JEE MAIN ANSWER KEY & SOLUTION

PAPER CODE :- PART TEST-1

CLASS-XI

ANSWER KEY

PHYSICS

1.	(C)	**2.**	(A)	**3.**	(A)	**4.**	(C)	**5.**	(C)	**6.**	(A)	**7.**	(B)
8.	(C)	**9.**	(A)	**10.**	(D)	**11.**	(B)	**12.**	(A)	**13.**	(B)	**14.**	(D)
15.	(A)	**16.**	(B)	**17.**	(C)	**18.**	(B)	**19.**	(D)	**20.**	(A)	**21.**	100
22.	25	**23.**	1000	**24.**	2	**25.**	4	**26.**	90	**27.**	2	**28.**	140
29.	4	**30.**	625										

CHEMISTRY

31.	C	**32.**	D	**33.**	B	**34.**	C	**35.**	C	**36.**	A	**37.**	B
38.	B	**39.**	A	**40.**	B	**41.**	B	**42.**	C	**43.**	A	**44.**	C
45.	A	**46.**	A	**47.**	C	**48.**	B	**49.**	A	**50.**	B	**51.**	5
52.	5	**53.**	60	**54.**	50.6	**55.**	5475	**56.**	16	**57.**	121	**58.**	75
59.	90	**60.**	11.5										

MATHEMATICS

61.	(A)	**62.**	(B)	**63.**	(A)	**64.**	(B)	**65.**	(B)	**66.**	(D)	**67.**	(B)
68.	(B)	**69.**	(A)	**70.**	(C)	**71.**	(C)	**72.**	(D)	**73.**	(B)	**74.**	(B)
75.	(D)	**76.**	(B)	**77.**	(C)	**78.**	(C)	**79.**	(B)	**80.**	(B)	**81.**	4
82.	6	**83.**	1	**84.**	5	**85.**	7	**86.**	3	**87.**	1	**88.**	3
89.	53	**90.**	9										

SOLUTIONS

PHYSICS

1. (C)

Sol. Force exerted by string is always along the string and of pull type.
When there is a contact between a point and a surface the normal reaction is perpendicular to the surface and of push type.

2. (A)

Sol. $n_1u_1 = n_1u_2$
Let 1 dyne = nu
Where u = new unit of force
$[F] = [M^1L^1T^{-2}]$
$1\ gm.\ cm.s^{-2} = n\ .\ (10gm)\ .\ (10cm)\ .\ (0.1s)^{-2}$
where 10 gm, 10 cm are 0.1 s are
new units of mass, length and time respectively
solving the above relation we get $n = 10^{-4}$
i.e. 1 dyne $= 10^{-4}u$
or 10^{-5} newton $= 10^{-4}$ u

or $u = \frac{1}{10}$ Newton

3. (A)

Sol. Slope of V-t graph = acceleration. $= -\frac{5}{10-5} = -1\ m/s^2$.

4. (C)

Sol. In this condition velocity and acceleration both are perpendicular w.r.t. ground.
So path on ground will be parabolic.

5. (C)

Sol. for upward motion $t_a = \frac{u}{g\sin\alpha + \mu g\cos\alpha}$ ...(1)

$u^2 = 2(g\sin\alpha + \mu g\cos\alpha)s$...(2)

for downward motion $t_d = \frac{v}{g\sin\alpha - \mu g\cos\alpha}$ ...(3)

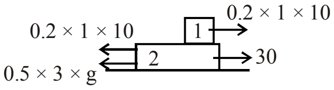
$v^2 = 2(g\sin\alpha - \mu g\cos\alpha)s$ ...(4)

Solving equation (1), (2), (3) & (4)

$$\frac{t_a}{t_d} = \sqrt{\frac{\sin\alpha - \mu\cos\alpha}{\sin\alpha + \mu\cos\alpha}} = \frac{1}{2} \quad \Rightarrow \quad u = 0.6\tan\alpha \quad]$$

6. (A)

Sol.



$1a_1 = 0.2 \times 1 \times 10 = 2\ m/s^2$
$2a^2 = 30 - 2 - 15 = 13$
$a_2 = 6.5\ m/s^2$
$a_{12} = -4.5\ m/s^2$
$s_{12} = \frac{1}{2}a_{12}t^2$
$-1 = \frac{-9}{4}t^2$
$t = \frac{2}{3}$ sec.

7. (B)

Sol. $\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$

$$10\hat{i} - 50\hat{j} - 40\hat{j} + \vec{F}_3 = 0$$

$$\vec{F}_3 = 30\hat{i} - 50\hat{j}$$

$\Rightarrow$ IVth quadrant.

8. (C)

Sol. Let $\alpha t + \beta$

$$v = \frac{\alpha t^2}{2} + \beta t + \gamma$$

at $t = 0$ $v = 0$ $\Rightarrow \gamma = 0$

$$\Rightarrow v = \frac{\alpha t^2}{2} + \beta t$$

at $t = 2$ $v = 6$

$6 = 2\alpha + 2\beta$

$\alpha + \beta = 3$ .... (1)

at $t = 4$ $v = 20$

$20 = 8\alpha + 4\beta$

$2\alpha + \beta = 5$ ... (ii)

from (i) & (ii)

$\alpha = 2$

$\beta = 1$

$\therefore$ at $t = 1$ $a = 2t + 1 = 3$

9. (A)

Sol. Arrangement A :

$2mg - T = 2ma$

$T - mg = ma$

$mg = 3ma$

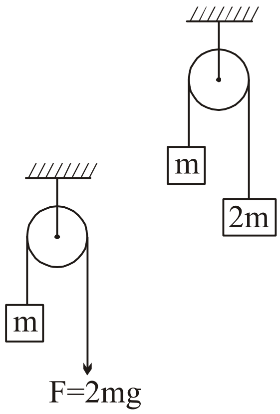
$a = g/3$ ... (1)

$F - mg = ma$

$2mg - mg = ma$

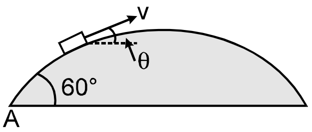
$a = g$ ... (2)

By eq. (1) & (2) ratio is 1 : 3



10. (D)

Sol. If the normal reaction is always zero, the particle always moves under action of gravitational force. Hence the path of particle (and also the nature of surface) is parabolic.



