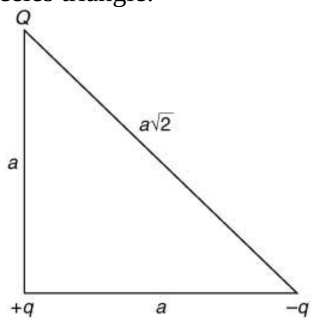
JEE Main 2019 Paper 1
January 11, Shift 1
Section: Physics

1. Let a be the two equal sides of isosceles triangle.



Thus, net electrostatic energy is given as

$$U = \frac{Kq^2}{a} + \frac{KQ^2}{a} + \frac{KQq}{a\sqrt{2}}$$

Since, the net electrostatic energy is zero.
Therefore,

$$\frac{Kq^2}{a} + \frac{KQq}{a} + \frac{KQq}{a\sqrt{2}} = 0$$

$$\Rightarrow K\left[\frac{q^2}{a} + \frac{qQ}{a} + \frac{Qq}{a\sqrt{2}}\right] = 0$$

$$\Rightarrow \frac{q^2}{a} + \frac{qQ}{a}\left(1 + \frac{1}{C}\right) = 0$$

$$\Rightarrow \frac{q^2}{a} = -\frac{qQ}{a}\left(1 + \frac{1}{\sqrt{2}}\right)$$

$$\Rightarrow q = -Q\left(1 + \frac{1}{\sqrt{2}}\right)$$

$$\Rightarrow Q = \frac{-q\sqrt{2}}{\sqrt{2}+1}$$

Answer: (4).

2. For adiabatic process,

$$TV^{\gamma-1} = \text{constant}$$

$$\Rightarrow \gamma - 1 = x$$

$$\gamma \text{ for diatomic} = \frac{7}{5}$$

Therefore,

$$\frac{7}{5} - 1 = x \Rightarrow x = \frac{2}{5}$$

Answer: (1).

3. We have

$$\text{Centripetal force} = \text{Gravitational force}$$

$$\frac{mv^2}{R_E} = \frac{GmM_E}{R_E^2}$$

$$\Rightarrow V = \sqrt{\frac{GM_E}{R_E}}$$

$$\text{K.E} = \frac{1}{2}mv^2 = \frac{GMm}{2R}$$

$$\text{P.E} = -\frac{GMm}{2R}$$

Escape velocity is

$$\frac{1}{2}mv_E^2 + \left(\frac{-GMm}{R}\right) = 0$$

$$\Rightarrow v_E = \sqrt{\frac{2GM}{R}}$$

Now, change in velocity = $v_E - v$

$$= \sqrt{\frac{GMm}{R}} - \sqrt{\frac{GM}{R}}$$

$$= \sqrt{\frac{GM}{R}}(\sqrt{2} - 1)$$

$$= \sqrt{gR}\,(\sqrt{2} - 1) \qquad \left[g = \frac{GM}{R^2}\right]$$

Answer: (4).

4. Let amount of ice is m.

According to principal of calorimeter,

Heat taken by ice = Heat given by water

$$\Rightarrow 20 \times 2.1 \times m + (m - 2) \times 334 = 50 \times 4.2 \times 40$$

$$\Rightarrow 376m - 6680 = 8400$$

$$\Rightarrow 367m = 8400 + 6680$$

$$\Rightarrow 367m = 15080 \Rightarrow m = 41.08 \approx 40 \text{ g}$$

Answer: (3).

5. Suppose M is mass and l is side of larger triangle then, $M/4$ and $l/2$ will be the mass and side of smaller triangle.

Thus, moment of inertia is

$$I = Kml^2$$

$$\Rightarrow I_{\text{complete}} = I_{\text{remaining}} + I_{\text{removed}}$$

$$\Rightarrow I = I_{\text{remaining}} + K\left(\frac{M}{4}\right)\left(\frac{l}{2}\right)^2 = I_{\text{remaining}} + \frac{KMl^2}{16}$$

$$\Rightarrow I = I_{\text{remaining}} + \frac{I}{16}$$

$$\Rightarrow I - \frac{I}{16} = I_{\text{remaining}}$$

$$\Rightarrow \frac{15I}{16} = I_{\text{remaining}}$$

Answer: (1).

6. Energy of Photon is

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

$$= \frac{12500}{980} = 12.75$$

We know that

$$\Delta E = -13.6Z^2\left(\frac{1}{n_2^2} - \frac{1}{n_1^2}\right)$$

Here $n_1 = 1$ and $Z = 1$ putting these values with ΔE value we get $n_2 = 4$

Thus, $R \propto n^2 a_0$

$$= (4)^2 a_0$$

$$\Rightarrow R = 16a_0$$

Answer: (4).

7. Balanced condition of wheatstone bridge is,

$$\frac{P}{Q} = \frac{R}{S}$$

Now,
$$\frac{P}{Q} = \frac{400}{x} \quad (1)$$

$$\frac{Q}{P} = \frac{405}{x}$$

$$\Rightarrow \frac{P}{Q} = \frac{x}{405} \quad (2)$$

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

$$\frac{400}{x} = \frac{x}{405}$$

$$\Rightarrow x^2 = 400 \times 405$$

$$\Rightarrow x = \sqrt{400 \times 405}$$

$$\Rightarrow x = 20\sqrt{405}$$

$$\Rightarrow x = 402.5 \text{ ohm}$$

Answer: (4).

8. Momentum per second carried by liquid per second = $\rho A v^2$ $\quad \left[F = \frac{dp}{dt}\right]$

Force due to 25% which loses all its momentum $\Rightarrow \frac{\rho A v}{4} \times v$

$$\Rightarrow \frac{\rho A v^2}{4}$$

Force due to 25% which come back with same speed $\Rightarrow \frac{\rho A v}{4} \times 2v$

$$\Rightarrow \frac{\rho A v^2}{2}$$

Total force $= \frac{\rho A v^2}{4} + \frac{\rho A v^2}{2}$

$$= \frac{2\rho A v^2 + \rho A v^2}{4}$$

$$= \frac{3}{4}\rho A v^2$$

Net pressure, $P = \frac{F}{A} \quad = \frac{3/4 \rho A v^2}{A} \quad = \frac{3}{4}\rho v^2$

Answer: (1).

9. Lens equation is,

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

$$\Rightarrow \frac{1}{13} = \frac{1}{v} - \frac{1}{(-20)}$$

$$\Rightarrow \frac{10}{3} = \frac{1}{v} + \frac{1}{20}$$

$$\Rightarrow \frac{1}{v} = \frac{10}{30} - \frac{1}{20}$$

$$= \frac{200-3}{60}$$

$$\Rightarrow \frac{1}{v} = \frac{197}{60}$$

$$\Rightarrow v = \frac{60}{197}$$

Thus, $$m = \frac{v}{u} = \frac{60/197}{20}$$

$$= \frac{60}{3940} = 0.015$$

Therefore, $$v_1 = m^2 v_0$$

$$= (0.015)^2\,(-5)$$

$$= 1.15 \times 10^{-3} \text{ towards the lens}$$

Answer: (1).

10. We have $y = 0.03 \sin (450\,t - 9x)$

General wave equation is $y = a \sin (\omega t - kx)$

So,

$$\omega = 450$$

$$k = 9$$

$$v = \frac{\omega}{k} = \frac{450}{9}$$

$$= 50 \text{ m/s}$$

We also know that

$$\Rightarrow v = \sqrt{\frac{T}{\mu}}$$

$$\Rightarrow T = v^2\mu$$

$$= (50)^2 \times 5 \times 10^{-3}$$

$$= 2500 \times 5 \times 10^{-3}$$

$$= 12.5 \text{ N}$$

Answer: (4).

