^{4x}(4\alpha + 4\beta x + \beta)$
$e^{4x}(4\beta + 16\alpha + 16\beta x + 4\beta) + A\cdot e^{4x}(4\alpha + 4\beta x + \beta) = B(\alpha + \beta x)\cdot e^{4x}$
$\Rightarrow 16\alpha + 8\beta + 16\beta x + A(4\alpha + 4\beta x + \beta)$
$= B(\alpha + \beta x)$
$\Rightarrow 16\alpha + 8\beta + 16\beta x = \alpha(-4A + B) - \beta A + \beta x(B - 4A)$
∴ $A = -8$
$B - 4A = 16$
$B = 4A + 16 = -16$
$\frac{A-B}{4}=\frac{-8-(-16)}{4}=\frac{8}{4}=2$

(8) **Answer :** 9
Hint:
OA, *OB*, *OC* are mutually perpendicular.
Solution:
OA, *OB*, *OC* are mutually perpendicular.
as $\left|\overrightarrow{OA}\cdot\left(\overrightarrow{OB}\times\overrightarrow{OC}\right)\right|=6$

$\left|\overrightarrow{OA}\times\overrightarrow{OC}\right|^2\cdot\left|\overrightarrow{d}\right|^2\left(\cos^2\theta+\sin^2\theta\right)$

⇒ 1 × 9 × 1 = 9

Section-II

(9) **Answer :** (A)
Hint:
Find λ using distance formulae.
Solution:
$P(2\lambda + 2, 3\lambda - 1, 6\lambda + 4)$
Given: $(2\lambda)^2 + (3\lambda)^2 + (6\lambda)^2 = 9$
⇒ $\lambda=\pm\frac{3}{7}$

∴ $P\left(\frac{6}{7}+2,\ \frac{9}{7}-1,\ \frac{18}{7}+4\right)$

$= P\left(\frac{20}{7},\ \frac{2}{7},\ \frac{46}{7}\right)$

$Q\left(-\frac{6}{7}+2,\ -\frac{9}{7}-1,\ -\frac{18}{7}+4\right)$

$= Q\left(\frac{8}{7},\ -\frac{16}{7},\ \frac{10}{7}\right)$

$PQ=\sqrt{\frac{144}{49}+\frac{324}{49}+\frac{(36)^2}{49}}$
= 6

(10) **Answer :** (A,B)
Hint:
Possible coordinates are:
(0, 7), (7, 0), (1, 6), (6, 1), (5, 2), (2, 5), (3, 4), (4, 3)
Solution:
Possible coordinates are:
(0, 7), (7, 0), (1, 6), (6, 1), (5, 2), (2, 5), (3, 4), (4, 3)
∴ $|\alpha - \beta| = 1, 3, 5, 7$
Valid points : (3, 4) → ${}^7C_3 = 35$
(4, 3) → ${}^7C_4 = 35$
Total possible = $2^7 = 128$
So, probability = $\frac{70}{128}=\frac{35}{64}$

(11) **Answer :** (C,D)
Hint:
Solve D.E.
Solution:

$\frac{dy}{dx}=\frac{x+y-4}{x-y}$

$\frac{dy}{dx}=\frac{(x-2)+(y-2)}{(x-2)-(y-2)}$

$x-2=X$, $y-2=Y$

$\frac{dY}{dX}=\frac{X+Y}{X-Y}$

$\Rightarrow Y=vX$

$\frac{dY}{dX}=v+X\frac{dv}{dX}$

$v+X\frac{dv}{dX}=\frac{1+v}{1-v}$

$\Rightarrow\ X\frac{dv}{dX}=\frac{1+v}{1-v}-v=\frac{1+v^2}{1-v}$

$\Rightarrow\ \int\frac{dX}{X}=\int\frac{1-v}{1+v^2}\cdot dv$

$\Rightarrow\ \tan^{-1}v-\frac{1}{2}\log\left(1+v^2\right)=\ln X+\ln c$

$\tan^{-1}\left(\frac{y-2}{x-2}\right)=\frac{1}{2}\log\left(1+\left(\frac{y-2}{x-2}\right)^2\right)+\ \log\left(x-2\right)+c$

$f(3)=2$

$0=0+0+c\Rightarrow c=0$

$f(\lambda+2)=3$

$\tan^{-1}\left(\frac{1}{\lambda}\right)=\frac{1}{2}\log\left(1+\frac{1}{\lambda^2}\right)+\log\lambda$

$\Rightarrow\ 2\tan^{-1}\left(\frac{1}{\lambda}\right)=\log\left(1+\frac{1}{\lambda^2}\right)+\log\lambda^2$

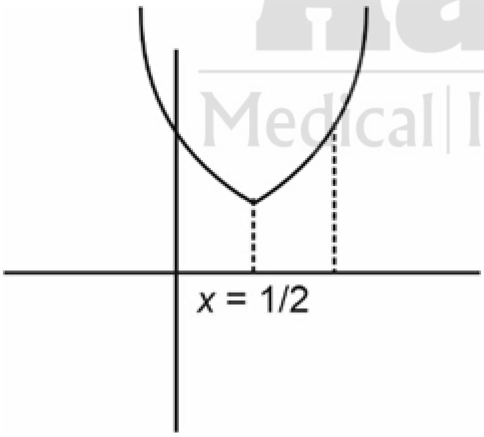
$\Rightarrow\ 2\tan^{-1}\left(\frac{1}{\lambda}\right)=\log\left(1+\lambda^2\right)$

$k_1=2$

$k_2=1$

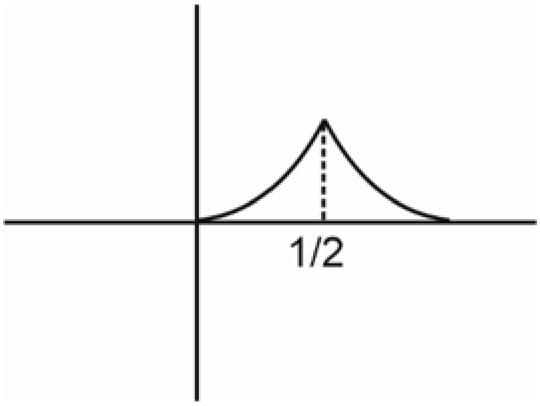
(12) **Answer :** (B,C)
Hint:
Make the graphs.
Solution:

