Corporate Office : AESL, 3rd Floor, Incuspaze Campus-2, Plot No. 13, Sector-18,
Udyog Vihar, Gurugram, Haryana - 122015, ***Ph.***+91-1244168300

MM : 180

AIATS For One Year JEE(Advanced)-2026 (XII Studying & XII Passed)_Test-5A_Paper-2_ONLINE

Time : 180 Min.

CHEMISTRY

Section-I

1. (C)

2. (A)

3. (B)

4. (B)

Section-II

5. (B,D)

6. (A,D)

7. (A,B,D)

8. (B,C)

Section-III

9. (07.00)

10. (01.75)

11. (07.00)

12. (03.80,03.95)

13. (02.57)

14. (10.53)

15. (07.65)

16. (04.00)

MATHEMATICS

Section-I

17. (C)

18. (C)

19. (B)

20. (D)

Section-II

21. (A,C,D)

22. (A,B)

23. (A,B,C)

24. (B,D)

Section-III

25. (11.00)

26. (08.00)

27. (05.00)

28. (02.00)

29. (08.00)

30. (04.00)

31. (01.00)

32. (03.00)

PHYSICS

Section-I

33. (D)

34. (B)

35. (C)

36. (A)

Section-II

37. (B,C)

38. (A,D)

39. (B,D)

40. (B,D)

Section-III

41. (01.00)

42. (56.00)

43. (00.00)

44. (03.00)

45. (28.00)

46. (10.60,10.70)

47. (01.75)

48. (15.00)

Hints and Solutions

CHEMISTRY

Section-I

(1) **Answer :** (C)

Solution:

Na + C + N → NaCN

NaCN + $FeSO_4$ → $Na_3[Fe(CN)_6]$

$$Na_3\left[Fe\left(CN_6\right)\right] + Fe^{3+} \rightarrow \underset{\text{(Prussian blue coloured complex)}}{Fe_4\left[Fe\left(CN\right)_6\right]_3}$$

This blue complex confirms the presence of nitrogen.

(2) **Answer :** (A)

Solution:

- $PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$

(complete hydrolysis gives orthophosphoric acid)

- $NCl_3 + 3H_2O \rightarrow NH_3 + 3HOCl$

(Hydrolysis of nitrogen trichloride gives ammonia)

- $SF_4 + 2H_2O \rightarrow SO_2 + 4HF$

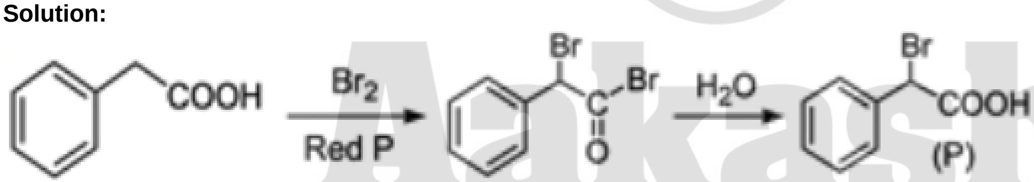
⇒ But this is not complete hydrolysis.

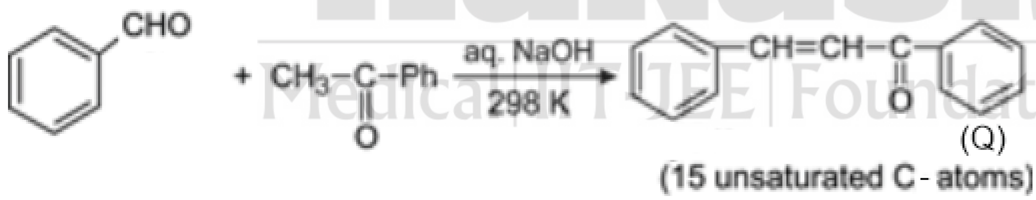
$SF_4 + 4H_2O \rightarrow H_2SO_3 + 4HF$

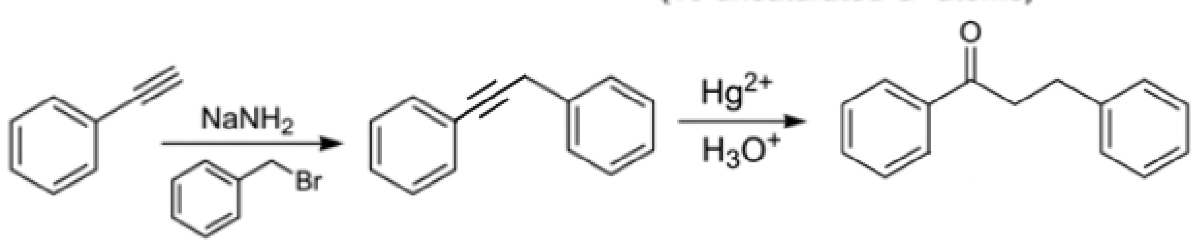
(Sulphur ends up in +4 oxidation state in sulphurous acid).

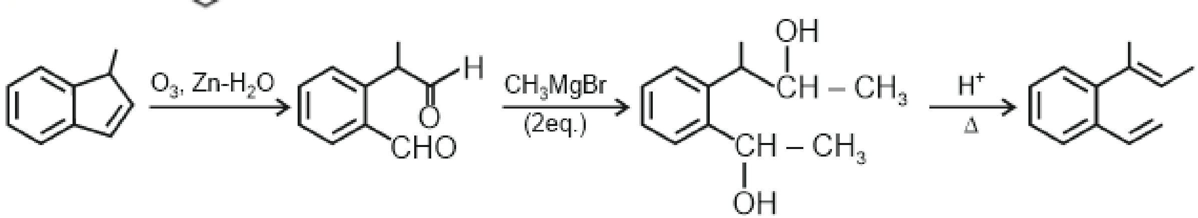
(3) **Answer :** (B)

Solution:



