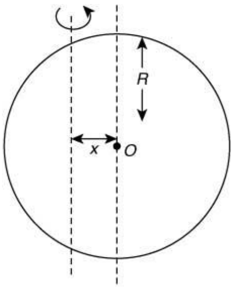
JEE Main 2019 Paper 1
January 12, Shift 2
Section: Physics

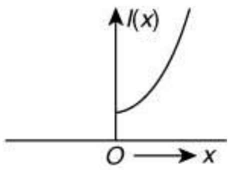
1. Moment of Inertia of hollow sphere

$$I = \frac{2}{3}mR^2$$

By parallel axis theorem

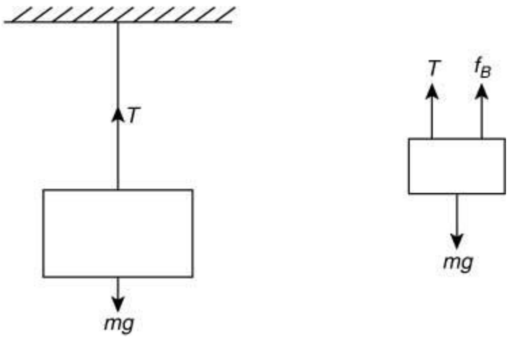
$$I_x = I + mx^2$$
$$= \frac{2}{3}mR^2 + mx^2$$





Answer: (4).

2.



ρ is the relative density of material.

Initial length of steel wire, l = 1 mm

Change in length with it loaded mass $(mg)\Delta l$ = 4 mm

Thus, young modulus is

$$Y = \frac{F/A}{\Delta l/l}$$

$$\Rightarrow \Delta l = \frac{Fl}{AY} = \frac{\rho Vgl}{AY} \qquad (1)$$

$$\Delta l' = \frac{(\rho - \sigma)Vgl}{AY} \qquad (2)$$

Dividing Eq. (2) by Eq. (1), we get

$$\frac{\Delta l}{\Delta l'} = \frac{\frac{(P-\sigma)Vgl}{AY}}{\frac{\rho Vgl}{AY}}$$

$$\Rightarrow \frac{\Delta l'}{\Delta l} = \frac{\rho - \sigma}{\rho}$$

$$\Rightarrow \Delta l' = \frac{(\rho - \sigma)}{\rho} \times \Delta l$$

$$= \frac{8-2}{8} \times 4 = \frac{6}{8} \times 4$$

$$\Rightarrow \Delta l' = 3\,\text{mm}$$

Answer: (1).

3. Given $V = 200\sqrt{2}\sin 100t$; $\omega = 100$

We know that

$$X_L = \omega L$$

$$= \frac{\sqrt{3}}{10} \times 100 = 10\sqrt{3}\,\Omega$$

And

$$X_C = \frac{1}{\omega C}$$

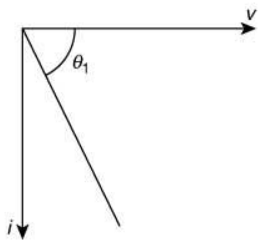
$$= \frac{1}{100 \times \frac{\sqrt{3}}{2} \times 10^6} = \frac{2 \times 10^4}{\sqrt{3}}$$

Now,

$$\tan\theta_1 = \frac{X_C}{R_2} = \frac{10^6}{50\sqrt{3} \times 20} = \frac{1000}{\sqrt{3}} = 577$$

$$\Rightarrow \theta_1 = 89.9° \simeq 90°$$

Thus, θ_1 is close to 90°



$$\tan\theta_2 = \frac{X_L}{R_1}$$

$$\Rightarrow \tan\theta_2 = \frac{10\sqrt{3}}{10} \Rightarrow \tan\theta_2 = \sqrt{3}$$

$$\Rightarrow \theta_2 = 60°$$

So, the phase difference = 90 + 60 = 150°

If R_2 is 20 kΩ, then the phase difference = 60 + 30 = 90°

Answer: (3).

4. Mean free path of a gas molecule is

$$\lambda = \frac{1}{\sqrt{2}\pi n d^2} \quad (1)$$

where n = number of molecules per unit volume

$$n = \frac{N}{V}$$

$$\Rightarrow \lambda = \frac{v_{av} \times t}{N} \quad (2)$$

From Eq. (1) and Eq. (2), we get

$$\frac{v_{av} \times t}{N} = \frac{1}{\sqrt{2}\pi \frac{N}{V} d^2}$$

$$\Rightarrow t = \frac{V}{\sqrt{2}\pi d^2 v_{av}} \quad (3)$$

As we know that

$$v_{av} = \sqrt{\frac{8kT}{\pi m}}$$

$$\Rightarrow v_{av} \propto \sqrt{T} \quad (4)$$

From Eq. (3) and Eq. (4), we get

$$t = \frac{V}{\sqrt{2}\pi d^2 \sqrt{T}}$$

$$\Rightarrow t \propto \frac{V}{\sqrt{T}}$$

Equation of ideal gas is

$$PV = nRT$$

$$\Rightarrow V = \frac{nRT}{P}$$

$$\Rightarrow t \propto \frac{\sqrt{T}}{P}$$

$$\Rightarrow \frac{t_2}{t_1} = \sqrt{\frac{T_2}{T_1}} \times \frac{P_1}{P_2}$$

$$\Rightarrow \frac{t_1}{6 \times 10^{-8}} = \sqrt{\frac{500}{300}} \times \frac{2}{4}$$

$$\Rightarrow t_1 = \sqrt{\frac{500}{300}} \times \frac{2}{4} \times 6 \times 10^{-8}$$

$$\Rightarrow t_1 = 3.87 \times 10^{-8} \text{ s} = 4 \times 10^{-8} \text{ s}$$

Answer: (2).

5. For output, at saturation, $V_{CE} = 0$

In CE circuit we have

$$V_{CC} - I_C R_C = V_{CE}$$

$$\Rightarrow V_{CC} - I_C R_C = 0$$

$$\Rightarrow I_C = \frac{V_{CC}}{R_C}$$

$$= \frac{5}{1 \times 10^3} = 5 \times 10^{-3} \text{ A}$$

Now,

$$\beta = \frac{I_C}{I_B}$$

$$\Rightarrow I_B = \frac{I_C}{\beta}$$

$$= \frac{5 \times 10^{-3}}{200}$$

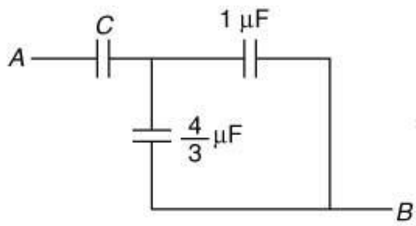
$$\Rightarrow I_B = 25 \ \mu\text{A}$$

At input side in BE circuit

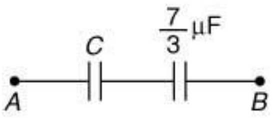
$$V_{BB} = I_B R_B + V_{BE}$$
$$= 25 \times 10^{-6} \times 100 \times 10^3 + 1$$
$$\Rightarrow V_{BB} = 3.5 \text{ V}$$

Answer: (1).

6. From given circuit



$\Rightarrow$



$$C_{eff} = \frac{C \times \frac{7}{3}}{C + \frac{7}{3}}$$

$$\Rightarrow \frac{1}{2} = \frac{\frac{7C}{3}}{\frac{7}{3} + C}$$

$$\Rightarrow \frac{7}{3} + C = \frac{14C}{3}$$

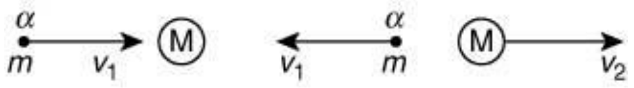
$$\Rightarrow \frac{7 + 3C}{3} = \frac{14C}{3}$$

$$\Rightarrow 7 + 3C = 14C$$

$$\Rightarrow C = \frac{7}{11} \mu\text{F}$$

Answer: (1).

7.



