FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2025
PART TEST – III
PAPER –1
TEST DATE: 22-12-2024

ANSWERS, HINTS & SOLUTIONS

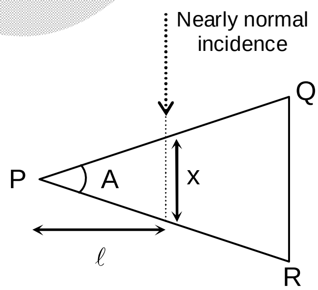
Physics

PART – I

SECTION – A

1. D

Sol. Path difference between waves for which interference takes place is



$$\Delta x = 2\mu x \pm \frac{\lambda}{2}$$

For constructive interference

$$2\mu x \pm \frac{\lambda}{2} = n\lambda$$

$$2\mu x = \left(n \pm \frac{1}{2}\right)\lambda$$

For first constructive interference

$$2\mu x = \frac{\lambda}{2}$$

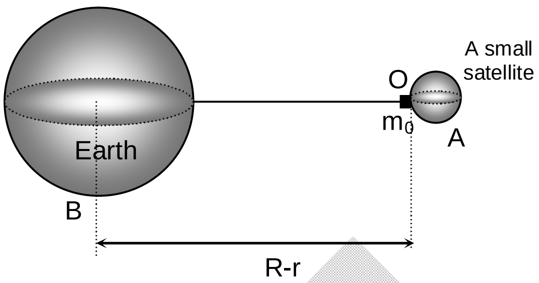
$$2\mu(A\ell) = \frac{\lambda}{2}$$

$$A = \frac{\lambda}{4\mu\ell}$$

$$= \frac{500\times10^{-9}}{4\times\left(\frac{5}{3}\right)\times6\times10^{-2}} = 1.25\times10^{-6}\text{ rad} = 7.165\times10^{-5}\text{ degree}$$

2. C

Sol. Satellite is orbiting around the earth with angular velocity $\omega = \sqrt{\frac{GM_e}{R^3}}$



From F.B.D of m_0

$$\frac{GM_e m_0}{(R-r)^2} - \frac{Gm_S m_0}{r^2} = m_0(R-r)\omega^2 \ \text{(Since, N = 0)}$$

$$\frac{GM_e}{(R-r)^2} - \frac{Gm_S}{R^3} = (R-r)\frac{GM_e}{R^3}$$

$$M_e\left[\frac{1}{(R-r)^2} - \frac{(R-r)}{R^3}\right] = \frac{m_S}{r^2}$$

$$R = r\left(\frac{3M_e}{m_s}\right)^{1/3}$$

3. D

Sol. There is no elongation/compression in the middle spring. So, restoring force on each block is due to only one spring

$F_r = -kx$

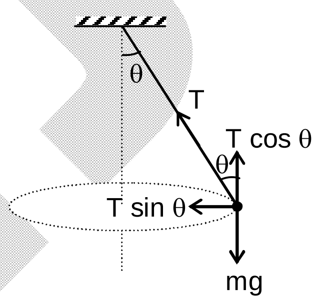
$$T = 2\pi\sqrt{\frac{m}{k}}$$

4. B

Sol. $T\cos\theta = mg$

$$T = \frac{mg}{\cos\theta} = \frac{2\times10}{0.64}$$

$$\Delta L = \frac{T\cdot L}{Y\cdot A} = \frac{T\cdot L}{Y\left(\frac{\pi d^2}{4}\right)} = 0.5971 \text{ mm}$$