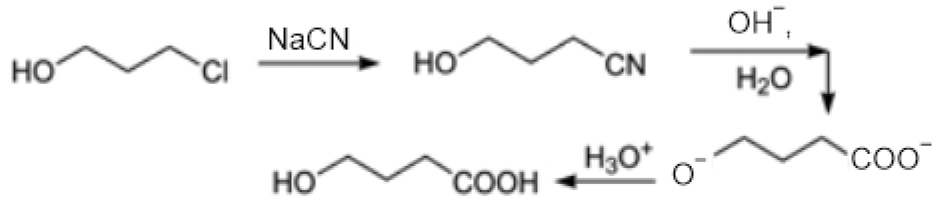


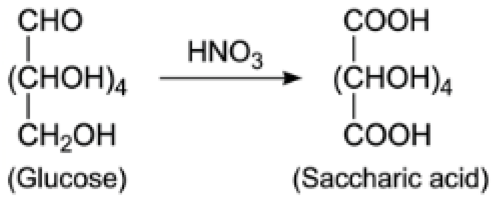




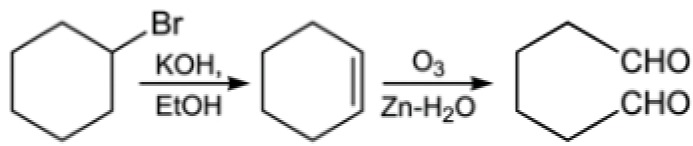
(4) **Answer :** (B)

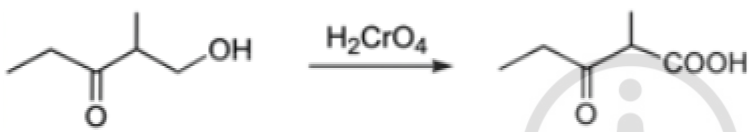
Solution:

(A) 

(B) 

(HNO_3 is a strong oxidising agent)

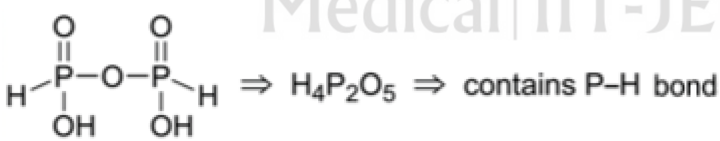
(C) 

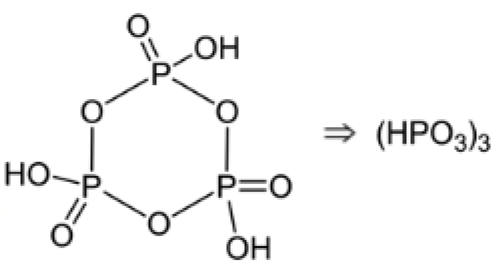
(D) 

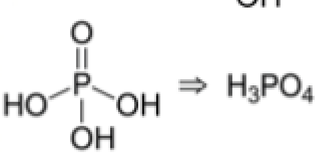
Section-II

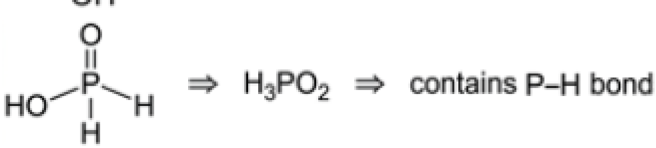
(5) **Answer :** (B,D)
Solution:
(A) Incorrect. London dispersion forces arises due to temporary/instantaneous dipoles and increase with molecular size and polarizability.
(B) Correct. For molecules of similar size, dipole-dipole interactions are generally stronger than dispersion forces because they involve permanent dipoles.
(C) Incorrect. H-bonding exist in all phases, especially strong in liquids and solids phases like water and ice.
(D) Correct. Ion-dipole interactions are stronger because they involve a full ionic charge interacting with a dipole.

(6) **Answer :** (A,D)
Solution:



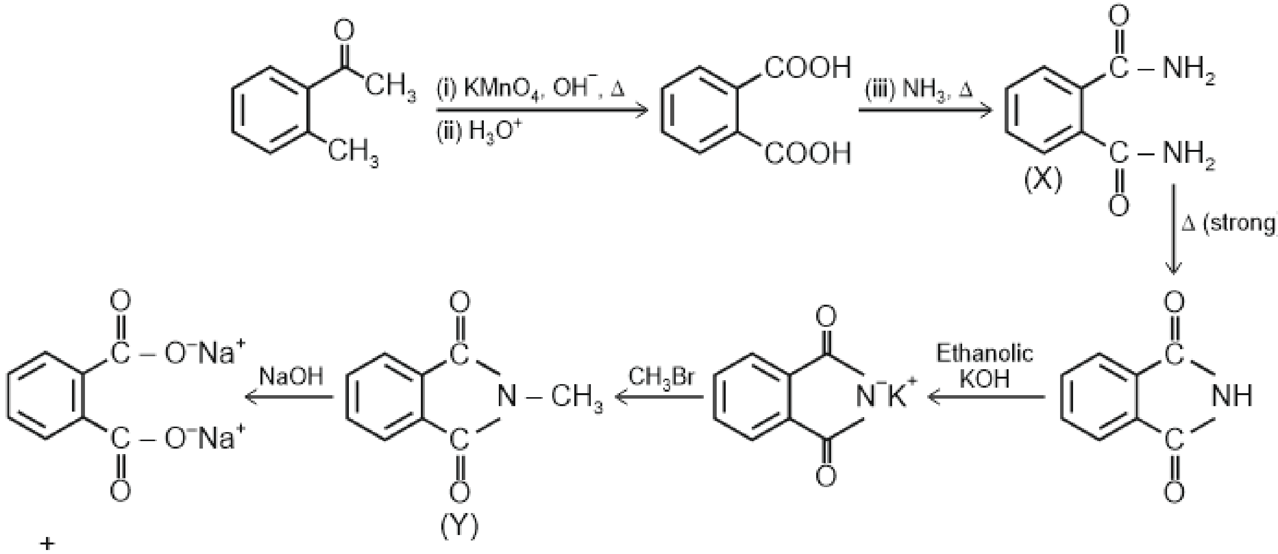






(7) **Answer :** (A,B,D)