Applying law of conservation of momentum before collision,

$$mu_1 + 0 = -mv_1 + Mv_2$$
$$\Rightarrow mu_1 = -mv_1 + Mv_2 \quad (1)$$

Since, α-particle is scattered in backward thus, losing 64% of initial energy.

$$\frac{1}{2}mv_1^2 = 36\% \text{ of } \frac{1}{2}mu_1^2$$

$$\Rightarrow \frac{1}{2}mv_1^2 = \frac{36}{100} \times \frac{1}{2}mu_1^2$$

$$\Rightarrow v_1^2 = \frac{36}{100}u_1^2$$

$$\Rightarrow v_1 = 0.6u_1 \quad (2)$$

Now, coefficient of restitution

$$e = \frac{v_2 + v_1}{u_1}$$

$$\Rightarrow 1 = \frac{v_2 - v_1}{u_1}$$

$$\Rightarrow u_1 = v_2 - v_1$$

$$\Rightarrow v_2 = u_1 - v_1 \quad (3)$$

Thus,

$$mu_1 = -m(0.6)u_1 + M(u_1 - v_1)$$

$$= -m(0.6)u_1 + M(u_1 - 0.6u_1)$$

$$\Rightarrow mu_1 = -m(0.6)u_1 + M(0.4)u_1$$

$$\Rightarrow mu_1 = + m(0.6)u_1 = M(0.4)u_1$$

$$\Rightarrow 1.6m = 0.4M$$

$$\Rightarrow M = 4m$$

Answer: (4).

8. Induced emf = $Bvl\sin\theta$

Since, $\theta = 45°$

$$\varepsilon = (0.3 \times 10^{-4}) \times (5) \times (10) \times \frac{1}{\sqrt{2}}$$

$$= 1.06 \times 10^{-3} \text{ V} = 1.1 \times 10^{-3} \text{ V}$$

Answer: (2).

9. Let d be the cover range of TV tower

Covering Range, $d = \sqrt{2hR}$

$$d \propto \sqrt{h}$$

Thus,

$$\frac{d_1}{d_2} = \frac{\sqrt{h_1}}{\sqrt{h_2}}$$

Squaring both the sides, we get

$$\frac{d_1^2}{d_2^2} = \frac{h_1}{h_2}$$

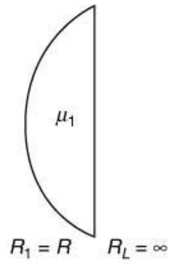
$$\Rightarrow h_2 = h_1\left(\frac{d_2}{d_1}\right)^2$$

$$= h_1\left(\frac{2d}{d}\right)^2$$

$$\Rightarrow h_2 = 4h_1$$

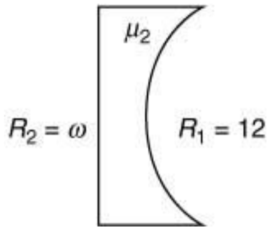
Answer: (3).

10. For Plano Convex Lens



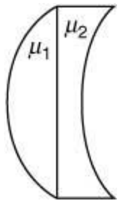
$$\frac{1}{f_1} = (\mu_1 - 1)\left[\frac{1}{-R} - \frac{1}{\infty}\right] \quad (1)$$

For Plano Concave Lens



$$\frac{1}{f_2} = (\mu_2 - 1)\left[\frac{1}{R} - \frac{1}{\infty}\right] \qquad (2)$$

When both the lens are combined



$$\frac{1}{f_{eq}} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\Rightarrow \frac{1}{f_{eq}} = \frac{\mu_1 - 1}{-R} + \frac{\mu_2 - 1}{R}$$

$$\Rightarrow \frac{1}{f_{eq}} = \frac{-\mu_1 + 1 + \mu_2 - 1}{R}$$

$$\Rightarrow \frac{1}{f_{eq}} = \frac{\mu_2 - \mu_1}{R}$$

$$\Rightarrow f_{eq} = \frac{R}{\mu_2 - \mu_1}$$

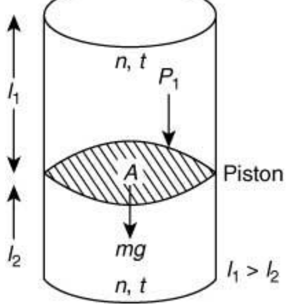
Answer: (2).

11. Let A be the area of the piston.

Since, the cylinder exert more pressure (P_2) on the lower part of the cylinder, ($l_1 > l_2$)

$$P_2A = P_1A + mg$$

$$\Rightarrow P_2 = P_1 + \frac{mg}{A}$$



We know that

$$PV = nRT$$

$$\Rightarrow P = \frac{nRT}{V}$$

Thus,

$$\frac{nRT}{Al_1} = \frac{nRT}{Al_2} + \frac{mg}{A} \qquad \text{[Volume = Area × length]}$$

$$\Rightarrow \frac{mg}{A} = \frac{nRT}{Al_2} - \frac{nRT}{Al_1}$$

$$\Rightarrow \frac{mg}{A} = \frac{nRT}{A}\left[\frac{1}{l_2} - \frac{1}{l_1}\right]$$

$$\Rightarrow mg = nRT\left[\frac{l_1 - l_2}{l_1 l_2}\right]$$

$$\Rightarrow m = \frac{nRT}{g}\left[\frac{l_1 - l_2}{l_1 l_2}\right]$$

Answer: (4).

12. Kinetic energy, $T = \frac{1}{2}mv^2$

We know that orbital velocity is

$$v = \sqrt{\frac{GM_E}{R}}$$ [M_E = mass of Earth]

Then $$T = \frac{1}{2}m\frac{GM_E}{R}$$

Now, kinetic energy for satellite A

$$T_A = \frac{GM_E m}{2R}$$

Kinetic energy for satellite B

$$T_B = \frac{GM_E(2m)}{2(2R)}$$

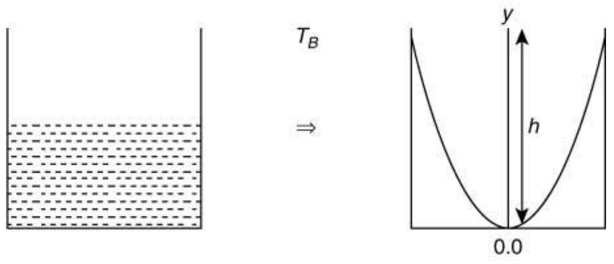
Therefore, ratio of KE is

$$\frac{T_A}{T_B} = \frac{\frac{GmM_E}{2R}}{\frac{GM_E \times 2m}{2 \times 2R}}$$

$$\Rightarrow \frac{T_A}{T_B} = 1$$

Answer: (2).

13.



$$h = \frac{\omega^2 r^2}{2g}$$ ($\omega = 2\pi f$)

$$= \frac{(2\pi f)^2 r^2}{2g}$$

$$\Rightarrow h = \frac{4\pi^2 f^2 r^2}{2g}$$

Given f = 2 rps; $r = 5 \times 10^{-2}$ m; g = 10 m/s^2

Therefore, $$h = \frac{4 \times (3.14)^2 \times 4 \times 25 \times 10^{-4}}{2 \times 10}$$

$$= 2 \times 10^{-2} \text{ m} = 2 \text{ cm}$$

Answer: (1).

