JEE Main 2019 Paper 1
January 10, Shift 2
Section: Physics

1. Color code of Orange = 3
Color code of Red = 2
Color code of Brown = 10
So, $R_1 = 32 \times 10 = 320\ \Omega$
The balanced condition of wheat stone bridge is

$$\frac{R_1}{R_3} = \frac{R_2}{R_4}$$

$$\Rightarrow \frac{320}{R_3} = \frac{80}{40}$$

$$\Rightarrow R_3 = \frac{320 \times 40}{80} = 160$$

$$R_3 = (\underset{\text{Brown}}{1} \times 10 + \underset{\text{Blue}}{6}) \times \underset{\text{Brown}}{10}$$

Hence, the color code is Brown, Blue, Brown.
Answer: (1).

2. $Ne^2 \rightarrow {}_2He^4 + C^{12}$
Amount of energy
ΔE = 2 × (Binding energy of He^4) + (Binding energy of C^{10}) – (Binding energy of Ne^{20})
= 2 × (4 × 7.07) + (12 × 7.86) – (20 × 8.03)
= 56.56 + 94.32 – 160.6
= −9.72 MeV
Hence, the energy of 11.9 MeV has to be supplied.
Answer: (4).

3. Let μ be the magnetic moment, M masses of hoop and solid cylinder and R is the radius of hoop and solid cylinder.
Oscillation period of hoop is

$$T_h = 2\pi\sqrt{\frac{I_h}{\mu B}}$$

$$\Rightarrow T_h = 2\pi\sqrt{\frac{MR^2}{(2\mu)B}} \qquad (1) \qquad [T_h = MR^2]$$

Oscillation period of cylinder is

$$T_c = 2\pi\sqrt{\frac{I_c}{\mu B}}$$

$$\Rightarrow T_c = 2\pi\sqrt{\frac{\frac{1}{2}MR^2}{\mu B}} \qquad \left[I_c = \frac{1}{2}MR^2\right]$$

$$T_c = 2\pi\sqrt{\frac{MR^2}{2\mu B}} \qquad (2)$$

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

$$\frac{T_h}{T_c} = \frac{2\pi\sqrt{\frac{MR^2}{2\mu B}}}{2\pi\sqrt{\frac{MR^2}{2\mu B}}}$$

$$\Rightarrow \frac{T_h}{T_c} = 1$$

$$\Rightarrow T_h = T_c$$

Answer: (1).

4. Let s be the specific heat of unknown metal.
We have stabilized temperature is 21.5 °C
$192 \times s \times (100 - 21.5) = 128 \times 392 \times (21.5 - 8.1) + 240 \times 42$
$\Rightarrow 15072 \times s = 657305.6 - 132048\ (21.5 - 8.4)$
$\Rightarrow s = 916\ \text{J kg}^{-1}\ \text{K}^{-1}$
Answer: (3).

5. Applying parallel axis theorem for ball

$$I_b = \frac{2}{5}MR^2 + M(2R)^3$$

$$= \frac{2}{5}MR^2 + 4MR^2$$

$$= \frac{22}{5}MR^2$$

Moment of Inertia of two balls $= 2 \times \frac{22}{5}MR^2$

$$= \frac{44MR^2}{5}$$

Moment inertia of rod $I_r = \frac{M(2R)^2}{R}$

$$= \frac{4MR^2}{12}$$

$$= \frac{4MR^2}{12} = \frac{MR^2}{3}$$

Moment of inertia of whole system is

$$I_s = I_b + I_\lambda$$

$$= \frac{44}{5}MR^2 + \frac{MR^2}{3}$$

$$= MR^2\left[\frac{44}{5} + \frac{1}{3}\right] = \frac{137}{15}MR^2$$

Answer: (1).

6. Induced emf, $L\frac{di}{dt} = 25$

$$\Rightarrow \frac{L \times (25 - 10)}{1} = 25$$

$$\Rightarrow \frac{L \times 15}{1} = 25$$

$$\Rightarrow L = \frac{25}{15} = \frac{5}{3}$$

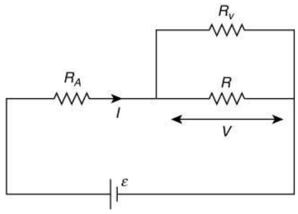
Therefore, change in energy of inductance is

$$\Delta E = \frac{1}{2} \times \frac{5}{3} \times (25^2 - 10)^2$$

$$= \frac{5}{6} \times 525 = 437.5 \text{ J}$$

Answer: (2).

7.



$$i = \frac{\varepsilon}{R_A + \frac{R_V R}{R_V + R}}$$

$$\Rightarrow i = \frac{\varepsilon (R_V + R)}{R_A (R_V + R) + R_V R}$$

$$\Rightarrow V = \frac{R_V R_\varepsilon}{(R_V + R)\left[R_A + \frac{R_V R}{R_V + R}\right]}$$

$$\Rightarrow V = \frac{R_V R_\varepsilon}{R_A R_V + R_A R + R_V R}$$

Now, $$R_{req} = \frac{V}{i}$$

$$\Rightarrow R_{req} = 30 - 30 \times \frac{5}{100}$$

$$= 30\left[1 - \frac{5}{100}\right]$$

$$= 30 \times \frac{95}{100} = 28.5$$

Thus, $$R_{req} = \frac{R_V R}{R_V + R}$$

$$\Rightarrow 28.5 = \frac{R_V R}{R_V + R}$$

$$\Rightarrow 28.5 = \frac{R_V \times 30}{R_V + 30} \qquad [R = 30\ \Omega]$$

$$\Rightarrow 28.5\ (R_V + 30) = R_V \times 30$$

$$\Rightarrow 28.5R_V + 28.5 \times 30 = 30R_V$$

$$\Rightarrow 28.5 \times 30 = 30R_V - 28.5R_V$$

$$\Rightarrow 28.5 \times 30 = 1.5R_V$$

$$\Rightarrow R_V = \frac{28.5 \times 30}{1.5} = 570\ \Omega$$

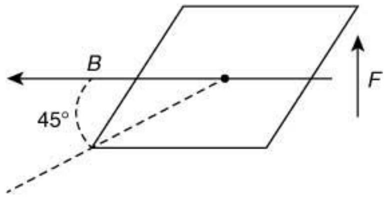
Answer: (2).

8. We have,

$$B_H = B_{Earth}\cos 45°$$

$$\Rightarrow B_H = B_{Earth}\frac{1}{\sqrt{2}}$$

$$\Rightarrow B_{Earth} = \sqrt{2}\,B_H$$



$$\mu B_{Earth}\sin 45° = F\times\frac{l}{2}\times\sin 45°$$

Therefore, $F = 2\mu B_{Earth}$

$= 2 \times 1.8 \times 18 \times 10^{6}$

$= 64.8 \times 10^{-6}$

$= 6.5 \times 10^{-5}$ N

Answer: (4).