(A)



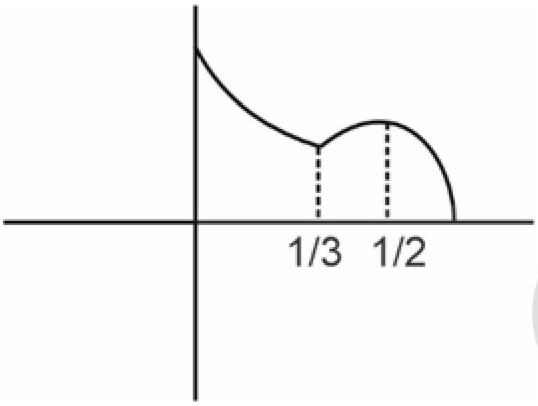
$$A=\int_0^{1/2}(x-1)^2dx+\int_{1/2}^{1}x^2dx=\frac{7}{12}$$

(B)



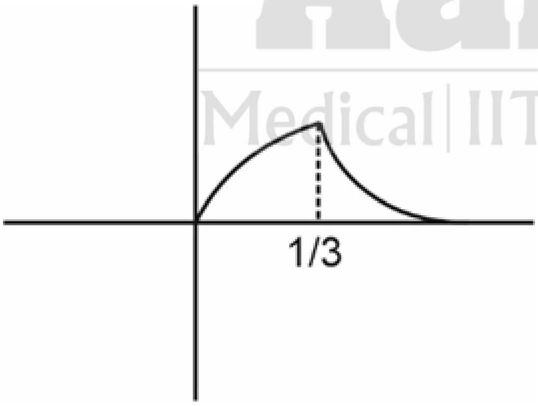
$$A=\int_0^{1/2} x^2dx+\int_{1/2}^{1}(x-1)^2dx=\frac{1}{12}$$

(C)



$$A=\int_0^{1/3} (x-1)^2dx+\int_{1/3}^{1}2x\,(1-x)dx=\frac{13}{27}$$

(D)



$$A=\int_0^{1/3} 2x\,(1-x)dx+\int_{1/3}^{1}(1-x)^2dx=\frac{5}{27}$$

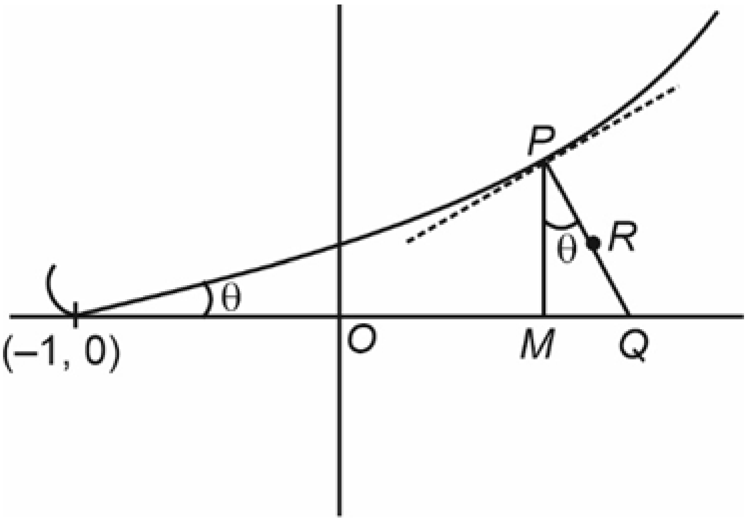
(13) Answer : (A,D)

Hint:

OQ = *OM* + *MB*

= $x + y\tan\theta = x + yy'$

Solution:



$OQ = OM + MQ$
$= x + y\tan\theta = x + yy'$
$Q(x + yy', 0)$
$R\left(x+\frac{yy'}{2},\frac{y}{2}\right)$
$\left(\frac{y}{2}\right)^2 = x+\frac{yy'}{2} \Rightarrow \frac{y^2}{4} = x + yy'$
$\Rightarrow 2yy' - y^2 = -4x$
$y^2 = t$
$2yy' = \frac{dt}{dx}$
$\frac{dt}{dx} - t = -4x$
IF = e^{-x}
$\therefore\ t\cdot e^{-x} = \int -4x\cdot e^{-x}dx$
$y^2\cdot e^{-x} = -4\left(-xe^{-x}+\int e^{-x}dx\right)$
$\Rightarrow y^2 = 4x + 4 + ce^x$
$f(-1) = 0$
$\Rightarrow c = 0$
$\Rightarrow y^2 = 4(x + 1)$

(14) Answer : (A,B,C,D)
Hint:
$\sum_{x=1}^{\infty} P(X=x) = 1$
Solution:
$\frac{4}{25} = k\cdot(a)' \Rightarrow ka = \frac{4}{25}$
$\sum_{x=0}^{\infty} P(X=x) = 1$
$\Rightarrow P(0) + P(1) + \ldots.. = 1$
$\Rightarrow k(a^0 + a^1 + a^2 + \ldots.) = 1$
$\Rightarrow\ k\frac{1}{1-a} = 1 \Rightarrow k = 1 - a \Rightarrow \boxed{a+k=1}$
$ka = \frac{4}{25}$
$k = \frac{1}{5}, a = \frac{4}{5}$
$P(X \geq 1) = 1 - P(0)$
$= 1 - k$
$= \frac{4}{5}$
$E(X) = \sum xP(X=x)$
$= 0 + P(1) + 2P(2) + 3P(3) + \ldots.$
$= k\left(\frac{4}{5} + 2\cdot\left(\frac{4}{5}\right)^2 + 3\cdot\left(\frac{4}{5}\right)^3 + \ldots.\right)$
Let

$$S = \frac{4}{5} + 2\cdot\left(\frac{4}{5}\right)^2 + ...$$

$$\frac{4}{5}S = \quad \left(\frac{4}{5}\right)^2 + ...$$

$$\frac{S}{5} = \frac{4}{5} + \left(\frac{4}{5}\right)^2 + \left(\frac{4}{5}\right)^3 + ...$$