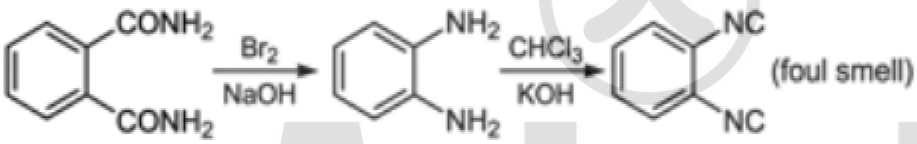
Solution:



+

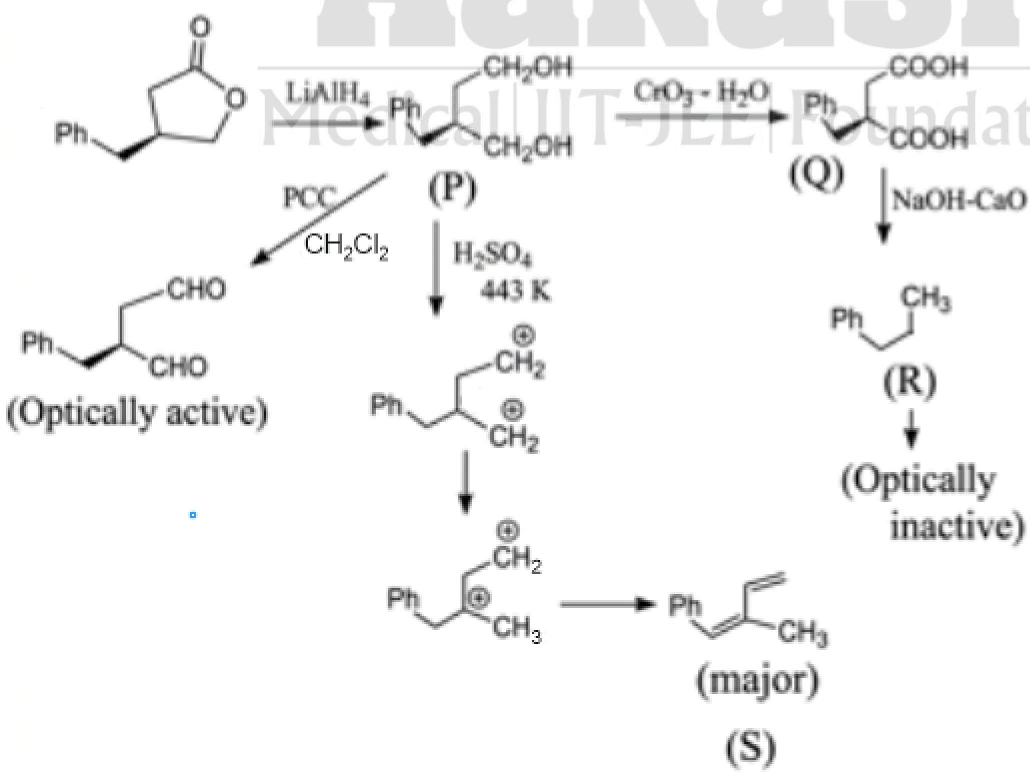
$CH_3 - NH_2$

(Z)

- Aromatic 1° amines cannot be synthesised by Gabriel phthalimide synthesis.
- In aqueous medium $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$ is the correct order of basic strength.
- 

(8) **Answer :** (B,C)

Solution:



Section-III

(9) **Answer :** 07.00

Solution:

For BCC $\Rightarrow Z = 2$

$\rho = \frac{MZ}{N_A(a)^3}$

$M = 56\ g\ \text{mol}^{-1}$

$Z = 2$

$N_A = 6 \times 10^{23}\ \text{mol}^{-1}$

$a = 300\ \text{pm} = 3 \times 10^{-8}\ \text{cm}$

$\therefore\ \rho\left(\text{density}\right) = \frac{2 \times 56.0}{6 \times 10^{23} \times \left(3 \times 10^{-8}\right)^3}$

$= \frac{112.0}{6 \times 27 \times 10^{-1}} = \frac{1120}{162}$

$\rho = 6.91\ \text{g}\ \text{cm}^{-3}$

(10) **Answer :** 01.75

Solution:

$\text{Pb(NO}_3)_2(\text{aq.}) + 2\,\text{KI(aq.)} \rightleftharpoons \text{PbI}_2(s) + 2\,\text{KNO}_3(\text{aq.})$

Moles before mixing $\Rightarrow$Lead nitrate = $0.015 \times 0.15 = 0.00225\ \text{mol} = 2.25\ \text{mmol}$

$\Rightarrow$Potassium iodide = $0.12 \times 0.250 = 0.030\ \text{mol} = 30\ \text{mmol}$

After mixing, total volume = (150 + 250) mL = 0.4 L

I^-concentration left after reaction (assuming reaction uses all Pb^{2+})

Pb^{2+} initial = 0.00225 mol

I^-ions needed to react = $2 \times 0.00225 = 0.0045\ \text{mol}$

I^-ions left = 0.030 mol - 0.0045 mol = 0.0255 mol

I^-ion concentration left = $\frac{0.0255}{0.4} = 0.06375\ M$

Now apply, $K_{\text{sp}} = \left[\text{Pb}^{2+}\right][I^-]^2 = 7.1 \times 10^{-9}$

$\left[\text{Pb}^{2+}\right] = \frac{7.1 \times 10^{-9}}{(0.06375)^2} = 1.75 \times 10^{-6}\ M$

$\therefore$Solubility of $\text{PbI}_2 = y \times 10^{-6} = 1.75 \times 10^{-6}$

$\therefore y = 01.75$

(11) **Answer :** 07.00

Solution:

Freundlich isotherm : $\frac{x}{m} = KC^{1/n}$

$\frac{x}{m} = 2.5$ when $C = 8$——> (1)

