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SET-1_ONLINE

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Medical | IIT-JEE | Foundations

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MM : 300 AIATS For One Year JEE(Main)-2026 (XII Passed)_Test-03_SET-1_ONLINE **Time : 180 Min.**

Mathematics

Section-I

1. (3)
2. (1)
3. (1)
4. (4)
5. (1)
6. (3)
7. (4)
8. (1)
9. (4)
10. (3)
11. (2)
12. (2)
13. (2)
14. (2)
15. (3)
16. (1)
17. (2)
18. (4)
19. (2)
20. (3)

Section-II

21. (2)
22. (5)
23. (8)
24. (18)
25. (49)

Physics

Section-I

26. (1)
27. (1)
28. (2)
29. (4)
30. (2)
31. (2)
32. (3)
33. (2)
34. (2)
35. (3)
36. (1)
37. (2)
38. (2)
39. (3)
40. (2)
41. (2)
42. (2)
43. (4)
44. (3)
45. (3)

Section-II

46. (1)

47. (159)

48. (1)

49. (2)

50. (114)

Chemistry

Section-I

51. (3)

52. (3)

53. (1)

54. (1)

55. (3)

56. (3)

57. (1)

58. (1)

59. (3)

60. (4)

61. (2)

62. (2)

63. (1)

64. (3)

65. (2)

66. (4)

67. (1)

68. (1)

69. (2)

70. (3)

Section-II

71. (20)

72. (8)

73. (15)

74. (40)

75. (13)

Hints and Solutions

Mathematics

Section-I

(1) **Answer :** (3)
Hint:
$z = \frac{y^2}{1-y^2} \Rightarrow \frac{2y}{(1-y^2)^2}\frac{dy}{dx} = \frac{dz}{dx}$
Solution:
$\frac{2y}{(1-y^2)^2}\frac{dy}{dx} + \frac{y^2}{1-y^2}\cdot\frac{1}{x} = \frac{1}{x^3}$
Put $z = \frac{y^2}{1-y^2} \Rightarrow \frac{2y}{(1-y^2)^2}\frac{dy}{dx} = \frac{dz}{dx}$
$\Rightarrow \frac{dz}{dx} + \frac{z}{x} = \frac{1}{x^3}$
$\Rightarrow x^2y^2 = (cx-1)(1-y^2)$

(2) **Answer :** (1)
Hint:
$\overrightarrow{AB} + \overrightarrow{BC} + \overrightarrow{CA} = \overrightarrow{O}$
Solution:
$\overrightarrow{AB} + \overrightarrow{BC} + \overrightarrow{CA} = \overrightarrow{O}$
$\Rightarrow \alpha = 2, \beta = 4, \gamma - \delta = 3$
Now, $\frac{1}{2}\left|\overrightarrow{AB} \times \overrightarrow{AC}\right| = 5\sqrt{6}$
$(\delta - 12)^2 + (2\delta + 12)^2 + 100 = 600$
$\Rightarrow \delta = 5, \gamma = 8$
$\because \overrightarrow{CB}\cdot\overrightarrow{CA} = 60$

(3) **Answer :** (1)
Hint:
S.D $= \frac{\left|\left(\vec{a}_2 - \vec{a}_1\right)\cdot\left(\vec{b}_1 \times \vec{b}_2\right)\right|}{|b_1 \times b_2|}$
Solution:
S.D $= \frac{\left|\left(\vec{a}_2 - \vec{a}_1\right)\cdot\left(\vec{b}_1 \times \vec{b}_2\right)\right|}{|b_1 \times b_2|}$
$\vec{b}_1 \times \vec{b}_2 = \begin{vmatrix} i & j & k \\ 2 & 3 & \lambda \\ 1 & 4 & 5 \end{vmatrix}$
$= i(15 - 4\lambda) - \hat{j}(10 - \lambda) + \hat{k}(8 - 3)$
$= (15 - 4\lambda)\hat{i} + (\lambda - 10)\hat{j} + 5\hat{k}$
$\left|\vec{b}_1 \times \vec{b}_2\right| = \sqrt{(15-4\lambda)^2 + (\lambda - 10)^2 + 25}$
S.D $= \frac{\left|\left[(2-1)\hat{i} + (4-2)\hat{j} + (5-3)\hat{k}\right]\cdot\left[(15-4\lambda)\hat{i} + (\lambda-10)\hat{j} + 5\hat{k}\right]\right|}{\sqrt{(15-4\lambda)^2 + (\lambda-10)^2 + 25}}$
$\frac{1}{\sqrt{3}} = \frac{|(15-4\lambda) + 2(\lambda - 10) + 2(5)|}{\sqrt{(15-4\lambda)^2 + (\lambda-10)^2 + 25}}$
Squaring both the sides and solving we get
$\lambda^2 - 16\lambda + 55 = 0$
$\Rightarrow (\lambda - 5)(\lambda - 11) = 0$
$\Rightarrow \lambda = 5, 11$
$\therefore$ Sum = 5 + 11 = 16

(4) **Answer :** (4)
Hint:

Let sin$x$ = t

cos$x$ dx = dt

Solution:

Let sin$x$ = t

cos$x$ dx = dt

$$\int \frac{dt}{t^2+4t+5} = \int \frac{dt}{(t+2)^2+1^2}$$

= $\tan^{-1}(t+2)+c$

= $\tan^{-1}(\sin x+2)+c$

(5) **Answer :** (1)

Hint:

Standard deviation remains unchanged.

Solution:

Standard deviation remains unchanged if each data of a set is increased or decreased by a constant. When data is multiplied or divided by a constant then the new standard deviation will be scaled by the absolute value of that constant.

