FIITJEE
ALL INDIA TEST SERIES
JEE (Advanced)-2024
FULL TEST – IV
PAPER –2
TEST DATE: 08-02-2024

ANSWERS, HINTS & SOLUTIONS

Physics

PART – I

SECTION – A

1. C

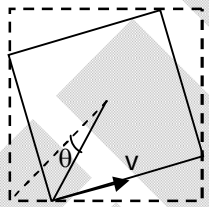
Sol. $L_1 = 45$ cm $L_2 = 55$ cm

M = 20 kg

More gain of customer = $M\frac{l_1}{l_2} + M\frac{l_2}{l_1} - 2M$

2. B

Sol. $\frac{d\theta}{dt} = \omega = \frac{v}{R - vt}$



3. A

Sol. Of α, β are left and right end corrections then; $\frac{100}{200} = \frac{33+\alpha}{67+\beta}$ & $\frac{200}{100} = \frac{67+\alpha}{33+\beta}$

$\Rightarrow 2\alpha - \beta = 1$ and $2\beta - \alpha = 1$

$\therefore \alpha = 1\,\text{cm}$ and $\beta = 1\,\text{cm}$

4. C

Sol. mean energy flow per sec = $I_o \times$ area

$$= I_o\, 2\pi L^2 \left(1 - \frac{L}{\sqrt{R^2 + L^2}}\right)$$

$$= 20\,\mu W$$

5. BD

Sol. Temperature $T = T_1 + \left(\frac{T_2 - T_1}{L}\right)x$

$\frac{dx}{dt} = k\sqrt{T}$

by solving $L = \frac{Kt}{2}\left(\sqrt{T_2} + \sqrt{T_1}\right)$

Distance average velocity $= \frac{\int_0^L v\,dx}{L}$

$= \frac{2K}{3}\frac{\left(T_2^{3/2} - T_1^{3/2}\right)}{\left(T_2 - T_1\right)}$

Time average velocity = $\frac{L}{t}$

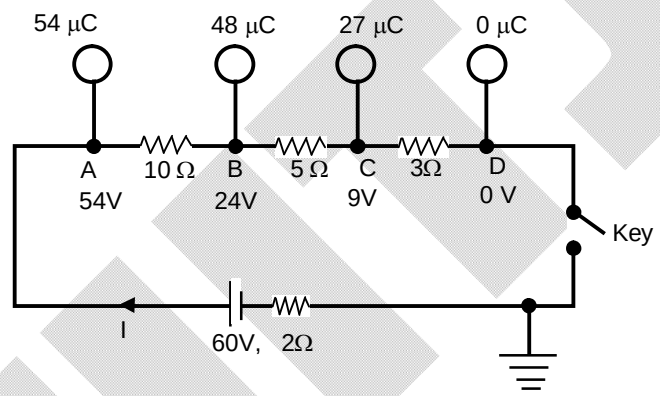
6. ABD

Sol. Displacement of the boat after finishing watermelon = $\frac{M}{M+M_o}.L\left(1-\frac{1}{2}+\frac{1}{4}-.....\infty\right)$

$= \frac{1}{2}\left(\frac{M}{M+M_o}\right)L.$

7. BD

Sol.



(A) $q_{net} = 129\mu C$

(B) Charge on B = 48 ΩC

(C) $I = 4A$

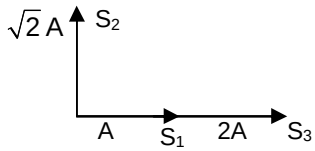
(D) $q_{net} = 112\mu C$

SECTION – B

8. 11

Sol. $S_2P - S_1P = \frac{1}{2}\frac{d^2}{D} = \frac{\lambda}{4}(\text{given}) = \frac{\pi}{2}$

$S_3P - S_1P = 2\frac{d^2}{D} = 2\pi\left(\Delta\phi = \frac{2\pi}{\lambda}\Delta x\right)$