$\frac{x}{m} = 5.5$ when $C = 18$——> (2)

From equation (1) and (2) :-

$\frac{5.5}{2.5} = \left(\frac{18}{8}\right)^{1/n} \Rightarrow 2.2 = \left(\frac{9}{4}\right)^{1/n}$

Taking log on both sides:-

$\log\ 2.2 = \log\ \left(\frac{9}{4}\right)^{1/n}$

$\log\ 2.2 = \frac{1}{n}\log\ \frac{9}{4}$

$0.34 = \frac{1}{n}\left(2\log 3\right) - \left(2\log 2\right)\ \left(\because \log\ 2.2 \simeq 0.34\right)$

$0.34 = \frac{1}{n}\left(0.96 - 0.6\right)$

$n = \frac{0.36}{0.34} \simeq 1.06$

Now, use either eq. 1 or eq. 2 to find the value of K.

$2.5 = K(8)^{1/1.06}$

$\log 2.5 = \log K + \frac{1}{1.06}\log\left(8\right)$

$0.398 = \log K + (0.943) \times 3 \times (0.3)$

$\log K = 0.4 - 0.849$

$\log K \equiv 0.4507$

$K = 10^{(-0.4507)}$

$K = 0.354$

$\frac{x}{m} = 0.354 \times (25)^{\frac{1}{1.06}}$

= (0.354) × $(25)^{0.943}$

= 0.354 × 20.8

= 7.36 g/ml

(12) Answer : 03.80,03.95

Solution:

Initially, $[A_0] = a$

$[B_0] = 8a$

When the reaction is 30% complete, A has decreased by $0.3a$:-

$[A] = a - 0.3a = 0.7a$

Since, the reaction is $A + B \rightarrow \text{Product}$ (1:1 stoichiometry), B has also decreased by $0.3a$.

$[B] = 8a - 0.3a = 7.7a$.

Actual rate :- $(\text{Rate})_a = k[A][B] = k(0.7a)(7.7a)$

Pseudo first order rate :- (assuming $[B] \approx \text{constant} = 8a$)

$(\text{Rate})_{\text{pseudo}} = k\left[A\right]\left[B\right] = k\left(0.7a\right)\left(8a\right)$

Relative error = $\frac{(\text{Rate})_{\text{pseudo}} - (\text{Rate})_{\text{actual}}}{(\text{Rate})_{\text{actual}}} \times 100$

= $\frac{k(0.7)(8)a^2 - k(0.7)(7.7)a^2}{k(0.7)(7.7)a^2} \times 100$

= $\frac{0.3}{7.7} \times 100 \simeq 03.90\%$

(13) Answer : 02.57

Solution:

Density of solution = $1.00\ \text{g cm}^{-3} = 1000\ \text{kg/m}^3$.

Height = $2.5\ \text{cm} = 2.5 \times 10^{-2}\ \text{m}$.

$g = 10\ \text{m/s}^2$

Osmotic pressure from height :-

$\pi = \rho \text{hg} = 1000\ \text{kg/m}^3 \times 2.5 \times 10^{-2}\ \text{m} \times 10\ \text{m/s}^2 = 250\ \text{Nm}^{-2}$

Osmotic pressure using van't hoff equation :-

$\pi = \text{CRT}$

$\text{C} = 2.5\ \text{g/cm}^3$

$\text{C} = 2.5 \times 1000\ \text{g/dm}^3 = 2500\ \text{g/dm}^3$

$250 = \frac{2500}{\text{M}_\text{w}} \times 8.3 \times 310$

$\text{M}_\text{w} = 8.3 \times 310 \times 10$

$\text{M}_\text{w} = 25730\ \text{gmol}^{-1}$

$\text{M}_\text{w} = 2.57 \times 10^4\ \text{g/mol}$

$y = 2.57$

(14) Answer : 10.53

Solution:

$C_3H_8 + 5O_2 \rightarrow 3\,\text{CO}_2 + 4H_2O$

$\Delta_r G_r^\circ = [3(-394) + 4(-237)] - [(-24)] = (-1182 - 948) + 24 = -2106\ \text{kJ}$

$E^\circ = \frac{-\Delta G^\circ}{\text{nF}}$

$E^\circ = -\left(\frac{-2106}{20\,F}\right)$

n = 20 electrons, since each propane molecule gives 20 e^-on complete oxidation and $5O_2$ is converting to O^{2-}in H_2O, hence 20 electrons gained by O.

$E^\circ = \frac{10X}{F} \times 10^3 = -\left(\frac{-2106}{20\,F}\right)$

$10X \times 10^3 = \frac{+2106 \times 10^3\ J}{20}$

$10X = \frac{+2106}{20} = 105.3$

$X = 10.53$

(15) Answer : 07.65

Solution:

$[FeF_6]^{3-} \Rightarrow Fe^{3+}$

F^- weak field ligand $\rightarrow [FeF_6]^{3-}$ is a high spin complex.

$Fe^{3+} = t_{2g}^3 e_g^2 \rightarrow 5$ unpaired e^-

$\mu_I = \sqrt{5(5+2)} = \sqrt{35} = 5.92 \text{ BM}$

$[Fe(CN)_6]^{3-} \Rightarrow Fe^{3+}$

CN^- is strong field ligand $\rightarrow [Fe(CN)_6]^{3-}$ is a low spin complex.

$Fe^{3+} \Rightarrow t_{2g}^5 e_g^0 \rightarrow 1$ unpaired e^-

$\mu_{II} = \sqrt{1(1+2)} = \sqrt{3} = 1.73 \text{ BM}$

$\mu_I + \mu_{II} = 5.92 + 1.73 = 07.65$

(16) Answer : 04.00

Solution:

Octasaccharide + $7H_2O \rightarrow$ Arabinose + Fructose + Xylose

Total mass of reactant side $= 1104 + (7 \times 18) = 1230 \text{ g}$

Mass of Arabinose formed $= 1230 \times \frac{48.80}{100} = 600 \text{ g}$

Total units of Arabinose $= \frac{600}{150} = 4 \text{ units}$

Possible unit of Fructose = 1 unit

Possible unit of Xylose = 3 unit

$\therefore$ Total mass of products $= 600 + 180 + 450 = 1230 \text{ g}$

$\therefore$ Ans is 4.