= $\frac{S}{5} = \frac{4/5}{1-4/5} = 4$

⇒ $S = 20$

$\therefore\ E(X) = \frac{1}{5}\times 20 = 4$

$P(X \le 3) = P(0) + P(1) + P(2) + P(3)$

$= k(1 + a + a^2 + a^3)$

= $\frac{1}{5}\left(\frac{1-\left(\frac{4}{5}\right)^4}{\left(1-\frac{4}{5}\right)}\right) = \frac{369}{625}$

Section-III

(15) Answer : (B)

Hint:

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

Solution:

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

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

Let $\vec{c} = \lambda\left(4\vec{b}-\vec{a}\right)$

$= \lambda\left(40\hat{i}-3\hat{j}+3\hat{k}\right)$

$2\vec{a}+3\vec{b} = 41\hat{i}-5\hat{j}+5\hat{k}$

$\lambda(1640 + 15 + 15) = 3340$

$\lambda = 2$

$\left|\vec{c}\right|^2 = 6472$

(16) Answer : (A)

Hint:

Use the formulae of S.D.

Solution:

S.D = $\dfrac{\begin{vmatrix} 4 & 2 & -c-7 \\ 3 & 2 & 2 \\ 3 & -2 & 0 \end{vmatrix}}{\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3 & 2 & 2 \\ 3 & -2 & 0 \end{vmatrix}}$

⇒ $14 = \left|\frac{16+12(c+7)(12)}{14}\right|$

⇒ $\pm196 = 28 + 12(c + 7)$

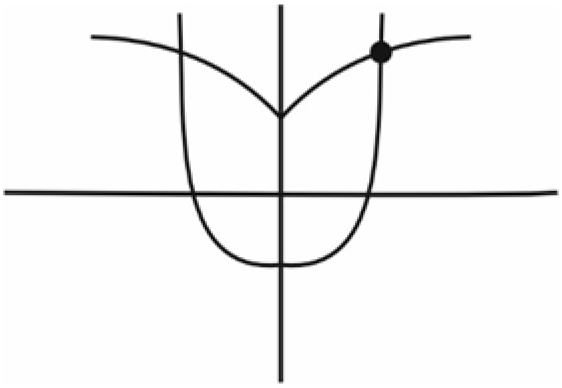
⇒ $c = 7,\ -\frac{77}{3}$

(17) Answer : (C)

Hint:

Find the point of intersection and then find area.

Solution:



$x^2-1=\sqrt{x+1}, x \geq 0$

$x^4 + 1 - 2x^2 = x + 1$

$\Rightarrow x^3 - 2x = 1$

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

$\Rightarrow\ x=\frac{\sqrt{5}+1}{2}$

$$2\int_0^{\frac{\sqrt{5}+1}{2}}\left(\left(\sqrt{x+1}\right)-\left(x^2-1\right)\right)dx$$

$$= 2\left(\frac{(x+1)^{3/2}}{3/2}-\frac{x^3}{3}+x\right)\Bigg|_0^{\frac{\sqrt{5}+1}{2}}$$

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

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

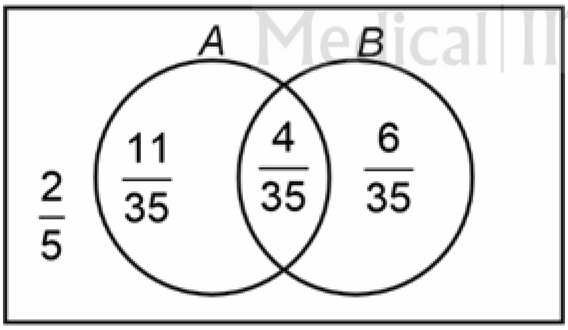
$$= \frac{4}{3}\left(\frac{\sqrt{5}+3}{2}\right)^{3/2}-\frac{5}{3}+\frac{\sqrt{5}}{3}$$

(18) **Answer :** (D)

Hint:

Make Venn diagram.

Solution:



$P(A\cup B)=1-\frac{2}{5}=\frac{3}{5}$

$P(A)=\frac{3}{7}$

$P(B)=\frac{2}{7}$

$P(A\cap B)=\frac{5}{7}-\frac{3}{5}=\frac{4}{35}$

$$P\left(\frac{A^C}{B}\right)=\frac{P\left(B\cap A^C\right)}{P(B)}=\frac{6/35}{2/7}=\frac{3}{5}$$

$$P\left(\frac{B}{A^C}\right)=P\left(\frac{B\cap A^C}{A^C}\right)=\frac{6/35}{4/7}=\frac{3}{10}$$

$$P\left(\frac{A^C}{B^C}\right)=P\frac{\left(A^C\cap B^C\right)}{P\left(B^C\right)}$$

$$= \frac{2/5}{5/7}=\frac{14}{25}$$

$P\left(\frac{A}{B^C}\right)=\frac{P\left(A\cap B^C\right)}{P\left(B^C\right)}$

= $\frac{11/35}{5/7}=\frac{11}{25}$

PHYSICS

Section-I

(19) **Answer :** 6

Hint:

$P=\frac{h}{\lambda}$

Solution:

$\frac{h}{2\lambda}=p_1=mv_1$

$\frac{h}{3\lambda_2}=p_2=mv_2$

$\frac{h}{\lambda'}=p=2mv$

$m\left(v_1-v_2\right)=2mv$

$\Rightarrow\ v=\frac{v_1 . v_2}{2}\Rightarrow\frac{h}{2m\lambda'}=\frac{1}{2}\left\{\frac{h}{2\lambda m}-\frac{h}{3\lambda m}\right\}$

$\Rightarrow\ \frac{1}{2\lambda'}=\frac{1}{2}\left\{\frac{1}{2\lambda}-\frac{1}{3\lambda}\right\}$

$\frac{1}{\lambda'}=\frac{3-2}{6\lambda}$

$\lambda' = 6\lambda$

(20) **Answer :** 2

Hint:

Activity = $A_0e^{-\lambda t}$

Solution:

(A) activity = $A_0e^{-\lambda t}$

As detected by counts = $\frac{Aa}{4\pi r^2}=\frac{A_0a}{4\pi r_0^2}$

$\Rightarrow\ \frac{A_0e^{-\lambda t}a}{4\pi r^2}=\frac{A_0a}{4\pi r_0^2}$

$\Rightarrow\ r=r_0e^{-\frac{\lambda t}{2}}$

$v=\frac{dv}{dt}=-\frac{r_0\lambda}{2}e^{-\frac{\lambda t}{2}}$

$n = 2$

(21) **Answer :** 8

Hint:

$N = N_0e^{-\lambda t}$

Solution:

$\frac{A_1(t=0)}{(A_1+A_2)t=0}=0.1\ \Rightarrow\ \frac{A_2}{A_1}\Big|_{t=0}=9$

A_1 → activity of ^{33}P

A_2 → activity of ^{32}P

$t = t_0$

$\frac{A_1(t)}{A_1(t)+A_2(t)}=0.9\Rightarrow\ \frac{A_2}{A_1}\Big|_{t=t_0}=\frac{1}{9}$

$\frac{A_2}{A_1}=\frac{A_2(t=0)e^{-\lambda_2t}}{A_1(t=0)e^{-\lambda_7t}}=\frac{1}{9}=9e^{-(\lambda_2-\lambda_1)t}$

$t_0=\frac{2200}{39}$

(22) **Answer :** 2

Hint:

Use radioactive decay equation.

Solution:

$\frac{dN}{dt}=\alpha-\lambda N$, on solving the differential equation we get 2.

(23) Answer : 4

Hint:

$p=\sqrt{2mKE}$

Solution:

$p_{\text{atom}}=\sqrt{2mK}$

$p_{\text{photon}}=\frac{E}{c}$

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

$E=c\sqrt{2mK}$

E = 6400 eV = $(80)^2$ eV

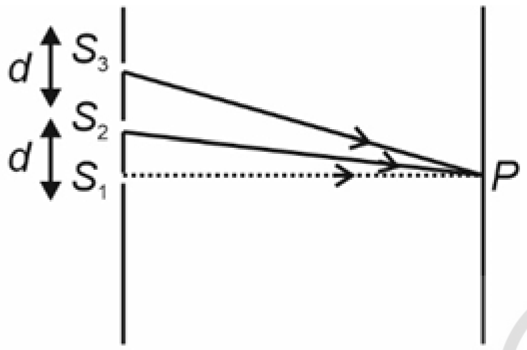
x = 8

(24) Answer : 3

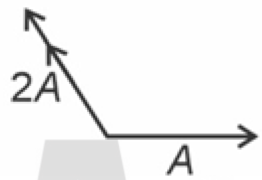
Hint:

$I=\sqrt{I_1}+\sqrt{I_2}+2\sqrt{I_1I_2}\cos\Delta\phi$

Solution:



$\vec{A}_1+\vec{A}_2+\vec{A}_3$



$A^2 = 4A^2 + A^2 + 4A^2 (\cos 120°) = 3A^2$

$I' = 3I_0$

$S_2P - S_1P = \frac{\lambda}{3}$

$\frac{d}{2}\cdot\frac{d}{D}=\frac{\lambda}{3}$

$\frac{d^2}{D}=\frac{2\lambda}{3}$

$S_3P - S_1P = 2d.\frac{d}{D}$

$\frac{2d^2}{D}=\frac{4\lambda}{3}$

(25) Answer : 4

Hint:

$a\sin\theta_1=\lambda$

Solution:

First diffractions minima ⇒ $a\sin\theta_1=\lambda$

$\sin\theta_1=\frac{\lambda}{a}$

For interference maxima

$d\sin\theta=n\lambda$

$\sin\theta=\frac{n\lambda}{d}=\frac{n\lambda}{2a}$

$\Rightarrow\ \frac{\lambda}{a}=\frac{n\lambda}{2a}$ n = 0, ± 1, ± 2

5 fringes within the central diffraction envelope.

(26) Answer : 7

Hint:

$\Delta x=n\lambda$

Solution:

$\Delta x=2n_2d+\frac{\lambda}{2}=\frac{3}{2}\lambda$

$\Rightarrow 2n_2d=\lambda$

$\Rightarrow\ n_2=\frac{\lambda}{2d}=\frac{572}{2\times215}\approx1.33=\frac{4}{3}=\frac{\alpha}{B}$

Section-II

(27) **Answer :** (B,D)
Hint:
$\frac{m_e v^2}{r} = \frac{Gm_p m_e}{r^2}$
Solution:
$\frac{m_e v^2}{r} = \frac{Gm_p m_e}{r^2} \quad mvr = n\frac{h}{2\pi}$
$\Downarrow$
$KE = \frac{4\pi^2 G^2 m_p^2 m_e^2}{2n^2 h^2} \quad PE = -\frac{Gm_p m_e}{r}$
$= -\frac{4\pi^2 G^2 m_p^2 m_e^2}{n^2 h^2}$
$TE = -\frac{2\pi^2 G^2 m_p^2 m_e^2}{n^2 h^2}$

(28) **Answer :** (A,B,C)
Hint:
$E = \frac{hc}{\lambda}$
Solution:
$\lambda_{K_\alpha} = \frac{1242n \text{ meV}}{38.2 \text{ keV}} = 32.51 \text{ pm}$
48.5 – 10.3
E = 69.5 keV for ionisation of K-electron
$\lambda_{\min} = \frac{1242 \text{ meV}}{48.5 \text{ eV}} = 25.6 \text{ pm}$

(29) **Answer :** (A,B)
Hint:
$2A = A_0 e^{-\lambda t_1}$
$A = A_0 e^{-\lambda t_2}$
Solution:
$2A = A_0 e^{-\lambda t_1}$
$A = A_0 e^{-\lambda t_2}$
$2 = e^{\lambda(t_2 - t_1)}$
$\therefore \lambda = \frac{\ln 2}{(t_2 - t_1)}$
$2A = N_1 \lambda$
$A = N_2 \lambda$
$N_1 - N_2 = \frac{A}{\lambda}$
$= \frac{A}{\ln 2}(t_2 - t_1)$