∴ S.D. of $2a_1+1$, $2a_2+1$ …. $2a_{2025}+1$ is 2 × (3.5) = 7

(6) **Answer :** (3)

Hint:

$$\int_0^a f(x)dx = \int_0^a f(a-x)dx$$

Solution:

$$I = \int_0^4 \frac{1}{1+nf(x)}\,dx$$

$$I = \int_0^4 \frac{1}{1+nf(4-x)}\,dx$$

$$2I = \int_0^4 \left[\frac{1}{1+nf(x)} + \frac{1}{1+nf(4-x)}\right]dx$$

$$= \int_0^4 \frac{2+n(f(x)+f(4-x))\,dx}{1+n^2f(x)f(4-x)+n(f(x)+f(4-x))}$$

$$= \int_0^4 dx = 4$$

∴ $I = 2$

(7) **Answer :** (4)

Hint:

Required probability = $\frac{^7C_2}{^{12}C_2} + \frac{^5C_2}{^{12}C_2}$

Solution:

Required probability = $\frac{^7C_2}{^{12}C_2} + \frac{^5C_2}{^{12}C_2}$

= $\frac{21+10}{66}$

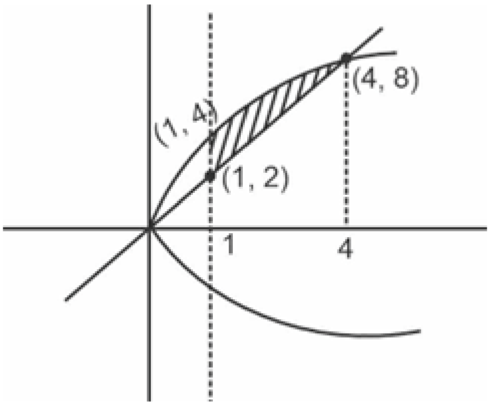
= $\frac{31}{66}$

(8) **Answer :** (1)

Hint:

Area = $\int_1^4 (4\sqrt{x}-2x)\,dx$

Solution:



$y^2 = 16x$ …(i)
$y = 2x$ …(ii)
$16x = 4x^2$
$4x^2 - 16x = 0$
$4x(x - 4) = 0$
$x = 0, 4$

Area = $\int_1^4 (4\sqrt{x} - 2x)\, dx$

$= 4\left[\frac{x^{3/2}}{3/2}\right]_1^4 - 2\left[\frac{x^2}{2}\right]_1^4$

$= \frac{4\times 2}{3}\left[(4)^{3/2} - 1\right] - \frac{2}{2}[16-1]$

$= \frac{8}{3}\times 7 - 15$

$= \frac{56-45}{3} = \frac{11}{3}$

(9) **Answer :** (4)
Hint:
Let $\frac{1}{x^5} + \frac{1}{x^2} + 1 = t$
Solution:

$$\int \frac{2x^{12}+5x^9}{\left(1+x^3+x^5\right)^3}\, dx$$

$$= \int \frac{2x^{12}+5x^9}{x^{15}\left(1+\frac{1}{x^2}+\frac{1}{x^5}\right)^3}$$

$$= \int \frac{\frac{2}{x^3}+\frac{5}{x^6}}{\left(\frac{1}{x^5}+\frac{1}{x^2}+1\right)^3}\, dx$$

Let $\frac{1}{x^5} + \frac{1}{x^2} + 1 = t$

⇒ $\int -\frac{dt}{t^3} = \frac{1}{2t^2} + c$

$= \frac{1}{2\left(\frac{1}{x^5}+\frac{1}{x^2}+1\right)^2} + c = \frac{x^{10}}{2(1+x^3+x^5)^2} + c$

∴ $m = 10, l = 2, r = 2$

∴ $\frac{m+l}{r} = \frac{10+2}{2} = 6$

(10) **Answer :** (3)
Hint:

$$\int \frac{3^y}{3^y-1}\, dy = \int 3^x\, dx$$

Solution:

$\frac{dy}{dx} = \frac{3^{x+y}-3^x}{3^y} = \frac{3^x(3^y-1)}{3^y}$

⇒ $\int \frac{3^y}{3^y-1}\, dy = \int 3^x\, dx$

$\Rightarrow \ \frac{\log(3^y-1)}{\log 3} = \frac{3^x}{\log 3} + c$

$y(0) = 1$

$\Rightarrow \ \frac{\log 2}{\log 3} = \frac{1}{\log 3} + c \quad \Rightarrow \quad c = \frac{\log 2 - 1}{\log 3}$

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

$\Rightarrow \ \log(3^y - 1) = 3^x + \log 2 - 1$

If $x = 1$, then

$\log(3^y - 1) = 2 + \log 2 = \log 2e^2$

$3^y - 1 = 2e^2$

$3^y = 2e^2 + 1$

$y = \log_3(2e^2 + 1)$

(11) **Answer :** (2)

Hint:

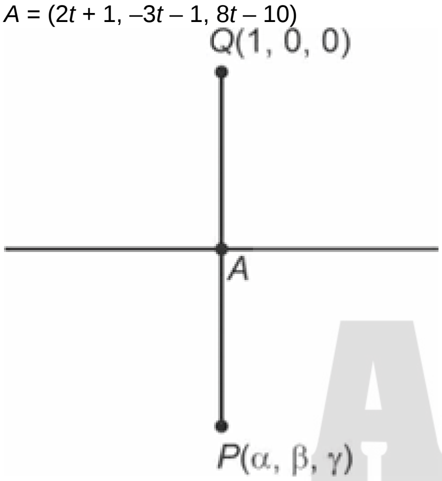
$\frac{x-1}{2} = \frac{y+1}{-3} = \frac{z+10}{8} = t$

Solution:

$\frac{x-1}{2} = \frac{y+1}{-3} = \frac{z+10}{8} = t$

$\vec{b} = 2\hat{i} - 3\hat{j} + 8\hat{k}$

$A = (2t + 1, -3t - 1, 8t - 10)$



$\overrightarrow{QA} = 2t\hat{i} - (3t+1)\hat{j} + (8t-10)\hat{k}$

$\overrightarrow{QA} \cdot \vec{b} = 0$

$\Rightarrow \ (2t)(2) - (3t + 1)(-3) + (8t - 10)(8) = 0$

$\Rightarrow \ 4t + 9t + 3 + 64t - 80 = 0$

$\Rightarrow \ 77t = 77 \Rightarrow \ t = 1$

$A(3, -4, -2)$

$\therefore \ \frac{1+\alpha}{2} = 3 \quad \Rightarrow \quad \alpha = 5$

$\frac{0+\beta}{2} = -4 \quad \Rightarrow \quad \beta = -8$

$\frac{0+\gamma}{2} = -2 \quad \Rightarrow \quad \gamma = -4$

$\therefore \ \alpha^2 + \beta + \gamma = 25 - 8 - 4 = 13$

(12) **Answer :** (2)

Hint:

Mean deviation = $\frac{1}{N}\sum_{i=1}^{n} f_i|d_i|$

Solution:

x_i	f_i	c.f.	$\lvert d_i \rvert = \lvert x_i - 13 \rvert$	$f_i \lvert d_i \rvert$
5	2	2	8	16
7	4	6	6	24
9	6	12	4	24
11	8	20	2	16
13	10	30	0	0

15	12	42	2	24
17	8	50	4	32
	$N = \Sigma f_i = 50$			$\Sigma f_i \lvert d_i \rvert = 136$

$\frac{N}{2} = \frac{50}{2} = 25$

The *c.f.* just greater than 25 is 30 & the corresponding value of *x* is 13.