9. We know that

$$\left|\vec{A}+\vec{B}\right|^2 = A^2 + B^2 + 2AB\cos\theta$$

and

$$\left|\vec{A}-\vec{B}\right|^2 = A^2 + B^2 - 2AB\cos\theta$$

According to the question

$$\left|\vec{A}+\vec{B}\right| = n\left|\vec{A}-\vec{B}\right|$$

Squaring both the sides, we get

$\left|\vec{A}+\vec{B}\right| = n^2\left|\vec{A}-\vec{B}\right|^2$

$\Rightarrow A^2 + B^2 + 2AB\cos\theta = n^2(A^2 + B^2 - 2AB\cos\theta)$

$\Rightarrow A^2 + B^2 + 2B\cos\theta = n^2A^2 + n^2B^2 - 2n^2AB\cos\theta$

$\Rightarrow 2AB\cos\theta + 2n^2A\cos\theta = n^2A^2 - A^2 + n^2B^2 - B^2$

$\Rightarrow \cos\theta \times 2AB(1 + n^2) = (n^2 - 1)A^2 + (n^2 - 1)B^2$

$= (n^2 - 1)(A^2 + B^2)$

$$\Rightarrow \cos\theta = \frac{(n^2-1)A^2+B^2}{(1+n^2)2AB}$$

$$= \frac{(n^2-1)2B^2}{(1+n^2)2B^2} \qquad [A = B]$$

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

Answer: (1).

10. Energy incident on plate per second = IA

$= 1.6 \times 10^{-3} \times 1 \times 10^{-4}$

$= 1.6 \times 10^{-7}$ W

Kinetic energy

$$K = hv - \phi$$

$= 10 - 5 = 5$ eV

Now,

$$\frac{Nhc}{\lambda} = 1.6 \times 10^{-7}$$

$$\Rightarrow N = \frac{1.6^{-7}}{10 \times 1.6 \times 10^{-19}} = 10^{11}$$

Therefore, number of emitted electrons per second $= N \times \frac{10}{100}$

$$= 10^{11} \times \frac{10}{100} = 10^{10}$$

Answer: (4).

11. Work done $= \vec{F} \cdot \vec{d}$

$$= (3\hat{i} - 12\hat{j}) \cdot (4\hat{i})$$

$$= 12 \text{ J}$$

According to work-energy theorem

$W = \Delta\text{KE}$

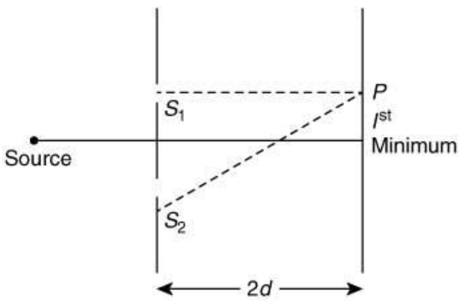
$\Rightarrow W = K_f - K_i$

$\Rightarrow 12 = K_f - 3$

$\Rightarrow K_f = 12 + 3 = 15$ J

Answer: (4).

12.



At point P we have

$$\Delta x = \sqrt{5d} - 2d$$

$$= d(\sqrt{5} - 2)$$

For first minima we know that,

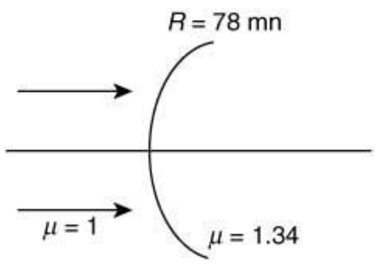
$$\Delta x = \frac{\lambda}{2}$$

$$\Rightarrow d(\sqrt{5} - 2) = \frac{\lambda}{2}$$

$$\Rightarrow d = \frac{\lambda}{2(\sqrt{5} - 2)}$$

Answer: (1).

13. We have $\frac{\mu_r}{v} - \frac{\mu_i}{u} = \frac{\mu_r - \mu_i}{R}$



It is given that

$u = -\infty,\ \mu_r = \frac{4}{3} = 1.34,\ R = 7.8$ mm

$$\Rightarrow \frac{4}{3v} - \frac{\mu_i}{\infty} = \frac{4/3 - 1}{7.8}$$

$$\Rightarrow \frac{4}{3v} - 0 = \frac{\frac{4-3}{3}}{7.8}$$

$$\Rightarrow \frac{4}{3v} = \frac{1}{3 \times 7.8}$$

$\Rightarrow v = 4 \times 7.8$

$= 31.2$ mm $= 3.1$ cm

Answer: (4).

14. Power

$$P = i^2R$$

$$4.4 = (2)^2 \times 10^{-6} \times R$$

$$\Rightarrow R = \frac{4.4}{(2)^2 \times 10^{-6}}$$

$$\Rightarrow R = 1.1 \times 10^6$$

Now, dissipated power is

$$P_D = \frac{(11)^2}{R}$$

$$= \frac{11 \times 11}{1.1 \times 10^6} = 11 \times 10^{-5}\ \text{W}$$

Answer: (1).

15. Diameter, $D + \Delta D = 12.6 \pm 0.1$ cm

height, $h + \Delta h = 34.2 \pm 0.1$ cm

Volume of cylinder, $V = \pi r^2 h$

$$= \frac{\pi d^2 h}{4}$$

$$= \frac{\pi}{4} \times (12.6)^2 \times 34.2$$

$$= 4262.229 = 4260$$

$$\Rightarrow \frac{\Delta V}{V} = \frac{2dD}{D} + \frac{\Delta h}{h}$$

$$\Rightarrow \Delta V = \left[2 \times \frac{0.1}{12.6} + \frac{0.1}{34.2}\right] \times 4266$$

$\Rightarrow \Delta V = 80$

$\Rightarrow V + \Delta V = 4260 \pm 80\ \text{cm}^3$

Answer: (3).

16. Potential at origin is

$$V_A = \frac{kQ}{2} + \frac{kQ}{2} + \frac{kQ}{\sqrt{2^2 + 4^2}} + \frac{kQ}{\sqrt{2^4 + 4^2}}$$

$$= \frac{kQ}{2} + \frac{kQ}{2} + \frac{kQ}{\sqrt{20}} + \frac{kQ}{\sqrt{20}}$$

$$= 2 \cdot \frac{kQ}{2} + 2 \cdot \frac{kQ}{2\sqrt{5}}$$

$$= kQ\left(1 + \frac{1}{\sqrt{5}}\right)$$

Now, work done, $W = q\Delta V$

$$= q[V_A - V_\infty] \qquad [V_\infty = 0]$$

$$= qV_A$$

$$= q\,kQ\left(1 + \frac{1}{\sqrt{5}}\right)$$

$$= \frac{Q^2}{4\pi\varepsilon_0}\left(1 + \frac{1}{\sqrt{5}}\right) \qquad \left[k = \frac{1}{4\pi\varepsilon_0}\right]$$

Answer: (2).

17. Amplitude modulated wave consist of three waves

f_c, $f_c - f_m$, $f_c + f_m$, $f_c - f_m$ and $f_c + f_m$ are side band frequency

$f_c = 250 \times 10 = 2500$ kHz

$\Rightarrow f_c + f_m = 2500 + 250 = 2750$ kHz

$\Rightarrow f_c - f_m = 2500 - 250 = 2250$ kHz

For accepted frequency, two bandwidths do not overlap

$f_2 = f_c + 2f_m = 3000$ kHz

or

$f_2 = f_c - 2f_m = 200$ kHz

Answer: (4).