(30) **Answer :** (A,C,D)
Hint:
Momentum conservation.
Solution:
$E_n - E_K = h\nu_0$ case (i)
Δp of atom = $\frac{h\nu}{c}$ in case (ii)
$\frac{\Delta p}{p} = \frac{1}{2}\frac{\Delta KE}{KE} \Rightarrow \frac{h\nu}{mvc} = \frac{1}{2}\frac{\Delta KE}{\frac{1}{2}mv^2}$
$\Rightarrow \Delta KE = h\nu\left(\frac{v}{c}\right)$
$h\nu + \Delta KE + \Delta E_{n-K} = h\nu\frac{v}{c} + h\nu_0$
$v = \frac{\nu_0}{\left(1 - \frac{v}{c}\right)} = \nu_0\left(1 + \frac{v}{c}\right)$

(31) **Answer :** (B,C)
Hint:
$I = I_0 \cos^2\theta$
Solution:
$I_1 = \frac{I_0}{2}$
$I_2 = \frac{I_0}{2}\cos^2\theta$
$I_3 = I_2 \cos^2(90 - \theta)$

$I_3 = \frac{I_0}{2}\cos^2\theta\sin^2\theta = \frac{11.52}{100} I_0$

$\Rightarrow \frac{\cos^2\theta}{2}\left(1 - \cos^2\theta\right) = 0.1152$

$\Rightarrow \cos^2\theta - \cos^2\theta + 0.2304 = 0$

$\cos^2\theta = \frac{0.64}{0.36}$

$\cos\theta = \frac{0.8}{0.6}$

$\cos\theta = \frac{4}{5}, \frac{3}{5}$

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

Hint:

$E = \frac{hc}{\lambda}$

Solution:

$E_{(photon)} = \frac{1242}{600} = 2.07 \text{ eV}$

$KE_{max} = E - \varphi = 2.07 - 1.5 \text{ eV} = 0.57 \text{ eV}$

(C) If φ = 2.5 eV, $E < \varphi$

(D) $\frac{N}{t} = n\frac{P}{E} = \frac{10^{-2}\times10^{-2}\times60}{2.07\times1.6\times10^{-19}}$

$\approx 1.81 \times 10^{16}$

Section-III

(33) Answer : (C)

Hint:

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

Solution:

$N = N_0 e^{-\lambda t}$ $N = N_0$ at 8.30 AM

$N_1 = \frac{N_0}{2}$ at 9.00 AM ($T_{1/2}$ = 30 min)

$N_2 = \frac{N_0}{2^{\frac{t}{\pi/2}}}$ at 9.15 AM

$N_2 = \frac{N_0}{2\sqrt{2}}$

$\Rightarrow N_1(1 \text{ ml}) = N_2(V_2)$

$\Rightarrow \frac{N_0}{2}(1 \text{ m}) = \frac{N}{2\sqrt{2}}(V_2)$

$\Rightarrow V_2 = \sqrt{2} \text{ ml} \approx 1.41 \text{ ml}$

(34) Answer : (B)

Hint:

Energy mass relation.

Solution:

Rest mass energy of an electron

= 511 keV

Increase in K.E. = eV = 200 keV

Total Energy = $mc^2 = m_0c^2$ + K.E = 711 keV

% increase = $\frac{m - m_0}{m_0} \times 100 = \frac{200}{511} \times 100 = 39\%$

(35) Answer : (D)

Hint:

Momentum conservation.

Solution:

$Q = \left(\frac{m_\alpha + m_H}{m_H}\right) K_\alpha$

$K_\alpha = \left(\frac{m_H}{m_\alpha + m_H}\right) Q \quad \frac{m_H}{m_\alpha + m_H} < 1$

($m_\alpha << m_H$)

$\boxed{K_\alpha \sim Q}$

(36) Answer : (B)

Hint:

EMW

Solution:

Plane of propagation 1 to the direction of propagation.

$\left(x\hat{i}+y\hat{j}+z\hat{k}\right)\cdot\left(2\hat{i}+3\hat{j}\right)=0$

$\Rightarrow 2x + 3y = 0$

CHEMISTRY

Section-I

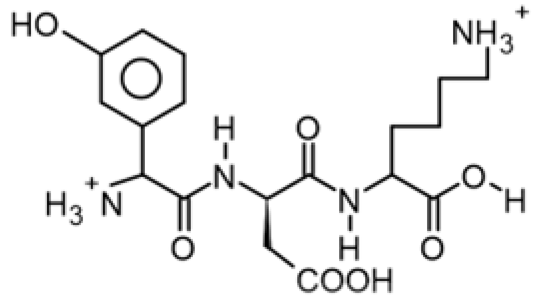
(37) **Answer :** 5

Hint:

pH decreases, protonation increases.

Solution:

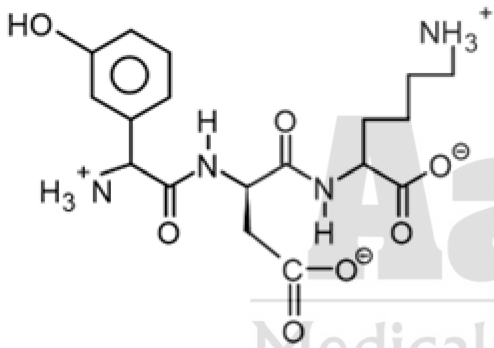
Solution : At pH = 2. (Highly acidic), peptide appears as.



Both amino groups are protonated

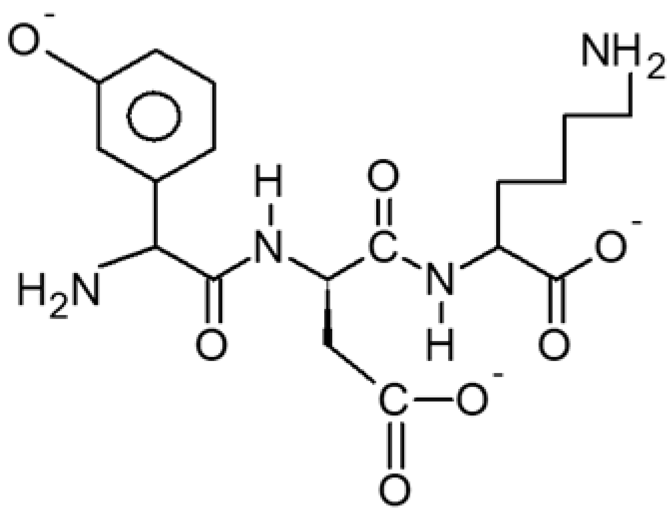
Net charge = $|q_1|$=2

At pH = 6. (close to neutral) – peptide appears as



Net charge = 0. $|q_2|$ = 0.