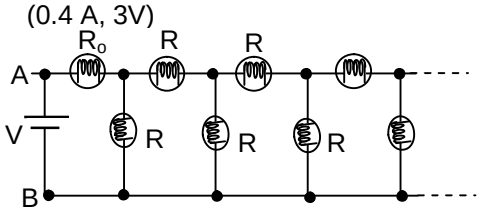


Phasor diagram

Ans. $\sqrt{11}A \equiv 11 I_o$

9. 4

Sol. (0.4 A, 3V)



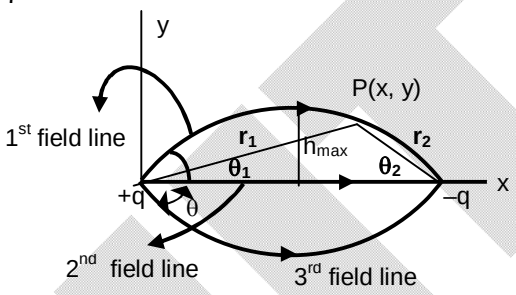
$R_o = \frac{3}{0.4} = 7.5\Omega, \qquad R = \frac{1}{0.2} = 5\Omega$

$R_{eq} = R_o + \left(\frac{\sqrt{5}-1}{2}\right)R = 10.5\Omega$

$V_{max} = I_{max}\, R_{eq} = 0.4 \times 10.5 = 4.2\ \Omega$

10. 7

Sol.



$\frac{dy}{dx} = \frac{r_2^2 \sin\theta_1 - r_1^2 \sin\theta_2}{r_2^2 \cos\theta_1 + r_1^2 \cos\theta_2}$ by solving

$\cos\theta_1 + \cos\theta_2 = \text{constant}$

$\therefore \quad \cos\theta_1 + \cos\theta_2 = 1 + \cos\theta$

$h_{max} = \sqrt{7}$

11. 5

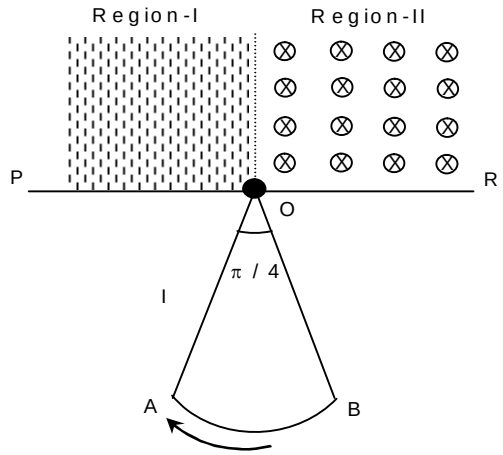
Sol. Pressure at distance r

$P = P_o\left(R^2 - r^2\right)$

n = 5

12. 14

Sol.



Indused emf $\varepsilon = \frac{1}{2}B\omega L^2, \qquad t = \frac{\pi}{4\omega}$

Thermal energy $= 2\times\frac{\varepsilon^2}{R}t + \frac{(2\varepsilon)^2}{R}t = \frac{6\varepsilon^2}{R}t$

$= \frac{3\pi}{8}\frac{B^2\omega L^4}{R}$

13. 3

Sol. Using conservation of mechanical energy and conservation of angular momentum.

We get $r_{max} = r_o$ and $r_{min} = \frac{r_o}{3}$

SECTION – C

14. 6020.80

Sol. $f_{receiver} - f_{transmitter} = 800$ Hz.

$\Rightarrow f_{receiver} = (6020 + 0.8)$ KHz

Reading of display 2 = $f_{receiver} = 6020.8$ KHz.

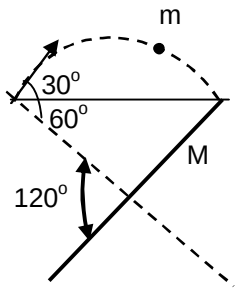
15. 0.50

Sol. $\frac{dV}{dt} = 1.2$ cc/s = $v_A A_A = v_B A_B$

$\Rightarrow \frac{v_B}{v_A} = \frac{\frac{dV}{dt}}{A_B \times v_A} = \frac{1.2\times10^{-6}}{2\times10^{-5}\times0.12} = 0.5$

16. 8.65

Sol.