11. Initial compression is

$$mg = kx$$

$$3 \times 10 = 1.25 \times 10^6 \left(\frac{x}{100}\right)$$

$$\Rightarrow 30 = 1.25 \times 10^4 \times x$$

$$\Rightarrow x = \frac{3}{1250}$$

Velocity of 1 kg block just before it collides with 3 kg block

$$v_i = \sqrt{2gh}$$

$$\Rightarrow v_i = \sqrt{2\times10\times100} = \sqrt{2000}$$

Applying momentum conversation just before and just after collision, we have

$$1\times\sqrt{2000} = 4v_f$$

$$v_f = \frac{\sqrt{2000}}{4}\text{ m/s}$$

Now, applying work-energy theorem,

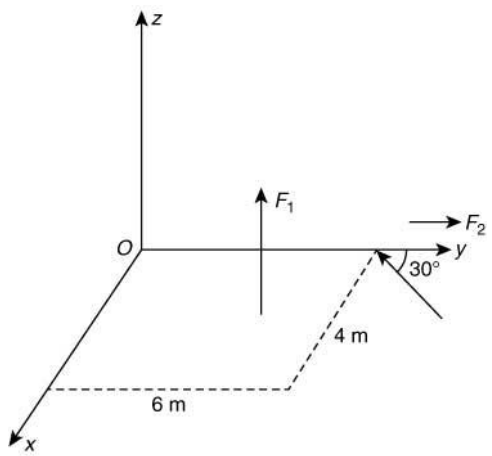
$$\frac{1}{2}mv_f^2 = \frac{1}{2}kx^2$$

$$\Rightarrow 4\times5\times5\times5 = 1.25\times10^6\left(\frac{x}{100}\right)^2$$

$$\Rightarrow x = 2\text{ cm}$$

Answer: (*).

12.



Moment of force is

$$\tau = \vec{r}_1\times\vec{F} + \vec{r}_2\times\vec{F}_2$$

$$= (2\hat{i}+3\hat{j})\times F\hat{k} + 6\hat{j}\left(-F\frac{\sqrt{3}}{2}\hat{j} - \frac{F}{2}\hat{i}\right)$$

$$= 2F(-\hat{j}) + (3F\hat{i}) + (3F\hat{k})$$

$$= (3\hat{i} - 2\hat{j} + 3\hat{k})F$$

Answer: (1).

13. We have,

$$\varepsilon - L\frac{di}{dT} - iR = 0$$

$$\Rightarrow \varepsilon = L\frac{di}{dT} + iR$$

$$\Rightarrow \varepsilon - iR = L\frac{di}{dT}$$

Now, integrating both the sides, we get

$$\int\frac{dt}{L} = \int\frac{di}{\varepsilon - iR}$$

Let $\varepsilon - iR = P$

$$\Rightarrow \int\frac{dt}{L} = \frac{-1}{R}\int\frac{dP}{P}$$

$$\Rightarrow \frac{-R}{L}t = \ln P$$

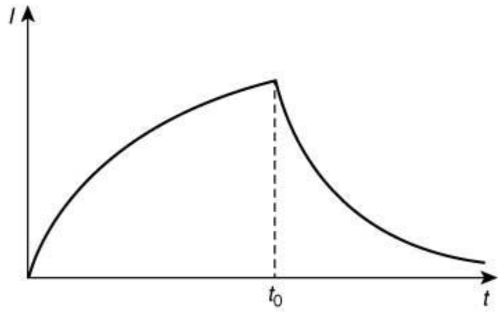
$$\Rightarrow \frac{-R}{L}t = \ln\left(\frac{\varepsilon - iR}{\varepsilon}\right)$$

$$\Rightarrow e^{-\frac{R}{L}t} = 1 - \frac{iR}{\varepsilon}$$

$$\Rightarrow i = \frac{\varepsilon}{R}\left(1 - e^{\frac{1}{\varepsilon}}\right)$$

$$\Rightarrow \quad \tau = \frac{L}{R}$$

$$\Rightarrow i = i_{\max} e^{-\frac{1}{\tau}}, \text{ during decay}$$



Answer: (1, 2, 4).

14. In series condition, power consumed is

$$P = \frac{V^2}{2R}$$

$$\Rightarrow 60 = \frac{V^2}{2R}$$

$$\Rightarrow \frac{V^2}{R} = 120$$

In parallel condition, power consumed is

$$\frac{V^2}{R_{\text{eq}}} = \frac{2V^2}{R} = 2(120) = 240\text{W}$$

Answer: (4).

15. When potential drop across 1500 Ω is 10 V then current flowing through it is

$$I_2 = \frac{10}{500} \qquad [V = IR]$$

$$= 6.61 \text{ mA}$$

Now, 2 V will be the potential difference across 500 Ω.
Thus, electric current flowing through it is

$$I_1 = \frac{2}{500}$$

$$= 4 \text{ mA}$$

So, $I_2 > I_1$ this condition is not possible.
Therefore, voltage across Zener diode must be less than 10 V therefore it will not work in break down region and its resistance will be infinite and current through it is equal to 0.
Answer: (1).

16. Growth and decay of current in LR circuit is

$$-R-\frac{LdI}{dt}+\varepsilon=0$$

$$\Rightarrow\ \varepsilon=\frac{LdI}{dt}+iR$$

$$\Rightarrow\ \varepsilon=IR=\frac{LdI}{dt}$$

$$\int\frac{dt}{L}=\int\frac{dI}{\varepsilon-iR}$$

Let $\varepsilon - iR = A$

$$\Rightarrow\int\frac{dt}{L}=\int\frac{dt}{A}$$

$$\Rightarrow\ -\frac{R}{L}t=\ln P$$

$$\Rightarrow\ -\frac{R}{L}t=\ln\left(\frac{\varepsilon-iR}{\varepsilon}\right)$$

$$\Rightarrow\ e^{\frac{R}{L}t}=1-\frac{iR}{\varepsilon}$$

$$\Rightarrow\ i=\frac{\varepsilon}{R}\left(1-e^{\frac{1}{2}}\right)\ \text{during growth}$$

Time constant, $I=\frac{L}{R}$

$i=i_{\max}e^{-\frac{1}{2}}$ during decay

Therefore, the given charge shows the potential of a uniformly charged spherical shell.

Answer: (2).

17. Let null point J be at l cm from A.

Then at balance condition we have

$$E_1\left(\frac{6}{4+2}\right)\times\frac{4}{L}x=\frac{1}{2}$$

$$\Rightarrow\ \frac{x}{L}=\frac{1}{8}$$

$$E_2=\left(\frac{6}{4+6}\right)\times\frac{4}{L}\times x$$

$$=\frac{6}{10}\times\frac{4}{1}\times\frac{1}{8}$$

$$= 0.3\ \text{V}$$

Answer: (1).

18. We have,

$$U_1=\frac{f_1}{2}n_1RT\ =\frac{5}{2}(3RT)$$

$$U_2=\frac{f_2}{2}n_2RT\ =\frac{3}{2}5RT$$

Therefore, total energy, $U = U_1 + U_2$

$$=\frac{15}{2}RT+\frac{15}{2}RT$$

$$=2\times\frac{15}{2}RT$$

$$\Rightarrow U = 15\,RT$$

Answer: (1).