At pH = 12 (strongly basic), peptide appears as,



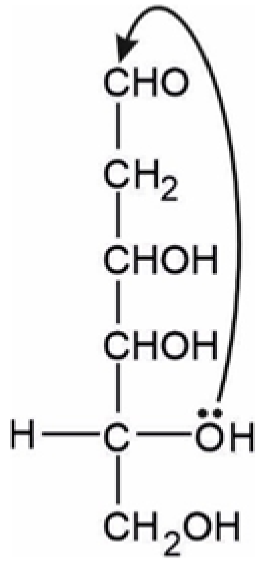
Net charge = –3. $|q_3|$ = 3

(38) **Answer :** 8

Hint:

Number of stereoisomers = 2^n (for unsymmetrical molecule)

Solution:



Number of Chiral centers = 4
Total Stereoisomers $= 2^4 = 16$

(39) **Answer :** 7

Hint:

KI reacts with $K_3[Fe(CN)_6]$ to give $K_4[Fe(CN)_6]$

Solution:

$$2\,KI + 2K_3[Fe(CN)_6] \rightarrow \underset{('S')}{2K_4[Fe(CN)_6]} + I_2$$

No. of moles of ‘S’ per mol of KI = 1

No. of moles of KI = $\frac{1162}{166} = 7$

= No. of moles of S.

(40) **Answer :** 3

Hint:

Mn^{2+} and Zn^{2+} do not give black precipitate.

Solution:

MnS → Buff color
ZnS → White
CdS → Yellow

(41) **Answer :** 0

Hint:

Maltose has C1 – C4 glycosidic linkage between two α-D-Glucose

Solution:

Maltose has C1 – C4 glycosidic linkage between two α-D-Glucose and lactose has C1 – C4 glycosidic linkage between β-D-galactose and β-D glucose respectively.

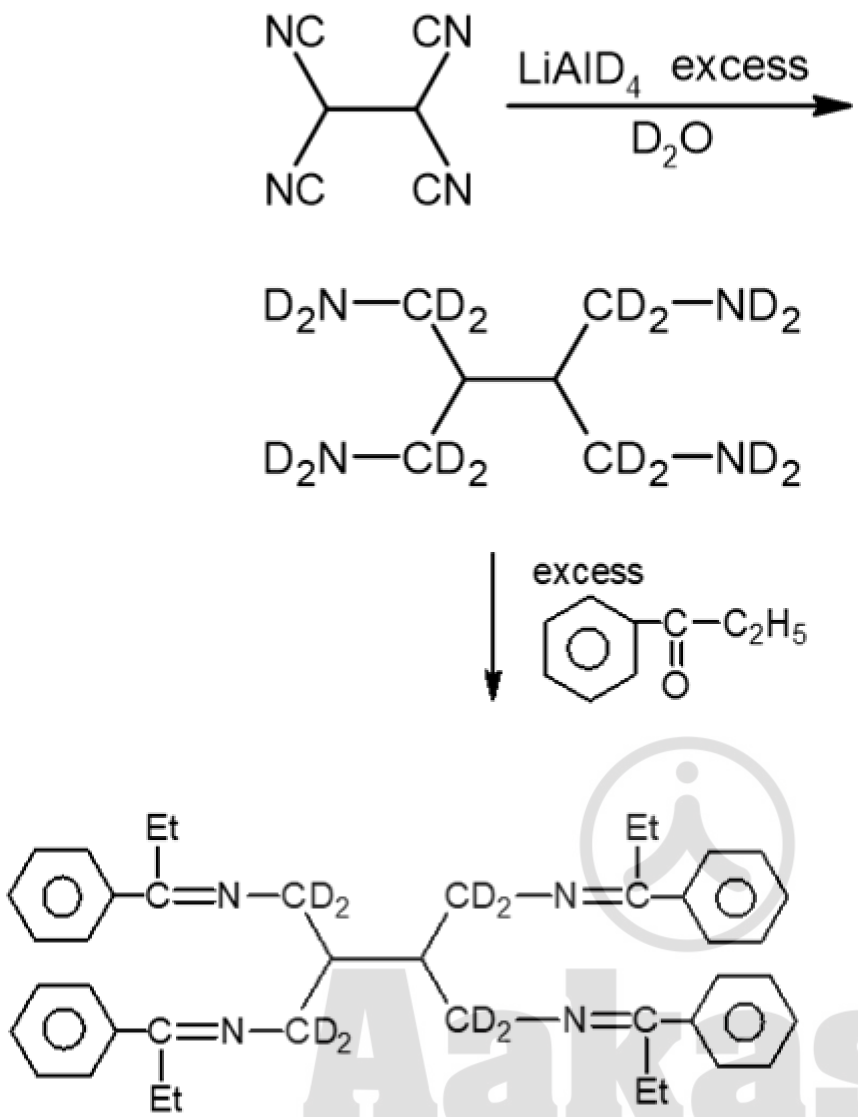
so, (x + y) – (m + n)
= (1 + 4) – (1 + 4) = 0

(42) **Answer :** 8

Hint:

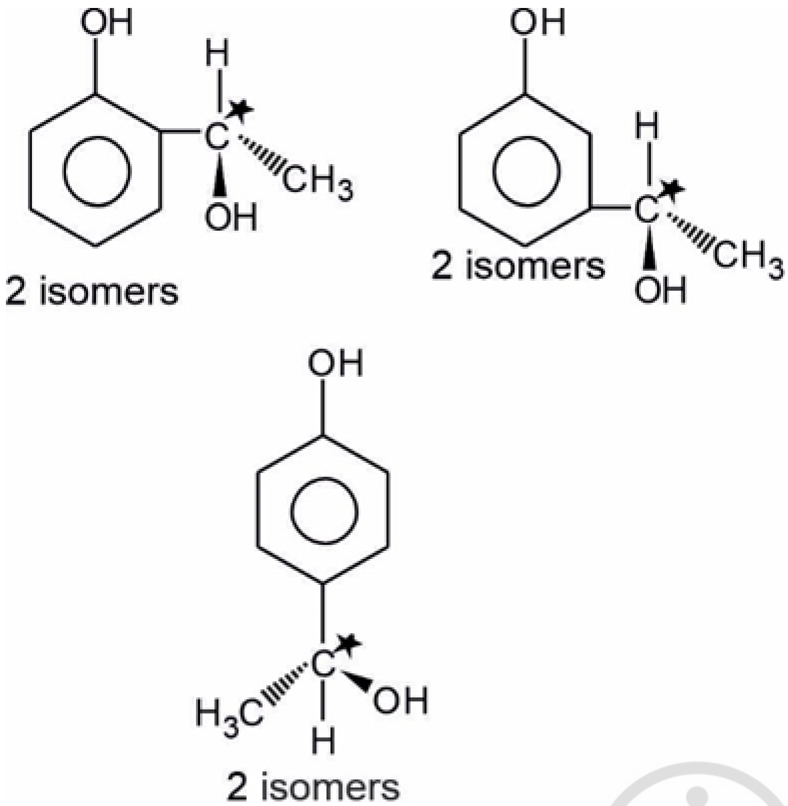
$LiAlH_4$ reduces –CN to amines.

Solution:



Number of sp^2 hybridised atom = (6 + 1 +1) × 4
=32

(43) **Answer :** 6
Hint:
Any chiral C giving *d* and *l* isomers is equal to 1 resolvable pair.
Solution:
Resolvable enantiomeric pair means P has chiral carbon. Since, ‘P’ produces violet colour with neutral $FeCl_3$ – it most contain Phenolic group.

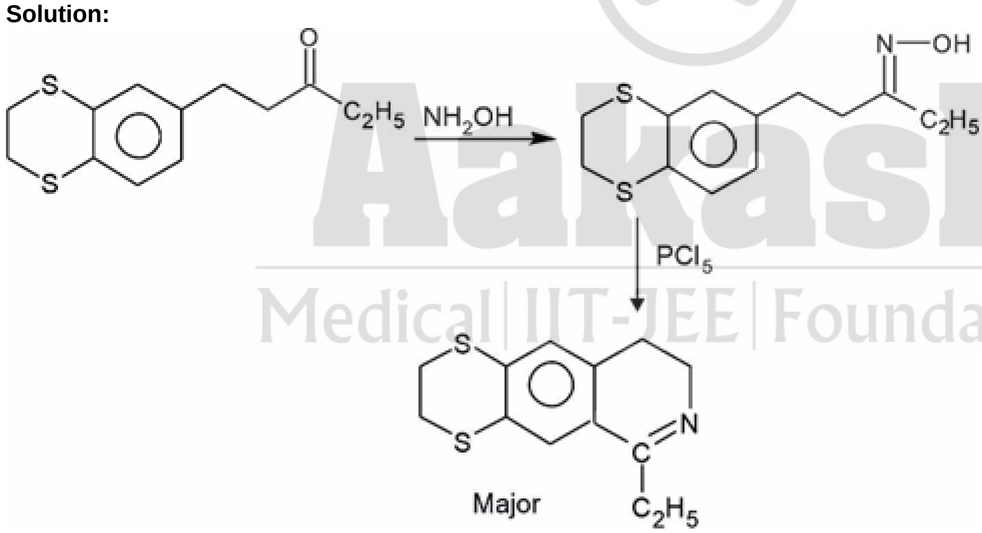


(44) **Answer :** 7

Hint:

Intramolecular Friedel Craft acylation.

Solution:



Double bond equivalent of compound is 7

Section-II

(45) **Answer :** (A,B)

Hint:

CN^- complexes with Au.

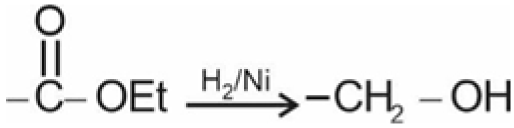
Solution:

$$4\,Au + 8\,NaCN + 2H_2O + O_2 \rightarrow 4NaOH + 4\,Na[Au(CN)_2]$$
(S) (T)

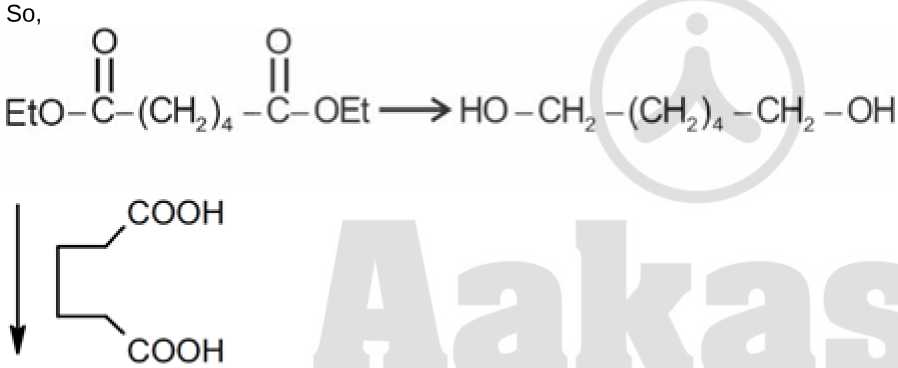
$$2\,Na[Au(CN)_2] + Zn \rightarrow Na_2[Zn(CN)_4] + 2\,Au$$
(T) (U) (V)

(46) **Answer :** (B,C,D)
Hint:
(S^{2-} ion causes precipitation.)
Solution:
CuS and PbS are black precipitates.