14. Block is at rest then, 2 N force is applied.

$$R_1 = mg \cos \theta$$

$$\Rightarrow R_1 = \frac{\sqrt{3}}{2} mg$$

Now, friction is

$$f = \mu R_1$$

$$\Rightarrow f = \frac{\sqrt{3}}{2} \mu mg$$

When 2 N force is applied in downward direction, thus

$$2 + mg \sin 30° = f$$

$$\Rightarrow f - \frac{mg}{2} = 2$$

$$\Rightarrow \frac{\sqrt{3}}{2} \mu mg - \frac{mg}{2} = 2 \qquad (1)$$

Block is rest (10 N force is applied)

$$R_2 = mg \cos 30°$$

$$\Rightarrow R_2 = \frac{\sqrt{3} mg}{2}$$

When 10 N force is applied in upward direction, then

$$mg \sin 30° + f = 10$$

$$\Rightarrow \frac{mg}{2} + \frac{\sqrt{3}}{2} \mu mg = 10 \qquad (2)$$

Dividing Eq. (1) by Eq. (2), we get

$$\frac{\frac{\sqrt{3}}{2} \mu mg - \frac{mg}{2}}{\frac{mg}{2} + \frac{\sqrt{3}}{2} \mu mg} = \frac{2}{10}$$

$$\Rightarrow \frac{\frac{mg}{2}(\sqrt{3}\mu - 1)}{\frac{mg}{2}(\sqrt{3}\mu + 1)} = \frac{1}{5}$$

$$\Rightarrow (\sqrt{3}\mu - 1) \times 5 = (\sqrt{3}\mu + 1) \times 1$$

$$\Rightarrow 5\sqrt{3}\mu - 5 = \sqrt{3}\mu + 1$$

$$\Rightarrow 5\sqrt{3}\mu - \sqrt{3}\mu = 1 + 5$$

$$\Rightarrow 4\sqrt{3}\mu = 6$$

$$\Rightarrow \mu = \frac{6}{4\sqrt{3}} = \frac{3}{2\sqrt{3}}$$

$$\Rightarrow \mu = \frac{\sqrt{3}}{2}$$

Answer: (1).

15. In Frank-Hertz experiment

$$E(\text{eV}) = \frac{12400}{\lambda}$$

$$\Rightarrow \lambda = \frac{12400}{5.6 - 0.7}$$

$$\Rightarrow \lambda = \frac{12400}{4.9}$$

$$= 2530 \text{ Å} = 253 \text{ nm} \approx 250 \text{ nm}$$

Answer: (4).

16. According to the conservation of energy

$$\frac{1}{2}mv_1^2 + hmg = \frac{1}{2}mv_2^2$$

Given, h = 10 m; v_1 = 5 m; g = 10

$$m\left(\frac{1}{2}v_1^2 + hg\right) = \frac{1}{2}mv_2^2$$

$$\Rightarrow \frac{1}{2}(5)^2 + 10 \times 10 = \frac{1}{2}v_2^2$$

$$\Rightarrow \frac{25}{2} + 100 = \frac{1}{2}v_2^2$$

$$\Rightarrow 225 = v_2^2$$

$$\Rightarrow v_2^2 = \sqrt{225}$$

Angular momentum at point B about point O is

$$L = mrv \qquad (r = h + a)$$

$$= mv_2(h + a)$$

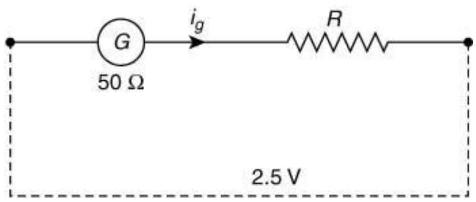
$$= 20 \times 10^{-3} \times 15 \times 20 = 6 \text{ kg m}^2/\text{s}$$

Answer: (3).

17. Current flowing through galvanometer is

$$I_g = 4 \times 10^{-4} \times 25$$

$$= 10^{-2} \text{ A}$$



Now,

$$2.5 = (50 + R) \times I_g \qquad [V = IR]$$

$$\Rightarrow 2.5 = (50 + R) \times 10^{-2}$$

$$\Rightarrow 2.5 \times 10^2 = 50 + R$$

$$\Rightarrow 250 = 50 + R$$

$$\Rightarrow R = 200 \ \Omega$$

Answer: (2).

18. Pressure difference in water droplet is

$$\Delta P = \frac{2T}{R}$$

where R is the radius of drop and T is temperature.
Since, volume increases with time at constant rate

$$V = Ct$$

$$\Rightarrow \frac{4}{3}\pi R^3 = Ct$$

$$\Rightarrow R^3 \propto t$$

$$\Rightarrow R \propto t^{1/3}$$

$$\Rightarrow R = kt^{1/3}$$

where k = constant

Now,

$$P = P_0 + \frac{4T}{kt^{1/3}}$$

$$\Rightarrow P = P_0 + C\left(\frac{1}{t^{1/3}}\right)$$

Therefore, option (4) is correct.

Answer: (4).

19. From using KCL at point S

$$I_5 + I_3 = I_4$$

$$\Rightarrow I_3 = 0.8 - 0.4$$

$$\Rightarrow I_3 = 0.4 \text{ A} \qquad (1)$$

At point P

$$I_5 = I_6 = 0.4 \text{ A} \qquad (2)$$

At point Q

$$I_3 + I_6 = I_1 + I_2$$

$$\Rightarrow I_2 = I_3 + I_6 - I_1$$

$$= 0.4 + 0.4 - (-0.3)$$

$$= 0.4 + 0.4 + 0.3 = 1.1 \text{ A}$$

Answer: (2).

20. Let f be the frequency

For f = 512 Hz, marked 11 cm below reference mark

$$11\,\text{cm} + e = \frac{\lambda_1}{4}$$

$$\Rightarrow 11\,\text{cm} + e = \frac{v}{512 \times 4} \qquad (1)$$

For f = 256 Hz marked 27 cm below reference mark

$$27\text{ cm} + e = \frac{\lambda_2}{4}$$

$$\Rightarrow 27\text{ cm} + e = \frac{v}{256 \times 4} \qquad (2)$$

From Eq. (1) and Eq. (2), we get

$$(27 - 11) \times 10^{-2} = \frac{v}{256 \times 4}\left[1 - \frac{1}{2}\right]$$

$$\Rightarrow 16 \times 10^{-2} = \frac{v}{256 \times 4} \times \frac{1}{2}$$

$$\Rightarrow v = 16 \times 10^{-2} \times 256 \times 4 \times 2 = 328 \text{ m/s}$$

Answer: (4).

21. As we know that relation between temperature and susceptibility is

$$\chi \propto \frac{1}{T_C}$$

where, T_C = Curie's Temperature

$$\Rightarrow \frac{\chi_1}{\chi_2} = \frac{T_{C_2}}{T_{C_1}}$$

$$\Rightarrow \frac{2.8 \times 10^{-4}}{\chi_2} = \frac{300}{350}$$

$$\Rightarrow \chi_2 = \frac{2.8 \times 350 \times 10^{-4}}{300}$$

$$= 3.266 \times 10^{-4} \approx 3.267 \times 10^{-4}$$

Answer: (1).

22. We have,

$${}^{232}_{90}Th \xrightarrow{6\alpha} {}^{208}_{78}Y + {}^{4}_{2}He$$

$${}^{208}_{78}Y \longrightarrow {}^{208}_{82}Y + 4\beta \text{ (Particle)}$$

Hence $Z = 82$, $A = 208$ and element is Pb.

Answer: (3).

23. Dimension of inductance = $[M^1L^2T^{-2}A^{-2}] = [l]$

Dimension of capacitance = $[M^{-1}L^{-2}T^4A^2] = [c]$

Dimension of resistance = $[M^1L^2T^{-3}A^{-2}] = [r]$

Dimension of voltage = $[M^1L^2T^{-3}A^{-1}] = [v]$

$$\text{Dimension of } \frac{l}{rcv} = \frac{[M^1L^2T^{-2}A^{-2}]}{[M^{-1}L^2T^4A^2][M^1L^2T^{-3}A^{-2}][M^1L^2T^{-3}A^{-1}]}$$

$$= \frac{[ML^2T^{-2}A^{-2}]}{[ML^2T^{-2}A^{-1}]}$$

$$= [A^{-1}]$$

Answer: (2).

24. Focal length

$$F = (\mu - 1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Since, whole set up is immersed in water without disturbing the object and screen position. Thus, focal length of lens will change hence image disappear from the screen.

Answer: (1).

25. Energy of incident photon is

$$E = W_0 + e\left(\frac{V_0}{2}\right)$$

$$h\nu = W_0 + \frac{eV_0}{2} \quad (1)$$

$$\frac{h\nu}{2} = W_0 + eV_0 \quad (2)$$

From Eq. (1) and Eq. (2), we get

$$W_0 = \frac{-3}{2}h\nu$$

$$\Rightarrow h\nu_0 = \frac{-3}{2}h\nu$$

$$\Rightarrow \nu_0 = \frac{-3\nu}{2}$$

Answer: (4).