19. We have,

$$V(t) = 10 + \frac{3}{2}[\sin(572\times10^3 t)\sin(528\times10^3 t)]$$

$$\omega_1 = 572 \times 10^3$$
$$2\pi f_1 = 572 \times 10^3$$
$$f_1 = \frac{572\times10^3}{2\times\left(\frac{22}{7}\right)}$$
$$= 9.1 \times 10^4 = 91\text{ kHz}$$

Now,
$$\omega_2 = 528 \times 10^3$$
$$2\pi f_2 = 528 \times 10^3$$
$$f_2 = \frac{528\times10^3}{2\times\frac{22}{7}} \Rightarrow f_2 = 84\text{ kHz}$$

Answer: (4).

20. We have,

$$D_m = (\mu - 1)A$$

Since, on increasing the wavelength, μ decreases and hence D_m decreases.

Answer: (1).

21. Self-Inductance is $L = \mu_0 n_1^2 \pi r_1^2 l$ $\quad [\phi = Li]$

Mutual inductance is $M = \mu_0 n_1 n_2 \pi r_1^2 l$ $\quad [\phi_1 = Mi_2]$

Now,
$$\frac{M}{L} = \frac{\mu_0 n_1 n_2 l \pi r_1^2}{\mu_0 n_1^2 \pi r_1^2 l} \Rightarrow \frac{M}{L} = \frac{n_2}{n_1}$$

Answer: (4).

22. Potential energy, $P = \frac{1}{2}KA^2\sin^2\omega t$

Kinetic energy, $K = \frac{1}{2}mv^2$

$$= \frac{1}{2}m(A\omega\cos\omega t)^2$$

$$= \frac{1}{2}kA^2\cos^2\omega t$$

Therefore,
$$\frac{K}{P} = \frac{\frac{1}{2}kA^2\cos^2\omega t}{\frac{1}{2}kA^2\sin^2\omega t} = \cot^2\omega t$$

$$\Rightarrow \frac{K}{P} = \cot^2\left[\frac{\pi}{4}\times210\right] = \cot^2\left(\frac{7\pi}{3}\right) = \frac{1}{3}$$

Answer: (2).

23. 6 μF and 4 μF are parallel to each other. Total charge is 30 μF.

Charge on 6 μF capacitor $= \frac{6}{6+4}\times30$ $\quad [Q = CV]$

$= 18$ μC

Therefore, charge on right plate is +18 μC.

Answer: (1).

24. As we know that,

$$c = \frac{1}{\sqrt{\mu_0 \varepsilon_0}} \qquad (1)$$

For transparent medium

$$v = \frac{1}{\sqrt{K \varepsilon_0 \mu_0}} \qquad (2)$$

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

$$\frac{c}{v} = \frac{\frac{1}{\sqrt{\mu_0 \varepsilon_0}}}{\frac{1}{\sqrt{K \mu_0 \varepsilon_0}}}$$

$$\Rightarrow \frac{c}{v} = \sqrt{K} = n$$

We know that, intensity in term of electric field is

$$I = \frac{1}{2} \varepsilon_0 E_0^2 c \qquad (3)$$

$$I = \frac{1}{2} \varepsilon_0 K E^2 v \qquad (4)$$

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

$$E_0^2 c = K E^2 v$$

$$\Rightarrow \frac{E_0^2}{E^2} = \frac{Kv}{c}$$

$$\Rightarrow \frac{E_0^2}{E^2} = \frac{n^2}{n}$$

$$\Rightarrow \frac{E_0}{E} = \sqrt{n}$$

Similarly, in terms of magnetic field

$$I = \frac{B_0^2 c}{2\mu_0} \qquad (5)$$

$$I = \frac{B^2 v}{2\mu_0} \qquad (6)$$

From Eq. (5) and Eq. (6), we get

$$\frac{B_0^2 c}{2\mu_0} = \frac{B^2 v}{2\mu_0}$$

$$\Rightarrow \frac{B_0^2}{B^2} = \frac{v}{c} = \frac{1}{\sqrt{n}}$$

Answer: (3).

25. Given,

$$F = \alpha B e^{\left(-\frac{x^2}{\alpha K T}\right)}$$

$$\Rightarrow \frac{k^2}{\alpha K T} = \text{dimensionless}$$

Dimension of α,

$$[\alpha] = \frac{x^2}{KT} = \frac{[L^2]}{[ML^2T^{-2}]}$$

$\Rightarrow [\alpha] = [M^{-1}T^{2}]$

Dimension of F = Dimension of α × Dimension of β

Therefore, dimension of $\beta = \dfrac{\text{Dimension of } F}{\text{Dimension of } \alpha}$

$$= \frac{[MLT^{-2}]}{[M^{-1}T^{+2}]}$$

$$= [M^2LT^{-4}]$$

Answer: (4).

26. We know

$$r = \frac{mv}{qB}$$

$$= \frac{\sqrt{2mK}}{qB} = \frac{\sqrt{2mqV}}{\sqrt{q^2}B}$$

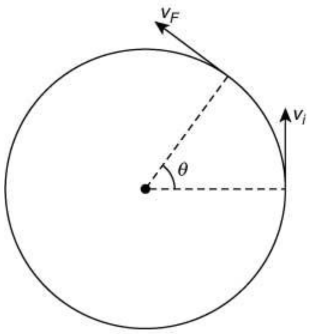
$$= \frac{\sqrt{2 \times 9.1 \times 10^{-31} \times 500}}{100 \times 10^{-3}\sqrt{1.6 \times 10^{-19}}}$$

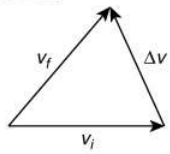
$$= \frac{75.4 \times 10^{-6}}{100 \times 10^{-3}}$$

$$\Rightarrow r = 7.5 \times 10^{-4} \text{ m}$$

Answer: (4).

27.





$$\Delta v = v_f - v_i$$

$$= \sqrt{v^2 + v^2 + 2v^2\cos(\pi - \theta)}$$

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

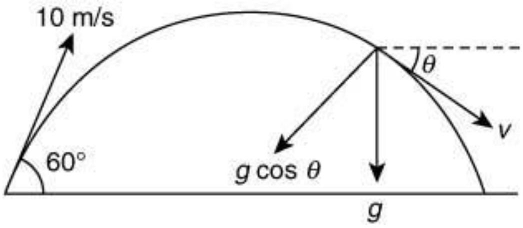
$$= 10 \text{ m/s}$$

Answer: (3).

28. At $t = 1$

$$v = \left|5\sqrt{3} - 10\right|$$

$$= 10 - 5\sqrt{3}$$



$$\tan\theta = \frac{10 - 5\sqrt{3}}{5}$$

$$\Rightarrow \tan\theta = (2 - \sqrt{3})$$

$$\Rightarrow \theta = \tan^{-1}(2 - \sqrt{3}) \Rightarrow \theta = 15°$$

The radius of curvature of the trajectory is

$$R = \frac{v^2}{g\cos\theta}$$

$$= \frac{26.79}{10 \times 0.97}$$

$$= 2.77 \text{ m} = 2.8 \text{ m}$$

Answer: (2).

29. We have

$$\lambda = \frac{10^{-3} \times 3 \times 10^{8}}{6 \times 10^{14}} = 0.5 \times 10^{-9} \Rightarrow \lambda = 5 \times 10^{-10}$$

Since, $\lambda = \frac{h}{mv} \Rightarrow v = \frac{h}{m\lambda}$

$$= \frac{6.6 \times 10^{-34}}{5 \times 10^{-10} \times 9.1 \times 10^{-31}}$$

$$= 1.45 \times 10^{6} \text{ m/s}$$

Answer: (1).