18. For closed organ pipe, resonate frequency is

$$f = (2n-1)\frac{v}{4l}$$

$$\Rightarrow f = (2n-1)\frac{v}{4l}$$

$$\Rightarrow f = (n - 1) \times 1500$$

f_{max} for audible frequency = 20,000 Hz

$$(2n-1) < \frac{200}{15}$$

$$\Rightarrow 2n-1 < \frac{40}{3}$$

$$\Rightarrow 2n - 1 = 13.33$$

$$\Rightarrow 2n < 13.33 + 1$$

$$\Rightarrow 2n < 14.33$$

$$\Rightarrow n < 7.16$$

$$\Rightarrow n = 7$$

Therefore, number of overtone = $n - 1$

$= 7 - 1 = 6$

Answer: (1).

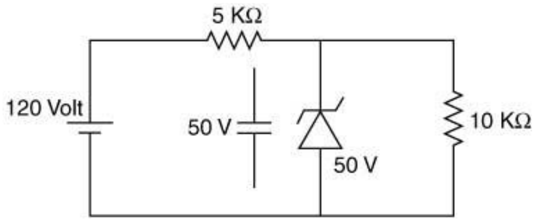
19. If Zener diode does not undergo breakdown

$$V_1 = 120 - 50$$

$$= 70$$

$$\Rightarrow V = IR$$

$$70 = I \times 5 \times 10^3$$



Now, $I = \frac{70}{5\times10^3}$ = 14 mA

V_1 = 50 V

$V_1 = I_1 R$

$50 = 10 \times 10^3 \times I_1$

$\Rightarrow I = \frac{50}{10\times10^3}$ = 4 mA

Current through diode is

$I_2 = I - I_1$

= 14 – 5= 9 mA

Answer: (1).

20. Electric field is

$$E = 10\hat{j}\cos(6x + 8z)$$

$$= 10\hat{j}\cos[(6\hat{i} + 8\hat{k})(x\hat{i} - z\hat{k})]$$

$$= 10\hat{j}\cos[\vec{k}\,.\,\vec{r}]$$

Since, $\vec{k} = 6\hat{i} + 8\hat{k}$ is direction of waves

So, direction of $\hat{B}$ will be along

$$\hat{c}\times\hat{E} = \frac{6\hat{i} + 8\hat{k}}{\sqrt{3b + 64}} = \frac{6\hat{i} + 8\hat{k}}{10}$$

Let $\vec{B} = a\hat{i} - b\hat{j} + d\hat{k}$ and unit vector in direction of propagation of EM wave is

$$\frac{\vec{E}\times B}{\left|\vec{E}\right|\left|\vec{B}\right|} = \frac{6\hat{i} + 8\hat{k}}{10}$$

$$\Rightarrow \frac{10d\hat{i} + \hat{k}(-10a)}{10\sqrt{a^2 + b^2 + d^2}} = \frac{6\hat{i} + 8\hat{k}}{10}$$

$$\Rightarrow \left|\vec{B}\right| = \frac{E}{c} = \frac{10}{c}$$

$$\Rightarrow \frac{c[10d\hat{i} - 10a\hat{k}]}{10\times10} = \frac{6\hat{i} + 8\hat{i}}{10}$$

$$\Rightarrow c\left|d\hat{i} + a\hat{k}\right| = 6\hat{i} + 8\hat{k}$$

Thus, $d = \frac{6}{c}, a = \frac{-8}{C}$

$$\vec{B} = \frac{-8}{c}\hat{i} + \frac{6}{c}\hat{k}$$

Therefore, $B = \frac{6\hat{k} - 8\hat{i}}{c}\cos(6x + 8z - 10ct)$

Answer: (2).

21. Electric field on equatorial plane of dipole is $F = QE$

At P, $F = \frac{KP}{y^3}Q$ (1)

At P′, $F' = \frac{KP}{(y/3)^3}Q$

$$\Rightarrow F' = \frac{27KPQ}{y^3} \quad (2)$$

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

$$\frac{F'}{F} = \frac{\frac{27KPQ}{y^3}}{\frac{KPQ}{y^3}}$$

$$\Rightarrow \frac{F'}{F} = 27$$

$$\Rightarrow F' = 27F$$

Answer: (4).

22. We have, $d = 2 \times 10^{11}$

So, $R = \frac{d}{2} = \frac{2\times10^{11}}{2} = 10^{11}$

Let v be the minimum speed of no meteorite.

$$\frac{1}{2}mv^2 + m\left[\frac{-GM}{r} - \frac{GM}{r}\right] = 0$$

$$\Rightarrow \frac{1}{2}mv^2 - \frac{2GMm}{r} = 0$$

$$\Rightarrow \frac{1}{2}mv^2 = \frac{2GMm}{r}$$

$$\Rightarrow v = \frac{4GM}{r}$$

$$= \frac{4\times6.67\times3\times10^{-11}\times10^{31}}{10^{11}}$$

$$\Rightarrow v = 2.8 \times 10^5 \text{ m/s}$$

Answer: (4).

23. We have,

R = 1 atm, n = 0.5

T_1 = 20 °C, T_2 = 90 °C

Therefore, work done = $P\Delta V = nR\Delta T$

$= nR(T_2 - T_1)$

= 0.5 × 8.31 × (90 – 20)

= 0.5 × 8.31 × 70 = 291 J

Answer: (2).

24. Initial energy of capacitor

$$U_i = \frac{1}{2}\frac{Q^2}{C}$$

$$= \frac{1}{2}\times\frac{120\times120}{12} \qquad [Q = CV = 12\times10\,\text{pC} = 120\,\text{pC}]$$

= 600 J

Since battery is disconnected so charge remains same.

Final energy of capacitor is

$$U_f = \frac{1}{2}\frac{Q^2}{C}$$

$$= \frac{1}{2} \times \frac{120 \times 120}{12 \times 6.5} = 92 \text{ J}$$

Therefore, work done is

$$W = U_i - U_f$$

$$= 600 - 92 = 508 \text{ pJ}$$

Answer: (2).

25. As we know that, area under *v*-*t* curve gives displacement.

Therefore, area $= \Delta S = \frac{1}{2} \times 2 \times 2 + 2 \times 2 + 3 \times 1$

$$= \frac{1}{2} \times 4 + 4 + 3 = 2 + 4 + 3 = 9 \text{ m}$$

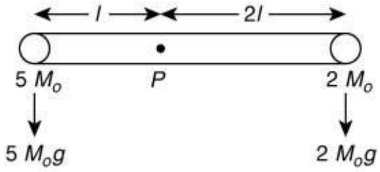
Answer: (4).

26. We have,

$$\tau_p = 5\,M_0gl - 2\,M_0g \times 2l$$

$$= 5\,M_0gl - 4\,M_0gl$$

$$= M_0gl$$



$\Rightarrow \tau_p = I_p\alpha$

$\Rightarrow M_0gl = [5M_0l^2 + 2M_0 \times 4l^2]\alpha$

$\Rightarrow M_0gl = 13M_0l^2\alpha$

$\Rightarrow \alpha = \frac{g}{13l}$

Answer: (1).