∴ Median = 13

Mean deviation = $\frac{1}{N}\sum_{i=1}^{n} f_i|d_i|$

= $\frac{1}{50} \times 136$

= 2.72

(13) **Answer :** (2)

Hint:

$$\int_0^{\frac{11\pi}{3}} \sqrt{2}|\cos x|\,dx$$

$$= \int_0^{3\pi} |\sqrt{2}\cos x|\,dx + \int_{3\pi}^{3\pi + 2\pi/3} |\sqrt{2}\cos x|\,dx$$

Solution:

$$\int_0^{\frac{11\pi}{3}} \sqrt{2}|\cos x|\,dx$$

$$= \int_0^{3\pi} |\sqrt{2}\cos x|\,dx + \int_{3\pi}^{3\pi+2\pi/3} \sqrt{2}\,|\cos x|\,dx$$

$$= 3\sqrt{2}\int_0^{\pi}|\cos x|\,dx + \sqrt{2}\int_0^{2\pi/3}|\cos x|\,dx$$

$$= 6\sqrt{2}\int_0^{\pi/2} \cos x\,dx + \sqrt{2}\int_0^{\pi/2} \cos x\,dx - \sqrt{2}\int_{\pi/2}^{2\pi/3} \cos x\,dx$$

$$= 6\sqrt{2} + \sqrt{2} - \sqrt{\frac{3}{2}} + \sqrt{2}$$

$$= 8\sqrt{2} - \sqrt{\frac{3}{2}}$$

(14) **Answer :** (2)

Hint:

Area = $\frac{1}{2}\left|\left(2\vec{a} - \vec{b}\right) \times \left(\vec{a} - 2\vec{b}\right)\right|$

Solution:

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

$\vec{a} - 2\vec{b} = -4\hat{i} + 3\hat{j} - 4\hat{k}$

Area = $\frac{1}{2}\left|\left(2\vec{a} - \vec{b}\right) \times \left(\vec{a} - 2\vec{b}\right)\right|$

$\left(2\vec{a} - \vec{b}\right) \times \left(\vec{a} - 2\vec{b}\right) = 3\hat{i} + 24\hat{j} + 15\hat{k}$

Area = $\frac{1}{2} \times \sqrt{(3)^2 + (24)^2 + (15)^2}$

= $\frac{1}{2} \times \sqrt{810}$

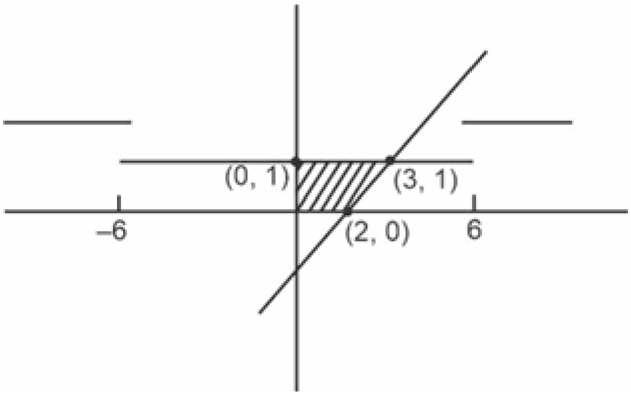
= $\frac{9\sqrt{10}}{2}$

(15) **Answer :** (3)

Hint:

Area = $\frac{1}{2}(2+3)\times 1=\frac{5}{2}$

Solution:



Area = $\frac{1}{2}(2+3)\times 1=\frac{5}{2}$

(16) **Answer :** (1)

Hint:

$\vec{r}=\vec{a}+t\vec{b}$

Solution:

$\vec{b}_1=\hat{i}-\hat{j}+\hat{k}$

$\vec{b}_2=\hat{j}-3\hat{k}$

Now, vector perpendicular to $\vec{b}_1 \& \vec{b}_2$ is

$$\vec{b}=\vec{b}_1\times\vec{b}_2=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 1 & -1 & 1\\ 0 & 1 & -3\end{vmatrix}$$

$= \hat{i}(3-1)-\hat{j}(-3)+\hat{k}(1)$

$= 2\hat{i}+3\hat{j}+\hat{k}$

Equation of line passing through $\vec{a}=(1,\ 2,\ -1)$

$=\hat{i}+2\hat{j}-\hat{k}$ & perpendicular to the given lines i.e., parallel to $\vec{b}$ is

$\vec{r}=\vec{a}+t\vec{b}$

$\vec{r}=\left(\hat{i}+2\hat{j}-\hat{k}\right)+t\left(2\hat{i}+3\hat{j}+\hat{k}\right)$

(17) **Answer :** (2)

Hint:

Concept of probability using P_nC.

Solution:

Total ways in which 4 customers can order is 5^4 = 625.