MATHEMATICS

Section-I

(17) Answer : (C)

Solution:

$\lim\limits_{t\to 0} \frac{\int_{-t}^{t} \ln(1+x)\,dx}{t^2} \left(\frac{0}{0}\right)$

$= \lim\limits_{t\to 0} \frac{\ln(1+t)+\ln(1-t)}{2t}$

$= \frac{1}{2}\lim\limits_{t\to 0} \frac{\ln(1+t)}{t} + \frac{1}{2}\lim\limits_{t\to 0} \frac{\ln(1-t)}{t}$

$= \frac{1}{2} - \frac{1}{2} = 0$

(18) Answer : (C)

Solution:

$f(x) = \min\{|\tan x|, |\cot x|\}$.

Req. area = $2\int_0^{\frac{\pi}{4}} \tan x\, dx + 2\int_{\frac{\pi}{4}}^{\frac{\pi}{2}} \cot x\, dx$

= $2[2\ln\sqrt{2}]$

= $\ln 4$

(19) Answer : (B)

Solution:

$\because \sin\theta + \sqrt{3}\cos\theta = 6x - x^2 - 11$

$\sin\left(\theta + \frac{\pi}{3}\right) = \frac{6x - x^2 - 11}{2}$

$-1 \le \sin\left(\theta + \frac{\pi}{3}\right) \le 1$

$\Rightarrow -1 \le \frac{6x - x^2 - 11}{2} \le 1$

$\Rightarrow x = 3$

$\therefore \sin\left(\theta + \frac{\pi}{3}\right) = -1$

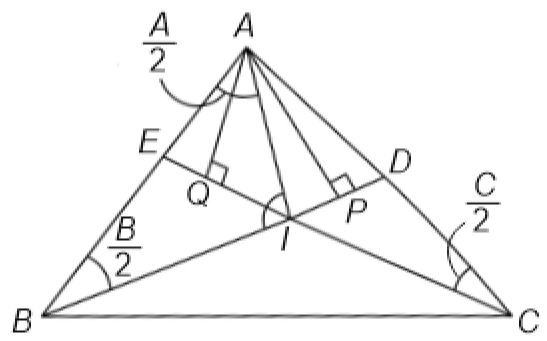
$\theta + \frac{\pi}{3} = 2n\pi - \frac{\pi}{2}$

$\theta = 2n\pi - \frac{5\pi}{6}$

$\therefore \theta = \frac{7\pi}{6}, \frac{19\pi}{6}$

(20) Answer : (D)

Solution:



$\angle B + \angle C = \frac{2\pi}{3} \Rightarrow \angle A = \frac{\pi}{3}$

$\sin\frac{B}{2} = \frac{AP}{AB}$ and $\frac{BI}{\sin\left(\frac{A}{2}\right)} = \frac{AB}{\cos\left(\frac{C}{2}\right)}$

$\frac{AP}{BI} = \frac{\sin\left(\frac{B}{2}\right)\cos\left(\frac{C}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

Similarly $\frac{AQ}{CI} = \frac{\sin\left(\frac{C}{2}\right)\cos\left(\frac{B}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

$\frac{AP}{BI} + \frac{AQ}{CI} = \cot\frac{A}{2} = \cot\frac{\pi}{6} = \sqrt{3}$

Section-II

(21) Answer : (A,C,D)

Solution:

(A) $a_{ij} = -a_{ji} \Rightarrow a_{ij} + a_{ji} = 0 \Rightarrow A$ is skew symmetric

(C) $A^2 = 2A \Rightarrow A^3 = 2^2 A \Rightarrow A^6 = 2^5 A$.

(D) *A* is a skew symmetric matrix of odd order.

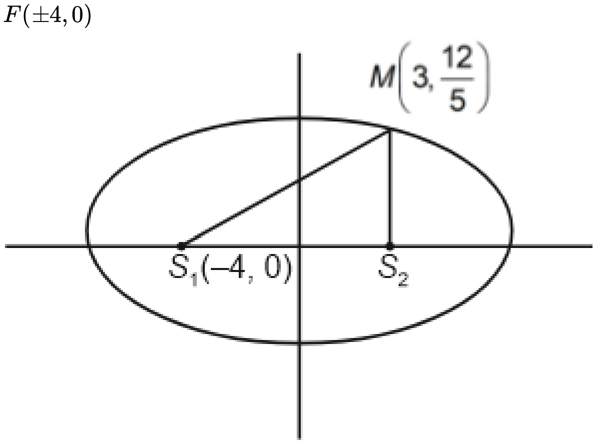
(22) Answer : (A,B)

Solution:

$\frac{x^2}{25} + \frac{y^2}{9} = 1$

$e = \sqrt{1 - \frac{9}{25}} = \frac{4}{5}$.

