MOTION IIT-JEE
(Where Faith Counts the Success)

TARGET IIT-JEE
HINT & SOLUTIONS

ANSWER KEY WITH SOLUTION

PAPER-II CLASS XI (DATE 20-09-09)

MATHEMATICS

Q.	1	2	3	4	5	6	7	8	9
A.	A	B	B	B	All	A,C	A,B,C	B,C,D	B,C,D

Q.	10	11
A.	(A) – R, (B) – S, (C) – P, (D) – Q	(A)–(R), (B)–(T), (C)–(T), (D)–(P), (Q)

Q.	12	13	14	15	16	17	18	19
A.	0	1	5	3	3	4	7	2

PHYSICS

20. B **21.** B **22.** A **23.** C **24.** B,C **25.** A **26.** A,B,D

27. B,C,D **28.** A,C,D

29. (A) $\rightarrow$ Q,R,S ; (B) $\rightarrow$ P,S ; (C) $\rightarrow$ Q,S ; (D) $\rightarrow$ R

30. (A) $\rightarrow$ R; (B) $\rightarrow$ S ; (C) $\rightarrow$ P ; (D) $\rightarrow$ Q

31. $\frac{15}{32}$ **32.** 3500 ms **33.** $\mu = \frac{1}{\sqrt{2}}\tan\theta$ **34.** $\beta = 30°$ **35.** $\frac{1}{\sqrt{3}}$ **36.** 2 **37.** 2

38. $v_2 = \frac{v_1(1-\cos\alpha)}{\cos\alpha}$

CHEMISTRY

39. D **40.** C **41.** A **42.** B **43.** A,B,C **44.** A,B **45.** A,C,D

46. A,B,C **47.** C

48. A $\rightarrow$ P,Q,R,T ; B $\rightarrow$ P,Q,R,T ; C $\rightarrow$ Q,R; D $\rightarrow$ S

49. A $\rightarrow$ P,Q; B $\rightarrow$ P,Q; C $\rightarrow$ P,R; D $\rightarrow$ Q,S

50. 2 **51.** 6 **52.** 6 **53.** 7th Row **54.** 53% **55.** 56 mL CO_2 + 40 mL O_2

56. 0.34 **57.** 1.5 ml

1. Any number that leaves a remainder of 1 when divided by 2, 3, 4, 5 and 6 must exactly 1 more than a number that is divisible by all 5 of these. The smallest being 60.

Hence the series n

$$61 + 121 + 181 + \ldots\ldots + 961$$

now $961 = 61 + \overline{n-1}\,60 \Rightarrow n = 16$

$$\therefore S = \frac{16}{2}(61 + 961) = 8(1022) = 8176 \text{ Ans.}$$

2. $2xr + r(p+q) = x^2 + (p+q)x + pq$

$x^2 + (p+q-2r)x + pq - r(p+q) = 0$

Suppose roots are α, β,

then given $\alpha = -\beta$ or $\alpha + \beta = 0$

But $\alpha + \beta = -(p + q - 2r) = 0$.

So, $p + q = 2r$.

So, (B) is correct.

3. $(a^2 + b^2 + c^2)p^2 - 2(ab + bc + cd)p + (b^2 + c^2 + d^2) \le 0$

$D \le 0 \Rightarrow 4(ab + bc + cd)^2 \le 4(a^2 + b^2 + c^2)(b^2 + c^2 + d^2)$

$(ab + bc + cd)^2 \le (a^2 + b^2 + c^2)(b^2 + c^2 + d^2)$

Also $(ab + bc + cd)^2 \ge (a^2 + b^2 + c^2)(b^2 + c^2 + d^2)$

(carry shows an inequality)

Hence equality holds and we get (B).

4. $T_n = [n(n+1) - (n-1)]\,n!$

$= n.(n+1)! - (n-1).n!$

Now put $n = 1, 2, 3, \ldots\ldots, n$ and add

5. $S_n = n^2p \Rightarrow S_p = p^3 \Rightarrow$ (C)

$t_n = S_n - S_{n-1} = p[n^2 - (n-1)^2] = (2n-1)p$

$t_1 = a_1 = p \Rightarrow$ (A)

$t_p = a_p = 2p^2 - p \Rightarrow$ (D)

common difference $a_2 - a_1 = 3p - p = 2p \Rightarrow$ (B)

6. d, e, f are in G.P. $\Rightarrow e^2 = df$ ..... (1)

$dx^2 + 2ex + f = 0$ given

$\Rightarrow dx^2 + 2\sqrt{df}\,x + f = 0$ using (1)