27. Let θ be the angle P and Q

$$\left|\vec{P} + \vec{Q}\right|^2 = P^2 + Q^2 + 2PQ\cos\theta$$

$$= (2F)^2 + (3F)^2 + 2(2F)(3F)\cos\theta$$

$$= 4F^2 + 9F^2 + 12F^2\cos\theta$$

$$= F_R^2$$

Since, $Q = 2Q$

$$\left|\vec{P} + 2\vec{Q}\right|^2 = P^2 + 4Q^2 + 4PQ\cos\theta$$

$$= 4F^2 + 36F^2 + 24F^2\cos\theta$$

$$= 4F_R^2$$

Thus,

$F^2 + 9F^2 + 6F^2\cos\theta = 4F^2 + 9F^2 + 12F^2\cos\theta$

$\Rightarrow -3F^2 = 6F^2\cos\theta$

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

$\Rightarrow \theta = 120°$

Answer: (1).

28. We know that $B_F = \rho A h g$

And according to second law of motion we have

$ma = B - mg$

$\Rightarrow -ma = \rho A(h + \Delta h)g - \rho Ahg$

$\Rightarrow -ma = \rho Ag\Delta h$

$\Rightarrow a = \dfrac{-\rho Ag\Delta h}{m}$

Now, $\omega^2 = \dfrac{\rho Ag}{m}$

$\Rightarrow \omega = \sqrt{\dfrac{10^3 \times \pi(2.5)^2 \times 10^{-4} \times 10}{310 \times 10^{-6} \times 10^3}}$

$= \sqrt{63.60}$ = 7.95 rad s^{-1}

Answer: (*).

29. We have,

$$a = -\omega^2 x = -\omega^2 4$$

Now, $$v = \omega\sqrt{A^2 - x^2}$$

$$= \omega\sqrt{5^2 - 4^2}$$

Since, $$\omega^2 \times 4 = \omega \times 3$$

Angular velocity is $\omega = \dfrac{3}{4}$

Thus, $$\omega = \frac{2\pi}{T}$$

$$\Rightarrow T = \frac{2\pi}{\omega} = \frac{2\pi}{3/4} = \frac{8\pi}{3}\text{s}$$

Answer: (3).

30. $\text{Density} = \dfrac{\text{Mass}}{\text{Volume}}$

$\text{Volume} = \dfrac{\text{Mass}}{\text{Density}}$

$= \dfrac{2}{8} = \dfrac{1}{4} m^3$

Since, $PV = nRT$

$\Rightarrow 4 \times 10^4 \times \dfrac{1}{4} = nRT$

$\Rightarrow 10^4 = nRT$

Thus, internal energy $= \dfrac{3}{2} nRT = \dfrac{3}{2} \times 10^4$

$= 15 \times 10^4$ J

Therefore, order is 10^4 J.

Answer: (3).

Section: Chemistry

31. The energy for the n^{th} orbital of the hydrogen atom is

$$(E_n)^{th} = (E_{Ground})_H \frac{Z^2}{n^2}$$

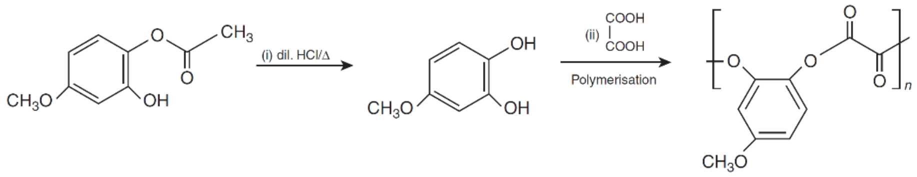
Energy for He^+ ($Z = 2$) in second excited state is

$$= (-13.6\ eV)\frac{2^2}{3} = -6.04\ eV$$

Answer: (3).

32. Gold sol is negatively charged sol and Hb is positively charged.
Answer: (1).

33. In first step of the reaction, aromatic ester will hydrolysis to given corresponding aromatic alcohol, then in second step, aromatic diol will polymerize with oxalic acid.



Answer: (1).

34. We know

$$\text{Molarity} = \frac{\text{No. of moles of solute}}{\text{Volume of solution in Liters}} = \frac{w}{M \times \text{Volume}}$$

$$0.1 = \frac{w}{342 \times 2}$$

$$w = 2 \times 342 \times 0.1 = 68.4\ g$$

Hence, 68.4 g of sugar is required to prepare 0.1 M sugar solution of volume up to 2 L.
Answer: (3).

35. Since I_2 is the least reactive halogen, so it required a catalyst (i.e., Pt) to react with H_2.

$$H_2 + I_2 \xrightarrow{Pt} 2HI$$

Answer: (1).

36. Decomposition of NH_4SH is

	NH_4SH (s) $\rightleftharpoons$	NH_3(g) +	H_2S (g)
Initally	0.1	0	0
At 30% dissocitaion	$0.1(1-0.3)$	0.1×0.3	0.1×0.3

Total moles at equilibrium = 0.03 + 0.03 = 0.06 moles
We know

$$p_{Total}V = nRT$$

$$p_{Total} = \frac{0.06 \times 0.082 \times 600}{3} = 0.984\ atm$$

Since, $p_{NH_3} = p_{H_2S} = \frac{p_{Total}}{2} = \frac{0.984}{2} = 0.492\ atm$

Therefore,

$$K_p = p_{NH_3} \times p_{H_2S}$$
$$= 0.492 \times 0.492 = 0.242 \text{ atm}^2$$

Answer: (4).

37. The following reactions involved in the ozone layer depletion in stratosphere:

(I) The upper stratosphere consists of O_3 which protect us from harmful U.V. from the Sun. (λ = 255 nm)

(II) When CFCs release $\dot{Cl}$ free radical

Then $CF_2Cl_2(g) \xrightarrow{hv} \dot{Cl} + \dot{C}F_2Cl$

(III) $\dot{Cl} + O_3 \rightarrow Cl\dot{O} + O_2$

(IV) $Cl\dot{O} + O \rightarrow \dot{Cl} + O_2$

Hence, the reaction of CH_4 with O_3 does not occur in the ozone layer depletion.

Answer: (3).

38. The half-cell reaction are:

At anode $\frac{1}{2}H_2(g) \rightarrow H^+(aq) + e^-$

At cathode $AgCl(s) + e^- \rightarrow Ag(s) + Cl^-(aq)$

So, overall reaction: $AgCl(s) + \frac{1}{2}H_2(g) \rightarrow Ag(s) + Cl^-(aq) + H^+(aq)$

We know,

$E^o_{cell} = E^o_{cathode} - E^o_{anode} = (S.R.P.)_{cathode} - (S.R.P)_{anode}$

Since standard hydrogen potential is zero.

So, $(S.R.P.)_{anode} = 0$

$(S.R.P)_{cathode} = x$

$E^o_{cell} = x$

Using Nernst equation

$$E_{cell} = E^o_{cell} - \frac{2.303\,RT}{nF}\log\left(\frac{[Cl^-][H^+]}{(p_{H_2})^{1/2}}\right)$$

$$E_{cell} = E^o_{cell} - 0.06 \times \log[Cl^-][H^+] \qquad (p_{H_2} = 1 \text{ bar})$$

$$0.92 = x - \frac{0.06}{1}\log[10^{-6} \times 10^{-6}]$$

$$\Rightarrow x = 0.20 \text{ V}$$

Answer: (4).

39. Electronic configuration of element X with atomic no. 71 is [Xe] $4f^{14}\,5d^1\,6s^2$

so, the last e^- is in $5d$ orbital.

Answer: (3).