At a height h = 5 metre above the projection the speed of the particle is

$$v^2 = \sqrt{u^2 - 2gh} = \sqrt{400 - 2 \times 10 \times 5} = 10\sqrt{3} \text{ m/s}$$

The horizontal component of velocity does not change

$\therefore \quad v \cos\theta = 20 \cos 60°$

$$\cos\theta = \frac{1}{\sqrt{3}} \qquad \text{or } \tan\theta = \sqrt{2} \qquad \Rightarrow \quad \theta = \tan^{-1}\sqrt{2}$$

11. (B)

Sol. Let $m_1 + m_2 = m = \text{constant and } m_1 = x \Rightarrow m_2 = m - x$

$$a = \frac{x-(m-x)}{m} g$$

$$T = \frac{2x(m-x)}{m} g$$

$$\Rightarrow \quad T = \frac{m}{2g}(g^2 - a^2)$$

12. (A)

Sol. $\vec{v}_1 = \vec{u}_1 + \vec{g}t$

$\vec{v}_2 = \vec{u}_2 + \vec{g}(t-\tau)$

$\vec{v}_2 - \vec{v}_1 = \vec{u}_2 - \vec{u}_1 - \vec{g}\tau$

$\vec{u}_2 - \vec{u}_1$ = constant. This constant difference in their velocities makes the difference in their positions $\vec{r}_2 - \vec{r}_1$ change with time.]

13. (B)

Sol. Let $K = \frac{1}{2} m v_0^2$

velocity when angle is 30° = v'

$v_0 \cos 60° = v' \cos 30°$

$$v' = \frac{v_0}{\sqrt{3}}$$

$$k' = \frac{1}{2} m v^{12} = \frac{k}{3}$$

14. (D)

Sol. $y \max \Rightarrow \frac{dy}{dt} = 0$

$\Rightarrow 10 - 2t = 0$

$t = 5$ sec.

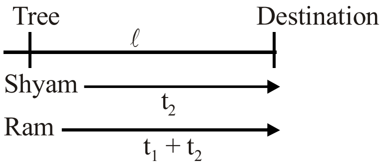
$y = 50 - 25 = 25$ m]

15. (A)

Sol. $R = vt$ ....(1)

16. (B)

Sol.



$\ell = v_S\, t_2$

$\ell = v_R\,(t_1 + t_2)$] $h = \frac{1}{2}gt^2$ ....(2)

$\tan 30° = \frac{h}{R}$ ....(3)]

17. (C)

Sol. Average speed = $\frac{\text{distance}}{\text{time}} = \frac{2\Delta y}{\Delta t}$]

18. (B)

Sol. $v_1 = \frac{dx_1}{dt}$

$v_2 = \frac{dx_2}{dt}$

$\overline{v}_{rel} = \overline{v}_1 - \overline{v}_2$]

19. (D)

Sol. Direction of flutter = $\vec{V}_{\text{wind / boat}}$

$= \vec{V}_{\text{wind}} - \vec{V}_{\text{boat}}$

$= \vec{V}_{\text{wind}} - \left(\vec{V}_{\text{boat / water}} + \vec{V}_{\text{water}}\right)$

20. (A)

Sol. $a = v\frac{dv}{dx} = \alpha - \beta x$

$\Rightarrow \int_6^0 v\,dv = \alpha\int_6^0 dx - \beta\int x\,dx$ $\Rightarrow 0 = ax - \frac{\beta x^2}{2}$ $\therefore\ x = \frac{2\alpha}{\beta}$]

21. 100

Sol. from graph $\frac{dv}{dx} = \frac{90-50}{40-20} = \frac{40}{20}$

$\frac{dv}{dx} = 2$

$v\,(\text{at } x = 20) = 50$ m/s

$a = v\,\frac{dv}{dx}$

$a = 50 \times 2 = 100$ m/s^2 **Ans.**

22. 25

Sol. $y = x\tan\theta - \frac{1}{2}g\frac{x^2}{v^2\cos^2\theta}$

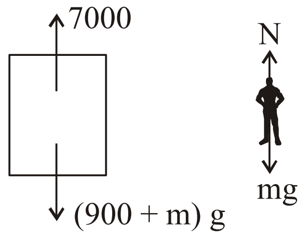
$x = 38 + 2 = 40$

$y = 18$

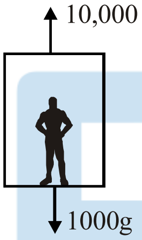
$\theta = 60°$ $\Rightarrow v = 25$ m/s

23. 1000

Sol.



$$\begin{array}{c} 7000-(900+m)g=(900+m)a \\ N-mg=ma \\ \hline 7000-9000-N=900a \end{array}$$



$-2700 = 900\,a$

$a = -3$ m/s^2

$700 - mg = m \times -3$

$700 = 7 \times m \Rightarrow m = 100$ kg

$10000 - 1000\,g = 1000\,a \Rightarrow a = 0$

$N = 100\,g = 1000$ N

24. 2

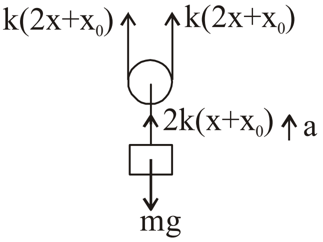
Sol. $F - 5g = \frac{5g}{6}$

$$\begin{array}{c} (5+m)g - F = (5+m)g/6 \\ \hline mg = (10+m)g/6 \end{array}$$

$\Rightarrow 5m = 10$ $\Rightarrow m = 2$ kg]

25. 4

Sol. In equilibrium



$2kx_0 = mg$

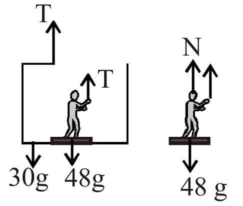
Now, $2k(2x + x_0) - mg = ma$

$4kx = ma$

$a = \frac{4kx}{m} = \frac{4 \times 10 \times 1}{10} = 4$ cm/s^2

26. 90

Sol.