26. We have

$$y = 5(\sin 3\pi t + \sqrt{3}\cos 3\pi t)$$

$$= 5\sin 3\pi t + 5\sqrt{3}\cos 3\pi t \quad (1)$$

Let

$$5 = A\cos\theta \quad (2)$$

$$5\sqrt{3} = A\sin\theta \quad (3)$$

By squaring and adding Eq. (2) and Eq. (3), we get

$$A^2(\cos^2\theta + \sin^2\theta) = (5)^2 + (5\sqrt{3})^2$$

$$\Rightarrow A^2 = 100$$

$$\Rightarrow A = 10 \text{ cm}$$

Substituting the value of Eq. (2) and Eq. (3) in Eq. (1), we have

$$y = A\cos\theta \sin 3\pi t + A\sin\theta\cos 3\pi t$$

$$\Rightarrow y = A\sin(3\pi t + \theta) \quad (4)$$

$$\Rightarrow y = 10\sin(3\pi t + \theta)$$

General wave equation is

$$y = a\sin(\omega t + kx)$$

On comparing with Eq. (4), we get

$$\omega = 3\pi$$

$$\Rightarrow \frac{2\pi}{T} = 3\pi$$

$$\Rightarrow T = \frac{2}{3}\text{s}$$

Answer: (1).

27. Both the particles rotating with same angular speed in opposite direction

$$\theta = \omega t$$

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

$$\Rightarrow \theta = \frac{\pi}{2}$$

After $\frac{\pi}{2}$ rotation their velocities will be

$$v_A = R_1\omega(-\hat{i})$$

$$v_B = R_2\omega(-\hat{i})$$

Therefore,

$$v_A - v_B = R_1\omega(-\hat{i}) - R_2\omega(-\hat{i})$$

$$= (R_2 - R_1)\omega(\hat{i})$$

Answer: (3).

28. Intensity of EM wave is

$$I = \frac{1}{2}\varepsilon_0 E^2 c$$

$$\Rightarrow I = \varepsilon_0 c E_{\text{rms}}^2$$

As we know that

$$E_{\text{rms}} = cB_{\text{rms}}$$

So,

$$I = \varepsilon_0 c^3 B_{\text{rms}}^2$$

$$\Rightarrow B_{\text{rms}} = \sqrt{\frac{I}{\varepsilon_0 c^3}}$$

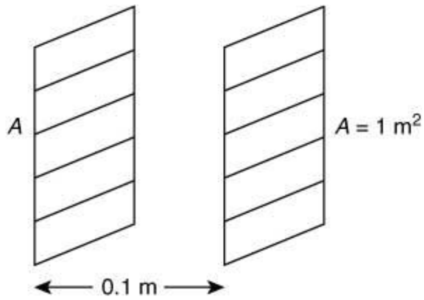
$$= \sqrt{\frac{10^8}{8.35 \times 10^{-12} \times (3 \times 10^8)^3}}$$

$$= 10^{-4}\ \text{T}$$

Answer: (4).

29. By Gauss law electric field is

$$E = \frac{\sigma}{\varepsilon_0} = \frac{Q}{A\varepsilon_0}$$



Charge on plate, $Q = A\varepsilon_0 E$

$= 1 \times 8.85 \times 10^{-12} \times 100$

$= 8.85 \times 10^{-10}$ C

Answer: (3).

30. Slope of *q*-*t* graph gives current

$$I = \frac{dq}{dt}$$

At $t = 4$ s, slope is zero.

Hence, current at 4 s will be zero.

Answer: (1).

Section: Chemistry

31. Moles of NaOH $= \frac{8}{40} = \frac{1}{5}$

Moles of H_2O $= \frac{18}{18} = 1$

Mole fraction of NaOH is solution $x_{NaOH} = \frac{\frac{1}{5}}{\frac{1}{5}+1}$

$$= \frac{1}{5} \times \frac{5}{6} = \frac{1}{6} = 0.167$$

Molality of solution $= \frac{no.\ of\ moles\ of\ NaOH}{mass\ of\ solvent\ in\ kg}$

$$= \frac{\frac{1}{5}\times 1000}{18}$$

$$= \frac{1000}{90} = \frac{100}{9} = 11.11\, mol\ kg^{-1}$$

Answer: (3).

32. Homoleptic complex of Mn(II) means only one type of ligand is present.
Since, magnetic moment is 5.9 B.M.

$$\mu_{\text{spin}} = \sqrt{n(n+2)}$$

$$5.9 = \sqrt{n(n+2)}$$

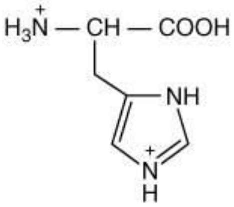
$$n = 5$$

Five unpaired electrons are present which is only possible in case of weak field ligand that is, NCS^-.
Answer: (3).

33. Pd does not show catenation due to metallic character.
Answer: (4).

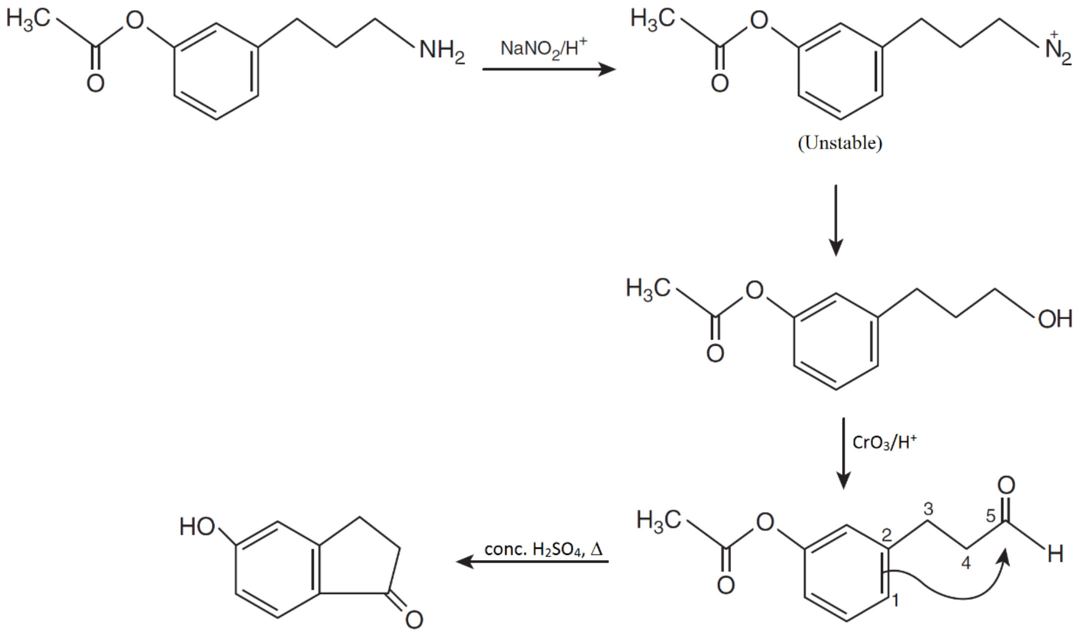
34. Latex is a colloidal solution of rubber particles which are negatively charged.
Answer: (4).

35. At pH = 2, H^+ ion concentration is high, therefore structure of histidine is



Answer: (3).

36. The reaction involved is



Answer: (1).

37. Molar conductance at infinite dilution for HA

$$\Lambda_m^\infty = \lambda_{HCl^+} + \lambda_{NOA} - \lambda_{NaCl}$$

$$= 425.9 + 100.5 - 126.4$$

$$= 526.4 - 126.4$$

$$= 400 \text{ S cm}^2 \text{ mol}^{-1}$$

Given, conductivity $(\kappa)_{HA} = 5 \times 10^{-5}$ S cm^{-1}

$$\Rightarrow \Lambda_m = \frac{\kappa \times 1000}{M}$$

$$= \frac{5 \times 10^{-5} \times 1000}{0.001}$$

$$= 50 \text{ S cm}^2 \text{ mol}^{-1}$$

Now, degree of dissociation $(\alpha) = \frac{\Lambda_m}{\Lambda_m^\infty} = \frac{50}{400} = 0.125$

Answer: (3).