30. Let I be the intensity of each wave

$$\Delta x = \frac{\lambda}{8}$$

$$\Delta\phi = \frac{\Delta x}{\lambda} \times 2\pi$$

$$= \frac{\frac{\lambda}{8}}{\lambda} \times 2\pi = \frac{\pi}{4}$$

Now, $I' = I + I + 2I\cos\theta$

$$= 2I + 2I\cos\left(\frac{\pi}{4}\right)$$

$$= 2I + \sqrt{2}I$$

$$= 2I + (1.41)I$$

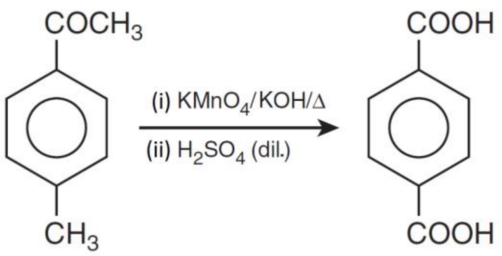
$$= (3.41)\ I$$

Therefore, $\frac{I'}{4I} = \frac{3.41}{4} = 0.85$

Answer: (4).

Section: Chemistry

31.



Answer: (4).

32. (a) If produces less pollutants than petrol.

(b) A cylinder of compressed dihydrogen weighs is 30 times more than a petrol tank producing the same amount of energy.

(c) Dihydrogen is stared is tanks of metal allays like $NaNr_5$.

Answer: (1).

33. $[C_xH_yN_z] \xrightarrow[\text{Method}]{\text{Dumas}} 6CO_2 + 4\,H_2O + N_2$

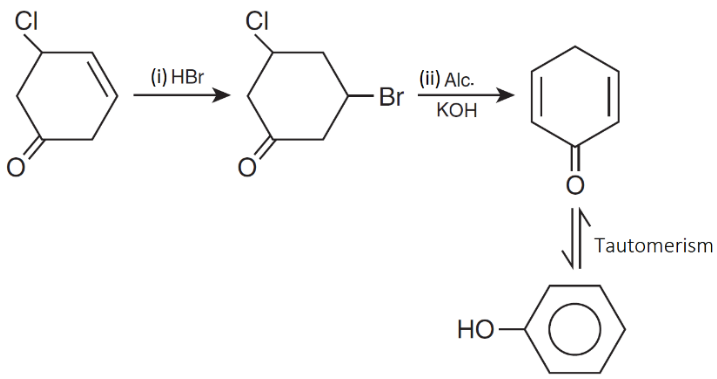
Analysis the stoichiometry of the above reaction, the formula of the organic compound is $C_6H_8N_2$.

Answer: (3).

34. Colloids in which solid particles are dispersed is solid medium are solid sol. Gem stones are an example of solid sol.

Answer: (4).

35. The reaction involved is



Answer: (2).

36. Wavelength of radiation $\lambda = 900$ nm

$$\frac{1}{\lambda} = R_{\text{H}}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

Paschen $(n_1 = 3)(n_2 = \infty)$

For transition $\infty \rightarrow 3$

$$\frac{1}{\lambda} = 10^7 \left(\frac{1}{(3)^2} - \frac{1}{\infty} \right)$$

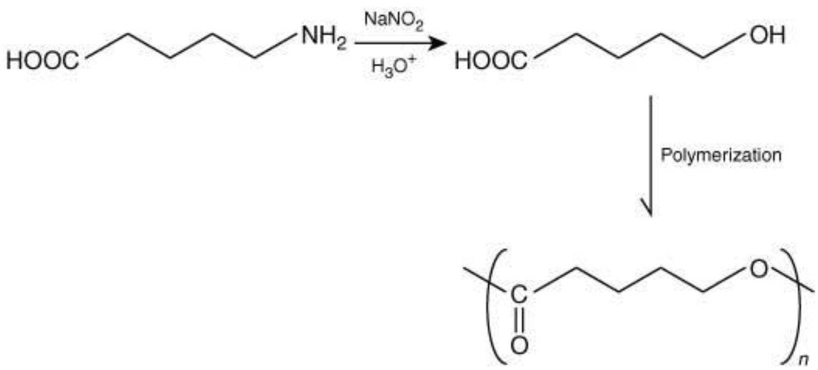
$$\frac{1}{\lambda} = 10^7 \left(\frac{1}{9} \right)$$

$$\lambda = 9 \times 10^{-7}\,\text{m}$$

$$\lambda = 900\ \text{nm}$$

Answer: (4).

37.



Answer: (1).

38. NaH is an example of ionic hydride which is also known as saline hydride. They react violently with water producing dihydrogen gas.

$$\text{NaH (s)} + \text{H}_2\text{O (l)} \rightarrow \text{NaOH}\,(\text{aq}) + \text{H}_2\,(\text{g})$$

Answer: (1).

39. For the reaction

$$2\text{NH}_3 \rightleftharpoons \text{N}_2 + 3\text{H}_2,\ \frac{1}{K_\text{p}}$$

At $t = 0$	p_1	0	0
At $t = \text{t}_{\text{eq.}}$	p_{NH_3}	$\frac{p_1}{2}$	$\frac{3p_1}{2}$

Since $$2p_1 = p$$

$$p_1 = \frac{p}{2} \qquad (1)$$

$$K_{\text{eq}} = \frac{(p_{\text{N}_2})(p_{\text{H}_2})^3}{(p_{\text{NH}_3})^2} \Rightarrow \frac{1}{K_\text{P}} = \frac{\left(\frac{p_1}{2}\right)\left(\frac{3p_1}{2}\right)^3}{(p_{\text{NH}_3})^2} \qquad (2)$$

By substitute Eq. (1) in Eq. (2), we get

$$\frac{(p_{\text{NH}_3})}{K_\text{P}} = \left(\frac{p}{2\times 2}\right)\left(\frac{3p}{2\times 2}\right)^3 = \frac{3p^4}{(4)^4}$$

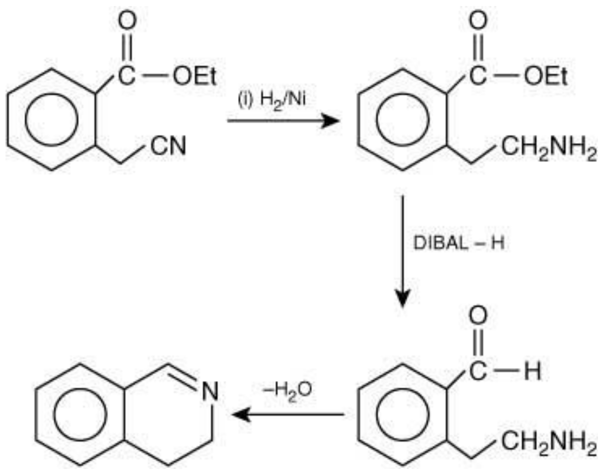
$$p_{NH_3} = \left(K_P \frac{p^4}{4^4} 3^3\right)^{\frac{1}{2}}$$

$$p_{NH_3} = \frac{K_P^{1/2} p^2 3^{3/2}}{16}$$

Answer: (2).