$2T = 78$ g $\quad N + T = 48$ g

$T = 390 \quad \therefore N = 90$

27. 2

Sol. $a_{max} = \mu g = 0.2\times 10 = 2 m/sec^2$

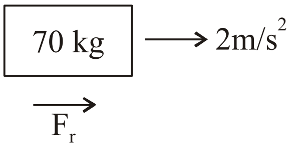
$v = u + at$

$0 = 4 - 2t$

$t = 2sec$

28. 140

Sol. Draw combined FBD



$F_r = 70\,(2) = 140$

29. 4

Sol. $v = u + at$

$= 12.376 + (2.00 \times 1.82)$

$= 12.376 + (3.64)$

$= 16.02$

$\Rightarrow$ 4sd.

30. 625

Sol. $[E] = mL^2T^{-2}$

$$K_2 = K_1\left[\frac{m_1}{m_2}\right]^a\left[\frac{L_1}{L_2}\right]^b\left[\frac{T_1}{T_2}\right]^c$$

$$= 10\left[\frac{1kg}{100gm}\right]^1\left[\frac{1m}{200cm}\right]^2\left[\frac{1\,sec}{5\,sec}\right]^2$$

$$= 10\left[\frac{1000gm}{100gm}\right]\left[\frac{100\,cm}{200\,cm}\right]^2[5]^2$$

$$= 10\times 10\times\frac{1}{4}\times 25 = 625 \text{ Ans.}$$]

31. C

Sol. CS_2, CO_2, SO_2]

32. D

Sol. 9.108×10^{-31} kg = mass of $1e^-$.

number of electrons in 1 kg $= \frac{10^{31}}{9.108}$ e $= \frac{10^{31}}{9.108 \times 6.023 \times 10^{23}} = \frac{10^8}{9.108 \times 6.023}$ mole electron.

33. B

Sol. Given HNO_3 = 0.009 mole

and NaOH = 0.001 mole

1 mole HNO_3 react with 1 mole of NaOH

$\therefore$ Left HNO_3 = 0.008 mole

Accroding to question

1 mole HNO_3 react with 1 mole NH_3

$\therefore$ 0.008 mole HNO_3 react with 0.008 mole NH_3

& 1 mole NH_3 contain 1 mole nitrogen

$\therefore$ % N in sample $= \frac{0.008}{2.8} \times 14 \times 100 = 4\,\%$]

34. C

Sol. Vapour density $= \frac{\text{Molecular mass}}{2}$

$40 = \frac{\text{Molecular mass}}{2}$

$\therefore$ Molecular mass of gaseous mixture = 40 × 2 = 80

Volume ratio $= \frac{2}{3}$ therefore mole ratio $= \frac{2}{3}$ (as V α n)

Now, $M_{avg} = \frac{2}{5} \times 20 + \frac{3}{5} \times M_B = 80$

$\Rightarrow M_B = 120$

35. C

Sol. $C \quad + \quad O_2 \longrightarrow CO \quad + \quad CO_2$

$\frac{9.6}{32} = 0.3 \text{ moles}$ 4 x mole   x mole

4x + 2x = 0.6

x = 0.1

$\therefore$ Moles of carbon = 4x + x = 5x

= 5 × 0.1 = 0.5

$\therefore$ Mass of graphite = 0.5 × 12 = 6 gm

36. A

Sol. $d = \frac{M}{V}$

M = 4 × 1.5 = 6 gm

6 gm have 60 drops

1 drop will have 0.1 gm

$n = \frac{0.1}{8} \times 6 \times 10^{23} = 7.5 \times 10^{20}$ molecules]

37. B

Sol. 3.2×10^5 atoms have mass = 8×10^{-18} gm

6×10^{23} atoms have mass

$$= \frac{8\times10^{-18}}{3.2\times10^{5}}\times6\times10^{23}$$

$$= \frac{480}{32}=15\text{gm}$$

38. B

Sol. $n_{O_2} = n_{SO_2}$ (under identical conditions of P & T)

$$\frac{w_{O_2}}{32}=\frac{w_{SO_2}}{64}$$

$$w_{O_2}=\frac{1}{2}w_{SO_2}$$

39. A

Sol.

2Al +	$Fe_2O_3 \longrightarrow$	Al_2O_3 +	$2Fe_{(s)}$
5.4 gm	18.5 gm	10.2 gm	11.2 gm

Initial mass = 18.5 + 5.4 = 23.9 gm

Weigth of product = 10.2 + 11.2 = 21.4 gm

Mass of unreacted Fe_2O_3 = 2.5 gm

40. **B**

Sol. Molality of pure ethanol = $\dfrac{\frac{1}{46}}{1000} = \dfrac{1000}{46}$

Molality of pure water = $\dfrac{\frac{1}{18}}{1000} = \dfrac{1000}{18}$

$m_{C_2H_5OH} < m_{H_2O}$

density is not used to calculate molality.

41. B

Sol. Redox titration

Eq. of $K_2C_2O_4.3H_2C_2O_4.4H_2O$ = Eq. of $KMnO_4$

$$\frac{0.1\times V}{1000}=\frac{20\times0.05\times5}{1000}$$

V = 50 ml

n factor of $K_2C_2O_4.\ 3H_2C_2O_4.4H_2O$

for redox titration = 8

for acid base titration = 6

$\therefore$ for acid base titration normality of $K_2C_2O_4.3H_2C_2O_4.4H_2O = \dfrac{0.1}{8}\times 6$ N

Eq. of acid = Eq. of base

$$\frac{0.1\times50}{8\times1000}\times6=\frac{1}{8}\times\frac{\text{Vml}}{1000}$$

Vml = 30 ml Ans.]

42. C

Sol. $(NH_4)_3\,PO_4 \xrightarrow[16\,ml]{KMnO_4} NO_3^- + PH_3$

–3 +5 +5 –3

+24 – 8 = 16

50 × 0.2 M

n–factor of $KMnO_4$ in acidic medium = 5

n-factor of $(NH_4)_3PO_4$ = 16

Eq. of $(NH_4)_3PO_4$ = Eq. of $KMnO_4$

$$\frac{0.2\times 50}{1000}\times 16 = \frac{N\times 16}{1000}$$

N= 10 Ans.]