$F(\pm 4, 0)$



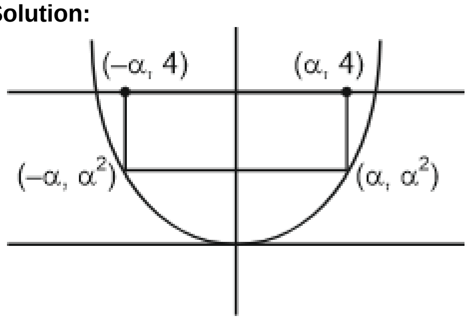
Reflected ray passes through (4, 0) and $\left(3, \frac{12}{5}\right)$ or (4, 0) and $\left(3, -\frac{12}{5}\right)$

$\therefore$ Equation of reflected ray $5y = -12x + 48$

$5y=12x-48$

(23) **Answer :** (A,B,C)
Solution:
(h, 0) satisfies the normal
$y=mx-2am-am^3$
$0=hm+2m+m^3$
$m\left(h+2+m^2\right)=0$
$m^2=-\left(h-2\right)>0$
$h+2<0$
$h<-2$

(24) **Answer :** (B,D)
Solution:



Perimeter $=2\left(2\alpha\right)+2\left(4-\alpha^2\right)$
$P=4\alpha+8-2\alpha^2$
$\frac{dP}{d\alpha}=0\Rightarrow\alpha=1$
$\frac{d^2P}{d\alpha^2}=-4<0$ local maxima at $\alpha=1$
$\therefore\ P=4\alpha+8-2\alpha^2\Rightarrow 4+8-2=10$

Section-III

(25) **Answer :** 11.00
Solution:
$3x^2\frac{dx}{dy}=\frac{x^3}{x^3-y}$
Let $x^3=t$.
$\frac{dt}{dy}=\frac{t}{t-y}$
$\Rightarrow(t-y)dt=tdy$
$tdt=ydt+tdy$
$\frac{t^2}{2}=ty+\frac{c}{2}$
$\Rightarrow x^6=2x^3y+c$

(26) **Answer :** 08.00
Solution:
$\text{AM}\geq\text{GM}$
$\left(\frac{a}{b}+\frac{c}{d}\right)+\left(\frac{b}{c}+\frac{d}{a}\right)\geq 2\left\{\sqrt{\frac{ac}{bd}}+\sqrt{\frac{bd}{ac}}\right\}$
$\geq 2\left\{\frac{ac+bd}{\sqrt{abcd}}\right\}$
$\geq 2\left\{\frac{(a+c)(b+d)}{\sqrt{abcd}}\right\}$
$\geq 2\left\{\frac{2\sqrt{ac}\cdot 2\sqrt{bc}}{\sqrt{abcd}}\right\}$
≥ 8

(27) **Answer :** 05.00
Solution:
First note out of 8 selected cards, one pair of cards share the same number and another pair of cards have to share same colour. Now these two pair of cards cannot be same or else these 2 cards will be exactly same.
Let nos be 1, 1, 2, 3, 4, 5, 6, 7 and colour be *a, a, b, c, d, e, f* and *g*

Case I: discards 1*a*.
$2\times 6=12$ in this case
Case II: 1*b*, 1*c*, 2*a*, 3*a*, 4*d*, 5*e*, 6*f* and 7*g* we cannot discard $={}^6C_2$
$P=\frac{12}{12+15}=\frac{4}{9}\therefore\left|p-q\right|=5$

(28) **Answer :** 02.00
Solution:
$\because \vec{c}$ & $\vec{d}$ are collinear
$\Rightarrow\begin{bmatrix}x-2 & 1\\ 2x+1 & -1\end{bmatrix}\begin{bmatrix}\vec{a}\\ \vec{b}\end{bmatrix}=0$
$\Rightarrow\begin{vmatrix}x-2 & 1\\ 2x+1 & -1\end{vmatrix}=0$
$-(x-2)-(2x+1)=0$
$-3x+1=0$
$\Rightarrow x=\frac{1}{3}$
$\Rightarrow 6x=2$

(29) **Answer :** 08.00
Solution:
The triangle has circumcentre at origin and its orthocentre lies on the circumcircle.

(30) **Answer :** 04.00
Solution:
$fog=\sqrt{\sin(\cos\ x)}$
$\left(fog\right)'\left(x\right)=\frac{1}{2\sqrt{\sin(\cos\ x)}}\times\left(\cos\left(\cos\ x\right)\right)\left(-\sin\ x\right)$
$gof\left(x\right)=\cos\left(\sqrt{\sin\ x}\right)$
$=-\left(\sin\left(\sqrt{\sin\ x}\right)\right)\times\frac{1}{2\sqrt{\sin\ x}}\times\cos\ x$
$fog(x)$w.r.t $gof\left(x\right)=\frac{(fog)'}{(gof)'}$
$=\frac{\frac{\sin(x)(\cos(\cos\ x))}{\sqrt{\sin(\cos\ x)}}}{\frac{(\cos\ x)(\sin(\sqrt{\sin\ x}))}{\sqrt{\sin\ x}}}$
$=\frac{\cos\left(\frac{1}{\sqrt{2}}\right)\cdot\left(\sqrt{\frac{1}{\sqrt{2}}}\right)}{\sin\left(\sqrt{\frac{1}{\sqrt{2}}}\right)\sqrt{\sin\left(\frac{1}{\sqrt{2}}\right)}}$
$\Rightarrow\ l=\frac{1}{\sqrt{2}}\Rightarrow 8l^2=4$

(31) **Answer :** 01.00
Solution:
$\left(\cot^2 36^\circ\cot^2 72^\circ-1\right)+1$
$\left(\frac{\cos^2 36^\circ\cos^2 72^\circ-\sin^2 36^\circ\sin^2 72^\circ}{\sin^2 36^\circ\sin^2 72^\circ}\right)+1$
$=\frac{(1+\cos 144^\circ)(1+\cos 72^\circ)-(1-\cos 144^\circ)(1-\cos 72^\circ)}{4\sin^2 36^\circ\sin^2 72^\circ}+1$
$=\frac{\cos 144^\circ+\cos 72^\circ}{2\sin^2 36^\circ\sin^2 72^\circ}+1$
$=1-\frac{(\cot 36^\circ\cot 72^\circ)^2}{\cos 36^\circ\cos 72^\circ}$
$=1-\frac{2\sin 36^\circ(\cot 36^\circ\cot 72^\circ)^2}{2\sin 36^\circ\cos 36^\circ\cos 72^\circ}$
$=1-\frac{4\sin 36^\circ(\cot 36^\circ\cot 72^\circ)^2}{\sin 144^\circ}$
$=\cot^2 36^\circ\cot^2 72^\circ=1-4\cot^2 36^\circ\cot^2 72^\circ$
$\Rightarrow 5\cot^2 36^\circ\cot^2 72^\circ=1$