(47) **Answer :** (A,B,C,D)
Hint:
Polyamides and polyesters are condensation polymers.
Solution:

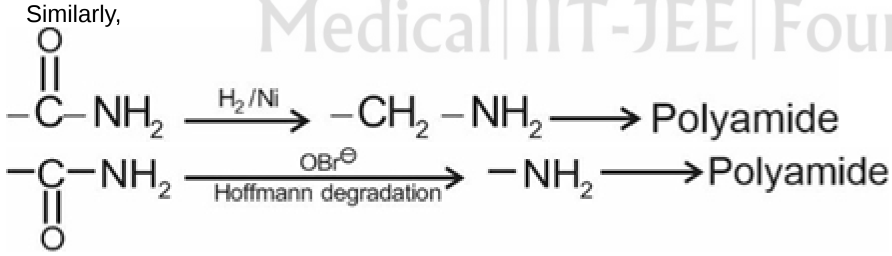


So,



Polyester

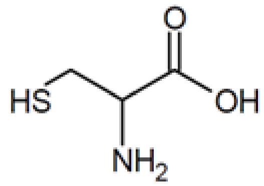
Similarly,



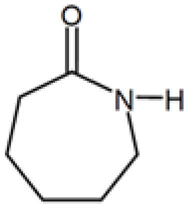
$$-C\equiv N \xrightarrow{H_2/\,Ni} -CH_2-NH_2 \rightarrow \text{Polyamide}$$

(48) **Answer :** (B,D)
Hint:
Precipitation as hydroxides.
Solution:
Al^{3+} and Fe^{3+} are group III basic radical gets precipitated as $Al(OH)_3$ and $Fe(OH)_3$.

(49) **Answer :** (A,B,C)
Hint:
(Cysteine gives NaCN + Na_2S.)
Solution:
Cysteine



gives test of N & S – blood red colour.
Moreover, presence of – CO_2 H group causes effervescence of CO_2 with $NaHCO_3$.

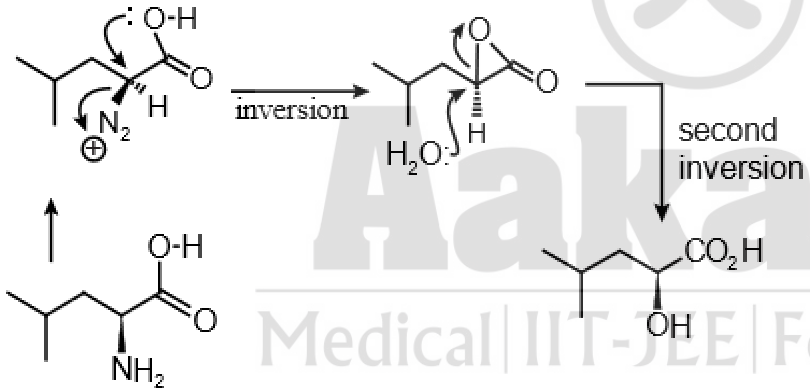


Caprolactam gives Lassaigne's test for N – via formation of Prussian blue.

(50) **Answer :** (A,C)
Hint:
CrO_2Cl_2 is deep red.
Solution:
$CrO_2Cl_2(g)$ is released. Its reaction with NaOH gives yellow Na_2CrO_4.

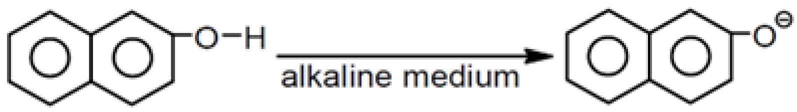
Section-III

(51) **Answer :** (A)
Hint:
2 consecutive inversions give rise to retention.
Solution:



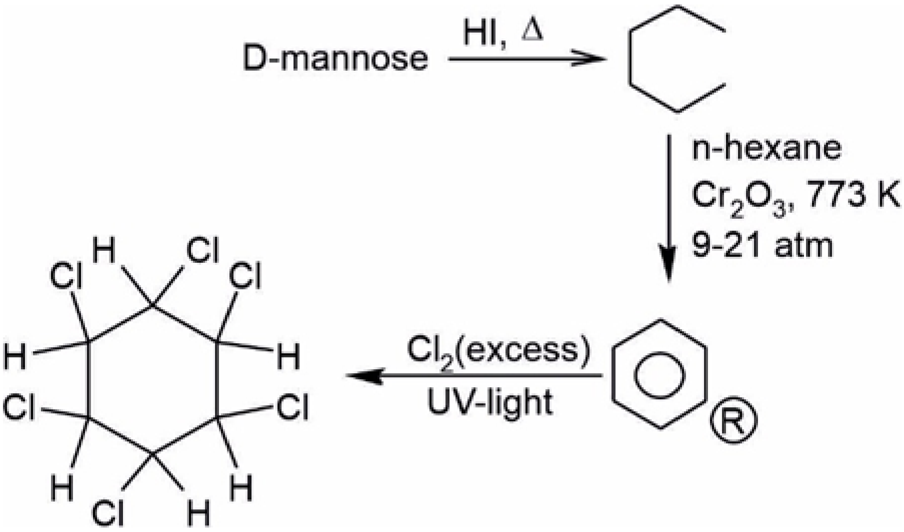
Two back-to back inversion causes retention of configuration.

(52) **Answer :** (B)
Hint:
β-naphthol is acidic.
Solution:



O^- is more activating than – OH group – towards further reaction.
β-naphthol dissolves poorly in acidic medium.

(53) **Answer :** (C)
Hint:
HI at high temperature is strong reducing agent.
Solution:



(54) Answer : (C)

Hint:

$FeO + SiO_2 \rightarrow FeSiO_3$

Solution:

→ $PbS + 2PbO \rightarrow SO_2 + 3Pb$

→ During extraction of Cu, silica is added to remove Fe-impurities to give ferrous silicate;

$FeO + SiO_2 \rightarrow \underset{(Slag)}{FeSiO_3}$

→ $2\ CuFeS_2 \xrightarrow{O_2} Cu_2S + 2FeS + SO_2$

Copper pyrites

$Cu_2S + 2Cu_2O \xrightarrow{\text{self reduction}} 6Cu + SO_2$

↳ blister Cu