43. A

Sol. $2MnO + 5PbO_2 \longrightarrow 2HMnO_4 + 5\,Pb(NO_3)_2$

$+ 10\,HNO_3 + 4\,H_2O$]

44. C

Sol. $Fe^{+2} \longrightarrow Fe^{3+} + e^-$

$Cr_2^{6+} \longrightarrow Cr^{+6} + 6e^-$

$FeCr_2O_4 \longrightarrow Fe_2O_3\,K_2CrO_4 + 7e^-$]

45. A

Sol. $O_2 + FeS_2 \longrightarrow FeO + SO_2$

Oxidation half reaction :

$S_2^{2-} \longrightarrow 2s^{4+} + 10e^-$ .... (i)

Reduction half reaction :

$4e^- + O_2 \longrightarrow 2O^{2-}$ .....(ii)

So, on doing 2 × (i) + 5 (ii)

$\therefore\ 2S_2^{2-} + 5O_2 \longrightarrow 4s^{4+} + 10\,O^{2-}$

$2FeS_2 + 5O_2 \longrightarrow 4SO_2 + 2FeO$

$\because$ Since one molecule of FeS_2 liberates 10 electrons

So 2 moles of FeS_2 required to liberate 20 mole e^-.]

46. A

Sol. +7 +3 +2 +6

$MnO_4^- + CrCl_3 \longrightarrow MnCl_2 + Cr_2O_7^{2-} + Cl^-$

RHR OHR

$Mn^{+7} + 5e^- \longrightarrow Mn^{+2}$ ....(i) × 6 $2Cr^{+3} \longrightarrow Cr_2^{+6} + 6\,e^-$ .... (ii) × 5

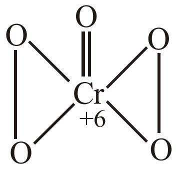
$6MnO_4^- + 10\,CrCl_3 + 11H_2O \longrightarrow 6\,MnCl_2 + 5Cr_2O_7^{-2} + 18\,Cl^- + 22\,H^+$

$$\frac{\text{stoichiometric coefficient of } CrCl_3}{\text{stoichiometric coefficient of } MnO_4^-} = \frac{10}{6} = \frac{5}{3}$$ Ans.]

47. C

Sol. Compound Y is CrO_5

Butterfly structure



48. B

Sol. $n_{KMnO_4} = \dfrac{20}{1000} \times \dfrac{1}{50}$

$n_{Fe^{+2}} = 5 \times n_{kMnO_4}$

$= 5 \times \dfrac{20}{1000} \times \dfrac{1}{50} = 0.002$

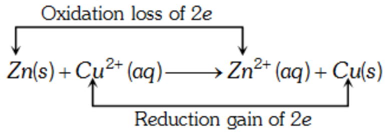
$n_{N_2H_4}$ is 10 ml $= \dfrac{1}{4}\ n_{Fe^{+2}} = \dfrac{0.002}{4}$

$n_{N_2H_4}$ is 1L $= \dfrac{0.002}{4} \times 100 = \dfrac{0.2}{4}$

mass of $N_2H_6SO_4$ in 1L $= \dfrac{0.2}{4} \times 130 = 6.5$ gm

49. A

Sol. Both **Statement - 1 :** and **Statement - 2 :** are true and reason is the correct explanation of **Statement - 1 :** .



50. B

Sol. (B) Both **Statement - 1 :** and **Statement - 2 :** are true but **Statement - 2 :** is not the correct explanation of **Statement - 1 :** .

Oxidation number can be calculated using some rules. H is assigned +1 oxidation state and 0 has oxidation number –2

$\therefore$ O. No. of C in CH_2O :

O. no. of $C + 2(+1) + (-2) = 0$

$\therefore$ O. No. of $C = 0$

51. 5

Sol. Let, molarity of the solution be M mol/L

and take 1L solution.

$\therefore\ m_{sol} = V.d = 1000 \text{ ml} \times 2 \text{ g/ml}$

$= 2000 \text{ g};\ m_{solute} = (180M) \text{ g}$

$\therefore\ m_{solvent} = (2000 - 180M) \text{ g}$

$= (2 - 0.18M) \text{ kg}$

$\therefore$ Molality (m) $= \dfrac{M}{(2 - 0.18M)}$

$\Rightarrow \dfrac{m}{M} = \dfrac{1}{2 - 0.18M}$

$\Rightarrow 5 = \dfrac{1}{2 - 0.18M} \Rightarrow 2 - 0.18\,M = 0.2$

$\Rightarrow 0.18\,M = 1.8 \qquad \therefore\ M = 10$

$\therefore$ **Ans** $\dfrac{10}{2}$ M $= 5$ M

52. 5

Sol. Mass of oxygen added to Fe = (21.5 – 20)g

$= 1.5\text{g}$

$$\therefore \quad 2Fe(s) + \frac{3}{2}O_2(g) \rightarrow Fe_2O_3(s)$$

$$2\,\text{mol} \quad \frac{3}{2}\,\text{mol} \quad \text{gives} \quad 1\text{mol}$$

$$112\text{g} \quad 48\text{g} \quad \text{gives} \quad 160\,\text{g}$$

$\because$ O_2 is L.R.

$$\therefore\ m_{Fe_2O_3}\,(\text{formed}) = \frac{160}{48} \times 1.5\ \text{g} = 5\ \text{g}$$

53. 60

Sol. Let, Partial pressure of $CH_4(g)$ and $C_2H_6(g)$

be P_1 atm and P_2 atm respectively.

$\therefore P_1 + P_2 = 0.5$ ....(1)

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

t = 0 P_1atm $2P_1$ atm 0   0

after rxn: 0   0 P_1 atm $2P_1$ atm

$$C_2H_6(g) + 3.5O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$$

t = 0 P_2atm $3.5P_2$ atm   0   0

after rxn: 0   0 $2P_2$ atm $3P_2$ atm

$\therefore$ Final $P_{total} = 3P_1 + 5P_2 = 2.1$ ....(2)

Solving (1) and (2) $P_1 = 0.2$ and $P_2 = 0.3$

$$\therefore\ X_{C_2H_6(g)} = \frac{0.3}{0.5} = 0.6$$

$\therefore$ **Ans.** $0.6 \times 100 = 0060$

54. 50.6%

Sol. H_2SO_4 → TlI

Applying POAC

2 × moles of Tl_2SO_4 = 1 × moles of TlI

$$\frac{2 \times x}{506} = \frac{1 \times 6.64}{332}$$

$$x = \frac{506 \times 6.64}{332 \times 2} = 5.06$$

$$\text{mass \% of } Tl_2SO_4 = \frac{5.06}{10} \times 100 = 50.6\%$$

55. 5475

Sol. $PCl_5\,(g) + 4H_2O\,(l) \xrightarrow{30\%} H_3PO_4\,(aq) + 5HCl\,(aq)$

2 mol.   4 mol

Theoritical yield of HCl = 5 mol

$$\%\ \text{yield} = \frac{\text{Actual yield}}{\text{Theoritical yield}} \times 100$$

$$\Rightarrow \text{Actual yield} = \frac{5 \times 30}{100} = 1.5\ \text{mol}$$

$= 54.75 \times 100 = 5475$ **Ans.**

56. 16

Sol.