(32) Answer : 03.00

Solution:

Let $x^2+x^3+x^4=t$

$(2x^2+3x^2+4x^3)\,dx=dt$

$\alpha=\int_0^3 \frac{dt}{2\sqrt{t}}$

$\alpha=\left[\sqrt{t}\right]_0^3=\alpha^2=3$

PHYSICS

Section-I

(33) Answer : (D)

Solution:

$\mu=\frac{V_d}{E}$

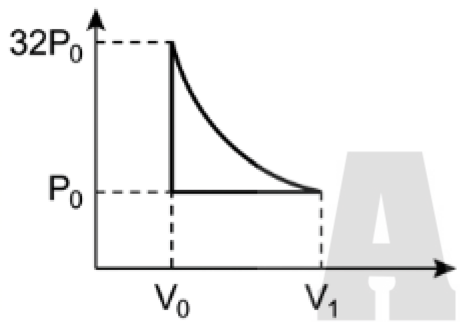
$V_d=\frac{I}{neA}$

$\mu=\frac{I}{neAE}$

$\Rightarrow\ I=\mu neAE=M^0L^0T^0I$

(34) Answer : (B)

Solution:



$V_1=V_0\left(\frac{P_0}{32P_0}\right)^{1/\gamma}$

$\gamma=\frac{5}{3}\Rightarrow V_1=8V_0$

$Q_{in}=nC_v\Delta T=\frac{3}{2}\left(nR\Delta T\right)$

$=\frac{3}{2}\times 31\ P_0V_0=\frac{93}{2}P_0V_0$

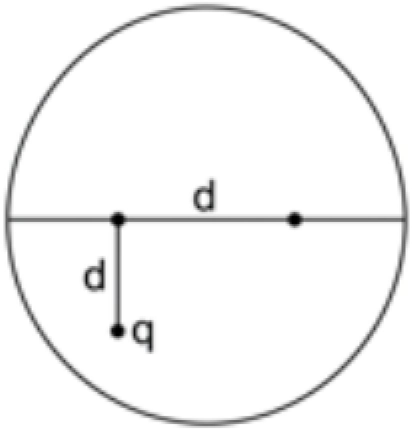
$Q_{out}=nC_p\Delta T=\frac{5}{2}\ nR\Delta T=\frac{5}{2}\times\left(8-1\right)P_0V_0=\frac{35}{2}P_0V_0$

$=\frac{5}{2}\times\left(8-1\right)P_0V_0=\frac{35}{2}P_0V_0$

$\eta=\frac{Q_{in}-Q_{out}}{Q_{in}}=\frac{93-35}{93}=\frac{58}{93}$

(35) Answer : (C)

Solution:



Flux through upper hemisphere $= \left(1 - \frac{5}{7}\right)\frac{q}{\varepsilon_0} = \frac{2}{7}\frac{q}{\varepsilon_0}$

(36) **Answer :** (A)
Solution:

(i) $\frac{5}{3}mR^2\alpha = K\left(R\theta\right)R + K\left(2R\theta\right)2R$

$\left[\frac{5}{3}mR^2\alpha = 5KR^2\theta\right]$

$\alpha = \frac{K}{m}\theta \Rightarrow \omega_1 = \sqrt{\frac{3K}{m}}$

(ii) $\frac{5}{3}mR^2\alpha = \left(K\frac{4R}{3}\theta + K\frac{4R}{3}\theta\right)\frac{4R}{3}$

$\frac{f_1}{f_2} = \frac{\omega_1}{\omega_2} = \sqrt{\frac{45}{32}}$

Section-II

(37) **Answer :** (B,C)
Solution:
$h = \frac{1}{2}gt_1^2 + v_s\left(t - t_1\right)$
t = 3 sec.
$\Rightarrow t_1 = 1 \text{ sec}$
h = 665 m
$h' = h - \frac{gt^2}{2} = 660 \text{ m}$
$f' = f_0\left(\frac{330}{330 - gt_1}\right) = 520\left(\frac{330}{320}\right) = 536.25 \text{ Hz}$

(38) **Answer :** (A,D)
Solution:

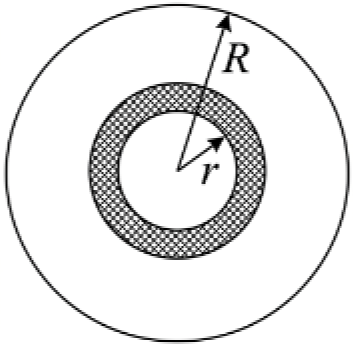
$V_B = \frac{\rho}{6\varepsilon_0}\left[\left(3R^2\right) - \left(3\frac{R^2}{4} - \frac{R^2}{4}\right)\right] = \frac{5\rho R^2}{12\varepsilon_0}$

$V_A = \frac{\rho}{6\varepsilon_0}\left[\left(3R^2 - \frac{R^2}{4}\right) - \left(\frac{3R^2}{4} - 0\right)\right] = \frac{\rho R^2}{3\varepsilon_0}$

(39) **Answer :** (B,D)
Solution:
At steady state, Power generated = Power loss

$\frac{dQ}{dt} = P = \sigma AT^4 \Rightarrow T^4 = \frac{P}{\sigma 4\pi R^2} \Rightarrow T = \left[\frac{P}{4\pi\sigma R^2}\right]^{1/4}$

Inside sphere
Rate of power generated = rate of heat transfer.



$\Rightarrow \frac{dQ}{dt} = \frac{Pr^3}{R^3}$ in small element.