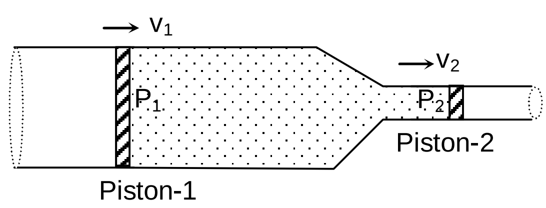
5. A, D

Sol. From continuity equation

$$\pi r_1^2 v_1 = \pi r_2^2 v_2 \quad \text{...(i)}$$

From Bernoulli's equation

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2 \quad \text{...(ii)}$$



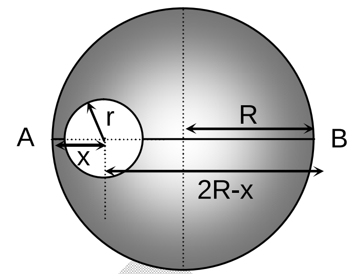
From equation (i) and (ii)

$$v_1 = r_2^2\sqrt{\frac{2(P_1-P_2)}{\rho(r_1^4-r_2^4)}}$$

$$v_2 = r_1^2\sqrt{\frac{2(P_1-P_2)}{\rho(r_1^4-r_2^4)}}$$

6. A, C

Sol. $g = \frac{GM}{R^2}$ …(i)



Let M′ is mass of cavity

$M' = \frac{Mr^3}{R^3}$ …(i)

At 'A' acceleration due to gravity becomes minimum and at 'B' it is maximum

$\frac{g}{6} = g - \frac{GM'}{x^2}$ …(iii)

$\frac{g}{4} = g - \frac{GM'}{(2R-x)^2}$ …(iv)

$\frac{GM'}{x^2} = \frac{5g}{6}$

$\frac{GM'}{(2R-x)^2} = \frac{3g}{4}$

$\frac{2R-x}{x} = \frac{\sqrt{10}}{3}$

$x = \frac{6R}{\sqrt{10}+3}$

Now, from equation (iii)

$r = \frac{(30)^{1/3}}{(3+\sqrt{10})^{2/3}}R$

7. B, C

Sol. Liquid will not flow out in figure (ii), figure (iii) and figure (iv), nature of radius of curvature of meniscus will be manage it.

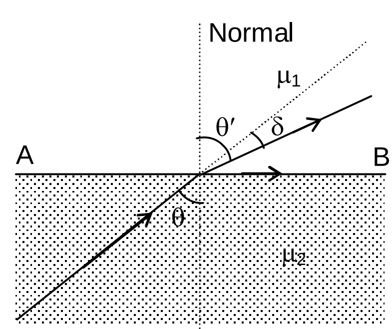
$\Delta p = \frac{2S}{R}$

$\rho g \frac{H}{3} = \frac{2S}{R}$

$R = \frac{6S}{\rho g H}$

8. D

Sol. Critical angle will be



$C = \sin^{-1}\left(\frac{\mu_1}{\mu_2}\right)$

For $\theta < C$

$\mu_2 \sin\theta = \mu_1 \sin\theta'$

$\sin\theta' = \frac{\mu_2 \sin\theta}{\mu_1}$

$\theta' = \sin^{-1}\left(\frac{\mu_2 \sin\theta}{\mu_1}\right)$

$\delta = \theta' - \theta$

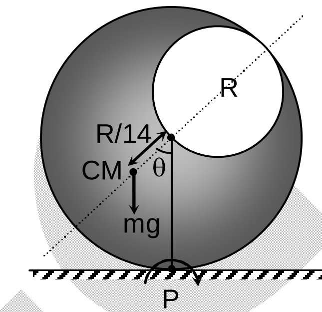
Maximum deviation for refraction $\delta_{max} = \frac{\pi}{2} - C$

Maximum deviation for reflection $\delta_{max} = \pi - 2C$

At grazing angle of incidence, refracted ray goes along the surface AB

9. B

Sol. Mass of cavitied sphere M= $\rho \times \frac{4}{3}\pi(R)^3 - \rho \times \frac{4}{3}\pi\left(\frac{R}{2}\right)^3 = \frac{4}{3}\pi R^3 \rho\left(\frac{7}{8}\right)$



Mass of cavity m = $\rho \times \frac{4}{3}\pi\left(\frac{R}{2}\right)^3 = \frac{M}{7}$