Now, for the 4^{th} person, number of ways is ${}^5C_1$ = 5 & for the other 3 persons, number of ways = 4 × 4 × 4

∴ Total number of ways 4^{th} person orders unordered item = 5 × 4^3

∴ Probability = $\frac{5\times 4^3}{5^4}=\frac{64}{125}$

∴ $m + n$ = 64 + 125 = 189

(18) **Answer :** (4)

Hint:

$\vec{c}=\lambda\vec{a}+\mu\vec{b}+\gamma\left(\vec{a}\times\vec{b}\right)$

Solution:

Let $\vec{c}=\lambda\vec{a}+\mu\vec{b}+\gamma\left(\vec{a}\times\vec{b}\right)$, then

$\vec{a}\cdot\vec{c}=\lambda \quad\Rightarrow\quad \lambda=\cos\theta$

Similarly, μ = cosθ

Also $\left|\vec{c}\right|^2=\lambda^2+\mu^2+\gamma^2\left|\vec{a}\times\vec{b}\right|^2$

$\Rightarrow$ 1 = $2\lambda^2+\gamma^2\left[\left|\vec{a}\right|^2\left|\vec{b}\right|^2-\left(\vec{a}\cdot\vec{b}\right)^2\right]=2\lambda^2+\gamma^2$

[$\because$ λ = μ]

$\therefore$ $\gamma^2 = 1 - 2\lambda^2 = 1 - 2\cos^2\theta = -\cos 2\theta$

Now. $\gamma^2 \ge 0 \Rightarrow \cos 2\theta \le 0 \Rightarrow \frac{\pi}{4}\le\theta\le\frac{3\pi}{4}$

(19) **Answer :** (2)

Hint:

$$\int_0^a (4x^3+6x)\,dx=4$$

Solution:

$$\int_0^a (4x^3+6x)\,dx=4$$

$\Rightarrow$ $\left[x^4+3x^2\right]_0^a=4$

$\Rightarrow$ $a^4 + 3a^2 - 4 = 0$

$\Rightarrow$ $(a^2 + 4)(a^2 - 1) = 0$

$\Rightarrow$ $a^2 = 1$

$\Rightarrow$ $a = \pm 1$

Sum = 0

(20) **Answer :** (3)

Hint:

$y = A\cos(x + B) - Ce^x$

$A = c_1 + c_2$, $B = C_3$ & $C = c_4e^{c_5}$

Solution:

$y = A\cos(x + B) - Ce^x$

where, $A = c_1 + c_2$, $B = C_3$ & $C = c_4e^{c_5}$

$\frac{dy}{dx} = -A\sin(x + B) - Ce^x$

$\frac{d^2y}{dx^2} = -A\cos(x + B) - Ce^x$

$\frac{d^2y}{dx^2}+y = -2Ce^x$

$\Rightarrow$ $\frac{d^3y}{dx^3}+\frac{dy}{dx}=-2Ce^x=\frac{d^2y}{dx^2}+y$

$\Rightarrow$ $\frac{d^3y}{dx^3}-\frac{d^2y}{dx^2}+\frac{dy}{dx}-y=0$

$\therefore$ order = 3

Section-II

(21) **Answer :** 2

Hint:

$$\int_a^b f(x)dx=\int_a^b f(a+b-x)\,dx$$

Solution:

$$I_1=\int_{-1}^{3}\frac{dx}{(5+2x-x^2)(1+e^{3x-3})}\quad \ldots\text{(i)}$$

$$\int_a^b f(x)dx=\int_a^b f(a+b-x)\,dx$$

$$\therefore\ I_1=\int_{-1}^{3}\frac{dx}{(5+2x-x^2)(1+e^{3-3x})}\quad \ldots\text{(ii)}$$

from (i) + (ii)

$2I_1 = \int_{-1}^{3} \frac{dx}{(5+2x-x^2)} = I_2$

$\therefore \ \frac{I_2}{I_1} = 2$

(22) Answer : 5

Hint:

Area = $\int_0^1 x^2 dx + \int_1^4 \sqrt{x}\ dx$

Solution:

Area = $\int_0^1 x^2 dx + \int_1^4 \sqrt{x}\ dx$

= $\left[\frac{x^3}{3}\right]_0^1 + \left[\frac{2x^{3/2}}{3}\right]_1^4$

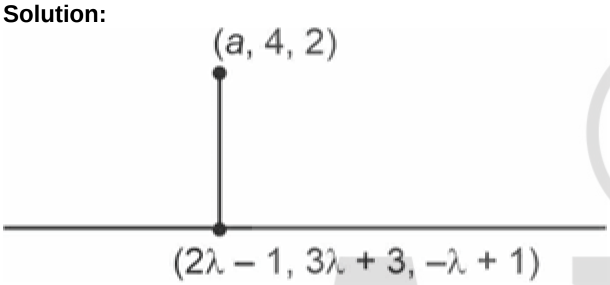
= $\frac{1}{3} + \frac{2}{3}\ [8-1] = 5$

(23) Answer : 8

Hint:

Let $\frac{x+1}{2} = \frac{y-3}{3} = \frac{z-1}{-1} = \lambda$

Solution:



$\frac{x+1}{2} = \frac{y-3}{3} = \frac{z-1}{-1} = \lambda$

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

$\Rightarrow$ $7\lambda - 2 - a = 0$

Now, $(5\lambda - 1)^2 + (3\lambda - 1)^2 + (\lambda + 1)^2 = 24$

$\Rightarrow 35\lambda^2 - 14\lambda - 21 = 0$

$\Rightarrow$ $(\lambda - 1)(35\lambda - 21) = 0$

For $\lambda = 1 \Rightarrow a = 5$

Let $(\alpha_1, \alpha_2, \alpha_3)$ be reflection point p

$\frac{\alpha_1+5}{2} = 1 \quad \Rightarrow \quad \alpha_1 = -3$

$\frac{\alpha_2+4}{2} = 6 \quad \Rightarrow \quad \alpha_2 = 8$

$\frac{\alpha_3+2}{2} = 0 \quad \Rightarrow \quad \alpha_3 = -2$

$\therefore$ $a + \alpha_1 + \alpha_2 + \alpha_3 = 5 - 3 + 8 - 2$

$= 8$

(24) Answer : 18

Hint:

Linear Differential Equation

Solution:

$\frac{dy}{dx} - \frac{x-2}{x(x-1)}y = \frac{x^3(2x-1)}{x(x-1)}$

I.F = $e^{\int \frac{-(x-2)}{x(x-1)}\, dx}$

= $e^{\int \left(\frac{1}{x-1} - \frac{2}{x}\right) dx}$

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

Solution is $y\frac{(x-1)}{x^2} = \int (2x-1)dx$

$= x^2 - x + c$

$y(2) = 0 \ \Rightarrow \ c = -2$

$y = x^3 - \frac{2x^2}{x-1}$
∵ $y(3) = 18$

(25) **Answer :** 49
Hint:
Concept of probability
Solution:
Total ways = 4^5
Favourable = $4^5 - {}^4C_1 \times 3^5 + {}^4C_2 \times 2^5 - {}^4C_3 = 240$
$P(E) = \frac{240}{4^5} = \frac{15}{64}$
∴ $n - m = 64 - 15 = 49$

Physics

Section-I

(26) **Answer :** (1)
Hint:
emf $= \left[\vec{V} \times \vec{B} \cdot \vec{l}\right] = VBl\sin\theta$
Solution:
emf $= \left[\vec{V} \times \vec{B} \cdot \vec{l}\right] = VBl\sin\theta$
$V = \frac{F}{m}t$
$\varepsilon = \frac{BlF}{m}t \times \frac{1}{2}$

(27) **Answer :** (1)
Hint:
Lenz's Law
Solution:
φ_B in both them decreases.
Hence current will try to increase the φ_B.