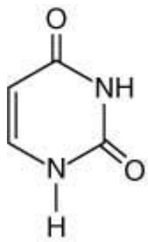
40. CCl_4 cannot get hydrolysed due to the absence of vacant orbital at carbon atom. Steric crowding due to presence of four large Cl atoms around C atom which do not allow water molecule to approach anti bounding orbitals of C-Cl bonds.
Answer: (1).

41.



Answer: (2).

42. Uracil is found in RNA.

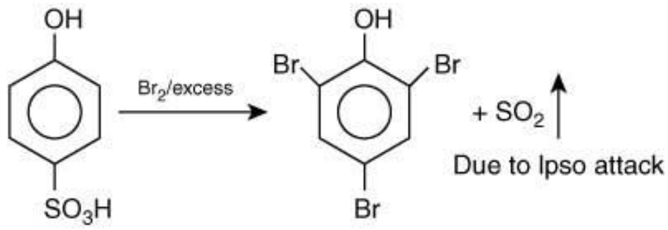


Answer: (2).

43. Peroxyacetyl nitrate (PAN) is an eye irritant and produced by photochemical smog.

$\underset{\substack{\| \\ O}}{CH_3COONO_2}$ it is one of the constituents of photochemical smog. It is toxic and irritating as it dissolves more readily in water than ozone.
Answer: (1).

44. The reaction involved is



Answer: (3).

45. $$\text{slope} = -y \qquad (1)$$

From Arrhenius Equation

$$\ln k = \ln\left(Ae^{-E_a/RT}\right)$$

$$\ln k = \ln A - E_a \frac{1}{RT} \qquad (2)$$

Comparing Eq. (2) with equation of straight line

$$y = mx + c$$

We get

$$\text{slope} = -E_a \qquad (3)$$

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

$$-y = -E_a$$
$$y = E_a$$

Answer: (1).

46. (A) Norethindrone - Anti-fertility
(B) Ofloxacin – Anti-biotic
(C) Equanil – Hypertension

Answer: (2).

47. The major product of the reaction $X \rightleftharpoons Y$ is depends on the spontaneity of the reaction, that is, value of $\Delta_r G°$, which is given by relation

$$\Delta G = 120 - \frac{3}{8}T$$

At equilibrium $\Delta G = 0$
At T = 315 K

$$\Delta_r G^o = 120 - \frac{3}{8}T$$
$$\Delta_r G^o = 120 - \frac{3}{8} \times 315 = 1.875 \text{ kJmol}^{-1}$$

$\Delta_r G^o = +1.875 \text{ kJ mol}^{-1}$, so, reaction is non-spontaneous at this temperature, therefore, X will be the major product.

Answer: (3).

48. Usually Sc (scandium) does not show variable oxidation state.
Most common oxidation state of:
(i) Sc: + 3
(ii) V: +2, +3, +4
(iii) Ti: +2, +3, +4
(iv) Cu: +1, +2

Answer: (1).

49.

Ores	**Chemical Formula**		**Metal Present**
Siderite	$FeCO_3$	$\rightarrow$	Iron
Kaolinite	$Al_2(OH)_4Si_2O_5$	$\rightarrow$	Aluminium
Malachite	$Cu(OH)_2 \cdot CuCO_3$	$\rightarrow$	Copper
Calamine	$ZnCO_3$	$\rightarrow$	Zinc

Answer: (4).

50.

Mixture		**Separation Method**
H_2O: Sugar	$\rightarrow$	Recrystallization
H_2O: Aniline	$\rightarrow$	Silicon distillation
H_2O: Toluene	$\rightarrow$	Differential extraction

Answer: (2).

51.

Freezing Point of Pure Milk	**Freezing Point of Diluted Milk**
$T_f = -0.5° C$	$T_f = -0.2° C$
$\Delta T_f = 0.5° C$	$\Delta T_f = 0.2^o C$

$$\Delta T_f = K_f m_{(cup)}$$

$$\frac{(\Delta T_f)}{(\Delta T_f)_2} = \frac{K_f \times x \times 1000 \times w_2}{w_1 \times K_f \times x \times 1000}$$

$$\frac{0.5}{0.2} = \frac{w_2}{w_1}$$

$$w_2 = \frac{5}{2} w_1$$

$$w_{water} = \frac{5}{2} w_1 - w_1$$

$$w_{water} = \frac{3}{2} w_1$$

Hence, 3 cups of water will be added to 2cups of pure milk.

Answer: (3).

52. Highest $E^o_{cell} = (SRP)_{cathode} - (SRP)_{Anode}$

To get the highest $E°_{cell}$ the SRP value of cathode must be highest. So, Au^{3t}/Au(s) has highest value of SRP 1.40 but per electron SRP values is $\frac{1.40}{3} = 0.467$ V. For Ag^+/Ag per electron SRP values is 0.80 V which is highest among the given electrodes.

Answer: (1).

53. $2NaHCO_3 + H_2C_2O_4 \rightarrow Na_2C_2O_4 + 2CO_2 + 2H_2O$

$$n\left(CO_2\right) = \frac{0.25 \times 10^{-3}}{25} = 10^{-5}$$

$$n\left(NaHCO_3\right) = 10^{-5}$$

$$\text{Mass}_{(NaHCO_3)} = 84 \times 10^{-5}\,\text{g}$$

$$\%\ \text{Mass} = \frac{84 \times 10^{-5} \times 100}{10 \times 10^{-3}}$$

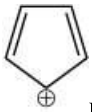
$$= 84 \times 10^{-1}$$

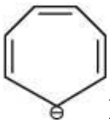
$$= 8.4\ \%$$

Answer: (2).

54.

(A)  It follows all the rule and here aromatic.

(B)  no. of M elections is 4 and does not follow Huckel's rule.

(C)  It does not follow the rules.

(D)  Its π elections are not delocalised.

Hence option (A) is aromatic and (B) (C) and (D) are not aromatic.

Answer: (2).

55. Moving in a period, atomic radii decreases and moving down the group increases. Hence, the atomic radii order: $C < S < Al < Cs$.

(i) C: 170 pm

(ii) S: 180 pm

(iii) Al: 184 pm

(iv) Cs: 300 pm

Answer: (3).

56. (P) Wilkinson Catalyst: $RhCl\left(PPh_3\right)_3$

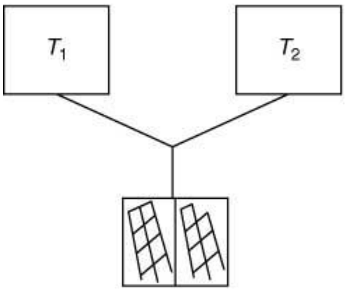
(Q) Chlorophyll: $C_{55}H_{72}O_5N_4Mg$

(R) Vitamin B_{12}: cobalt

(S) Carbonic anhydrase: Zinc ion

Answer: (1).

57.



$$T_t = \frac{T_1 + T_2}{2}$$

$$\Delta S = \int \frac{dq_{rev}}{T}$$

$$= nC_P \int \frac{dT}{T}$$

$$\Delta S_I = nC_p \int_{T_1}^{T_t} \frac{dT}{T}$$

$$\Delta S_I = nC_p \ln \frac{T_t}{T_1} \qquad (1)$$

$$\Delta S_{II} = nC_P \int_{T_2}^{T_t} \frac{dT}{T}$$

$$\Delta S_{II} = nC_p \ln \frac{T_t}{T_2} \qquad (2)$$

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

$$\Delta S_I + \Delta S_{II} = nC_P \ln \frac{T_t^2}{T_1 T_2}$$

$$\Delta S_{\text{total}} = nC_P \ln \frac{\left(\frac{T_1 + T_2}{2}\right)^2}{(T_1 T_2)}$$

$$\Delta S_{\text{total}} = C_P \ln \left[\frac{\left(\frac{T_1 + T_2}{2}\right)^2}{(T_1 T_2)} \right]$$

Answer: (2).