40. The correct match of the compounds which can be detected by the reagents are as follow:

(A) → (Q): Lysine is an amino acid which give blue color compound on reaction with ninhydrin

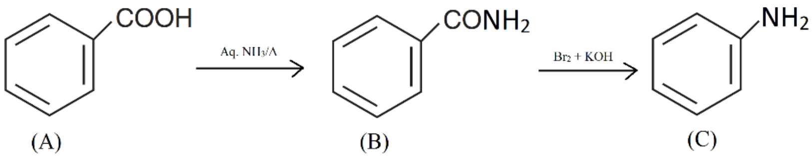
(B) → (P): Furfural is a heterocyclic aldehyde which on reaction with 1 – naphthol Molisch's reaction.

(C) → (S): Benzyl alcohol is a primary alcohol which give red color compound on reaction with ceric ammonia nitrate.

(D) → (R): Styrene can be oxidized by action of $KMnO_4$ to benzoic acid.

Answer: (1).

41. The reaction involved is



Answer: (1).

42. In synthesis of ammonia form N_2 and H_2

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

$$\Delta n_g = 2 - 4 = -2$$

Therefore, entropy change of the reaction is negative.

Answer: (4).

43. Work done of isothermal irreversible for ideal gas = $p_{ext}.(V_2 - V_1) = 4 \times (5 - 1) = 16$ Nm

We know

For isothermal process, $\Delta U = 0$

$$w = q = -16 \text{ J}$$

Heat used to increase temperature of 1 mole Al is

$$q = nC_m\Delta T$$

$$16 = 1 \text{ mol} \times 24 \text{ J mol}^{-1} \text{ K}^{-1} \times \Delta T$$

$$\Delta T = 2/3 \text{ K}$$

Answer: (3).

44. The relation between elevation in boiling point and depression in freezing point is

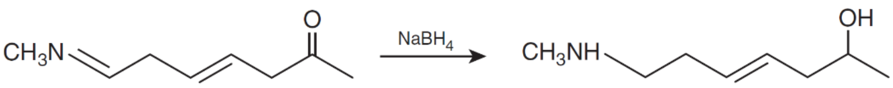
$$\frac{\Delta T_b}{\Delta T_f} = \frac{i \times m \times K_b}{i \times m \times K_f}$$

$$\frac{2}{2} = \frac{1 \times 1 \times K_b}{1 \times 2 \times K_f}$$

Hence, $K_b = 2K_f$

Answer: (4).

45. Since $NaBH_4$ reduces the keto-group to enol group and imine to amine but does not affect double bond.



Answer: (4).

46. The solvated e^- is responsible for a great deal of radiation chemistry of alkali metal dissolves in liquid ammonia gives blue color which is conducting mixture.

$$M + (x + y)NH_3 \longrightarrow [M(NH_3)_x]^+ + [e(NH_3)_y]^-$$

The blue color is due to ammoniated e^-s which absorb energy in the visible region of light.

Answer: (4).

47. For the reaction $A_2 \underset{k_{-1}}{\overset{k_1}{\rightleftharpoons}} 2A$

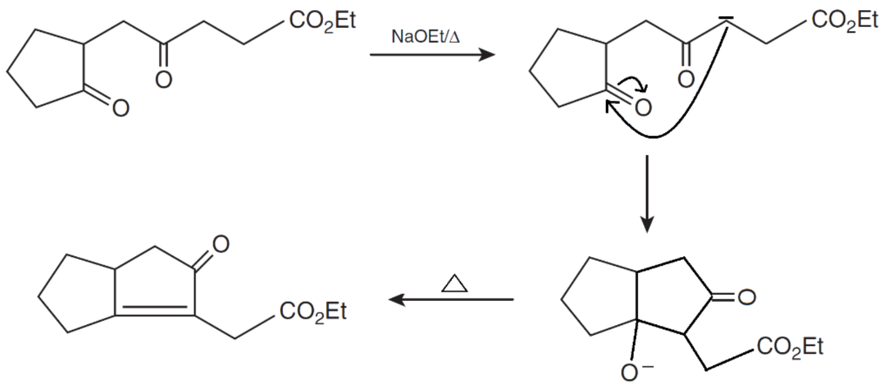
$$\frac{d[A]}{dt} = 2k_1[A_2] - 2k_{-1}[A]^2$$

Answer: (4).

48. Barfoed's test used for detecting the presence of monosaccharides. It is based on the reduction of copper (II) a chelate to copper (I) oxide, which forms a brick red ppt. While biuret test, ninhydrin, xanthoproteic are used for detecting amino acid.
Answer: (2).

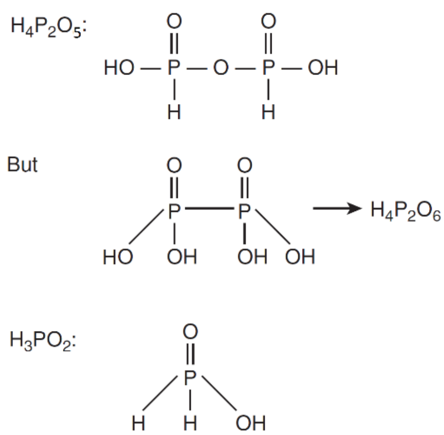
49. The electronic configuration Co^{2+} in high spin octahedral complexes is $t_{2g}^5\ e_g^2$; number of unpaired e^-s = 3.
Electronic configuration Co^{2+} in low spin octahedral complexes is $t_{2g}^6\ e_g^1$; number of unpaired e^-s = 1
Therefore, difference in unpaired electrons = 3 – 1 = 2
Answer: (3).

50. The reaction involved is



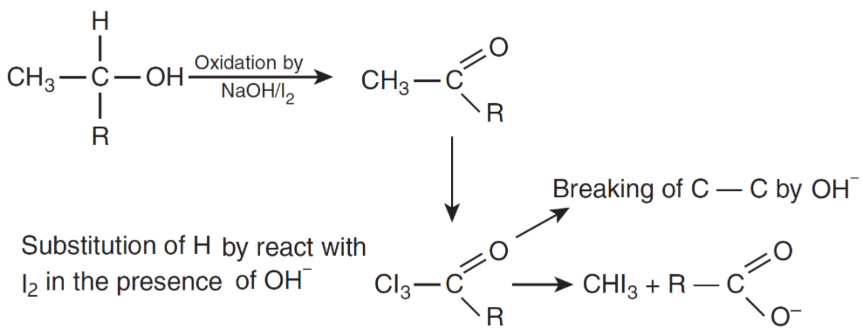
Answer: (4).

51. Since H_3PO_2 and $H_4P_2O_5$ contains 2P-H bonds



Answer: (2).

52. Since R is $CH_3 – CH = CH – CH_2 –$

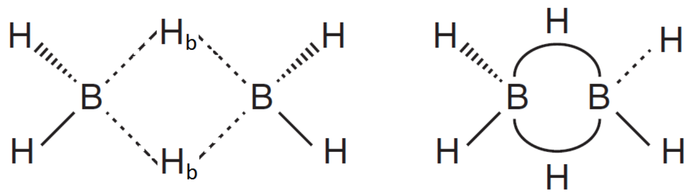


Answer: (2).

53. Since C = C have preference over halogen, therefore, the IUPAC nomenclature of the given compound is 4-Bromo-3-methylpent-2-ene.

Answer: (3).

54. Here H_b is the bridging hydrogen atom.



B_2H_6 have four 2-centre-2-electron bonds and two 3-centre-2-electron bonds.