(28) **Answer :** (2)
Hint:
$\varepsilon = \left[\vec{V} \times \vec{B}\right] \cdot \vec{l} = VBl\sin\alpha$
Solution:
$\varepsilon = \left[\vec{V} \times \vec{B}\right] \cdot \vec{l} = VBl\sin\alpha$
$l = 2R$
$\Rightarrow \varepsilon_{AB} = vB(2R)\sin\alpha$

(29) **Answer :** (4)
Hint:
$\varepsilon = \frac{d\phi}{dt}$
Solution:
$\varepsilon = \frac{d\phi}{dt} = 5 - 20t$
$T = 0.25$ s, $\varepsilon = 0$
$I = \frac{\varepsilon}{R} = 0$

(30) **Answer :** (2)
Hint:
$\frac{d\phi}{dt} = Bl\nu$
Solution:
$\varepsilon = \frac{d\phi}{dt} = Bl\nu$ $\quad x < a\ P = \varepsilon^2 R$
$\varepsilon = 0$ $\quad a < x < d = 0$
$\varepsilon = Bl\nu\ d < x < d + a = P = \varepsilon^2 R$

(31) Answer : (2)
Hint:
$\varepsilon = \frac{d\phi}{dt}$
Solution:
$\varepsilon = \frac{d\phi}{dt}$ φ = constant $\frac{d\phi}{dt} = 0$
$V_P - V_R = (V_P - V_S) + (V_S - V_R)$ $V_S - V_R = 0$ $\bar{\nu} || \bar{l}$

$$V_P - V_R = V_P - V_S = \int_a^{2a} \frac{\mu_0 i\nu}{2\pi x}\,dx = \frac{\mu_0 i\nu}{2\pi}\ln 2$$

(32) Answer : (3)
Hint:
Newton's Law & Kirchhoff's rule
Solution:
$F - Bil = \frac{mdv}{dt}$
$F - B^2l^2C\frac{dv}{dt} = \frac{mdv}{dt}$
$\Rightarrow \frac{dv}{dt} = a = \frac{F}{m+B^2l^2C}$
$i = \frac{dq}{dt} = \frac{d(CV)}{dt} = CBl\frac{dv}{dt}$
$I = CBla$
$q = CBlat = CBla\sqrt{\frac{2x}{a}}$

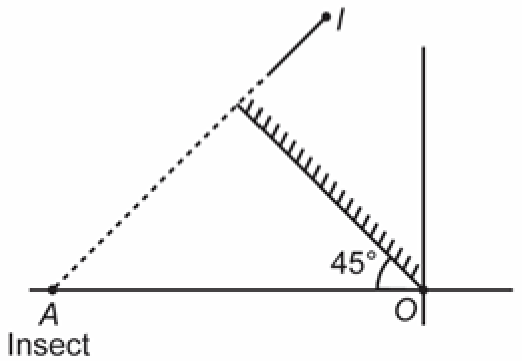
(33) Answer : (2)
Hint:
Use Kirchoff's rule with motional EMF
Solution:
$a = \frac{mg}{m+CB^2l^2}$
$\nu = at$

(34) Answer : (2)
Hint:
Faraday's law
Solution:
$E\,(2\pi r) = \pi a^2\left(\frac{dB}{dt}\right)$
$E2\pi r = \pi a^2 B_0$
$E = \frac{B_0 a^2}{2r}$
$F = qF$

(35) Answer : (3)
Hint:
$L\frac{di}{dt} = \frac{q}{C}$
Solution:
q in steady state $= 20\left(\frac{3\cdot 2}{3+2}\right)\mu\text{C} = 24\mu\text{C}$
$L\frac{di}{dt} = \frac{q}{C}$ $\quad i = -\frac{dq}{dt}$
$\Rightarrow q = q_0\sin(\omega t + \phi)$ $\quad \omega = \frac{1}{\sqrt{LC}}$ $\quad q_0 = 24\mu\text{C}$
at $t = 0$ $\quad q = q_0 = 24\mu\text{C}$ $\quad \phi = \frac{\pi}{2}$

(36) Answer : (1)
Hint:
2θ > = $\frac{1}{2}$
Solution:
For A $i_{\text{rms}} = \frac{i_0}{\sqrt{2}}$ i_{avg} full cycle = 0
For B $i_{\text{rms}} = \frac{i_0}{\sqrt{3}}$
For C $i_{\text{rms}} = \frac{i_0}{2}$ i_{avg} for half cycle = i_0
For D $i_{\text{rms}} = \frac{i_0}{2}$ i_{avg} for half cycle = i_0

(37) Answer : (2)
Hint:
$Z=\sqrt{(x_L-X_C)^2+R^2}$
Solution:
$V_L=\frac{V}{R}L\omega$
$=\frac{150}{\sqrt{2}\times 200}\times\frac{1}{\sqrt{9\times 2\times 10^{-6}}}$

(38) Answer : (2)
Hint:
$\vec{V}_{im}=-\vec{V}_{om}$
Solution:


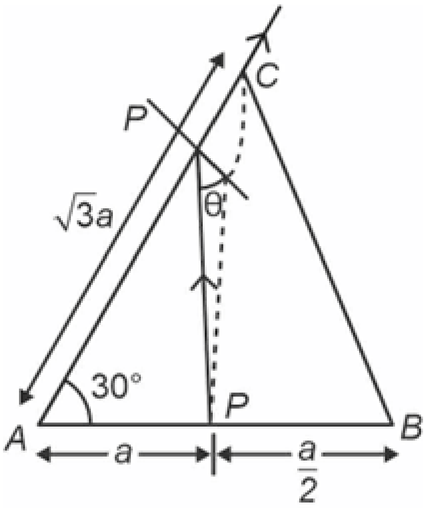
From point *A* to *O* insect can see his image in the mirror.
$AO=\frac{9}{\sin 45^\circ}=9\sqrt{2}$ m
$t=\frac{9\sqrt{2}\text{ m}}{3\sqrt{2}\text{ m/s}}=3\text{ sec.}$

(39) Answer : (3)
Hint:
Zener works in reverse mode
Solution:
V_Z = 4 V
i_Z = 0

(40) Answer : (2)
Hint:
mirror formula
Solution:
Particle is approaching the centre of curvature. Image will also approach centre of curvature.