$\Rightarrow \left(\sqrt{d}x + \sqrt{f}\right)^2 = 0 \Rightarrow x = \frac{-\sqrt{f}}{\sqrt{d}}$

Putting $x = -\frac{\sqrt{f}}{\sqrt{d}}$ in $ax^2 + 2bx + c = 0$, we get

$$a.\frac{f}{d} + c = 2b\sqrt{\frac{f}{d}}$$

$\Rightarrow \frac{a}{d} + \frac{c}{f} = \frac{2b}{\sqrt{fd}} \Rightarrow \frac{a}{d} + \frac{c}{f} = \frac{2b}{e}$ (from (1))

$\Rightarrow \frac{d}{a}, \frac{e}{b}, \frac{f}{c}$ are in H.P.

Again from (2)

$af + dc = 2b\sqrt{fd}$

$\Rightarrow aef + ced = 2be\sqrt{fd}$

$\Rightarrow aef + cde = 2bdf$ (using (1))

7. $x + y + z = a$ AM $\ge$ HM $\Rightarrow \frac{x+y+z}{3} \ge$ HM ... (1)

$\frac{1}{HM} = \frac{1}{3}\left(\frac{1}{x} + \frac{1}{y} + \frac{1}{z}\right) \Rightarrow \frac{3}{HM} = \frac{1}{x} + \frac{1}{y} + \frac{1}{z}$ ... (2)

$\frac{1}{HM} \ge \frac{3}{x+y+z} \Rightarrow \frac{1}{x} + \frac{1}{y} + \frac{1}{z} \ge \frac{9}{x+y+z}$ ... from (1), (2)

$= \frac{9}{a}$ Hence (A) is correct

$\frac{(a-x) + (a-y) + (a-z)}{3} \ge [(a-x)(a-y)(a-z)]^{1/3}$ (AM $\ge$ GM)

$\frac{3a - a}{3} \ge [(a-x)(a-y)(a-z)]^{1/3}$

$(a-x)(a-y)(a-z) \le \frac{8}{27}a^3$

Hence (C) is correct

For (B) use AM $\ge$ GM

$\frac{y+z}{2} \ge \sqrt{yz}$, $\frac{x+z}{2} \ge \sqrt{xz}$, $\frac{x+y}{2} \ge \sqrt{xy}$

$\Rightarrow \left(\frac{y+z}{2}\right)\left(\frac{x+z}{2}\right)\left(\frac{x+y}{2}\right) \ge \sqrt{yz}\sqrt{xz}\sqrt{zy}$

$\Rightarrow (a-x)(a-y)(a-z) \ge 8xyz$

A, B, C

8. $\sin^2\beta = \sin\alpha\cos\alpha$

$2\sin^2\beta = 2\sin\alpha\cos\alpha$

$1 - 2\sin^2\beta = 1 - \sin 2\alpha$

$\cos 2\beta = 1 - \sin 2\alpha = 1 - \cos\left(\frac{\pi}{2} - 2\alpha\right)$

$= 2\sin^2\left(\frac{\pi}{4} - \alpha\right) = 2\cos^2\left(\frac{\pi}{4} + \alpha\right)$

9. $x = \sec\phi - \tan\phi$, $y = \operatorname{cosec}\phi + \cot\phi$

$x = \frac{1 - \sin\phi}{\cos\phi}$ $\quad y = \frac{1 + \cos\phi}{\sin\phi}$

$xy = \frac{(1 - \sin\phi)(1 + \cos\phi)}{(\cos\phi)(\sin\phi)}$

$= \frac{1 - \sin\phi + \cos\phi - \sin\phi\cos\phi}{\sin\phi\cos\phi}$

$= \frac{1 - \sin\phi + \cos\phi}{\sin\phi\cos\phi} - 1$

and $x - y = \frac{(1 - \sin\phi)\sin\phi - \cos\phi(1 + \cos\phi)}{\cos\phi\sin\phi}$

$$= \frac{\sin\phi - \sin^2\phi - \cos\phi - \cos^2\phi}{\cos\phi \sin\phi}$$

$$= \frac{\sin\phi - \cos\phi - 1}{\cos\phi \sin\phi}$$

$= -(xy + 1)$ Thus $xy + x - y + 1 = 0$

$x = \frac{y-1}{y+1}$ & $y = \frac{1+x}{1-x}$

10. (A) $(5+\sqrt{2})x^2 - (4+\sqrt{5})x + 8 + 2\sqrt{5}$ $\langle^{x_1}_{x_2}$

H.M. $= \frac{2x_1x_2}{x_1+x_2} = \frac{2(8+2\sqrt{5})}{4+\sqrt{5}} = 4$ Ans.