38. Degree of association for benzoic acid

$$\alpha = \frac{i-1}{\frac{1}{n}-1}$$

$$2C_6H_5COOH \rightleftharpoons (C_6H_5COOH)_2$$

Therefore, $n = 2$

$\alpha = 80\%$ (given)

$$\Rightarrow \frac{80}{100} = \frac{i-1}{\frac{1}{2}-1}$$

$$i = 0.6$$

Now,

$$\Delta T_f = i \times K_f \times \frac{w \times 1000}{M \times \text{mass of solvent in g}}$$

$$2 = \frac{0.6 \times w \times 1000}{122 \times 30}$$

$$w = 2.4 \text{ g}$$

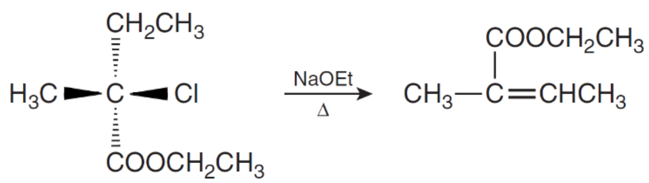
Answer: (1).

39. The reaction involved is

$$3Cl_2(aq) + \underset{(Hot,\ concentrated)}{6NaOH(aq)} \longrightarrow 5NaCl(aq) + NaClO_3(aq) + 3H_2O(l)$$

Answer: (1).

40. In presence of strong base like sodium ethoxide, elimination product obtained rather than substitution product.

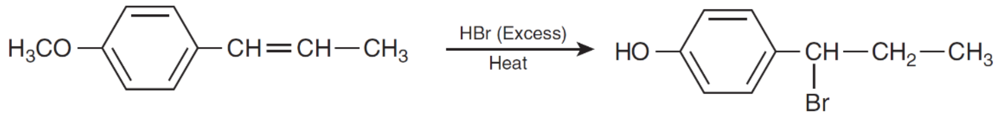


Answer: (2).

41. For isothermal expansion pV = constant that is, graph A and $p = \frac{\text{const.}}{V}$ that is, graph C.

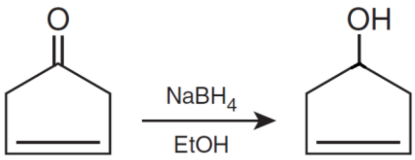
Answer: (1).

42. The reaction is



Answer: (3).

43. Since $NaBH_4$ is a weak reducing agent, so it will not affect double bond, but can reduce ketones/aldehydes to corresponding alcohols.



Answer: (2).

44. Lanthanoids have greater atomic radii than second period elements, therefore, nitrogen have smallest radius than among given. In lanthanoids moving across period size of the elements decreases, but Eu(exception) has greater radius than its follow lanthanoids. Therefore, correct order of atomic radii is

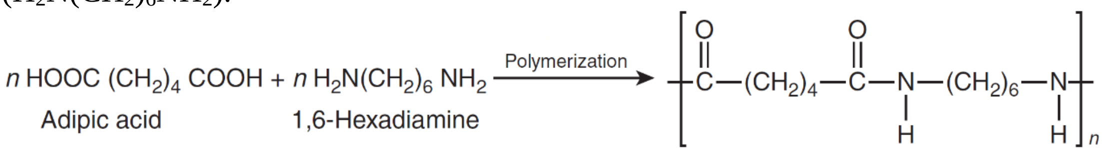
Eu > Ce > Ho > N.

Answer: (4).

45. Carbon shows greater ability to form $p\pi - p\pi$ multiple bonds.

Answer: (2).

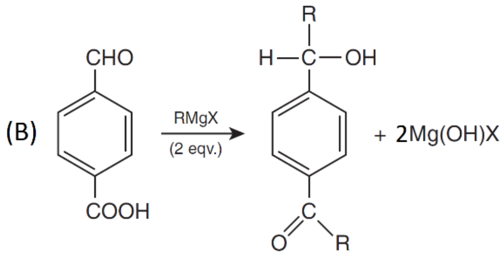
46. Monomers of nylon-6.6 are adipic acid ($HOOC(CH_2)_4COOH$) and 1,6-hexadiamine ($H_2N(CH_2)_6NH_2$).

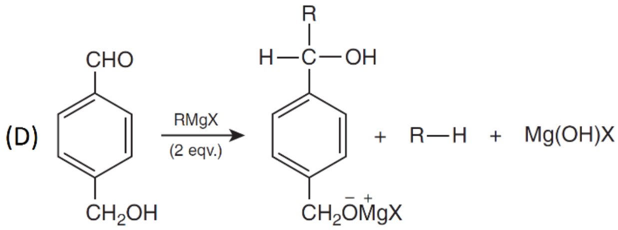


Nylon-6,6

Answer: (1).

47. Aldehyde consume one equivalent of Grignard reagents, apart from that, alcohols and carboxylic acids also react with Grignard’s reagent.





Answer: (1).

48. $C(graphite) + O_2(g) \rightarrow CO_2(g); \Delta_r H^o = x \text{ kJ mol}^{-1}$ (1)

$C(graphite) + \frac{1}{2}O_2(g) \rightarrow CO_2(g); \Delta_r H^o = y \text{ kJ mol}^{-1}$ (2)

$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g); \Delta_r H^o = z \text{ kJ mol}^{-1}$ (3)

Adding Eq. (2) and (3), we get

$C(graphite) + \frac{1}{2}O_2(g) \rightarrow CO_2(g); \Delta_r H^o = y \text{ kJ mol}^{-1}$

$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g); \Delta_r H^o = z \text{ kJ mol}^{-1}$

$C(graphite) + \frac{1}{2}O_2(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g); \Delta_r H^\circ = (y+z) \text{ kJ mol}^{-1}$

Or

$C(graphite) + O_2(g) + \rightarrow CO_2(g); \Delta_r H^\circ = (y+z) \text{ kJ mol}^{-1}$

Answer: (1).

49. Normality = n-factor × Molarity

Therefore, $N = 2 \times 1 = 2$ N [n-factor to $H_2O_2 = 2$]

Now, Volume strength = Normality × 5.6

= 2 × 5.6 = 11.2

Answer: (3).

50. Potassium ion activates many enzymes in the complex reactions in plants and participate in the oxidation of glucose to produce ATP. Potassium ions along with sodium ions is responsible for transmission of nerve signals in the body.

Answer: (3).

51. Freon or chlorofluorocarbons are the not a common component of photochemical smog.

Answer: (4).

52. From the plot, slope = −4606 K

Now,

$$\ln \frac{k_1}{k_2} = \frac{E_a}{R}\left[\frac{T_1 - T_2}{T_1 T_2}\right] \qquad (1)$$

T_1 = 400 K
T_2 = 500 K
$k_1 = 10^{-5}\ s^{-1}$
k_2 =?
Substituting all values in Eq. (1), we get

$$\ln\left(\frac{10^{-5}}{k_2}\right) = -4606\left[\frac{400-500}{400 \times 500}\right]$$

$$\log\left(\frac{10^{-5}}{k_2}\right) = \frac{-4606}{2.303} \times \frac{-100}{200000}$$

On solving, we get

$$\log 10^{-5} - \log k_2 = 1$$
$$-5 - \log k_2 = 1$$
$$\log k_2 = -4$$
$$k_2 = 10^{-4}\ s^{-1}$$

Answer: (3).