$2\times(-3e)$ $(+6)$

$$CrCl_3 + H_2O_2 \longrightarrow Na_2CrO_4 + 2H_2O$$

(-4) $3\times(+2e)$

(balanced skelton) $2CrCl_3 + 3H_2O_2 \longrightarrow 2Na_2CrO_4 + 6H_2O$

$+ 6NaCl$ (Chloride balance)

$+ 10NaOH$ (Sodium balance)

$+ 2H_2O$ (Oxygen balance)

$2CrCl_3 + 3H_2O_2 + 10NaOH \longrightarrow 2Na_2CrO_4 + 6NaCl + 8H_2O$

$\Rightarrow$ $a = 2$ $b = 3$ and $c = 10$]

57. 121

Sol.

$P_4^{+3} \to 4P^{+5} + 8e^-$ $(3e^- + N^{+5} \to N^{+2}) \times 44$

$S_6^{-2} \to 6P^{+4} + 36e^-$

$3\times[P_4^{+3} + S_6^{-2} \to 4P^{+5} + 6S^{+4} + 44e^-]$

$3P_4^{+3} + 3S_6^{-2} \to 12P^{+5} + 18S^{+4} + 132e^-$

$132e^- + 44N^{+5} \to 44N^{+2}$

$3P_4^{+3} + 3S_6^{-2} + 44N^{+5} \to 12P^{+5} + 18S^{+4} + 44N^{+2}$

$44H^+ + 3P_4S_6 + 44NO_3^- \to 12H_3PO_4 + 18SO_2 + 44NO + 4H_2O$

$a = 3, b = 44, C = 44, d = 12, e = 18$

$(a + b + c + d + e) = 121$ **Ans.**]

58. 75

Sol. Let CuO x mole

Cu_2O x mole

$Cu_2O + MnO_4^- \xrightarrow{H^+} 2Cu^{2+} + Mn^{2+}$

$n_f = 2$ $n_f = 5$

CuO will not react with $KMnO_4$

Equivalents of Cu_2O = equivalent of $KMnO_4$

$$x \times 2 = \frac{100 \times 0.1 \times 5}{1000}$$

$$x = \frac{5}{200}$$

final Cu^{+2} mole $= 2x + x = \frac{3 \times 5}{200} = \frac{3}{40}$

(From Cu_2O) (From CuO)

millimoles of $Cu^{2+} = \frac{3}{40} \times 1000 = 75$ milli moles]

59. 90

Sol. $Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6 + I^{-1}$

$n_f = 1 \quad n_f = 2$

$0.1 \times 1 = 2 \times \text{mole of } I_2$

$$\text{mole of } I_2 = \frac{0.1}{2} \text{ moles}$$

$\text{milli moles} = 0.1 \times 1000 / 2 = 50$

$IO_4^- + I_2 \longrightarrow IO_3^-$

$n_f = 2 \quad n_f = 10$

$10 \times \text{mole of } I_2 = 2 \times 0.2 \times 1$

$\text{mole of } I_2 = 0.04$

$\text{milli mole} = 40$

$\text{total milli mole} = 40 + 50 = 90$]

60. 11.5

Sol. $KMnO_4 + FeS_2 + CuS \longrightarrow Cu^{+2} + Fe^{+3} + SO_2$

$n = 11 \quad n = 6$

$\text{Eq. of } KMnO_4 = \text{Eq. of } FeS_2 + \text{Eq. of } CuS$

$$\frac{N \times V}{1000} = \frac{MV_{FeS_2}}{1000} \times n + \frac{MV_{CuS}}{1000} \times n$$

$$\frac{N \times 20}{1000} = \frac{10 \times 1}{1000} \times 11 + \frac{20 \times 1 \times 6}{1000}$$

$$N = \frac{110 + 120}{20} = \frac{230}{20} = 11.5\,N \text{ Ans.}$$]

61. (A)

Sol. $\frac{-\cot\alpha\ \sin\alpha}{\cos\alpha} + \sin\alpha\ .\ \sin\alpha + \cos\alpha\ .\ \cos\alpha$

$= -1 + 1 = 0$

62. (B)

Sol. $a\ \text{cosec}\alpha - b\sec\alpha = \frac{a}{\sin\alpha} - \frac{b}{\cos\alpha}$

$\frac{\sqrt{a^2+b^2}}{\sin\alpha\ \cos\alpha}\left[\frac{a}{\sqrt{a^2+b^2}}\cos\alpha - \frac{b}{\sqrt{a^2+b^2}}\sin\alpha\right]$

Now $\sin 3\alpha = \frac{a}{\sqrt{a^2+b^2}}$ gives

$\Rightarrow \sqrt{a^2+b^2}\left[\frac{\sin 3\alpha\cos\alpha - \cos 3\alpha\ \sin\alpha}{\sin\alpha\ \cos\alpha}\right] = 2\sqrt{a^2+b^2}$ Ans

63. (A)

Sol. $3\log_2 a + \log_2 b = x$

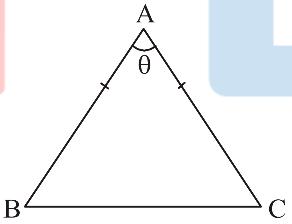
$\log_2 3 + \log_2 a - \log_2 b = y$

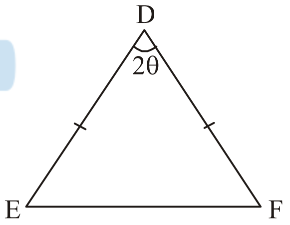
$4\log_2 a = x + y - \log_2 3$

$\therefore \quad \log_2 a = \frac{x+y-\log_2 3}{4} = \frac{x+y}{4} - \log_2 \sqrt[4]{3}$. **Ans.**

64. (B)