Mass of sphere = $M + \frac{M}{7} = \frac{8M}{7}$

Position of centre of mass from point of contact = $\frac{\left(\frac{8M}{7}\right)R - \left(\frac{M}{7}\right)\left(\frac{3R}{2}\right)}{\frac{8M}{7} - \frac{M}{7}} = \frac{13R}{14}$

Moment of Inertia about O = $\frac{2}{5}\left(\frac{8M}{7}\right)R^2 - \left[\frac{2}{5}\left(\frac{M}{7}\right)\left(\frac{R}{2}\right)^2 + \frac{M}{7}\left(\frac{R}{2}\right)^2\right] = \frac{57}{140}MR^2$

Moment of Inertia about point of contact

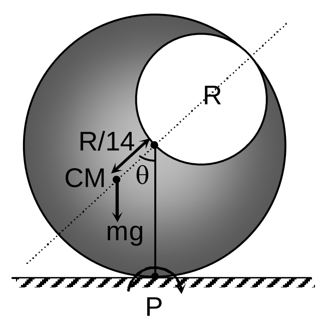
$= \left[\frac{2}{5}\left(\frac{8M}{7}\right)R^2 + \frac{8M}{7}R^2\right] - \left[\frac{2}{5}\left(\frac{M}{7}\right)\left(\frac{R}{2}\right)^2 + \frac{M}{7}\left(\frac{3R}{2}\right)^2\right] = \frac{177}{140}MR^2$

Taking torque about P

$I_P\alpha = -Mg\left(\frac{R}{14}\right)\sin\theta = -\frac{MgR}{14}\theta$

$\alpha = -\frac{10}{177}\frac{g}{R}\theta$

$\omega = \sqrt{\frac{10}{177}\left(\frac{g}{R}\right)}$



10. D

Sol. Dimension of h = $\left[ML^2T^{-1}\right]$

Dimension of G = $\left[M^{-1}L^3T^{-2}\right]$

Dimension of P = $\left[ML^2T^{-3}\right]$

Dimension of S = $\left[MT^{-2}\right]$

Dimension of η = $\left[ML^{-1}T^{-1}\right]$

11. A

Sol. $5\times10^{-15} = eV_0$

$$V_0 = \frac{5\times10^{-15}}{1.6\times10^{-19}} = 3.125\times10^4\,V$$

$$\Rightarrow \quad \Delta E = 5\times10^{-15} - 6\times10^{16} = 4.4\times10^{-15}\,J$$

$$\Rightarrow \quad 4.4\times10^{-15} = \frac{hC}{\lambda}$$

$$\lambda = \frac{6.67\times10^{-34}\times3\times10^{8}}{4.4\times10^{-15}} = 4.44\times10^{-11}m$$

$\Rightarrow$ Kinetic energy of electron emitted from M-level

$$4.4\times10^{-15} - 7\times10^{-17} = 4.33\times10^{-15}\,J$$

SECTION – B

12. 339

Sol. Let the reservoir is lowered by x, so that the level of water fall in the resonance tube by y

$$x - \frac{y}{5} = y\,,\ x = \frac{6y}{5}\,,\ y = \frac{5x}{6}$$

When x = 24 cm, y = 20 cm

When x= 54 cm, y = 45 cm

So, $\frac{\lambda}{4} = 20 + e$

$$\frac{3\lambda}{4} = 45 + e$$

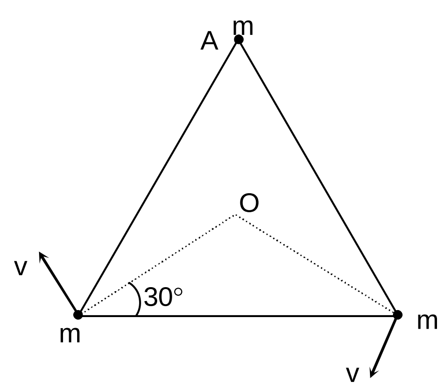
$$\frac{\lambda}{2} = 25$$

λ = 50 cm = $\frac{1}{2}$m

v = fλ = $678\times\frac{1}{2} = 339$ m/s

13. 32

Sol. $$\frac{mv^2}{\ell/\sqrt{3}} = \frac{\sqrt{3}Gm^2}{\ell^2}$$



$$v = \sqrt{\frac{Gm}{\ell}}$$

When particle ‘A’ escapes

$$v_{cm} = \frac{mv\cos60^\circ + mv\cos60^\circ}{m+m} = \frac{v}{2} = \sqrt{\frac{Gm}{4\ell}}$$