$$T = \frac{2u\sin 30^o}{g} = 1\,s$$

$u = 10\ m/s$

Velocity at highest point = $u\cos\theta$

$= 5\sqrt{3}$

Range = $L\cos 60^o$

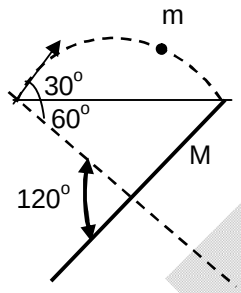
$L = 10\sqrt{3}$

From conservation of angular momentum

$$\frac{m}{M} = \frac{\pi}{3\sqrt{3}}$$

17. 0.60

Sol.



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From conservation of angular momentum

$$\frac{m}{M} = \frac{\pi}{3\sqrt{3}}$$

Chemistry

PART – II

SECTION – A

18. A
Sol. Factual

19. D
Sol. (A) $H^- + H_2O \longrightarrow H_2 + OH^-$
(B) due to decrease in stability of hydrides down the group in periodic table.
(C) M.P. $\propto$ % ionic character (apply Fazan's rule)

20. C
Sol. If P is low, for 1 mole of gas

$$\left(P + \frac{a}{V_m^2}\right)V_m = RT$$

$$\Rightarrow PV_m = RT - \frac{a}{V_m}$$

$$\Rightarrow z = 1 - \frac{a}{V_m RT}$$

The gas having greater slope has greater force of attraction.

21. B
Sol. Compound (A) = Na_2CrO_4, Compound (B) = H_2SO_4 or any other acid
[X] = Carbon [Y] = Al
Hence, (B) is the correct answer.

22. ABD
Sol. (A) In chain and cyclic silicates, two of the corners of SiO_4^{4-} units are shared, hence general formula is $(SiO_3)_n^{2n-}$.
(B) Higher the electronegativity of central atom, the more is the acid strength of the oxide.
(C) $H_3PO_2 > H_3PO_3 > H_3PO_4$ (due to increasing cross conjugation)
(D) BF_3 is thermodynamically more stable than BCl_3 due to more $p_\pi - p_\pi$ back bonding in former than the latter.

23. ABCD
Sol. Amount of Cu converted to Cu^{2+} ions = $\frac{1.50}{63.5} = 0.02362$ mol
Amount of electrons involved = 2 × 0.02362 = 0.04724 mol
Amount of electrons actually passed through solution = $\frac{1 \times 2 \times 60 \times 60}{96500}$ = 0.07461 mol
Amount of electrons involved in converting H_2O to O_2 = 0.07461 – 0.04724 = 0.02737 mol
Amount of oxygen liberated at anode = $\frac{1}{4} \times 0.02737$ = 0.006843 mol
$\therefore$ Volume of O_2 gas produced at STP at anode = 0.006843 × 22400 = 153.4 ml
Hence, (B) is correct.
Also, fraction of current used in the production of Cu^{2+} ions = $\frac{0.04724}{0.07461}$ = 0.633.

Hence, (C) is also correct.

$\therefore$ Mol. of H^+ ions produced at anode = 0.02737 mol.

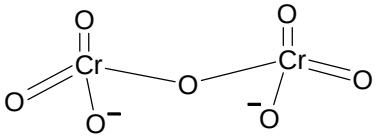
$\therefore (H^+)_{anode} = \dfrac{0.02737}{27.37} = 10^{-3}\,mol\,l^{-1}$

pH = 3

Hence, (D) is correct.

24. D

Sol.



Only 6 Cr – O bond lengths are equal

SECTION – B

25. 1

Sol. For the first part, millimole of $Na_2S_2O_3$ consumed = 15 × 0.4 = 6

$I_2 + 2Na_2S_2O_3 \longrightarrow 2NaI + Na_2S_4O_6$ millimoles of I_2 consumed = 3 millimoles (i)

For the second part, the reaction is $3I_2 + 6NaOH \longrightarrow 5NaI + NaIO_3 + 3H_2O$ reacted with I_2

millimoles of NaOH $= (100\times0.3) - (10\times0.3\times2) = 30 - 6 = 24$ millimoles .