58. $Be(OH)_2$ is amphoteric in nature while rest all are alkaline earth metal hydroxide are ionic in Nature.

Answer: (4).

59.

$$\rho = \frac{ZM}{a^3 N_A}$$

$$9\times10^3 = \frac{4M}{\left(200\sqrt{2}\times10^{-12}\right)^3\times N_A}$$

$$M = \frac{9\times10^3\times\left(200\sqrt{2}\times10^{-12}\right)^3\times6\times10^{23}}{4}$$

$$M = 0.0305 \text{ kg mol}^{-1}$$

Answer: (2).

60. In cold water, dissolved oxygen (DO) can reach a concentration up to 10 ppm.
Answer: (1).

Section: Mathematics

61. We have,

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

$$\text{I.F.} = e^{\int\left(\frac{2x+1}{x}\right)dx} = e^{\int\left(2+\frac{1}{x}\right)dx}$$

$$= e^{2x+\ln x} = e^{2x}.x$$

Thus, $y^{(x.e^{2x})} = \int e^{-2x}.xe^{2x} + C$

$\Rightarrow xye^{2x} = \int x.dx + C$

$\Rightarrow xye^{2x} = \frac{x^2}{2}+C$

$\Rightarrow 2xye^{2x} = x^2+2C$

Since, it passes through $\left(1,\frac{1}{2}e^{-2}\right)$, we get, C = 0

$y = \frac{xe^{-2x}}{2}$

Therefore, $\frac{dy}{dx} = \frac{1}{2}e^{-2x}(-2x+1)$

So, $y(x)$ is decreasing in $\left(\frac{1}{2},1\right)$

Hence, $y(\log_e 2) = \frac{(\log_e 2)e^{-2}(\log_e 2)}{2} = \frac{1}{8}\log_e 2$

Answer: (3).

62. We have

$$I = \int_{-2}^{2}\frac{\sin^2 x}{\left[\frac{x}{\pi}\right]+\frac{1}{2}}\,dx$$

$$= \int_0^2 \left(\frac{\sin 2x}{\left[\frac{x}{\pi}\right] + \frac{1}{2}} + \frac{\sin^2(-x)}{\left[\frac{-x}{\pi}\right] + \frac{1}{2}} \right) dx \qquad \left(\text{Since} \left[\frac{x}{\pi}\right] + \left[-\frac{x}{\pi}\right] = -1 \text{ as } x \neq n\pi \right)$$

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

$$\Rightarrow I = 0$$

Answer: (2).

63. We have

$$\int \frac{\sqrt{1-x^2}}{x^4} dx = A(x)(\sqrt{1-x^2})^m + C$$

$$\int \frac{\sqrt{1-x^2}}{x^4} dx = \int \frac{\sqrt{\frac{1}{x^2} - 1}}{x^3} dx$$

Let $\frac{1}{x^2} - 1 = t \Rightarrow \frac{dt}{dx} = \frac{-2}{x^3}$

Case-I: $x \geq 0$

$$-\frac{1}{2}\int \sqrt{t}\, dt \Rightarrow \frac{-t^{3/2}}{3} + C$$

$$\Rightarrow -\frac{1}{3}\left(\frac{1}{x^2} - 1\right)^{3/2} \Rightarrow \frac{(\sqrt{1-x^2})^3}{-3x^2} + C$$

$$A(x) = -\frac{1}{3x^2}$$

$m = 3$

$$\{A(x)\}^m = \left(-\frac{1}{3x^3}\right)^3 = -\frac{1}{27x^9}$$

Case – II: $x \leq 0$

$$\frac{(\sqrt{1-x^2})^3}{-3x^3} + C$$

$A(x) = \frac{1}{-3x^3}$, $m = 3$

$$\{A(x)\}^m = \frac{-1}{27x^9}$$

Answer: (3).

64. Let us suppose the common ratio be r.

Thus,

$$\frac{a_3}{a_1} = 25 \Rightarrow \frac{ar^2}{a} = 25$$

$\Rightarrow r^2 = 25 \quad \Rightarrow \quad r = 5$

Therefore, $\frac{a_9}{a_5} = \frac{ar^8}{ar^4} = \frac{a(5)^8}{a(5)^4} = 5^4$

Answer: (3).

65. It is given *q* is false and $(p \wedge q) \leftrightarrow r$ is true.

$\Rightarrow$ $p \wedge q$ is false which implies that *r* is false

$\Rightarrow$ *q* is false and *r* is false

$\Rightarrow$ $(p \wedge r)$ is always false

$\Rightarrow$ $(p \wedge r) \to (p \vee r)$ is tautology

Answer: (1).

66. We have

$$\left(-2-\frac{i}{3}\right)^3 = \left(\frac{(-6+i)}{3}\right)^3 = -\frac{(6-i)^3}{27}$$

$$\Rightarrow \frac{-1}{27}(6+i)^3 = \frac{-1}{27}(216+108i+18i^2+i^3)$$

$$\Rightarrow \frac{-1}{27}(198+107i) = \frac{x+iy}{27}$$

Thus, $x = -198$

$y = -107$

Therefore, $y - x = -107 - (-198) = 91$

Answer: (3).

67. Equation of general tangent on ellipse is

$$\frac{x}{a\sec\theta} + \frac{y}{b\operatorname{cosec}\theta} = 1$$

Given equation, $x^2 + 2y^2 = 2$

Dividing by 2 both the sides, we get

$$\frac{x^2}{2} + \frac{2y^2}{2} = \frac{2}{2}$$

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

Thus, $a = \sqrt{2}, b = 1$

Now, $\dfrac{x}{\sqrt{2}\sec\theta} + \dfrac{y}{\operatorname{cosec}\theta} = 1$

Let the mid-point be (*h*, *k*).

$$h = \frac{\sqrt{2}\sec\theta}{2} \Rightarrow \cos\theta = \frac{1}{\sqrt{2}h}$$

And, $$k = \frac{\operatorname{cosec}\theta}{2} \Rightarrow \sin\theta = \frac{1}{2k}$$

Since, $$\sin^2\theta + \cos^2\theta = 1$$

$$\Rightarrow \frac{1}{2k^2} + \frac{1}{4k^2} = 1$$

Hence, required equation of curve is $\dfrac{1}{2x^2} + \dfrac{1}{4y^2} = 1.$

Answer: (1).

68. Let the first term and common ratio of G.P be *a* and *r* respectively.

Since, $|r| < 1$ then

$$\frac{a}{1-r} = 3$$

$$\Rightarrow a = 3(1 - r) \qquad (1)$$

Now, $\frac{a^3}{1-r^3} = \frac{27}{19}$

$$\Rightarrow 19a^3 = 27(1 - r^3) \qquad (2)$$

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

$$19.27(1-r)^3 = 27(1-r^3)$$

$$\Rightarrow 19(1 - 2r + r^2) = (1 + r + r^2)$$

$$\Rightarrow 19 - 38r + 19r^2 = 1 + r + r^2$$

$$\Rightarrow 18r^2 - 39r + 18 = 0$$

$$\Rightarrow 3(6r^2 - 13r + 6) = 0$$

$$\Rightarrow 6r^2 - 9r - 4r + 6$$

$$\Rightarrow 3r(r - 3) - 2(r - 3)$$

$$\Rightarrow (3r - 2)(r - 3)$$

Thus, $r = \frac{2}{3}, r = 3$

But $|r| < 1$

Hence, $r = \frac{2}{3}$

Answer: (4).