Answer: (2).

55. The reaction is

$$2\,KMnO_4 + 5\begin{array}{c}COOH\\|\\COOH\end{array} + 3H_2SO_4 \longrightarrow K_2SO_4 + 2\,MnSO_4 + 10\,CO_2 + 8H_2O$$

In the above reaction, 5 oxalic acid molecules lose 10 electrons which taken by 2 moles of Mn^{7+} to produce 2 moles of Mn^{2+}. Therefore, 1 mole of electron produce 1 mole of CO_2.

Answer: (1).

56. The reaction involved is

$$CoCl_3 + \ 2C_2H_8N_2 \rightarrow [CoCl_2(en)_2]Cl$$

Now the possibility in two Cl^- ion can be either in *cis* or *trans* conformation.

Therefore, they are geometrical isomer in which *cis* isomer is optically active and *trans* is optically inactive.

Answer: (1).

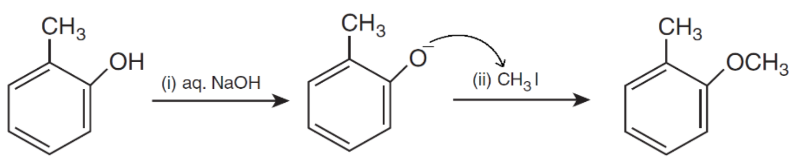
57. Electrolyte used for the electroplating of gold is the electrolyte contains gold metal, that is, $[Au(CN)_2]^-$ in the same way for electroplating of silver, electrolyte contain silver metal is used, that is, $[Ag(CN)_2]^-$.

Answer: (1).

58. Since A_2B_3 has a HCP lattice. If B form HCP lattice, then $1/3^{th}$ of tetrahedral voids must be occupied by A to form A_2B_3.

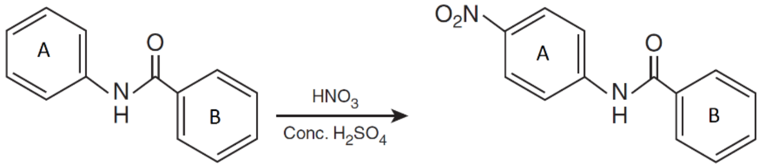
Answer: (4).

59. The reaction involved is



Answer: (2).

60. Ring A attached to nitrogen side is activated due to the electron donating nature of nitrogen, while ring B attached to carbonyl side is deactivated due to the electron withdrawing nature of carbonyl. Therefore, nitration will occur in the nitrogen attached ring A.



Answer: (4).

Section: Mathematics

61. Let $\lambda = \alpha$ and β, $\alpha + \beta = \lambda - 3$ and $\alpha\beta = 2 - \lambda$

$f(\lambda) = \alpha^2 + \beta^2$

$= (\alpha + \beta)^2 - 2\alpha\beta$

$= (\lambda - 3)^2 - 2(2 - \lambda)$

$= \lambda^2 + 9 - 6\lambda - 4 - 2\lambda$

$= \lambda^2 - 4\lambda + 5$

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

$= \lambda = 2$

Answer: (4).

62. We have,

$$2\sin\frac{\pi}{2^{10}}\cos\frac{\pi}{2^{10}}\cdots\cdots\cos\frac{\pi}{2^2}$$

$$\Rightarrow \frac{1}{2^9}\sin\frac{\pi}{2} = \frac{1}{512}$$

Answer: (1).

63. We have,

$(x^2 - y^2)dx + 2xy\,dy = 0$

$\Rightarrow x^2dx - y^2dx + 2xy\,dy = 0$

$\Rightarrow x^2dx = y^2dx - 2xy\,dy$

$$\Rightarrow -dx = d\left(\frac{y^2}{x}\right)$$

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

$\Rightarrow x^2 + y^2 + Cx = 0$

It passes through the point (1, 1).

So, $C = -2$

The equation is $x^2 - y^2 - 2x = 0$

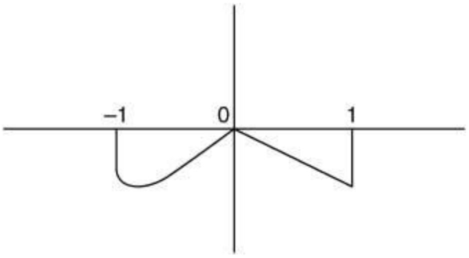
Hence, the required curve is a circle with centre on the x-axis.

Answer: (1).

64. We have,

$$f(x) = \max\left\{-|x|, -\sqrt{1-x^2}\right\}$$

Consider a graph



From the above graph, it can be concluded that $f(x)$ is non-derivable of $x = 0,\ \pm\frac{1}{\sqrt{2}}$ in (−1, 1).

Therefore, K has exactly three elements.

Answer: (3).

65. We have,

$$x^2\left({}^{10}C_r(\sqrt{x})^{10-r}\left(\frac{\lambda}{x^2}\right)^r\right) = x^2\left[{}^{10}C_r(x)\frac{10-r}{2}(\lambda)^2(x)^{-2r}\right]$$

$$= x^2\left[{}^{10}C_r\lambda^r\,\frac{10-5r}{x^2}\right]$$

Thus, $r = 2$

Hence, ${}^{10}C_2\ \lambda^2 = 720$

$\Rightarrow \lambda^2 = 16$

$\Rightarrow \lambda = \pm 4$

Answer: (1).

66. We have,

$y = x\,ex^2$

$$\Rightarrow \frac{dy}{dx}\Big|_{(1,e)} = (e.ex^2.2x + ex^2)\Big|_{(1,e)} = 2.e + e = 3e$$

Equation of tangent is $y - e = 3e\ (x - 1)$

$\Rightarrow\ y = 3ex - 3e + e$

$\Rightarrow\ y = (3e)x - 2e$

Therefore, $\left(\frac{4}{3}, 2e\right)$ lies on it.

Answer: (2).

67. Given,

$$f(n) = \begin{cases} \frac{n+1}{2} & \text{if } n \text{ is odd} \\ \frac{n}{2} & \text{if } n \text{ is even} \end{cases}$$

$$g(n) = n - (-1)^n \begin{cases} n+1: & n \text{ is odd} \\ n-1: & n \text{ is even} \end{cases}$$

$$f(g(n)) = \begin{cases} \frac{n}{2}; & \text{if } n \text{ is even} \\ \frac{n+1}{2}; & \text{if } n \text{ is odd} \end{cases}$$

Hence, $f(n)$ is onto but not one-one.

Answer: (1).

68. Given,

$x + 3y + 7z = 0$

$-x + 4y + 7z = 0$
$(\sin 3\theta)x + (\cos 2\theta)y + 2z = 0$
For non initial solutions, considering matrix

$$\begin{vmatrix} 1 & 3 & 7 \\ -1 & 4 & 7 \\ \sin 3\theta & \cos\theta & 2 \end{vmatrix} = 0$$

$\Rightarrow 4\sin^3\theta + 4\sin^2\theta - 3\sin\theta = 0$

$$\Rightarrow \sin\theta = 0, \frac{-1}{2}, \frac{-3}{2}$$

For $\theta \in (0, \pi)$

$\theta = \frac{\pi}{6}$ and $\frac{5\pi}{6}$ satisfying the equation.