14. 25

Sol. Initially from F.B.D. of block B and ice

$$m_A g = (m_B + m_i)g - \frac{v}{2}\rho_w g - v_i\rho_w g$$

$$m_A = (m_B + m_i) - \frac{m_B}{2\rho_B}\rho_w - \frac{m_i}{\rho_i}\rho_w$$

Divide the equation by m_i

$$\frac{m_A}{m_i} = \left(\frac{m_B}{m_i} + 1\right) - \left(\frac{m_B}{m_i}\right)\left(\frac{\rho_w}{2\rho_B}\right) - \frac{\rho_w}{\rho_i} \qquad \ldots(i)$$

After ice melts from F.B.D. of block B

$$m_A g = m_B g - v\rho_w g$$

$$m_A = m_B - \left(\frac{m_B}{\rho_B}\right)\rho_w$$

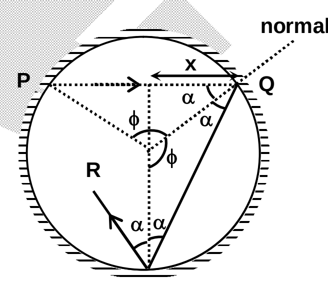
$$\frac{m_A}{m_i} = \frac{m_B}{m_i} - \left(\frac{m_B}{m_i}\right)\cdot\left(\frac{\rho_w}{\rho_B}\right) \qquad \ldots(ii)$$

Now, from (i) and (ii)

$$\frac{m_B}{m_i} = \frac{2\rho_B(\rho_w - \rho_i)}{\rho_i\rho_w} = \frac{2(8000)(100)}{900\times1000} = \frac{16}{9}$$

15. 179

Sol. $\cos\alpha = \frac{x}{R}$



x = R cos α

16 = 20 cos α

α = 37°

$\Rightarrow \phi = 180° - 2\alpha = 106°$

$\Rightarrow n_1\phi = n_2(360°)$

$n_1 \times 106 = n_2 \times 360$

$53n_1 = 180n_2$

n_1 and n_2 should be integer

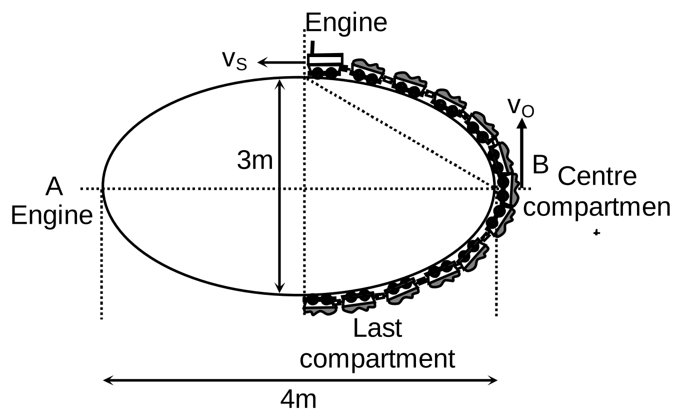
$n_1 = 180$

$n_2 = 53$

So, total no of reflections = 180 – 1 = 179

16. 671

Sol. $f_L = f_O = 4325\text{Hz}$



$$f_C = f_O\left(\frac{v + v_0\cos53°}{v + v_s\cos37°}\right)$$

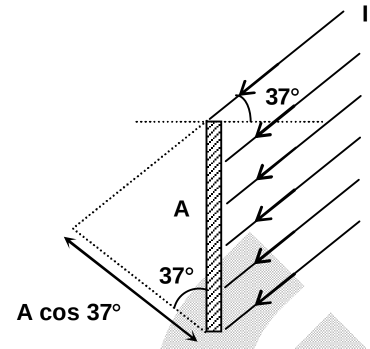
$$= 4325\left(\frac{332 + 5\times\frac{3}{5}}{332 + 5\times\frac{4}{5}}\right) = 4325\left(\frac{335}{336}\right)$$