(41) Answer : (2)
Hint:
$\mu_1\sin\theta_1=\mu(x)\sin\alpha$
Solution:
$\mu_1\sin\theta_1=\mu(x)\sin\alpha$
$\Rightarrow 1\cdot 1=\mu x\sin\alpha$
$\Rightarrow \mu(x)=\frac{1}{\sin\alpha}=\frac{1}{\cos\theta}\qquad \tan\theta=\frac{dy}{dx}$
$\Rightarrow \cos\theta=\frac{1}{\mu(x)}\Rightarrow\tan\theta=\sqrt{\mu x^2-1}$
$\frac{dy}{dx}=\left[\left(1+e^{\frac{2x}{a}}\right)-1\right]^{1/2}$
$\Rightarrow\frac{dy}{dx}=e^{\frac{x}{a}}\Rightarrow\int_0^{a/2}dy=\int_0^{x}e^{\frac{x}{a}}dx$
$x=a\ln 2$

(42) Answer : (2)
Hint:
Snell's Law
Solution:



$\mu \sin\theta = (1)\sin\left(\frac{\pi}{2}\right)$

⇒ μ sinθ = 1

$\mu_{\min} = \frac{1}{(\sin\theta)_{\max}}$

For θ_{max} Point $P \to C$, θ = 30°

(43) **Answer :** (4)

Hint:

$\beta = \frac{\lambda D}{d}$

Solution:

$\beta = \frac{\lambda D}{d}$

β∝λ

$\beta \propto \frac{D}{d}$

(44) **Answer :** (3)

Hint:

Bohr's model

Solution:

$V \propto \frac{Z}{n}$

$mV \propto \frac{Z}{n} \quad \Rightarrow p \propto \frac{1}{n}$

$KE = \frac{1}{2}\, mV^2 \propto \frac{Z^2}{n^2}$

(45) **Answer :** (3)

Hint:

Path difference = odd or even multiple of λ/2

Solution:

At *P*

$BP - AP = (2d)\frac{d}{D} = \frac{\lambda}{2}$

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

Section-II

(46) **Answer :** 1

Hint:

Kirchoff's Law

Solution:

$\frac{(2\phi-\phi)}{e} - Ed = 1.5 - 0.5 = 1$ eV

(47) **Answer :** 159

Hint:

Stefan's Law

Solution:

Radiation ∝ T^4

16 Times ⇒ $T_2 = 2T_1$

$\lambda \propto \frac{1}{T} \Rightarrow \lambda_2 = \frac{\lambda_1}{2} \Rightarrow \lambda_2 = 3000$ Å

Stopping potential $= \frac{13.6}{e}\left(\frac{1}{4} - \frac{1}{16}\right) = 13.6 \times \frac{3}{16}$ V

$\phi = \frac{hc}{\lambda} - 13.6 \times \frac{3}{16} = 4.14 - 2.55 = 1.59 = \frac{159}{100}$
α = 159

(48) **Answer :** 1
Hint:
de-Broglie hypothesis
Solution:
$\nu = \frac{eE}{m}$
$\nu = \frac{eE}{m}t \Rightarrow m\nu = eEt$
$\lambda_d = \frac{h}{m\nu} = \frac{h}{eEt}$
$\frac{d\lambda_d}{dt} = \frac{-h}{eEt^2} = -\frac{\alpha h}{eEt^2}$
⇒ (α = 1)

(49) **Answer :** 2
Hint:
$\frac{hC}{\lambda} = E_0$
Solution:
Cut-off wavelength $= \frac{hc}{eV}, \frac{1}{\lambda}$
$\lambda_{K_a} = R(Z-1)^2 \times \frac{3}{4}$

(50) **Answer :** 114
Hint:
Algebraic functions in years
Solution:
Fraction $\frac{\Delta g}{g} + \cot\theta\ \Delta\theta$
= $\frac{0.50}{10}$ + 0.64 × 0.01
Percentage = 0.5 + 0.64
= 5.64

Chemistry

Section-I

(51) **Answer :** (3)
Hint:
He is mixed with oxygen in diving tanks.
Solution:

(A)	XeF_6	(I)	Partial hydrolysis does not change oxidation state of central atom.
(B)	He	(II)	Used in modern diving apparatus
(C)	Ar	(III)	Central atom is sp^3d^2 hybridised with 2 lone pairs of electrons.
(D)	XeF_4	(IV)	For filling electric bulbs providing inert atmosphere.

(52) **Answer :** (3)
Hint:
C_{60} has 12 five membered and 20 six membered rings
Solution:
Each molecule of fullerene, contain both, single and double bond with C-C distance 143.5 and 133 pm respectively.