$\frac{dQ}{dt} = K4\pi r^2 \left(\frac{dT}{dr}\right) = \frac{Pr^3}{R^3}$

$\Rightarrow dT = \int_0^R \frac{Prdr}{4\pi KR^3} = \frac{P}{8\pi KR}$

(40) **Answer :** (B,D)
Solution:
$U_1 > U_2 \Rightarrow KE_1 > KE_2$

$\Delta K.E = \Delta U = \frac{k(dq)^2}{2R} = \alpha$

$dq = \sqrt{8\pi\varepsilon_0 \alpha R}$

$dq = \lambda dl = \sqrt{8\pi\varepsilon_0 \alpha R}$

$dl = \frac{\sqrt{8\pi\varepsilon_0 \alpha R}}{\lambda}$

Section-III

(41) **Answer :** 01.00
Solution:
Areal velocity = $\frac{\pi ab}{T} = \frac{L}{2M}$

$\Rightarrow L = \frac{2M\pi ab}{T} = \frac{2(M)\sqrt{r_1 r_2}(r_1+r_2)\pi}{T}$

$\Rightarrow \alpha = 1$

(42) **Answer :** 56.00
Solution:
$\Delta mc^2 = E = \frac{P^2}{2m_1} + \frac{P^2}{2m_2} = \frac{P^2}{2}\left(\frac{m_1+m_2}{m_1 m_2}\right)$

$P = \frac{h}{\lambda}$

$\Delta m = \frac{h^2}{2c^2\lambda^2}\left(\frac{m_1+m_2}{m_1 m_2}\right) = \frac{h^2}{2c^2\lambda^2} \cdot \frac{224}{220m_\alpha} = \frac{56h^2}{110c^2\lambda^2 m_\alpha}$

(43) **Answer :** 00.00
Solution:

B at mid-point $= \frac{\mu_0 IR^2}{2}\left[\frac{1}{\left(x^2+R^2\right)^{3/2}} + \frac{1}{\left[R^2+(R-x)^2\right]^{3/2}}\right]$

$\frac{dB}{dx} = \frac{\mu_0 IR^2}{2}\left[-\frac{3}{2}\frac{2x}{\left(R^2+x^2\right)^{5/2}} - \frac{3}{2}\frac{2(R-x)(-1)}{\left[R^2+(R-x)^2\right]^{5/2}}\right]$

at $x = \frac{R}{2}$, $\frac{dB}{dx} = 0$

(44) **Answer :** 03.00
Solution:
$\Delta\phi = \Delta U + \mathrm{dW}$
$2\,\Delta\,U = \Delta U + \mathrm{dW}$
$\Delta U = \Delta W \Rightarrow \mathrm{Pdv} = nC_v\,\mathrm{dT}$
$\mathrm{PV} = \mathrm{nRT}$

$\mathrm{Pdv} + \mathrm{VdP} = R(\mathrm{ndT})$

$\mathrm{Pdv} + \mathrm{VdP} = \frac{R}{C_v}\mathrm{Pdv} \qquad C_v = \frac{R}{\gamma - 1}$

$\Rightarrow \mathrm{Pdv}[1 - (\gamma - 1)] + \mathrm{VdP} = 0$

$\Rightarrow -\gamma \mathrm{Pdv} + \mathrm{VdP} = 0$

$-\gamma\left(\frac{\mathrm{dv}}{V}\right) + \frac{\mathrm{dP}}{P} = 0$

$\Rightarrow \mathrm{PV}^{-\gamma} = \mathrm{const}$

$K = 3$

(45) Answer : 28.00

Solution:

In *ABCA*

$Q_{in} \to A \to B$ and $B \to C$

$Q_{out} \to C \to A$

$\eta = \frac{1}{5} = \frac{Q_{in} - Q_{out}}{Q_{in}} = \frac{W}{Q_{in}} \quad \ldots$(i)

For process *ACDA*

$Q'_{in} \Rightarrow A - C$

$Q'_{out} \to C - D$ and $D \to A$

$Q'_{in} = Q_{out_{(C \to A)}} = Q_{in} - W$

$\eta_2 = \frac{1}{10} = \frac{W_2}{Q'_{in}} = \frac{W_2}{Q_{in} - W}$

$\Rightarrow Q_{in} = W + 10W_2 = 5W$ [from (i)]

$\eta_{ABCDA} = \frac{W + W_2}{Q_{in}} = \frac{W + W_2}{5W} = \frac{1 + \frac{W_2}{W}}{5} = \frac{1 + \frac{2}{5}}{5} = \frac{7}{25} \approx 28\%$

(46) Answer : 10.60,10.70

Solution:

$\left(dm\right)a = F = \frac{dmGM}{r^2}$

$a = \int_0^v v\frac{dv}{dr} = \int_{r_0}^r \frac{GM}{r^2} \qquad M = \rho\frac{4\pi}{3}r^3$

$\Rightarrow v = \left[\frac{8\pi G\rho r_0^2}{3}\left(\frac{r_0}{r} - 1\right)\right]^{1/2}$

$\frac{dr}{dt} = v$

$\Rightarrow \int dt = \int \frac{dr}{v}$

$t = \sqrt{\frac{3}{8\pi G r_0^2 \rho}} \int_0^{r_0} \frac{dr}{\left(\frac{r_0}{r} - 1\right)^{1/2}}$

$t = \sqrt{\frac{3\pi}{32 G\rho}}$

$\alpha = \frac{32}{3} = 10.66$

(47) Answer : 01.75

Solution:

$2\mu\mathrm{t} = \frac{\lambda}{2}$

$t = \frac{\lambda}{4\mu} = \frac{5 \times 10^{-7} \times 7}{4 \times 10}$

$\left(5 \times 10^{-2}\right)\theta = t = \frac{5 \times 10^{-7} \times 7}{40}$

$\theta = 1.75 \times 10^{-6}$ rad.

(48) Answer : 15.00

Solution:

$\left(+5\hat{i} + \left(5\sqrt{3} - gt\right)\hat{j}\right)\left(v\hat{i} + \left(-gt\right)\hat{j}\right) = 0$

$+5v = 5\sqrt{3}gt = g^2t^2$

$g^2t^2 - 5\sqrt{3}gt + 5v = 0$

$75g^2 \geq +4g^2\ 5v$

$\frac{15}{4} = \frac{75}{20} \geq v$