$$\frac{f_C}{f_L} = \frac{335}{336} = \frac{\lambda_1}{\lambda_2}$$

$$\lambda_1 + \lambda_2 = 671$$

17. 26

Sol. $E_1 = \frac{1240}{310} = 4\text{ eV}$



$E_2 = \frac{1240}{496} = 2.5\text{ eV}$

$E_3 = \frac{1240}{620} = 2\text{ eV}$

No. of ejected photoelectrons per sec(n) = $\dfrac{\frac{IA\cos\theta}{3}}{E}$

So, $n_1 = \dfrac{\frac{500}{3}(3\times10^{-4})\frac{4}{5}}{4\text{ eV}} = \frac{100}{e}\times10^{-4}$

$n_2 = \dfrac{\frac{500}{3}(3\times10^{-4})\frac{4}{5}}{2.5\text{ eV}} = \frac{160}{e}\times10^{-4}$

Total photo current = $(n_1+n_2)e = 26\text{ mA}$

Chemistry

PART – II

SECTION – A

18. C

Sol. d^6 (low spin) has symmetrical t_{2g} electronic configuration.

19. B

Sol. Weight of ice = 30 – 25 = 5 g
Heat gained by ice = heat lost by water

$$5\times2(0-T)+330\times5+5\times4.2(19-0)=25\times4.2(40-19)$$
$$-10T+1650+399=2205$$
$$-10T=156$$
$$T=-15.6^{o}$$

20. D

Sol. $[Re_2Cl_8]^{2-}$ having quadruple bond and the blue colour is due to $\delta\to\delta^*$ electronic transition

21. B

Sol. When almost all of the liquid converted into vapour phase

$$Y_{Benzene}=\frac{2}{3} \qquad Y_{Toluene}=\frac{1}{3}$$
$$\frac{\chi_{Toluene}}{\chi_{Benzene}}=\frac{P_{total}\times Y_{toluene}}{P^{o}_{Toluene}}\Big/\frac{P_{total}\times Y_{Benzene}}{P^{o}_{Benzene}}$$
$$=\frac{P^{o}_{Benzene}\times Y_{Toluene}}{P^{o}_{Toluene}\times Y_{Benzene}}=\frac{100\times\frac{1}{3}}{60\times\frac{2}{3}}$$
$$\frac{n_{Toluene}}{n_{Benzene}}=\frac{100}{120}$$
$$\frac{n_{Benzene}}{n_{Toluene}}=1.2$$

22. A, B, C, D

23. A, B, C

Sol.
$$Fe(0)\longrightarrow4s^{2}3d^{6} \qquad n=4$$
$$Fe(+2)\longrightarrow4s^{0}3d^{6} \qquad n=4$$
$$Fe(+4)\longrightarrow4s^{0}3d^{4} \qquad n=4$$
$$Fe(+6)\longrightarrow4s^{0}3d^{2} \qquad n=2$$

24. C, D

Sol. 1 equivalent of H_2SO_4 = 1 equivalent of H-atom

Moles of O_2 required for 28 gm of ethene $=\frac{28}{28}\times3=3$ mol

25. A

Sol. Pb^{2+}: $Pb^{2+} + 2KI \longrightarrow \underset{\text{Yellow}}{PbI_2} \downarrow + 2K^+$

$Pb^{2+} + K_2CrO_4 \longrightarrow \underset{\text{Yellow}}{PbCrO_4} \downarrow + 2K^+$