Millimoles of I_2 consumed $= \dfrac{24}{2} = 12$ millimoles. $\rightarrow$ (ii)

Total millimoles of I_2 consumed in reaction = (i) + (ii) = 3+ 12 = 15 millimoles

$\therefore$ molarity of $I_2 = \dfrac{15}{150} = 0.1M$ " 10 times initial molarity of I_2 " $= 0.1\times10 = 1$

26. 3

Sol. According to the law of conservation of momentum, momentum lost by photons = momentum gained by glow-worm

Momentum lost by photons

= no of photons x momentum lost by one photon

$= \dfrac{\text{Total energy}}{\text{energy of 1 photon}} \times \dfrac{h}{\lambda}$ $\left[\text{Debroglie's equation } \lambda = \dfrac{h}{p}.\ p = \dfrac{h}{\lambda}\right]$

$= \dfrac{\text{power}\times\text{time}}{\frac{hc}{\lambda}} \times \dfrac{h}{\lambda}$

$= \dfrac{\lambda}{hc} \times \text{power} \times \text{time} \times \dfrac{h}{\lambda}$

$= \dfrac{0.1\times365\times24\times60\times60\times10}{3\times10^8} \Rightarrow (1)$

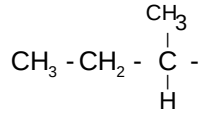
Momentum gained by glow-worm $= \dfrac{5}{1000} \times (v)\,\text{in m/sec} \longrightarrow (2)$

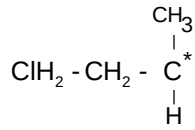
(1) = (2)

Hence v = 21 m/sec

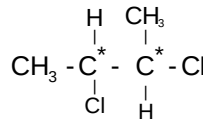
Ans. $\dfrac{v}{7} = 3$.

27. 9

Sol.  3- methyl pentane monochlorination, different products are

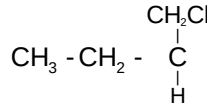


chiral, one chiral carbon atom pair of enantiomers

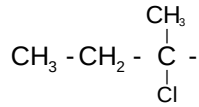


2 chiral carbon atoms 4 isomers. 2 pairs of enantiomers

4 pairs of diastereomers.



achiral molecule



achiral molecule

X = number of pairs of enantiomers = 3
Y = number of pairs of diastereomers = 4
Z = number of isomers which are achiral = 2
Total x + y + z = 9

28. 3

Sol. $\alpha = 0.115 \qquad \alpha = \frac{i-1}{n-1}$

So, i = 1.115

$\Delta T_f = i \times m \times K_f$

$0.416 = 1.115 \times \frac{x \times 1000 \times 1.86}{60 \times 249.25}$

$x = \frac{0.416 \times 60 \times 249.25}{1.115 \times 1000 \times 1.86} = 3\ g$

29. 4

Sol. As on hydrogenation only 8 hydrogens are added so definitely two rings must be present to satisfy 6 DBE.
Triple bond is not present otherwise on reductive ozonolysis only two compounds with only two oxygen would not have formed.

30. 5

Sol. Let number of amino groups be x.

$x = \frac{385 - 175}{42} = 5$

SECTION – C

31. 0.80

Sol. Let *x* mole, NH_4Cl was present initially.

$NH_4Cl(s) \longrightarrow NH_3(g) + HCl(g)$

x mole	0	0
-	x mole	x mole

Total moles of gas $\Rightarrow 2x$

Now, $PV = nRT$

$114 \times V = 0.01 \times R \times 300$

and $908 \times V = (0.01 + 2x) \times R \times 600$

32. 1.64

Sol. $V = \dfrac{0.01 \times 0.0821 \times 300 \times 760}{114} = 1.642\,L$

33. 0.60

Sol. $w = -nR.\Delta T = -1 \times 8.314 \times 72 = 598.6\,J = -0.6\,kJ$

34. 1.00

Sol. $\Delta U = q + w = 1.6 + (-0.6) = 1.0\ kJ$

Mathematics

PART – III

SECTION – A

35. B

Sol. $\sum_{r=1}^{10} {}^{15}C_r \cdot {}^{35}C_{10-r} = {}^{15}C_1 \cdot {}^{35}C_9 + {}^{35}C_8 + ++ {}^{15}C_{10} \cdot {}^{35}C_0$