(53) **Answer :** (1)
Hint:
Back bonding accounts for higher bond energy in Si-Cl and Ge-Cl which is not there in C-Cl bond.
Solution:
Bond energy of Si-Cl is higher than that of Ge-Cl and that is higher than that of C–Cl due to back bonding.
Bond energy C–Cl Si–Cl Ge–Cl Sn–Cl Pb–Cl
(kJ mol^{-1}) 327 381 349 323 243

(54) **Answer :** (1)
Hint:
Due to common ion effect $[OH^-]$ decreases.
Solution:

$NH_4OH \rightleftharpoons NH_4^+ + OH^-$

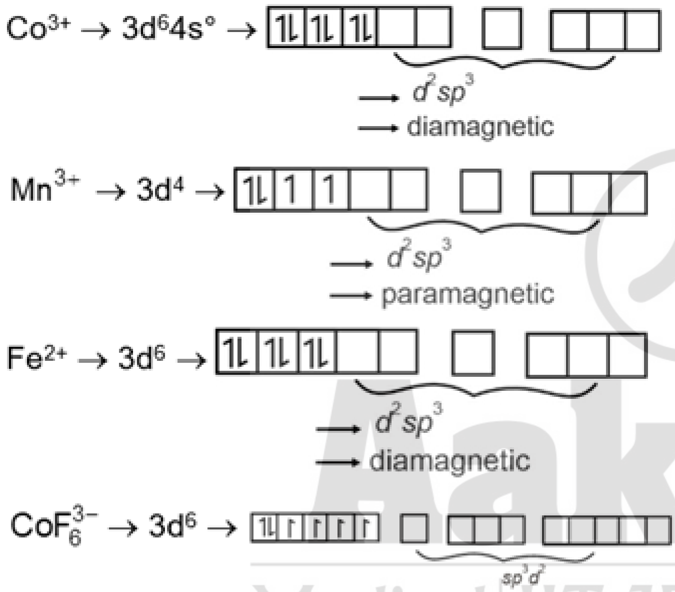
$NH_4Cl \rightarrow NH_4^+ + Cl^-$

Due to common ion effect of NH_4^+, $[OH^-]$ is decreasing so that only group-III cation can be precipitated.

(55) **Answer :** (3)
Hint:
Europium has the highest atomic radius among lanthanoids.
Solution:
Atomic radius of Europium is 199 pm which is higher than that of any other lanthanoid.

(56) **Answer :** (3)
Hint:
Manganese cannot accommodate more than four fluorine atoms around it.
Solution:
The highest oxidation state of manganese among its fluorides is +4 (MnF_4)

(57) **Answer :** (1)
Hint:
In presence of strong field ligand inner orbital octahedral complex will form.
Solution:



(58) **Answer :** (1)
Hint:
Sn reacts with dil.HNO_3 to form NH_4NO_3 which on heating gives N_2O gas.
Solution:

$4Sn + 10HNO_3 \rightarrow 4Sn(NO_3)_2 + NH_4NO_3 + 3H_2O$

$NH_4NO_3 \xrightarrow{\Delta} N_2O(g) + 2H_2O(g)$

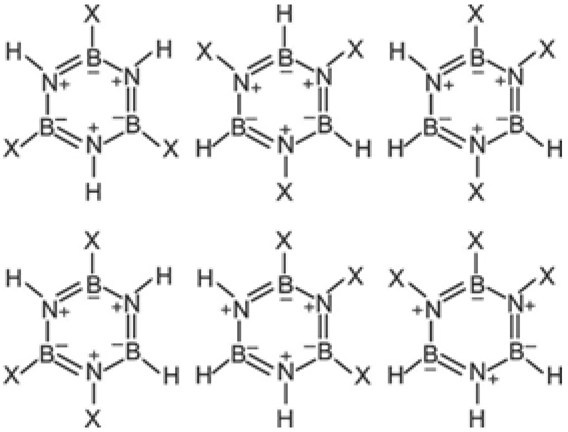
(59) **Answer :** (3)
Hint:
NO_2^- ion is completely decomposed to N_2 by sulphamic acid.
Solution:
Nitrite ion (NO_2^-) is completely decomposed by sulphamic acid without affecting NO_3^- ion.

$HO - SO_2 - NH_2 + NO_2^- \rightarrow N_2(g) + H^+ + SO_4^{2-} + H_2O$

(60) **Answer :** (4)
Hint:
Unpaired electron of ClO_2 is delocalised with vacant d-orbital of Cl-atom.
Solution:
ClO_2 has one unpaired electron which is delocalised with vacant d-orbital of Cl-atom. That makes ClO_2 paramagnetic but prevents it from dimerization.

(61) **Answer :** (2)
Hint:
Trisubstituted borazole has six possible stereo isomers.

Solution:
The isomers of trisubstituted borazole are



(62) **Answer :** (2)
Hint:
CCl_4 does not get hydrolysed as carbon does not have vacant d-orbitals.
Solution:
CCl_4 does not undergo hydrolysis due to its covalent nature and unavailability of vacant orbital in the valence shell of C-atom. $MgCl_2$ is an ionic compound and its aqueous solution is acidic due to hydrolysis of Mg^{2+} ions. The degree of hydrolysis of Mg^{2+} ions depends on K_b of $Mg(OH)_2$ and concentration of Mg^{+2} ions. $AlCl_3$, $SiCl_4$ and PCl_5 are covalent compounds. Their degree of hydrolysis depends on the oxidation state of the central atom. Higher the oxidation state of central atom, higher the degree of hydrolysis of the compound.

(63) **Answer :** (1)
Hint:
Zn reacts with dil. HNO_3 to liberate N_2O gas
Solution:
$$4Zn + 10\,HNO_3 \;\rightarrow\; 4\,Zn\,(NO_3)_2 + \underset{(X)}{N_2O} \;+\; 5H_2O$$
Oxidation state of N-atom of N_2O is +1

(64) **Answer :** (3)
Hint:
Cu^{2+} salt solution is coloured and gives black ppt. of unstable $Cu(SCN)_2$
Solution:
The basic radical present in inorganic salt is Cu^{2+} ion.
$$CuSO_4 + 2\,KSCN \;\rightarrow\; \underset{\substack{(Black)\\(Unstable)}}{Cu\,(SCN)_2\downarrow} + K_2\,SO_4$$
$$2\,Cu\,(SCN)_2 \;\rightarrow\; \underset{(White)}{2CuSCN\downarrow} \;+\; (SCN)_2$$
$$CuSO_4 + H_2S \;\rightarrow\; \underset{Black}{CuS\downarrow} \;+ H_2\,SO_4$$
$$CuS + 2\,KCN \;\rightarrow\; \underset{(Unstable)}{Cu\,(CN)_2} + \;K_2S$$
$2Cu(CN)_2 \rightarrow 2CuCN + (CN)_2$
$$CuCN + 3\,KCN \;\rightarrow\; \underset{(Soluble}{K_3[Cu\,(CN)_4]}$$

(65) **Answer :** (2)
Hint:
Higher the value of standard reduction potential, higher is its tendency to get reduced.
Solution:
E°($Mn^{3+}|Mn^{2+}$) > E°(Fe^{3+}/Fe^{2+}) > E°($Cr^{3+}|Cr^{2+}$)
∴ Fe^{3+} is more reducible than Cr^{3+} but less reducible than Mn^{3+}

(66) **Answer :** (4)
Hint:
Conjugate base of a weak acid is a strong base.
Solution:
The order of acidic strength of oxo acids of chlorine is
$HClO < HClO_2 < HClO_3 < HClO_4$

Conjugate base of a weak acid is a strong base.