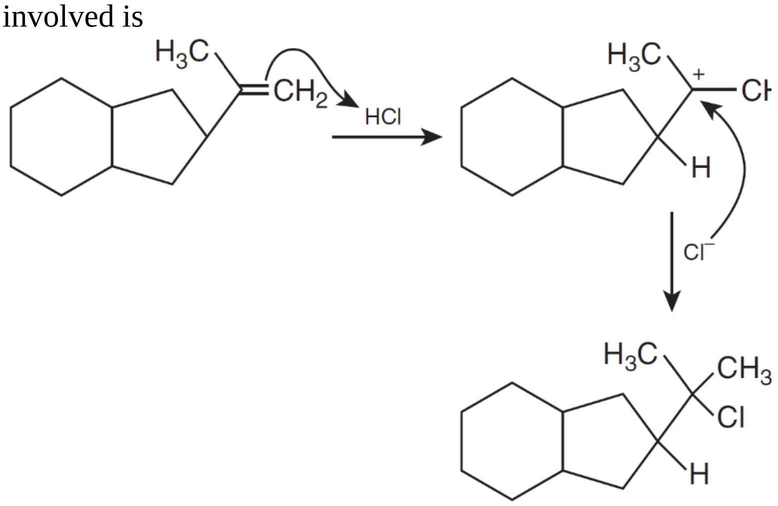
53. As $\frac{2}{5}$ air escape i.e. $\frac{3}{5}$ air remains in the vessel and volume is kept constant i.e. pV = constant
Therefore

$$n_1 T_1 = n_2 T_2$$
$$n_1 \times 300 = \left(\frac{3}{5} n_1\right) \times T_2$$
$$T_2 = 500\ \text{K}$$

Where $\left[\begin{array}{l} n_1 = \text{initial moles of air} \\ n_2 = \text{final moles of air} \\ n_2 = \frac{3}{5} n_1 \end{array}\right]$

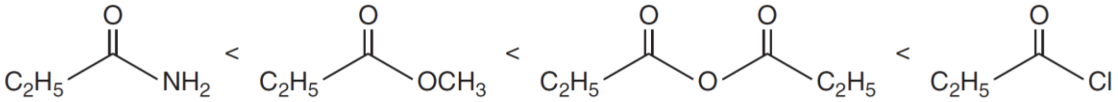
Answer: (2).

54. The reaction involved is



Answer: (4).

55. Acid chlorides is the most reactive among due to stability of the Cl^- ions by dispersion of negative charge on large chloride ion and amides is the least reactive due to the delocalization of lone pair of $-\ddot{N}H_2$ with carboxyl. Therefore, correct increasing reactivity order with $LiAlH_4$ is

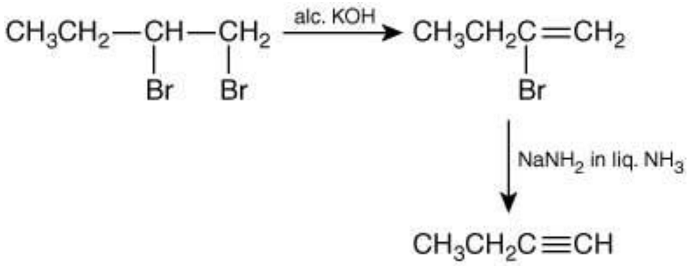


Answer: (3).

56. Magnesium is the high in relativity series, so it does not require calcination and $ZnCO_3$ require calcination to form ZnO.

Answer: (1).

57. The reaction involved is



Answer: (4).

58. $\underset{}{Ag_2CO_3} \rightarrow \underset{2S}{2Ag^+} + \underset{S}{CO_3^{2-}}$

In 0.1 M $AgNO_3$

Concentration of $Ag^+ = 2S + 0.1$

Now,

$$K_{sp(Ag_2CO_3)} = (2S + 0.1)^2 S \quad (1)$$

On solving Eq. (1), we get

$S = 8.0 \times 10^{-10}$ M

Answer: (3).

59. In upper stratosphere radius of the Sun's that fall in the region of wavelength of 200 – 315 nm.

Answer: (1).

60. According to de Broglie hypothesis

$$2\pi a_0 = n\lambda = \frac{n^2}{Z} \qquad (a_0 = \text{Bohr radius})$$

$$2\pi a_0 = n \times 1.5\pi a_0 \qquad (\lambda = 1.5\pi a_0 \text{ given})$$

$$\frac{n}{Z} = \frac{1.5}{Z} = 0.75$$

Answer: (4).

Section: Mathematics

61. We have

$$\lim_{x\to 1^-}\frac{\sqrt{\pi}-\sqrt{2\sin^{-1}x}}{\sqrt{1-x}}\times\frac{\sqrt{\pi}+\sqrt{2\sin^{-1}x}}{\sqrt{\pi}+\sqrt{2\sin^{-1}x}}$$

$$\lim_{x\to 1^-}\frac{2\left(\frac{\pi}{2}-\sin^{-1}x\right)}{\sqrt{1-x}(\sqrt{\pi}+\sqrt{2\sin^{-1}x})}$$

$$\lim_{x\to 1^-}\frac{2\cos^{-1}x}{\sqrt{1-x}}.\frac{1}{2\sqrt{\pi}}$$

Put $x = \cos\theta$

$$\lim_{\theta\to 0^+}\frac{2\theta}{\sqrt{2}\sin(\theta/2)}.\frac{1}{2\sqrt{\pi}}=\sqrt{\frac{2}{\pi}}$$

Answer: (2).

62.

$$\frac{f'(x)}{f(x)}=1\ \forall\ x\in\mathrm{R}$$

After Integration

$$f(x)=2e^{x-1}\Rightarrow f'(x)=2e^{x-1} \qquad \text{(Since } f(1)=2\text{)}$$

$$\Rightarrow h(x) = f(f(x))$$

$$h'(x)= f'(f(x))f'(x)$$

$$h'(1)= f'(f(1))f'(1) = f'(2)f'(1) \qquad \text{(Since } f'(x)=2e^{x-1}\text{)}$$

$$\Rightarrow h'(1)=2e.2$$

$$\Rightarrow h'(1)=4e$$

Answer: (2).

63.

$$\int_1^e\left\{\left(\frac{x}{e}\right)^{2x}-\left(\frac{e}{x}\right)^{x}\right\}\log_e x.dx$$

$$=\int_1^e\left(\frac{x}{e}\right)^{2x}\log_e x.dx-\int_1^e\left(\frac{e}{x}\right)\log_e x.dx$$

Let $\left(\frac{x}{e}\right)^{2x}=t,\quad \left(\frac{e}{x}\right)^{x}=v$

$$=\frac{1}{2}\int_{\left(\frac{1}{e}\right)^2}^{1}dt+\int_e^1 dv$$

$$=\frac{1}{2}\left(1-\frac{1}{e^2}\right)+(1-e)$$

$$=\frac{1}{2}-\frac{1}{2e^2}+1-e=\frac{3}{2}-\frac{1}{2e^2}-e$$

Answer: (4).

64.

$$(\vec{a}.\vec{c}).\vec{b}-(\vec{a}.\vec{b}).\vec{c}=\frac{1}{2}\vec{b}$$

Since, $\vec{b}$ and $\vec{c}$ are non-parallel. Thus,

$$\vec{a}\cdot\vec{c}=\frac{1}{2} \text{ and, } \vec{a}.\vec{b}=0$$

All given vectors are unit vectors.

$\vec{a}\wedge\vec{c}=60^\circ$ and $\vec{a}\wedge\vec{b}=90^\circ$

$$\Rightarrow |\alpha-\beta|=30^\circ$$

Answer: (1).

65. We have

$$I=\int\frac{3x^{13}+2x^{11}}{(2x^4+3x^2+1)^4}dx$$

$$I=\int\frac{\left(\frac{3}{x^3}+\frac{2}{x^5}\right)dx}{\left(2+\frac{3}{x^2}+\frac{1}{x^4}\right)^4}$$

Let $\left(2+\frac{3}{x^2}+\frac{1}{x^4}\right)=t$

Thus, $-\frac{1}{2}\int\frac{dt}{t^4}=\frac{1}{6t^3}+C$

$$I=\frac{x^{12}}{6(2x^4+3x^2+1)^3}+C$$

Answer: (2).