Sol. $\frac{\text{Area of } \Delta ABC}{\text{Area of } \Delta DEF} = \frac{\frac{1}{2}AB\cdot AC\cdot\sin\theta}{\frac{1}{2}DE\cdot DE\cdot\sin 2\theta}$





$= \frac{(2DE)(2DE)\sin\theta}{(DE)(DE)2\sin\theta\cos\theta}$

$= \frac{2}{\cos\theta} = 2\sec\theta = 2\sec A$ **Ans.**

65. (B)

Sol. $\frac{3\sin\theta - (3\sin\theta - 4\sin^3\theta)}{1+\cos\theta} + \frac{3\cos\theta + (4\cos^3\theta - 3\cos\theta)}{1-\sin\theta} = 4\sqrt{2}\cos\left(\theta + \frac{\pi}{4}\right)$

$\Rightarrow \quad 4\sin\theta(1-\cos\theta) + 4\cos\theta(1+\sin\theta) = 4\sqrt{2}\cos\left(\theta+\frac{\pi}{4}\right)$

$\Rightarrow \quad 4\sqrt{2}\sin\left(\theta+\frac{\pi}{4}\right) = 4\sqrt{2}\cos\left(\theta+\frac{\pi}{4}\right) \Rightarrow \tan\left(\theta+\frac{\pi}{4}\right) = 1 \Rightarrow \theta+\frac{\pi}{4} = n\pi + \frac{\pi}{4}, n \in I$

But $\quad 1 + \cos\theta \neq 0$

$\therefore \quad \theta = 2n\pi \ \forall\ n \in I$

Hence number of solution are 9 i.e. $\theta = -8\pi, -6\pi, -4\pi, -2\pi, 0, 2\pi, 4\pi, 6\pi, 8\pi$.

66. (D)

Sol. $\log_a b = c,\ \log_b c = 2d,\ \log_c d = 3a$ and $\log_d a = 4b$

Multiplying all $\log_a b \cdot \log_b c \cdot \log_c d \cdot \log_d a = 24$ abcd

$\Rightarrow\ 1 = 24abcd \Rightarrow abcd = \dfrac{1}{24}$. **Ans.**

67. (B)

Sol. $0 \le x < 2\pi$

$\cos x + \cos 2x + \cos 3x + \cos 4x = 0$

$(\cos x + \cos 4x) + (\cos 2x + \cos 3x) = 0$

$2\cos\dfrac{5x}{2}\cos\dfrac{3x}{2} + 2\cos\dfrac{5x}{2}\cos\dfrac{x}{2} = 0$

$2\cos\dfrac{5x}{2}\left[2\cos x\cos\dfrac{x}{2}\right] = 0$

$\cos\dfrac{5x}{2} = 0$ or $\cos x = 0$ or $\cos\dfrac{x}{2} = 0$

$x = \dfrac{(2n+1)\pi}{5}$ or $x = (2n+1)\dfrac{\pi}{2}$ or $x = (2n+1)\pi$

$x = \left\{\dfrac{\pi}{5}, \dfrac{3\pi}{5}, \pi, \dfrac{7\pi}{5}, \dfrac{9\pi}{5}, \dfrac{\pi}{2}, \dfrac{3\pi}{2}\right\}$

Number of solution is 7

68. (B)

Sol. Given expression

$$= \frac{\sin A}{\cos A} \times \frac{\sin A}{\sin A - \cos A} + \frac{\cos A}{\sin A} \times \frac{\cos A}{\cos A - \sin A}$$

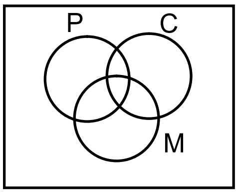
$$= \frac{1}{\sin A - \cos A}\left\{\frac{\sin^3 A - \cos^3 A}{\cos A \sin A}\right\}$$

$$= \frac{\sin^2 A + \sin A\cos A + \cos^2 A}{\sin A \cos A} = 1 + \sec A \operatorname{cosec} A$$

69. (A)

Sol. $n(P) = \left[\dfrac{140}{3}\right] = 46$

$n(C) = \left[\dfrac{140}{5}\right] = 28$



$n(M) = \left[\dfrac{140}{2}\right] = 70$

$n(P \cup C \cup M) = n(P) + n(C) + n(M) - n(P \cap C) - n(C \cap M) - n(M \cap P) + n(P \cap M \cup C)$

$= 46 + 28 + 70 - \left[\dfrac{140}{15}\right] - \left[\dfrac{140}{10}\right] - \left[\dfrac{140}{6}\right] + \left[\dfrac{140}{30}\right]$

$= 144 - 9 - 14 - 23 + 4$

$= 102$

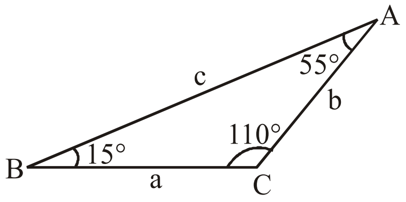
so required number of student $= 140 - 102 = 38$

70. (C)

Sol. $$\text{antilog}_{128}\left(\frac{3}{7}\right) = (128)^{\frac{3}{7}} = \left(2^7\right)^{\frac{3}{7}} = 2^3.$$

$$\therefore\ \log_{\sqrt{2}}(2)^3 = \frac{3}{1/2}\log_2 2 = 6.$$ **Ans.**

71. (C)



Sol. We have $\dfrac{c}{\sin 110^\circ} = \dfrac{b}{\sin 15^\circ} = \dfrac{a}{\sin 55^\circ} = k(\text{let})$

Now, $c^2 - a^2 = k^2(\sin^2 110^\circ - \sin^2 55^\circ)$

$= k^2(\sin 110^\circ + \sin 55^\circ)(\sin 110^\circ - \sin 55^\circ)$

$= k^2\left(2\sin\dfrac{165^\circ}{2}\cos\dfrac{55^\circ}{2}\right)\left(2\cos\dfrac{165^\circ}{2}\sin\dfrac{55^\circ}{2}\right)$

$= k^2 \sin 165^\circ \sin 55^\circ = (k\sin 15^\circ)(k \sin 55^\circ) = ab$ **Ans.**

72. (D)

Sol. $$2\left(\sin^4\frac{x}{2} - \cos^4\frac{x}{2}\right) = 1 \Rightarrow 2\left(\sin^2\frac{x}{2} - \cos^2\frac{x}{2}\right) = 1$$

$$\Rightarrow \cos x = \frac{-1}{2} = \cos\frac{2\pi}{3} \Rightarrow x = 2n\pi \pm \frac{2\pi}{3}.$$ **Ans.**

73. (B)

Sol. $X = \{0, 9, ... 4^n - 3n - 1\}$

$Y = \{0, 9, ..., 9(n-1)\}$

Now $4^n - 3n - 1 = (3+1)^n - 3n - 1 = 3^n + n.3^{n-1} + ... + {}^nC_2 .9.$

is a multiple of 9.