Ag^+: $2Ag^+ + 2NaOH \longrightarrow \underset{\text{Brown}}{Ag_2O} \downarrow + H_2O + 2Na^+$

$2Ag^+ + H_2S \longrightarrow \underset{\text{Black}}{Ag_2S} \downarrow + 2H^+$

Hg_2^{2+}: $Hg_2^{2+} + 2NaOH \longrightarrow \underset{\text{Black}}{Hg_2O} \downarrow + H_2O + 2Na^+$

$Hg_2^{2+} + H_2S \longrightarrow \underbrace{Hg \downarrow + HgS \downarrow}_{\text{Black}} + 2H^+$

$Hg_2^{2+} + 2KI \longrightarrow Hg_2I_2 + 2K^+$

26. C

27. A

Sol.

Triclinic	$a \neq b \neq c$	$\alpha \neq \beta \neq \gamma$
Orthorhombic	$a \neq b \neq c$	$\alpha = \beta = \gamma \neq 90^o$
Tetragonal	$a = b \neq c$	$\alpha = \beta = \gamma = 90^o$
Hexagonal	$a = b \neq c$	$\alpha = \beta = 90^o, \gamma = 120^o$

28. D

SECTION – B

29. 3

Sol. White $\rightarrow Ag_2SO_3, AgNO_2, ZnS, BaCO_3$

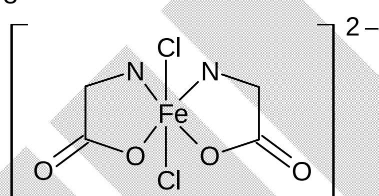
Black $\rightarrow Ag_2S, FeS, PbS$

Yellow $\rightarrow AgI$

Reddish brown $\rightarrow Fe(OH)_3$

30. 8

Sol.



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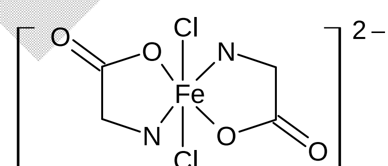

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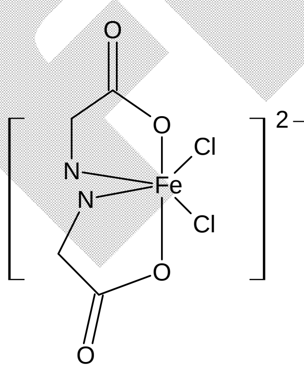

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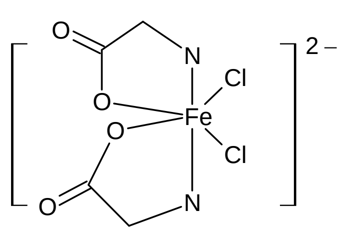

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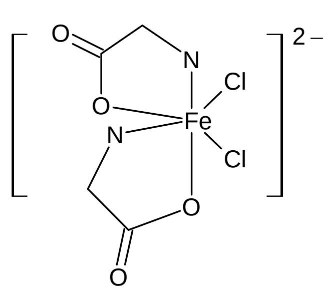


Optically active

$\therefore$ Total isomer = 8

31. 40

Sol. Weight of $CaCO_3$ = 1 × 0.8 = 0.8 gm

$\therefore$ Moles of $CO_2 = \frac{0.8}{100} = 8 \times 10^{-3}$ mole

$$\begin{array}{llll} CO_2 & + \ 2NaOH & \longrightarrow Na_2CO_3 & + H_2O \\ 8\,m.mol & 0.2 \times 100 & 0 & 0 \\ 0 & 4\ m.mol & 8\ m.mol & \end{array}$$

Now the solution is titrated against in HCl with phenolphthalein as indicator

$\therefore 0.3 \times V = 4 + 8$

$V = \frac{12}{0.3} = 40$ ml

32. 510

Sol. Let volume of butane = x ml

Volume of propane = y ml

Volume of propyne = z ml

x + y + z = 150

Given x = 60

$\therefore y + z = 90$

x ml of C_4H_{10} produce 4x ml CO_2

y ml of C_3H_8 produce 3y ml CO_2

z ml of C_3H_4 produce 3z ml CO_2

$\therefore$ 150 ml mixture will produce = 4x + 3(y + z)