69. We have

$$\text{R.H.L.} = \lim_{x\to 0^+} \tan(\pi \sin^2 x) + (|x| - \sin(x[x]))^2$$

(as $x \to 0^+ \Rightarrow [x] = 0$)

$$= \lim_{x\to 0^+} \frac{\tan(\pi \sin^2 x) + x^2}{x^2}$$

$$= \lim_{x\to 0^+} \frac{\tan(\pi \sin^2 x)}{(\pi \sin^2 x)} + 1 = \pi + 1$$

$$\text{L.H.L} = \lim_{x\to 0^-} \frac{\tan(\pi \sin^2 x) + (-x + \sin x)^2}{x^2}$$

(as $x \to 0^- \Rightarrow [x] = -1$)

$$\lim_{x\to 0^+} \frac{\tan(\pi \sin^2 x)}{\pi \sin^2 x} . \frac{\pi \sin^2 x}{x^2} + \left(-1 + \frac{\sin x}{2}\right)^2 = \pi$$

Since, R.H.L ≠ L.H.L

Therefore, the limit does not exist.

Answer: (1).

70. Given function

$$|f(x)| = \begin{cases} 1, & -2 \le x < 0 \\ 1 - x^2, & 0 \le x < 1 \\ x^2 - 1, & 1 \le x \le 2 \end{cases}$$

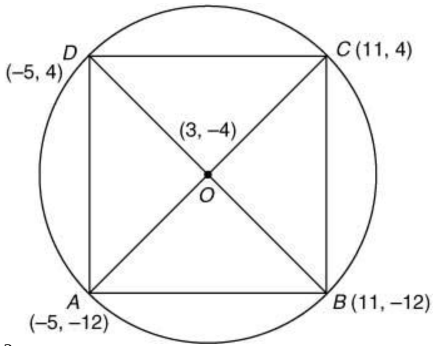
And, $|f(x)| = x^2 - 1, x \in [-2, 2]$

$$g(x)=\begin{cases} x^2, & x\in[-2,0] \\ 0, & x\in[0,1] \\ 2(x^2-1), & x\in[1,2] \end{cases}$$

Hence, it is not differentiable at x = 1.

Answer: (3).

71.



Equation of the circle is $x^2 + y^2 - 6x + 8y - 103 = 0$

$\Rightarrow (x-3)^2 + (y+4)^2 = 103 + 9 + 16$

$\text{Radius} = \sqrt{9+16+103} = \sqrt{128} = 8\sqrt{2}$

Distance of vertex A from the origin $= \sqrt{(-5-0)^2+(-12-0)^2}$ = 13

Distance of vertex B from the origin $= \sqrt{(11-0)^2+(-12-0)^2} = \sqrt{265}$

Distance of vertex C from the origin $= \sqrt{(11-0)^2+(4-0)^2} = \sqrt{137}$

Distance of vertex D from the origin $= \sqrt{(-5-0)^2+(4-0)^2}\ OD = \sqrt{41}$

Hence, vertex D is the nearest from the origin.

Answer: (3).

72. Since, A is orthogonal matrix

$\Rightarrow O^2 + P^2 + P^2 = 1$

$\Rightarrow |P| = \frac{1}{\sqrt{2}}$

Answer: (4).

73. Let the equation of plane be $a(x-0) + b(y+1) + c(z-0) = 0$.

It passes through (0, 0, 1) then

$b + c = 0$ (1)

Now, $\cos\frac{\pi}{4} = \frac{a(0)+b(1)+c(-1)}{\sqrt{2}, \sqrt{a^2+b^2+c^2}}$

$\Rightarrow a^2 = -2bc$ and $b = -c$

$\Rightarrow a^2 = 2c^2$

$a = \pm\sqrt{2}c$

Therefore, direction ratio $(a, b, c) = (\sqrt{2}, -1, 1)$

Answer: (*).

74. We have,

$f_4(x) - f_6(x)$

$= \frac{1}{4}(\sin^4 x + \cos^4 x) - \frac{1}{6}(\sin^6 x + \cos^6 x)$

$$= \frac{1}{4}\left(1 - \frac{1}{2}\sin^2 2x\right) - \frac{1}{6}\left(1 - \frac{3}{4}\sin^2 2x\right) = \frac{1}{12}$$

Answer: (2).

75. Since, sum of two number is even. So, either both are odd or both are even.

Therefore, number of elements in reduced samples space = ${}^5C_2 + {}^6C_2$

Hence, required probability $= \frac{{}^5C_2}{{}^5C_2 + {}^6C_2} = \frac{2}{5}$

Answer: (2).

76. Since, $[\vec{a}\ \vec{b}\ \vec{c}] = 0$

$$\Rightarrow \begin{vmatrix} 1 & 2 & 4 \\ 1 & \lambda & 4 \\ 2 & 4 & \lambda^2 - 1 \end{vmatrix} = 0$$

$\Rightarrow \lambda^3 - 2\lambda^2 - 9\lambda + 18 = 0$

$\Rightarrow \lambda^2 (\lambda - 2) - 9 (\lambda - 2) = 0$

$\Rightarrow (\lambda^2 - 9) (\lambda - 2) = 0$

$\Rightarrow \lambda = 2, 3, -3$

Thus, $\lambda = 2$ ($\vec{a}$ is parallel to $\vec{c}$ for $\lambda = \pm 3$)

Hence, $\vec{a} \times \vec{c} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & 2 & 4 \\ 2 & 4 & 3 \end{vmatrix}$

$\vec{a} \times \vec{c} = -10\hat{i} + 5\hat{j}$

Answer: (1).

77. The normal vector of required plane is $(2\hat{i} - \hat{j} + 3\hat{k}) \times (2\hat{i} + 3\hat{j} - \hat{k})$

$$= -8\hat{i} + 8\hat{j} + 8\hat{k}$$

So, direction ratio of normal is (−1, 1, 1).

Thus, required plane is

$-(x - 3) + (y + 2) + (2 - 1) = 0$

$\Rightarrow -x + y + z + 4 = 0$

Therefore, it is satisfied by (2, 0, −2).

Answer: (2).

78. We have $x \log_e (\log_e x) - x^2 + y^2 = 4$

Differentiating both the sides w.r.t. x, we get

$$\frac{d}{dx}[x\log_e(\log_e x) - x^2 + y^2] = \frac{d(4)}{dx}$$

$$\Rightarrow x.\frac{1}{\ln x}.\frac{1}{x} + \ln(\ln .x) - 2x + 2y\frac{dy}{dx} = 0$$

At $x = e$,

$$1 - 2e + 2y\frac{dy}{dx} = 0$$

$\Rightarrow \frac{dy}{dx} = \frac{2e^{-1}}{2y}$

$\Rightarrow \frac{dy}{dx} = \frac{2e-1}{2\sqrt{4+e^2}}$ As $y(e) = \sqrt{4+e^2}$

Answer: (2).

79. Here, $f(0) = 0$ and, $f(x)$ is odd.

If $x > 0$ then,

$f(x) = \frac{1}{x+\frac{1}{x}} \in \left(0, \frac{1}{2}\right)$

Hence, $f(x) \in \left[-\frac{1}{2}, \frac{1}{2}\right]$

Answer: (2).