Also Y consists of all multiples of '9' from 0, 9,.......

Hence all values of X are subset of values of Y.

Thus $X \cup Y = Y$

74. (B)

Sol. We have $\dfrac{\sin A}{c \sin B} = \dfrac{a}{bc}$

$$\therefore \quad \frac{\sin B}{c} + \frac{\sin C}{b} = \frac{c}{ab} + \frac{b}{ac}$$

$$\Rightarrow \quad \frac{b\sin B + c\sin C}{bc} = \frac{c^2 + b^2}{abc} \Rightarrow a = \frac{b^2 + c^2}{b\sin B + c\sin C} = \frac{b(2R\sin B) + c(2R\sin C)}{b\sin B + c\sin C}$$

$$\Rightarrow \quad a = 2R \qquad \left(\text{As} \frac{b}{\sin B} = \frac{c}{\sin C} = \frac{a}{\sin A} = 2R\right)$$

Hence $\angle A = \dfrac{\pi}{2}$

75. (D)

Sol. $\log_p\left(\frac{(16)^7}{(15)^7}\times\frac{(25)^5}{(24)^5}\times\frac{(81)^3}{(80)^3}\right)=8$

$\Rightarrow \log_p\left(\frac{16^7\times5^{10}\times3^{12}}{5^7\times3^7\times8^5\times3^5\times(16)^3\times5^3}\right)=8 \Rightarrow \log_p\left(\frac{16^4}{8^4\times8}\right)=8$

$\Rightarrow \log_p\left(\frac{2^4}{8}\right)=8 \Rightarrow \log_p 2=8 \Rightarrow 2=p^8.$

$\therefore\ p^{16}=4$. **Ans.**]

76. (B)

Sol. $Y\subseteq X,\qquad Z\subseteq X$

Let $a\in Y, a\in Z$...............(i)

$a\notin Y$, $a\in Z$..................(ii)

$a\in Y$, $a\notin Z$ ....(iii)

$a\notin Y$, $a\notin Z$ ....(iv)

$Y\cap Z=\phi$ (bt eq. (i), (ii), (iii), (iv))

$Y\cap Z=\phi$ has 3 options

Thus required possibilities for 5 elements of $X=3^5$.

77. (C)

Sol. $2\le\log_5 N<3 \Rightarrow 25\le N<125$

$\Rightarrow$ Number of integers = 125 – 25 = 100. **Ans.**

78. (C)

Sol. $4^{\log_9 3}+9^{\log_2 4}=10^{\log_x 83} \Rightarrow 4^{1/2}+9^2=83^{\log_x 10}$

$\Rightarrow 83=83^{\log_x 10} \Rightarrow 1=\log_x 10 \Rightarrow x=10$. **Ans.**

79. (B)

Sol. We have, $A\cup B=A\cup C \quad\Rightarrow\quad (A\cup B)\cap C=(A\cup C)\cap C$

$\Rightarrow (A\cap C)\cup(B\cap C)=C \qquad [\because (A\cup C)\cap C=C]$

$\Rightarrow (A\cap B)\cup(B\cap C)=C$ ...(i) $\qquad [\because A\cap C=A\cap B]$

Again, $A\cup B=A\cup C$

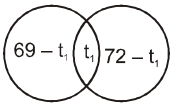
$\Rightarrow (A\cup B)\cap B=(A\cup C)\cap B \quad\Rightarrow\quad B=(A\cap B)\cup(C\cap B)$

$\Rightarrow (A\cap B)\cup(C\cap B)=B \quad\Rightarrow\quad (A\cap B)\cup(B\cap C)=B$ ...(ii)

From (i) and (ii), we get $B=C$

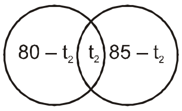
80. (B)

Sol.

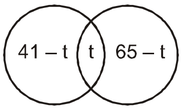


$70+72-t_1=100$

$t_1=42\% \Longrightarrow$ min. in $P\cap C=42\%$



$t_2=85\%-20\%=65\% \quad\Longrightarrow\quad$ min. $M\cap E=65\%$



$t=42-35=7\%$

min. in $((P\cap C)\cap(M\cap E))=7\%$

81. 4

Sol. $\underbrace{4\cos^2 x+\sec^2 x}_{\geq 4}+\underbrace{\tan^2 x+\cot^2 x}_{\geq 2}=6$

$\Rightarrow$ $4\cos^2 x=\sec^2 x$ & $\tan^2 x=1$

$\cos^2 x=\dfrac{1}{2}$ $\tan x=\pm 1$

$\cos x=\pm\dfrac{1}{\sqrt{2}}$

$\Rightarrow$ 4 solutions.

82. 6

Sol. $\log 1/2 (x+5)^2>\log 1/2\ (3x-1)^2$

$(x+5)^2>0 \implies x\ \ R-\{-5\}$ ....(i)

$(3x-1)^2>0 \implies x\ \ R-\left\{\dfrac{1}{3}\right\}$ ....(ii)

$(x+5)^2<(3x-1)^2$

$\implies 8x^2-16x-24>0$

$\implies x^2-2x-3>0$

$\implies (x-3)(x+1)>0$

$\implies x\ \ (-\infty,-1)\cup(3,\infty)$ ....(iii)