$= {}^{50}C_{10} - {}^{35}C_{10}$

36. B

Sol. $f(x) = \int x^{\sin x}\left(1 + x.\cos x.\ln x + \sin x\right)dx$

If $f(x) = x^{\sin x} = e^{\sin x.\ln x}$, then

$f(x) = \int \left(f(x) + xf'(x)\right)dx = x.x^{\sin x} + c$

$f\left(\frac{\pi}{2}\right) = \frac{\pi}{2} \cdot \left(\frac{\pi}{2}\right) + cc \qquad \Rightarrow c = 0$

$f(x) = (x)(x)^{\sin x}, f(\pi) = \pi$

37. C

Sol. Let $\vec{a} = 3\hat{i} + 2\hat{j} + 6\hat{k}, \vec{b} = 2\hat{i} + \hat{j} + \hat{k}$ and $\vec{c} = \hat{i} - \hat{j} + \hat{k}$

Then by definition, a vector orthogonal to $\vec{a}$ and coplanar

$\therefore$ Required unit vector $s = \frac{\vec{a} \times \left(\vec{b} \times \vec{c}\right)}{\left|\vec{a} \times \left(\vec{b} \times \vec{c}\right)\right|} = \frac{3\hat{j} - \hat{k}}{10}$.

38. C

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

$S_{10} = \left(\frac{1}{12} - \frac{1}{2^2}\right) + \left(\frac{1}{2^2} - \frac{1}{3^2}\right) + ... + \left(\frac{1}{10^2} - \frac{1}{11^2}\right)$

$= 1 - \frac{1}{121} = \frac{120}{121}$

39. ABC

Sol. $\because f(x) = 2 \times \max\left\{|x-1| + |x-3|, |2x-1|\right\}$

$\therefore x = 1, \frac{3}{2}$ point of non-differentiability and minimum value is 2

40. ABD

Sol. $\because \quad \int \cos(2017x + x)\sin^{2016} x\,dx = \int \cos 2017x \sin^{2016} x \cos x\,dx - \int \sin 2017x \sin^{2017} x\,dx$.....(i)

$\left\{\because \int \cos \underset{(i)}{2017x} \underbrace{\sin^{2016} x \cos x}_{(ii)}\,dx = \frac{\cos 2017x \sin^{2017} x}{2017} + \int \frac{2017 \sin 2017x}{2017} \sin^{2017} x\,dx\right\}$

$\therefore \quad \int \cos 2018x \sin^{2017} x\,dx = \frac{1}{2017} \cos 2017x \sin^{2017} x$

41. BD

Sol. $\because \quad f(x)=\dfrac{xf'(x)}{2\sqrt{f(x)}}+\sqrt{f(x)}$

$\Rightarrow \quad \sqrt{f(x)}=\dfrac{1}{1-cx}$

$\Rightarrow \quad f(x)=\dfrac{1}{(1-cx)^2}$

$\because \quad f(1)=\dfrac{1}{2}$

$\therefore \quad c=1-\sqrt{2}$

$\Rightarrow \quad f(x)=\dfrac{1}{\left[1+\left(\sqrt{2}-1\right)x\right]^2}$

SECTION – B

42. 8

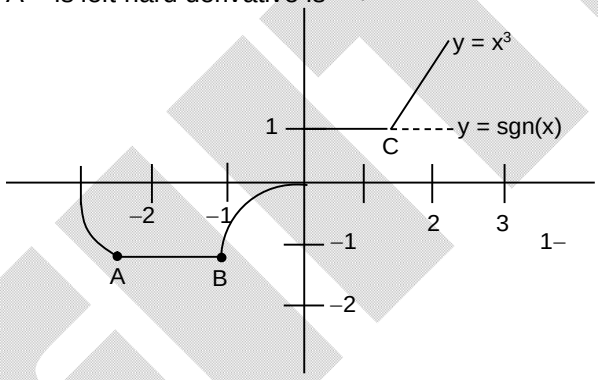
Sol. $x^2+x+1=0$

$\Rightarrow \quad x+\dfrac{1}{x}=-1$

$\therefore \quad \sum_{r=1}^{5}\left(x^r+\dfrac{1}{x^r}\right)^2=8$

43. 5

Sol. Let at A, B, C f(x) is continuous but not differentiable at A, B, C. Right hand derivative is $-\infty$ and A + is left hard derivative is $+\infty$