80. Middle term $= T_5 = {}^8C_4 \times \frac{x^{12}}{81} \times \frac{81}{x^4} = 5670$

$\Rightarrow 70x^8 = 5670$

$\Rightarrow x^8 = 81$

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

Hence the value of x is 0.

Answer: (1).

81. We have,

$P_1 : 2x + 2y + 3z = 9$

$P_2 : 3x - y + 5z = 6$

$P_3 : x - 3y + 2z = c$

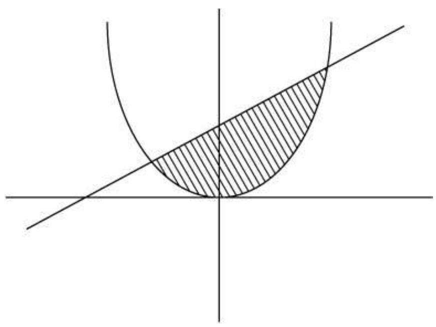
Thus, $P_1 = P_3 = P_2$

$\Rightarrow a + c = b$

$\Rightarrow b - a - c$

Answer: (1).

82.



We have $x = 4y - 2$ and $x^2 = 4y$

$\Rightarrow x^2 = x + 2 \Rightarrow x^2 - x - 2 = 0$

At $x = 2, -1$

Thus, $\int_{-1}^{2}\left(\frac{x+2}{4} - \frac{x^2}{4}\right)dx$

$= \frac{1}{4}\int_{-1}^{2}(x+2-x^2)dx = \frac{1}{4}\left[\frac{x^2}{2} + 2x - \frac{x^3}{3}\right]_{-1}^{2}$

$$= \frac{1}{4}\left[\left(\frac{4}{2}+4-\frac{8}{3}\right)-\left(\frac{1}{2}-2+\frac{1}{3}\right)\right]$$

$$= \frac{1}{4}\left[\left(6-\frac{8}{3}\right)-\left(\frac{5}{6}-2\right)\right]$$

$$= \frac{1}{4}\left[\frac{10}{3}+\frac{7}{6}\right] = \frac{1}{4}\times\frac{27}{6} = \frac{9}{8}$$

Answer: (1).

83. Let α be a root so, other root is α^3.

Thus,

$$\alpha^4 = \frac{256}{81}$$

$$\alpha = \pm\frac{4}{3}$$

Now, $\frac{-k}{81} = \alpha + \alpha^3$

$$k = -81(\alpha+\alpha^3)$$

$$\Rightarrow k = -81\left(\frac{4}{3}+\frac{64}{27}\right)$$

$$\Rightarrow k = -\frac{81(36+64)}{27}$$

$\Rightarrow k = -300$

Answer: (1).

84. Suppose that centres of circles are $(C, 0)$ and $(-C, 0)$

Equations of circles are $(x-1)^2 + (y-0)^2 = C^2 + 1$ and $(x+1)^2 + (y-0)^2 = C^2 + 1$

Equations of circles are $x^2 + y^2 - 2x + 1 = 0$ and $x^2 + y^2 + 2x + 1 = 0$

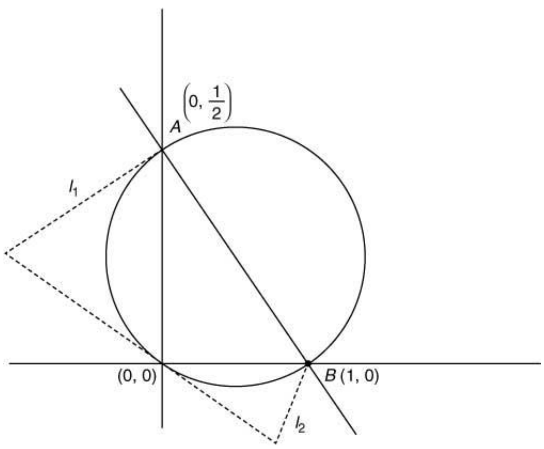
Since, circle are orthogonal so, $2(C)(-C) + (0)(0) = (-1) + (-1)$

$C^2 = 1 \quad \Rightarrow C \pm 1$

Therefore, distance between $(-1, 0)$ and $(1, 0)$ is 2.

Answer: (3).

85.



Equation of circle is

$$(x-1)(x-0)+(y-0)\left[y-\frac{1}{2}\right]=0$$

$x^2 + y^2 - x - \frac{y}{2} = 0$

Equation of tangent of origin is $2x + y = 0$

$l_1 + l_2 = \frac{2}{\sqrt{5}} + \frac{1}{2\sqrt{5}}$

$= \frac{4+1}{2\sqrt{5}} = \frac{5}{2\sqrt{5}}$

$= \frac{58}{2\sqrt{5}} \times \frac{2\sqrt{5}}{2\sqrt{5}} = \frac{10\sqrt{5}}{4\times 5} = \frac{\sqrt{5}}{2}$

Answer: (3).

86. Let a, b, c be the three sides.

It is given that $a + b = x$ and $ab = y$

If $x^2 - c^2 = y$

$\Rightarrow (a + b)^2 - c^2 = ab$

$\Rightarrow a^2 + b^2 + 2ab - c^2 = ab$

$\Rightarrow a^2 + b^2 - c^2 = -ab$

$\Rightarrow \frac{a^2 + b^2 - c^2}{2ab} = \frac{-1}{2}$

$\Rightarrow \cos c = \frac{-1}{2}$

Now, $\frac{c}{\sin c} = 2R = \frac{2c}{\sqrt{3}}$

$\Rightarrow R = \frac{c}{\sqrt{3}}$

Answer: (1).

87. Let the equation of tangent to parabola $y^2 = 4x$ be $y = mx + \frac{1}{m}$.

Since it is tangent to $xy = 2$

$x\left(mx + \frac{1}{m}\right) = 2$

$\Rightarrow x\left(\frac{m^2x + 1}{m}\right) = 2$

$\Rightarrow m^2x^2 + x = 2m$

$\Rightarrow m^2x^2 + x - 2m = 0$

$D = 0 \quad \Rightarrow m = \frac{-1}{2}$

Therefore, tangent is $2y + x + 4 = 0$.

Answer: (2).

88. $S = \{x \in R : x^2 + -11x \le 0\}$

$= \{x \in R, 5 \le x \le 6\}$

(Since, if $x^2 + 30 - 11x = 1$ ($x = 5, 6$))

$f(x) = 3x^3 - 18x^2 + 27x - 40$

$f'(x) = 9(x-1)(x-3)$

Since, $f'(x)$ is positive for $x = 5$ and 6; and $f(x)$ is increasing in $x = 5$ and 6.

Hence, the maximum value will be

$f(6) = 3(6)^3 - 18(6)^2 + 27(6) - 40 = 122$.

Answer: (4).

89. Variance is independent of origin. So, we shift the given data by $\frac{1}{2}$.

Thus, $\frac{10d^2 + 10 \times 0^2 + 10d^2}{30} - (0)^2 = \frac{4}{3}$

$\Rightarrow \frac{10d^2 + 10d^2}{30} = \frac{4}{3}$

$\Rightarrow 60d^2 = 120$

$\Rightarrow d^2 = 2$

$\Rightarrow |d| = \sqrt{2}$

Answer: (3).

90. Given sum = Coefficient of x^r in the expansion of $(1 + x)^{20} (1 + x)^{20}$

which is equal to ${}^{40}C_r$

It is maximum when $r = 20$.

Answer: (3).