= 4 × 60 + 3 × 90

= 510 ml

33. 4

Sol. Following pair will show +ve deviation

Ethanol + Hexane

Benzene + CCl_4

Acetone + CS_2

Acetone + Chloroform

34. 22

Sol. $\Delta T_f = iK_f m$

$$3.33 = \frac{\left((1+\alpha)\frac{5}{60} + \frac{5}{60}\right) \times 1.62}{90/1000}$$

$\Rightarrow 2 + \alpha = 2.22$

$\therefore \alpha = 0.22$

Mathematics PART – III

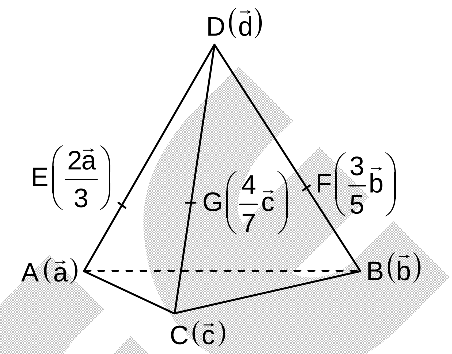
SECTION – A

35. C

Sol. Let D be origin, $A(\vec{a}), B(\vec{b}), C(\vec{c})$, then

$E\left(\frac{2\vec{a}}{3}\right), F\left(\frac{3\vec{b}}{5}\right), G\left(\frac{4\vec{c}}{7}\right)$

$$\text{Ratio} = \frac{\frac{1}{6}[\vec{a}\ \vec{b}\ \vec{c}] - \frac{1}{6}\left[\frac{2}{3}\vec{a}\ \ \frac{3}{5}\vec{b}\ \ \frac{4}{7}\vec{c}\right]}{\frac{1}{6}[\vec{a}\ \vec{b}\ \vec{c}]} = \frac{27}{35}$$



36. D

Sol. AB + BA = 0 $\Rightarrow$ AB = BA $\Rightarrow$ AB = 0
$\Rightarrow$ |AB| = |A| = |B| = 0

37. C

Sol. $\frac{x-0}{1} = \frac{y-4\cos\theta}{1} = \frac{z-3\sin\theta}{1} = -\frac{(4\cos\theta+3\sin\theta-1)}{3}$

$\Rightarrow \left(\frac{x-y}{4}\right)^2 + \left(\frac{z-x}{3}\right)^2 = 1 \Rightarrow 25x^2 + 9y^2 + 16z^2 - 18xy - 32xz = 144$

38. D

Sol. $x(x^2 + x - 1)(x^2 + x - 2) = 0$
So, 5 real roots

39. A, B, C, D

Sol. (A) There only 5 non-rotten fruits

(B) $\frac{3!}{2!} \times \frac{4!}{2!2!} \times 2! \times 3! = 216$

(C) $\frac{5!}{2!2!} \times \frac{4!}{2!} \times 3 = 1080$

(D) $\frac{4!}{2!} \times \frac{6!}{2!2!} = 2160$

40. B, C

Sol. $T_r = 1 + \frac{1}{(r+1)^3} - \frac{1}{(r-1)^3}$

$\sum_{r=2}^{n} T_r = n - 1 + \frac{1}{(n+1)^3} + \frac{1}{n^3} - \frac{1}{1} - \frac{1}{8} = n - \frac{17}{8} + \frac{2n^3+3n^2+3n+1}{(n^2+n)^3}$

41. B, C, D

Sol. $2024 = 2^3 \times 11 \times 23$
$n(S_1) = 2023$
$S_1 = S_i \cup S_j$ for 14 ordered pairs

$S_8 \neq S_i \cap S_j$ for any i, j $\neq 8$
$n(S_8 \cap S_{11} \cap S_{23}) = 2023 - 7 - 10 - 22 = 1984$