66. As we know that, A.M. $\geq$ G.M

$$\frac{\sin^4\alpha+4\cos^4\beta+1+1}{4}\geq\sin^4\alpha.4\cos^4\beta.1.1)^{1/4}$$

$$\Rightarrow \sin^4\alpha+4\cos^4\beta+2\geq4\sqrt{2}\sin\alpha\cos\beta$$

It is given $\sin^4\alpha+4\cos^4\beta+2=4\sqrt{2}\sin\alpha\cos\beta$

$$\Rightarrow \text{A.M.} = \text{G.M.} \Rightarrow \sin^4\alpha = 1 = 4\cos^4\beta$$

$$\Rightarrow \sin\alpha=1, \cos\beta=\pm\frac{1}{\sqrt{2}}$$

$$\Rightarrow \sin\beta=\frac{1}{\sqrt{2}} \text{ as } \beta\in(0,\pi)$$

Therefore, $\cos(\alpha+\beta)-\cos(\alpha-\beta)=-2\sin\alpha\sin\beta=-\sqrt{2}$

Answer: (4).

67. We have

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

$$\Rightarrow \frac{dy}{dx}+2\frac{y}{x}=x$$

$$\text{I.F}=e^{\int\frac{2}{x}dx}=x^2$$

So, $$y.x^2=\int x.x^2dx+C$$

$$=\frac{x^4}{4}+C$$

Thus, it passes through $(1,-2)$ $\Rightarrow C=\frac{-9}{4}$

$$yx^2 = \frac{x^4}{4} - \frac{9}{4} = \frac{x^4 - 9}{4}$$

$$\Rightarrow y = \frac{x^4 - 9}{4x^2}$$

Hence, it passes through $(\sqrt{3}, 0)$.

Answer: (2).

68. Denominators of line are 2, 1, −2. Normal vector of plane is $\hat{i} - 2\hat{j} - k\hat{k}$.

$$\sin\alpha = \frac{(2\hat{i} + \hat{j} - 2\hat{k}).(\hat{i} - 2\hat{j} - k\hat{k})}{3\sqrt{1+4+k^2}}$$

$$\Rightarrow \sin\alpha = \frac{2k}{3\sqrt{k^2+5}} \quad (1)$$

$$\Rightarrow \cos\alpha = \frac{2\sqrt{2}}{3} \quad (2)$$

By squaring Eq. (1) and Eq. (2), we have

$$\sin^2\alpha = \left(\frac{2k}{3\sqrt{k^2+5}}\right)^2, \cos^2\alpha = \left(\frac{2\sqrt{2}}{3}\right)^2$$

Adding above expressions, we get

$$\Rightarrow \sin^2\alpha + \cos^2\alpha = \left(\frac{2k}{3\sqrt{k^2+5}}\right)^2 + \left(\frac{2\sqrt{2}}{3}\right)^2$$

(Since $\sin^2\alpha + \cos^2\alpha = 1$)

$$k^2 = \frac{5}{3}$$

$$\Rightarrow k = \sqrt{\frac{5}{3}}$$

Answer: (1).

69.

$$\lim_{x\to\infty}\sum_{r=1}^{2n}\frac{n}{n^2+r^2}$$

$$\lim_{x\to\infty}\sum_{r=1}^{2n}\frac{1}{n\left(1+\frac{r^2}{n^2}\right)} = \int_0^2 \frac{dx}{1+x^2} = \tan^{-1}(2)$$

Answer: (4).

70. Gain/loss = $W \times 100 + L.W(-50 + 100) + L^2W(-50 - 50 + 100) + L^3(-150)$

where, W = Probability that outcome is 5 or 6

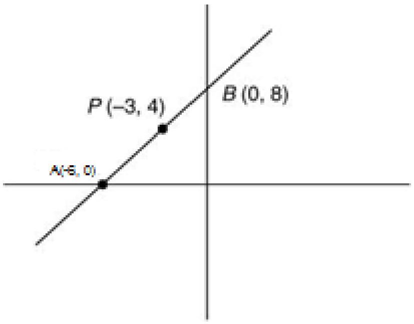
L = Probability that outcome is 1, 2, 3, 4

$$\text{Gain/loss} = \frac{1}{3}\times 100 + \frac{2}{3}.\frac{1}{3}(50) + \left(\frac{2}{3}\right)^2 \times \left(\frac{1}{3}\right) + \left(\frac{2}{3}\right)^3 (-150)$$

Therefore, Gain / loss = 0

Answer: (2).

71.



Let the line be $\frac{x}{a}+\frac{y}{b}=1$

$$(-3,4)=\left(\frac{a}{2},\frac{b}{2}\right)$$

Here, $a = -6$ and $b = 8$

Equation of line is,

$$\frac{x}{-6}+\frac{y}{8}=1$$

$$\Rightarrow -4x + 3y = 24$$

$$\Rightarrow 4x - 3y + 24 = 0$$

Answer: (2).

72. We have, m men and 2 women.

$${}^{m}C_2 \times 2 = {}^{m}C_1 \times {}^{2}C_1 \times 2 + 84$$

$$\Rightarrow m^2 - 5m - 84 = 0$$

$$\Rightarrow m^2 - 12m + 7m - 84 = 0$$

$$\Rightarrow m(m - 12) + 7(m - 12) = 0$$

$$\Rightarrow (m + 7)(m - 12) = 0$$

$$\Rightarrow m = -7,\ m = 12$$

Hence, the value of $m = 12$

Answer: (1).

73. Given equation of curve is

$$y = x^2 - 5x + 5$$

$$\frac{dy}{dx}=2x-5=2\Rightarrow x=\frac{7}{2}$$

At $x=\frac{7}{2},\ \ y=\frac{49}{4}-\frac{35}{2}+5=\frac{-1}{4}$

Equation of tangent at $\left(\frac{7}{2},\frac{-1}{4}\right)$ is $2x-y-\frac{29}{4}=0$

Hence, above lines passes through $\left(\frac{1}{8},-7\right)$.

Answer: (2).

74. All four points are coplanar so,

$$\begin{vmatrix} 1-\lambda^2 & 2 & 0 \\ 2 & -\lambda^2+1 & 0 \\ 2 & 2 & -\lambda^2-1 \end{vmatrix}=0$$

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

$$\Rightarrow \lambda = \pm\sqrt{3}$$

Answer: (2).

75. We have

Given that $|z_1| = 9$, $|z_2 - (3 + 4i)| = 4$

$C_1(0, 0)$ radius $r_1 = 9$

$C_2(3, 4)$ radius $r_2 = 4$

$C_1C_2 = |r_1 - r_2| = 5$

Since, the circle touches internally.

Therefore, minimum of $|z_1 - z_2| = 0$

Answer: (1).

76. General term $T_{r+1} = {}^{60}C_r \frac{60-r}{7^5} \frac{r}{3^{10}}$

Thus, total term = 61

So, for rational term, r = 0, 10, 20, 40, 50, 60

Number of terms = 7

Therefore, number of irrational terms = 61 – 7 = 54

Answer: (4).

77. Equation of parabola

$$x^2 = 8y$$

$$\Rightarrow \frac{dy}{dx} = \frac{x}{4} = \tan\theta$$

Thus, $x_1 = 4 \tan\theta$

$$y_1 = 2 \tan^2\theta$$

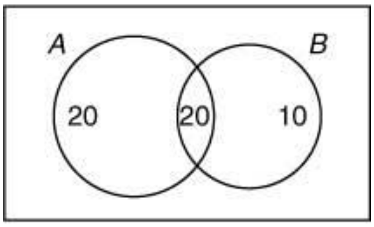
Therefore, equation of tangent is

$$y - 2\tan^2\theta = \tan\theta\,(x - 4\tan\theta)$$

$$\Rightarrow x = y\cot\theta + 2\tan\theta$$

Answer: (3).

Q78.



Given $n(A) = 40$, $n(B) = 30$

$$n(A \cup B) = n(A) + n(B) - n(A \cap B)$$

$$\Rightarrow n(A \cup B) = 40 + 30 - 20 = 50$$

Therefore, $P = \frac{60-50}{60} = \frac{10}{60} = \frac{1}{6}$

Answer: (1).