$(i)\cap(ii)\cap(iii)$ gives

$(-\infty,-5)\cup(-5,-1)\cup(3,\infty)$

83. 1

Sol. $\dfrac{\sqrt{2}\sin\alpha}{\sqrt{1+\cos\alpha}}=\dfrac{1}{7}$

$\Rightarrow\dfrac{\sqrt{2}\sin\alpha}{\sqrt{2}\cos\alpha}=\dfrac{1}{7}$

$\Rightarrow\tan\alpha=\dfrac{1}{7}$

$\Rightarrow\sqrt{\dfrac{1-\cos 2\beta}{2}}=\dfrac{1}{\sqrt{10}}$

$\Rightarrow\sqrt{\dfrac{2\sin^2\beta}{2}}=\dfrac{1}{\sqrt{10}}$

$\Rightarrow\sin\beta=\dfrac{1}{\sqrt{10}}$

$\Rightarrow\tan\beta=\dfrac{1}{3}$

$\tan 2\beta=\dfrac{2\tan\beta}{1-\tan^2\beta}$

$\tan 2\beta=\dfrac{2.\frac{1}{3}}{1-\frac{1}{4}}=\dfrac{3}{4}$

$\tan(\alpha+\beta)=\dfrac{\tan\alpha+\tan 2\beta}{1-\tan\alpha+\tan 2\beta}$

$=\dfrac{\frac{1}{7}+\frac{1}{3}}{1-\frac{1}{7}.\frac{1}{3}}=1$

84. 5

Sol. $y = \cos 63^\circ \cos 57^\circ \sin 87^\circ$

$= \cos 63^\circ \sin 57^\circ \cos 3^\circ$

$$= \frac{\cos 3\cdot 3^\circ}{4} = \frac{\cos 9^\circ}{4}$$

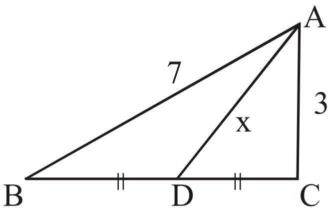
$\therefore\ k = 9,\ m = 4$

$\therefore\ k - m = 5$ **Ans.**

85. 7

Sol. In ΔABC

$$\cos B = \frac{c^2 + a^2 - b^2}{2ac} = \frac{49 + 36 - 9}{2\cdot 6\cdot 7} = \frac{76}{84} = \frac{19}{21}$$



In ΔABD,

$x^2 = 7^2 + 3^2 - 2\cdot 7\cdot 3 \cos B$

$$= 58 - 2\cdot 7\cdot 3\ \frac{19}{21}$$

$= 58 - 38 = 20$

$x = 2\sqrt{5} \Rightarrow p + q = 7$. **Ans.**

86. 3

Sol. $\sin 7\theta = \sin 3\theta + \sin \theta \quad \Rightarrow \quad \sin 7\theta - \sin \theta = \sin 3\theta$

$\Rightarrow \quad 2 \cos 4\theta \sin 3\theta = \sin 3\theta$

$\sin 3\theta = 0 \quad$ or $\quad \cos 4\theta = \frac{1}{2}$

$\theta = \frac{\pi}{3} \quad$ or $\quad \theta = \frac{\pi}{12}, \frac{5\pi}{12} \quad \Rightarrow \quad$ 3 solutions

87. 1

Sol. For $A \cap B$

$x^3 + (x-1)^3 = 1$ ==> $x^3 + x^3 - 3x^2 + 3x - 1 = 1$ ==> $2x^3 - 3x^2 + 3x - 2 = 0$==>$(x-1)(2x^2 - x + 2) = 0$

==> $x = 1$ ==> $y = 0$ ==> $(x, y) = (1, 0)$

For $A \cap C$

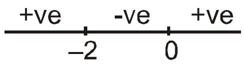
$x^3 + (1 - x)^3 = 1$ ==> $x^3 + 1 - 3x + 3x^2 - x^3 = 1$ ==> $x^2 - x = 0$==> $x = 0, 1$ ==> $(x, y) = (0, 1)\ (1, 0)$

88. 3

Sol. Domain $x > 0$

$\log_2^2 x + 2 \log_2 x \geq 0$

$\log_2 x\ (\log_2 x + 2) \geq 0$



$\log_2 x \leq -2$ or $\log_2 x \geq 0$

$0 < x \quad$ or $\quad x \geq 1$

$$x \in \left(0, \frac{1}{4}\right] \cup [1, \infty) \qquad ....(i)$$

Case-I $\quad 4 - \log2x < 0$

positive <negative (false)

Case -II $\quad 4 - \log_2 x \geq 0$ ==> $\log_2 x \leq 4$

$\Longrightarrow \quad \log_2^2 x\ 2\log_2 x < 2\,(4 - \log_2 x)^2$

$t^2 + 2t < 2\,(4 - t)^2$

$t^2 - 18t + 32 > 0$

$(t - 16)\,(t - 2) > 0$

$\Longrightarrow \quad t < 2 \cup t > 16$

$\log_2 x < 2 \cup \log_2 x > 16 \qquad$ (Rejected)

$\log_2 x < 2$

$x < 4 \qquad$ ....(ii)

by (i) and (ii)

$$x \in \left(0,\ \frac{1}{4}\right] \cup [1, 4)$$

89. 53

Sol. Difference of two prime numbers is odd $\Rightarrow$ one of them must be 2.

$\therefore \quad p = 2$

$$9^{-\log_{\sqrt{p+q}}\left(\tan\frac{\pi}{8}\right)} = 3 + 2\sqrt{2}$$

$$9^{\log_{\sqrt{p+q}}\left(\cot\frac{\pi}{8}\right)} = 3 + 2\sqrt{2}$$

$$\left(\cot\frac{\pi}{8}\right)^{\log_{\sqrt{p+q}} 9} = \left(\sqrt{2} + 1\right)^2$$

$$\left(\sqrt{2} + 1\right)^{\log_{\sqrt{p+q}} 9} = \left(\sqrt{2} + 1\right)^2$$

$\therefore \quad \log_{\sqrt{p+q}} 9 = 2 \Rightarrow 9 = p + q \Rightarrow p = 2$ and $q = 7$

Now, $\quad p^2 + q^2 = 2^2 + 7^2 = 4 + 49 = 53$. **Ans.**

90. 9

Sol. $p = 4\sec^2\theta + \cos^2\theta$

$p = (2\sec\theta - \cos\theta)^2 + 4$

$p_{\min} = 1 + 4 = 5 \quad (\text{at } \theta = 0^\circ)$

and $\ q = \operatorname{cosec}^2\phi + 4\sin^2\phi$

$q = (\operatorname{cosec}\phi - 2\sin\phi)^2 + 4$

$q_{\min} = 0 + 4 = 4 \quad (\text{at } \theta = 45^\circ)$

$(p + q)_{\min} = 5 + 4 = 9 \qquad$ **Ans.**]