42. C

Sol. (P) $\arg(z_1 - z_2) \in \left(-\frac{\pi}{6}, \frac{5\pi}{6}\right) \Rightarrow c = \pi$

(Q-R) $\arg(z_1 - z_2) = 0 \Rightarrow |z_1 - z_2| \in \left[3\sqrt{3} - 2, 3\sqrt{3} + 2\right]$

(S) $|z_1 - z_2|_{max} - |z_1 - z_2|_{min} = 2 \times$ radius of circle $= 2$

43. C

Sol. $P(1) = \frac{5}{^{25}C_5}$

$P(2) = \frac{2500}{^{25}C_5}$

$P(3) = \frac{22500}{^{25}C_5}$

$P(4) = \frac{25000}{^{25}C_5}$

$P(5) = \frac{3125}{^{25}C_5}$

$E = \frac{188130}{^{25}C_5}$

44. A

Sol. (P) $^{26}C_3 = 2600$

(Q) $^{26}C_3 - {}^{20}C_3 - {}^{21}C_3 + {}^{15}C_3 = 585$

(R) $^{17}C_3 = 680$

(S) $^{24}C_2 + {}^{19}C_2 + {}^{14}C_2 + {}^{9}C_2 + {}^{4}C_2 = 580$

45. A

Sol. $\sum_{r=0}^{n} f(r) = (n+1)(n+4)2^{n-2}$

$\sum_{r=0}^{n} g(r) = \frac{2^{n+1} - 1}{n+1}$

$\sum\sum_{i=j} f(i)g(j) = (n+2)\ {}^{2n-1}C_{n-1}$

$\sum\sum_{i \neq j} f(i)g(j) = (n+4)\left(2^{2n-1} - 2^{n-2}\right) - (n+2)\ {}^{2n-1}C_{n-1}$

SECTION – B

46. 6076

Sol. $\sum_{r=1}^{2025} \frac{2025^r}{r!}\left((r+2)2025 - r(r+1)\right) = \sum_{r=1}^{2025} \frac{2025^{r+1}(r+2)}{r!} - \frac{2025^r(r+1)}{(r-1)!}$

$= \frac{2025^{2026} \cdot 2027}{2025!} - 2025 \cdot 2 = \frac{2025^{2025} \cdot 2027}{2024!} - 4050$

47. 0

Sol. $\left(\left(\left(\vec{a}\times\vec{b}\right)\times\vec{c}\right)\times\left(\left(\vec{b}\times\vec{c}\right)\times\vec{a}\right)\right)\cdot\left(\left(\vec{c}\times\vec{a}\right)\times\vec{b}\right) =$
$(\vec{a}\cdot\vec{c})(\vec{a}\cdot\vec{b})(\vec{b}\cdot\vec{c})\left[\vec{a}\ \vec{b}\ \vec{c}\right]-(\vec{a}\cdot\vec{b})(\vec{b}\cdot\vec{c})(\vec{c}\cdot\vec{a})\left[\vec{a}\ \vec{b}\ \vec{c}\right]=0$

48. 0

Sol. $\Delta(x) = 0\ \forall\ x \Rightarrow \Delta'(x) = 0\ \forall\ x$

49. 2025

Sol. $(PQ^{-1})^3 = -I \Rightarrow |Q| = -|P| = 2025$

50. 27

Sol. A — getting a 6 on dice
B — drawing 3 colours

$$P\left(\frac{A}{B}\right)=\frac{P(A)\cdot P\left(\frac{B}{A}\right)}{P(B)} = \frac{\frac{1}{6}\cdot 1}{\frac{1}{6}\cdot\frac{8}{^6C_3}+\frac{1}{6}\left(1-\frac{^3C_2}{^6C_4}\right)+\frac{1}{6}\cdot 1+\frac{1}{6}\cdot 1}=\frac{3}{10}$$

51. 12

Sol. Maximum distance = $\left|\frac{2+4+3+27}{3}\right|$