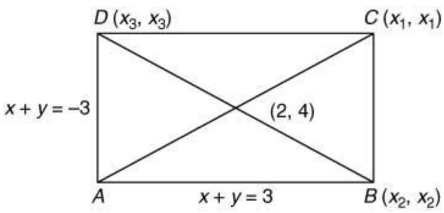
Therefore, 2 values of θ is possible.
Answer: (2).

69. Given,
$\vec{\alpha} = (\lambda - 2)\vec{a} + \vec{b}$
$\vec{\beta} = (4\lambda - 2)\vec{a} + 3\vec{b}$
For vectors $\vec{\alpha}$ and $\vec{\beta}$ are collinear if

$$\frac{\lambda - 2}{4\lambda - 2} = \frac{1}{3}$$

$\Rightarrow \lambda = -4$
Answer: (1).

70.



Solving $x + y = 3 > x - y = -3$ and $\frac{x_1 + 0}{2} = 2$; $x_i = 4$
Similarly,
$y_1 = 5$, $c = (4, 5)$
Now, equation of BC is
$x - y = -1$
Equation of CD is $x + y = 9$
Solving $x + y = 0$ and $x - y = -3$
Required point D is (3, 6).
Answer: (4).

71. We have,

$$\int_0^x f(t)dt = x^2 + \int_x^1 t^2 f(t)dt$$

Differentiating with respect to x, we get
$f(x) = 2x + 0 - x^2 f(x)$

$$\Rightarrow f(x) = \frac{2x}{1+x}$$

Again differentiating, we get

$$f^1(x) = \frac{(1+x^2)2 - 2x(2x)}{(1+x^2)^2}$$

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

$$\Rightarrow f^1\left(\frac{1}{2}\right) = \frac{2\times\left(\frac{1}{2}\right)^2 - 4\times\left(\frac{1}{2}\right)^2 + 2}{\left(1+\left(\frac{1}{2}\right)^2\right)^2}$$

$$\Rightarrow f^1\left(\frac{1}{2}\right) = \frac{24}{25}$$

Answer: (1).

72. We have,

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

$\Rightarrow z = e^{i5\pi/6} + e^{-i\pi/6}$

$$= \cos\frac{5\pi}{6} + i\sin\frac{5\pi}{6} + \cos\left(\frac{-5\pi}{6}\right) + i\sin\left(\frac{-5\pi}{6}\right)$$

$$= 2\cos\frac{5\pi}{6} < 0$$

Therefore, $I(z) = 0$ and $\mathrm{Re}(z) < 0$

Answer: (1).

73. Probability of hitting target, $P(\text{hitting target}) = \frac{1}{3}$

Let, the number of finals be n.

P(hitting target at least once) = 1 – q(not hitting)

$$= 1 - \left(\frac{2}{3}\right)^n > 5/6$$

$$\Rightarrow \left(\frac{1}{6}\right) > \left(\frac{2}{3}\right)^n$$

Hence, the minimum number of finals = 5

Answer: (3).

74. We have,

$$\int x^5 e^{-4x^3} dx = \frac{1}{98} e^{-4x^4} f(x) + C$$

Let, $x^3 = t$

$\Rightarrow 3x^2 dx = dt$

Now, $\int x^3 e.^{-4x^3} .x^2 dx = \frac{1}{3}\int t.e.^{-4t}\, dt$

$$= \frac{1}{3}\left[t.\frac{e^{-4t}}{-4} - \int \frac{e^{-4t}}{-4} dt\right]$$

$$= -\frac{e^{-4t}}{48}[4t+1] + C = -\frac{e^{-4x^3}}{48}[4x^3+1] + C$$

Hence, $f(x) = -1 - 4x^3$

Answer: (2).

75. We have,

$$\frac{\sqrt{3}}{4}a^2 = 27\sqrt{3}$$

$$\Rightarrow a^2 = \frac{27\sqrt{3}}{\frac{\sqrt{3}}{4}}$$

$\Rightarrow a^2 = 108$

$$\Rightarrow a = 6\sqrt{3}$$

Thus, $r = 9\times\frac{\sqrt{3}}{2}\times\frac{2}{3} = \frac{6\sqrt{3}\times\sqrt{3}\times 2}{2\times 3} = 3\times 2$

$\Rightarrow r = 6$

Therefore, $\sqrt{5^2 + r^2 - c} = 6$

$\Rightarrow 25 + 36 - c = 36$

$\Rightarrow c = 25$

Answer: (4).

76. Since, P is true, Q is false and R is true.

Hence, true statement is $P \vee ({\sim} Q \wedge R) = T \vee (T \wedge T) = T$

Answer: (4).

77. Equation of parabola is

$x^2 = 4y$

$$x - \sqrt{2}y + 4\sqrt{2} = 0$$

Solving both the equations, we get

$$x^2 = 4\left(\frac{x + 4\sqrt{2}}{\sqrt{2}}\right)$$

$$\Rightarrow \sqrt{2}x^2 + 4x + 16\sqrt{2}$$

$$\Rightarrow \sqrt{2}x^2 - 4x - 16\sqrt{2} = 0$$

$$x_1 + x_2 = 2\sqrt{2}; \quad x_1 x_2 = \frac{-16\sqrt{2}}{\sqrt{2}} = -16$$

Similarly,

$$(\sqrt{2}y - 4\sqrt{2})^2 = 4y$$

$\Rightarrow 2y^2 + 32 - 16y = 4y$

$\Rightarrow 2y^2 - 20y + 32 = 0$

Therefore, the length of the chord is $6\sqrt{3}$.

Answer: (4).

78. Given,

$$|A| = \begin{vmatrix} 2 & b & 1 \\ b & b^2+1 & b \\ 1 & b & 2 \end{vmatrix}$$

$= 2(2b^2 + 2 - b^2) - b(2b - b) + 1(b^2 - b^2 - 1)$

$= 2(b^2 + 2) - b^2 - 1$

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

$= b^2 + 3$

$$\Rightarrow \frac{|A|}{b} = b + \frac{3}{b}$$

Hence, the minimum value of $\frac{|A|}{b}$ will be $2\sqrt{3}$.

Answer: (1).

79. Consider,

$$\frac{y^2}{1+r} - \frac{x^2}{1-r} = 1$$

$$e = \sqrt{1 + \frac{1-r}{1+r}} = \sqrt{\frac{2}{r+1}}$$

If $r > 1$ then this curve is an ellipse with eccentricity

$$e = \sqrt{1 - \frac{r-1}{r+1}} = \sqrt{\frac{2}{r+1}}$$

Answer: (2).

80. We have,

$$\sum_{r=0}^{25} {}^{50}C_r \cdot {}^{5-r}C_{25-r}$$

$$= \sum_{r=0}^{25} \frac{50!}{r!(50-r)!} \times \frac{(50-r)!}{25!(25-r)!}$$

$$= \sum_{5=0}^{25} \frac{50!}{25!25!} \times \frac{25!}{(25-r)!(25-4)!}$$

$$= {}^{50}C_{25} \sum_{r=0}^{25} {}^{25}C_4 = (2^{25})^{50}C_{25}$$

$\Rightarrow K = 2^{25}$

Answer: (4).

81. Given,

Points (−3, −3, 4) and (3, 7, 8) are at right angles.

Perpendicular to plane has direction ratio (6, 10, 2) and it passes through (0, 2, 5).