(67) **Answer :** (1)
Hint:
Oxidising power of oxoanions of chlorine is inversely proportional to oxidation state of chlorine.
Solution:
Oxidising power of oxo anions of chlorine is inversely proportional to oxidation state of chlorine.
∴ Correct order of oxidising power
$ClO^- > ClO_2^- > ClO_3^- > ClO_4^-$

(68) **Answer :** (1)
Hint:
Ionic radius of lanthanide(+3) and actinides(+3) regularly decreases.
Solution:
Actinides have more charge density
Actinides have more tendency to form complex due to high charge density.

(69) **Answer :** (2)
Hint:
As bond order of metal-carbon bond increases, bond order of C–O bond decreases and hence C–O bond length increases.
Solution:
In $Ni(CO)_4$, 5 pair of electrons of Ni are being shared by 4 CO molecules. In $Fe(CO)_5$, 4 pair of electrons are being shared by 5 CO molecules. In $Cr(CO)_6$, 3 pair of electrons are being shared by 6 CO molecules. As more electrons of metal move into antibonding MO of CO ligands, C–O bond length increases.

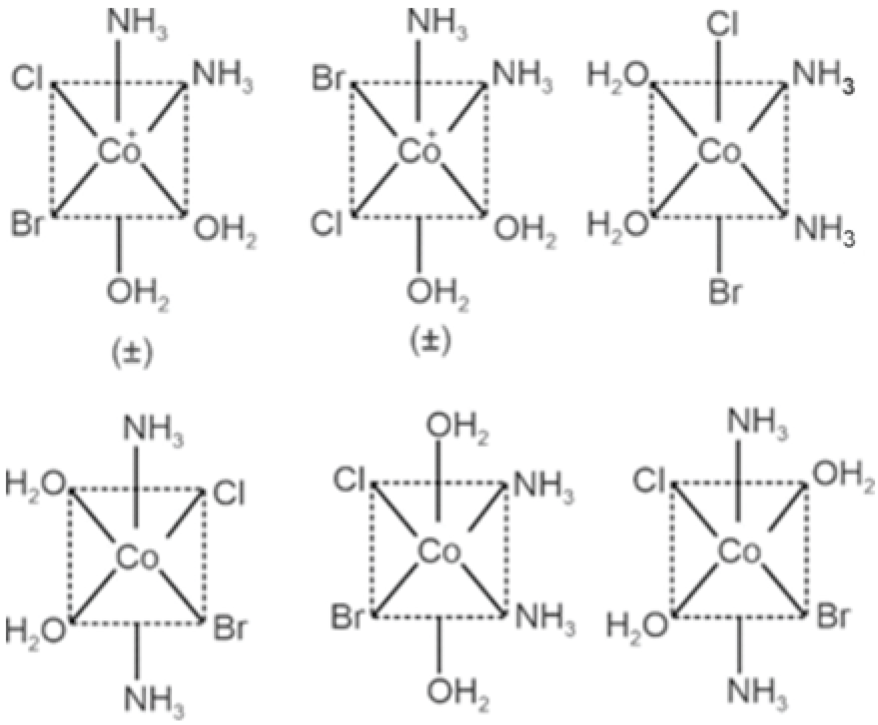
(70) **Answer :** (3)
Hint:
Fe^{3+} ion oxidises I^- to I_2 and itself gets reduced to Fe^{2+} ion.
Solution:

$$2I^- + S_2O_8^{2-} \xrightarrow{Fe^{3+}} I_2 + 2\,SO_4^{2-}$$
$$2\,Fe^{3+} + 2I^- \rightarrow 2\,Fe^{2+} + I_2$$
$$2\,Fe^{2+} + S_2O_8^{2-} \rightarrow 2\,Fe^{3+} + 2\,SO_4^{2-}$$

Section-II

(71) **Answer :** 20
Hint:
Cl^- ion present in ionisation sphere gets precipitated as AgCl.
Solution:
$[CoCl_2(en)_2]Cl + \underset{\text{Excess}}{AgNO_3}$
$[CoCl_2(en)_2]NO_3 + AgCl\downarrow$

(72) **Answer :** 8
Hint:
Number of stereoisomers are decided by interchanging the ligands.
Solution:
The possible stereoisomers of $[Co(NH_3)_2(OH_2)_2ClBr]^+$ are



(73) Answer : 15

Hint:

Number of moles of N = Number of moles of NH_3

Solution:

Mass of organic compound = 0.2325 g

Pressure of dry N_2 gas = 755.8 – 23.8 = 732 mm Hg

Volume of N_2 gas = 31.7 mL

Temperature of N_2 gas = 298 K

No. of moles of N_2 gas = $\frac{732 \times 31.7 \times 10^{-3}}{760 \times 0.0821 \times 298}$

= 1.248×10^{-3}

% of Nitrogen = $\frac{1.248 \times 10^{-3} \times 28 \times 100}{0.2325}$

$\simeq 15\%$

(74) Answer : 40

Hint:

% of N = $\frac{\text{No. of moles of } N_2 \times 28}{\text{Mass of organic compound}} \times 100$

Solution:

Mass of organic compound = 7g

Millimoles of NH_3 = Millimoles of HCl

= 80 × 2.5 = 200

Mass of nitrogen = $\frac{200 \times 14}{1000} = 2.8g$

Percentage of nitrogen in the organic compound

= $\frac{2.8 \times 100}{7} = 40\%$

(75) Answer : 13

Hint:

Highest possible oxidation state of plutonium is +7.

Solution:

The highest possible oxidation state of uranium is +6.

The highest possible oxidation state of plutonium is +7.

∴ x = +6 and y = +7

x + y = 6 + 7 = 13