$\therefore$ 5 points

44. 1

Sol. Equation line through $P(1,-2,3)$ and parallel to given line is $\dfrac{x+1}{2}=\dfrac{y+3}{3}=\dfrac{z-3}{-6}=\lambda$. General point online $Q(2\lambda+1,3\lambda-2,-6\lambda+3)$ if then point lie on plane, $\lambda=\dfrac{1}{7}$

$\therefore \quad Q\left(\dfrac{9}{7},-\dfrac{11}{7},\dfrac{15}{7}\right)$

$\therefore \quad PQ=\sqrt{\dfrac{4}{49}+\dfrac{9}{49}+\dfrac{36}{49}}=1$

45. 7

Sol. $9^x - 3^x + 1 = \left(3^2 - \frac{1}{2}\right)^2 + \frac{3}{4} \geq \frac{3}{4}$

46. 8

Sol. Let coin was tossed 'n' times.

Probability of getting atleast two heads $= 1 - \left[\frac{1}{2^n} + \frac{n}{2^n}\right]$

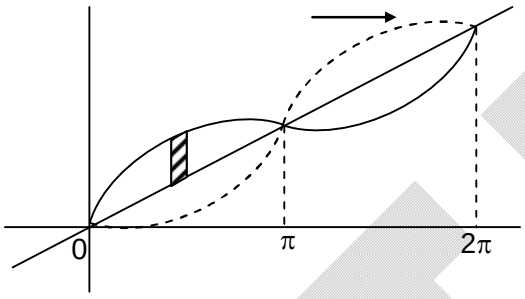
$\Rightarrow 1 - \left[\frac{n+1}{2^n}\right] \geq 0.96$

$\Rightarrow \frac{2^n}{n+1} \geq 25$

$\Rightarrow n \geq 8$

47. 8

Sol. $4\int_0^{\pi}\left((x + \sin x) - x\right)dx$



SECTION – C

48. 1.00

Sol. $\because \quad \begin{vmatrix} x & \sin x & 1+\sin x \\ 1 & \cos x & \cos x \\ 0 & \sin x & \sin x \end{vmatrix} = 0$

$\Rightarrow \quad x = (2n+1)\frac{\pi}{2}$

49. 0.00

Sol. $[f(x)\ g(x)\ h(x)] = \begin{vmatrix} \cos x & \sin x & \cos 2x \\ \tan x & \sin 3x & \cos 4x \\ \cos 3x & \sin 5x & \cos 6x \end{vmatrix}$

$\therefore \quad \int_0^{\pi}[f,g,h](x)\,dx = \int_0^{\pi}[f, g, h](\pi - x)\,dx$

$\Rightarrow \quad \int_0^{\pi}[f, g, h]dx = -\int_0^{\pi}[f, g, h]dx \qquad (\because C_1 \to -C_1)$

$\Rightarrow \quad \int_0^{\pi}[f, g, h]dx = 0$

50. 0.80

Sol. $\frac{x-2}{1}=\frac{y-1}{1}=4\sqrt{2}$ or $-4\sqrt{2}$

$$-\frac{1}{\sqrt{2}}=\frac{1}{2}$$

$\therefore$ $A(-2,5)\&B(6,-3)$

$\therefore$ Area of $\Delta CAB = 20$

$\Rightarrow$ sum $= 2\sqrt{20} = 4\sqrt{5}$

51. 4.00

Sol. $\sqrt{2\left(a^2+b^2\right)}=4 \Rightarrow a^2+b^2=8$

$\therefore$ $\frac{a^2+b^2}{2} \geq ab$

$\Rightarrow$ $ab \leq 4$