Therefore, equation of plane will be $3(x – 0) + 5(y – 2) + (z – 5) = 0$

Hence, it passes through (4, 1, –2).

Answer: (4).

82. We have,

$$\cot\left[\sum_{n=1}^{19} \cot^{-1}\left(1 + \sum_{P=1}^{n} 2P\right)\right]$$

$$= \cot \sum_{h=1}^{19} \tan^{-1}\left(\frac{n+1-n}{1+n(n+1)}\right)$$

$$= \cot(\tan^{-1} 20 - \tan^{-1} 1)$$

$$= \frac{1}{\tan(\tan^{-1} 20 - \tan^{-1} 1)} \qquad \left(\because \tan\theta = \frac{1}{\cot\theta}\right)$$

$$= \frac{\frac{1}{20-1}}{1+(20)\times 1} = \frac{21}{19}$$

Answer: (1).

83. We have,

$$\bar{x} = 10 \Rightarrow \sum_{i=1}^{5} xi = 50$$

$$\text{S.D} = \sqrt{\frac{\sum_{i=1}^{5} xi^2}{5} - (\bar{x})^2} = 8$$

$$\Rightarrow \sum_{i=1}^{5} (xi)^2 = 109 = \sum_{i=1}^{5} (xi)^2 = 109 \times 5 = 545$$

$$\text{Therefore, variance} = \frac{\sum_{i=1}^{5} (xi)^2 + (-50)^2}{6}$$

$$= \frac{545 + 2500}{6} = 507.5$$

Answer: (4).

84. Given,

$$f^1(x) = 7 - \frac{3}{4}\frac{f(x)}{x},$$

$$\Rightarrow \frac{dy}{dx} = 7 - \frac{3y}{4x}$$

$$\Rightarrow \frac{dy}{dx} + \frac{3y}{4x} = 7$$

This is linear differential equation.

Thus,

$$\text{I.F.} = e^{\int \frac{3}{4}\frac{dx}{x}} = e^{\frac{3}{4}\log x} = x^{3/4}$$

Therefore,

$$y.x^{\frac{3}{4}} = 7 \times \int x^3 dx$$

$$\Rightarrow y(x^{3/4}) = 4x^{7/4} + C$$

$$\Rightarrow f(x) = 4x + Cx^{-3/4}$$

$$\lim_{9 \to 0} x\ f\left(\frac{1}{x}\right) \Rightarrow \lim_{x \to 0} x\left(\frac{4}{x} + Cx^{3/4}\right) = 4.$$

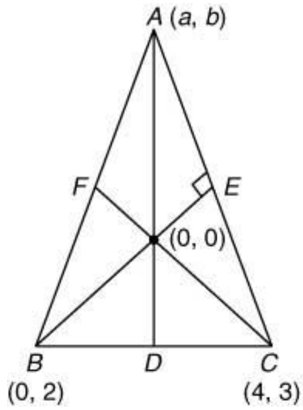
Hence, the limit exists and equals to 4.

Answer: (2).

85. We have,

$$m_{AD} \times m_{AD} = -1 \quad \Rightarrow \left(\frac{3-2}{4-0}\right) \times \left(\frac{6-0}{9-0}\right) = -1$$

$$\Rightarrow\ b + 4a = 0 \qquad (1)$$



$m_{AB} \times m_{CF} = -1 \quad \Rightarrow \left(\frac{(6-2)}{9-0}\right) \times \left(\frac{3}{4}\right) = -1$

$3b - 6 = -4a \quad \Rightarrow 4a + 3b = 6$ (2)

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

$a = \frac{-3}{4}, b = 3$

Therefore, it lies in the second quadrant.

Answer: (2).

86. We have,

$\int_{-\pi/2}^{\pi/2} \frac{dx}{[x]+[\sin x]+4}$

$= \int_{-\pi/2}^{0} \frac{dx}{[x]+3} + \int_{0}^{\pi/2} \frac{dx}{[x]+4}$

$= \int_{-\pi/2}^{-1} \frac{dx}{1} + \int_{1}^{0} \frac{dx}{2} + \int_{0}^{1} \frac{dx}{4} + \int_{1}^{\pi/2} \frac{dx}{5}$

$= \left(-1 + \frac{\pi}{2}\right) + \left(0 + \frac{1}{2}\right) + \frac{1}{4} + \frac{\pi}{10} - \frac{1}{5}$

$= \frac{12\pi - 9}{20}$

$= \frac{3}{20}(4\pi - 3)$

Answer: (3).

87. Equation of line is

$\frac{x-4}{2} = \frac{y-5}{2} = \frac{z-3}{1}$

Equation of plane is

$x + y + z = 2$

Point on the given line

$x = 2\lambda + 4$

$y = 2\lambda + 5$

$z = \lambda + 3$

Thus,

$2\lambda + 4 + 2\lambda + 5 + \lambda + 3 = 2$

$\lambda = -2$

Therefore, the point of intersection will lie on

$\frac{x-1}{1} = \frac{y-3}{2} = \frac{z+4}{-5}$

Answer: (3).

88. By applying $C_3 \to C_3 - C_2$ and $C_2 \to C_2 - C_1$ in the given determinant, we have

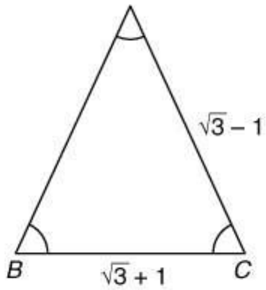
$D = 0$

Therefore, the number of elements in S is infinitely many.

Answer: (2).

89. We have,

$\angle A + \angle B = 120°$



$$\tan\frac{A-B}{2} = \frac{a-b}{a+b}\text{cof}\left(\frac{C}{2}\right)$$

$$= \frac{\sqrt{3}+1-\sqrt{3}+1}{2\sqrt{3}}\text{cof}(30°) = \frac{1}{\sqrt{3}}.\sqrt{3} = 1$$

$$\Rightarrow \frac{A-B}{2} = 45°$$

$\Rightarrow A - B = 90°$

Therefore, $A = 105°$and $B = 15°$

Hence, $\angle A : \angle B = 105 : 15 = 7 : 1$

Answer: (1).

90. Given,

$y - x^{3/2} = 7$

$\Rightarrow y = 7 + x^{3/2}$

Let, the point on curve be $P(x, 7 + x^{3/2})$

Given point $A\left(\frac{1}{2}, 7\right)$

Thus, nearest point normal at P passes through A

So, slope line AP – slope of normal at P

$$\Rightarrow \frac{x_1^{3/2}}{x_1^{-\frac{1}{2}}} = \left[-\frac{dy}{dx}\right]_{(x_1 y_1)} = -\frac{2}{3\sqrt{x_1}}$$

$\Rightarrow 3x_1^2 = 1 - 2x_1$

$\Rightarrow 3x_4^2 + 2x_1 - 1 = 0$

Now,

$x_1 = \frac{1}{3}$ ($x_1 = -1$ is not possible as $x_1 > 0$)

Point P is $\left(\frac{1}{3}, 7 + \frac{1}{3\sqrt{3}}\right)$

Hence,

$$AP = \sqrt{\frac{1}{36} + \frac{1}{27}} = \frac{1}{6}\sqrt{\frac{7}{3}}$$

Answer: (3).