79. We have,

Mean $\bar{x} = 4$

σ^2 (variance) = 5.2

$n = 5$, $x_1 = 3$, $x_2 = 4$, $x_3 = 4$

Thus, $\frac{x_1 + x_2 + x_3 + x_4 + x_5}{5} = 4$

$$\sum x_i = 20$$

$$x_4 + x_5 = 20 - x_1 + x_2 + x_3$$

$$x_4 + x_5 = 20 - 11 = 9 \quad (1)$$

$$\frac{\sum xi^2}{x} - (\overline{x})^2 = \sigma^2 \Rightarrow \sum xi = 106$$

$$x_4^2 + x_5^2 = 65 \quad (2)$$

From Eq. (1) and Eq. (2), we have

$$(x_4 - x_5)^2 = 49 \quad \Rightarrow \quad |x_4 - x_5| = 7$$

Answer: (1).

80.

$$|A| = \begin{vmatrix} 1 & \sin\theta & 1 \\ -\sin\theta & 1 & \sin\theta \\ -1 & -\sin\theta & 1 \end{vmatrix}$$

$$= 2(1 + \sin^2\theta)$$

$$\theta \in \left(\frac{3\pi}{4}, \frac{5\pi}{4}\right) \Rightarrow \frac{1}{\sqrt{2}} < \sin\theta < \frac{1}{\sqrt{2}}$$

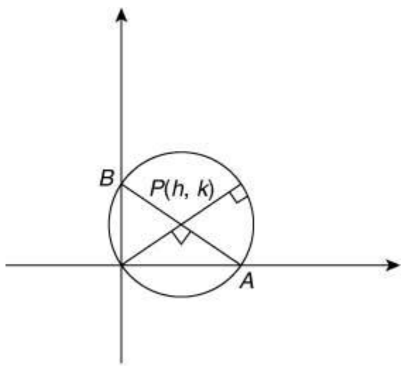
$$\Rightarrow 0 \le \sin^2\theta < \frac{1}{2}$$

Therefore, $|A| \in (2,3)$

Hence, det (A) lies in interval of 3/2 and 3.

Answer: (4).

81.



Slope of AB $= \frac{-h}{k}$

Equation of AB is $hx + ky = h^2 + k^2$

A$\left(\frac{h^2 + k^2}{h}, 0\right)$, B$\left(0, \frac{h^2 + k^2}{k}\right)$

AB = 2R,

$$\Rightarrow (h^2 + k^2)^3 = 4R^2 h^2 k^2$$

$$\Rightarrow (x^2 + y^2)^3 = 4R^2 x^2 y^2$$

Answer: (2).

82. By considering matrix,

$$\begin{vmatrix} \lambda-1 & 2 & 2 \\ 1 & 2-\lambda & 1 \\ 1 & 1 & 1 \end{vmatrix} = 0$$

$$\Rightarrow (\lambda-1)^3 = 0$$

$$\Rightarrow \lambda = 1$$

Answer: (1).

83. We have,

$$f(x) = x^3 - 3(a-2)x^2 + 3ax + 7$$

$$f'(x) = 3x^2 - 6(a-2)x + 3a$$

$$\Rightarrow f'(x) \geq 0 \ \forall x \in (0,1)$$

$$\Rightarrow f'(x) \leq 0 \ \forall x \in [1,5]$$

$$\Rightarrow f'(x) = 0 \text{ at } x = 1 \Rightarrow a = 5$$

$$f(x) - 14 = (x-1)^2 (x-7)$$

Therefore, $\dfrac{f(x)-14}{(x-1)^2} = x - 7$

Answer: (3).

84. We have,

$A = \{2^{(x+2)(x^2-5x+6)} = 1; x \in 1\}$

$B = \{-3 < 2x - 1 < 9; x \in 1\}$

Thus, $A = \{-2, 2, 3\}$

$B = \{0, 1, 2, 3, 4\}$

$$n(A \times B) = 15$$

Therefore, number of subsets = 2^{15}

Answer: (1).

85. We have,

$$2.{}^nC_5 = {}^nC_4 + {}^nC_6$$

$$\Rightarrow 2 = \frac{{}^nC_4}{{}^nC_5} + \frac{{}^nC_6}{{}^nC_5} \Rightarrow 2 = \frac{5}{n-4} + \frac{n-5}{6}$$

$$\Rightarrow n^2 - 21n + 98 = 0$$

$$\Rightarrow n^2 - 14n - 7n + 98 = 0$$

$$\Rightarrow n(n-14) - n(n-14) = 0$$

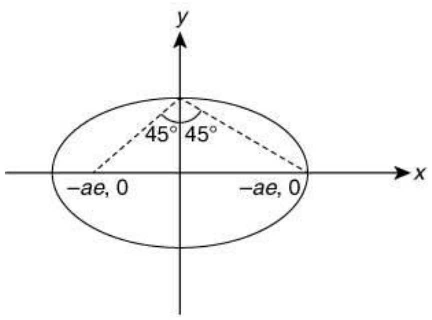
$$\Rightarrow (n-7)(n-14) = 0$$

$$\Rightarrow n = 7, n = 14$$

Hence, $n = 14$

Answer: (2).

86.



$$m_{S'B} \cdot m_{SB} = -1$$

$$\Rightarrow b^2 = a^2e^2 \quad (1)$$

Now, $\frac{1}{2} S'B \cdot SB = 8$

$$\Rightarrow S'B \cdot SB = 16$$

$$\Rightarrow a^2e^2 + b^2 = 16 \quad (2)$$

$$\Rightarrow b^2 = a^2(1 - e^2) \quad (3)$$

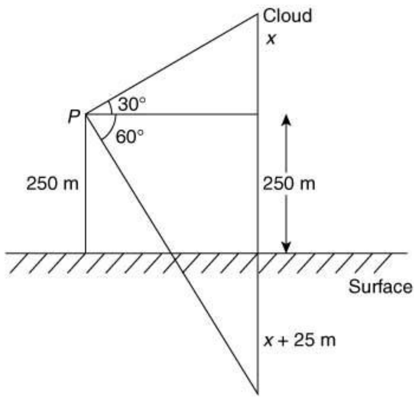
From Eq. (1), Eq. (2) and Eq. (3), we get

$$a = 4, b = 2\sqrt{2}, e = \frac{1}{\sqrt{2}}$$

Therefore, latus rectum $= \frac{2b^2}{a} = \frac{2 \times 8}{4} = 4$

Answer: (1).

87.



$$\tan 30° = \frac{x}{y} \Rightarrow y = \sqrt{3}x \quad (1)$$

$$\tan 60° = \frac{25 + x + 25}{y} \quad (2)$$

$$\Rightarrow \sqrt{3}y = 50 + x$$

$$\Rightarrow 3x = 50 + x$$

$$\Rightarrow x = 25 \text{ m}$$

Therefore, height of cloud from surface = 25 + 25 = 50 m

Answer: (2).

88. $\sim(\sim p \rightarrow q) = \sim p \wedge \sim q$

Answer: (1).

89. We have,

$$S = \left(\frac{3}{4}\right)^3 + \left(\frac{6}{4}\right)^3 + \left(\frac{9}{4}\right)^3 + \left(\frac{12}{4}\right)^3 + \cdots 15 \text{ term}$$

$$= \frac{27}{64} \sum_{r=1}^{15} r^3$$

$$= \frac{27}{64} \left[\frac{15(15+1)}{2}\right]^2 = 225k \text{ (given)}$$

$$= \frac{27}{64} \times \left[\frac{225 + 15}{2}\right]^2 = 225k$$

$$= \frac{27}{64} \times \frac{57600}{4} = 225k$$

$$\Rightarrow k = 27$$

Answer: (2).

90. Expression is always positive if

$$2m + 1 > 0 \; m > \frac{-1}{2}$$

And, $D < 0 \Rightarrow m^2 - 6m - 3 < 0$

$$3 - \sqrt{12} < m < 3 + \sqrt{12}$$

Thus, common interval is

$$3 - \sqrt{12} < m < 3 + \sqrt{12}$$

So, integral value of m = {0, 1, 2, 3, 4, 5, 6}

Hence, 7 integral values of m are possible.

Answer: (3).