$\Rightarrow$ (R)

(B) $a_1 + 9d = 3$ and $\frac{1}{h_{10}} = \frac{1}{h_1} + 9d_1$

$2 + 9d = 3$ $\quad \frac{1}{3} = \frac{1}{2} + 9d_1$

$d = \frac{1}{9}$ $\quad 9d_1 = -\frac{1}{6} \Rightarrow d_1 = -\frac{1}{54}$

$\therefore$ $a_4 = 2 + 3d = 2 + \frac{1}{3} = \frac{7}{3}$

$\frac{1}{h_7} = \frac{1}{2} + 6\left(-\frac{1}{54}\right) = \frac{1}{2} - \frac{1}{9} = \frac{7}{18}$

$\therefore$ $a_4h_7 = \frac{7}{3} \times \frac{18}{7} = 6$ **Ans.** $\Rightarrow$ (S)

(C) $3x + 4(mx + 1) = 9$

$3x + 4mx = 5$

$x = \frac{5}{3+4m}$

now intercept for x to be integer $m = -1$ or $m = -2$ $\Rightarrow$ 2 integral values $\Rightarrow$ (P)

(D) Product of n geometric means between two numbers is equal to n^{th} power of single geometric mean between them.

11. (A) $\frac{1-\tan^2\frac{x}{2}}{1+\tan^2\frac{x}{2}} = \frac{3-\tan^2\frac{y}{2}}{3+\tan^2\frac{y}{2}}$

$\Rightarrow \tan^2\frac{x}{2} = \frac{1}{3}\tan^2\frac{y}{2} \Rightarrow \cot^2\frac{x}{2}\tan^2\frac{y}{2} = 3$

(B) $(x-2)(x-3) + c = (x-\alpha)(x-\beta)$.

Replace x by $-\frac{1}{x}$: $(1 + 2x)(1 + 3x) + cx^2$

$= (1 + \alpha x)(1 + \beta x)$

$\Rightarrow (1 + \alpha x)(1 + \beta x) - cx^2 = (1 + 2x)(1 + 3x)$.

Hence roots are $-\frac{1}{2}, -\frac{1}{3}$.

(C) $3\cos 2\theta = 1 \Rightarrow 2\cos^2\theta - 1 = \frac{1}{3}$

$\Rightarrow \sec^2\theta = \frac{3}{2} \Rightarrow \tan^2\theta = \frac{1}{2}$

Now $2\cos^2\alpha - 3\cos\alpha = \frac{32}{16}$

$\Rightarrow 2\cos^2\alpha - 3\cos\alpha - 2 = 0$

$\cos\alpha = -\frac{1}{2}$

$\Rightarrow \cos 2\alpha = 2\cos^2\alpha - 1 = 2 \times \frac{1}{4} - 1 = -\frac{1}{2}$

(D) If $a_1, a_2, \ldots\ldots a_5$ are in H.P. then $a_1a_2 + a_2a_3 + \ldots\ldots + a_4a_5 = 4a_1a_5$

Equation is $x^2 + 4x - 5 = 0$

$\Rightarrow x = 1, -5$.

12. $(r-a)(r-b)(r-c)(r-d) = 9$

All of the factor on the LHS are distinct integer.

$9 = (-3)(-1)(1)(3)$

Assuming $a < b < c < d$,

$r - a = -3$ $\quad r - d = 3$.

$r - b = -1$, $\quad r - c = 1$

Hence on addition $4r - (a + b + c + d) = 0$.

13. 1; $b \ge \sqrt{ac} \Rightarrow b^3 \ge abc \Rightarrow b^3 \ge 4$ or $b \ge (4)^{1/3}$

$\Rightarrow [b] \ge 1$

14. Let k and k + 1 removed. Then

$$\frac{\frac{n}{2}(n+1) - 2k - 1}{n-2} = \frac{105}{4} \Rightarrow 2n^2 - 103n - 8k + 206 = 0$$

Since n and k are integers, so n must be even,

say $n = 2m$ then $k = \frac{4m^2 + 103(1-m)}{4}$.

(Clearly $(1 - m)$ must be divisible by 4.

Let $m = 1 + 4t$, then we get $k = 16t^2 - 95t + 1$

and $1 \le k < n$

$\Rightarrow 1 \le 16t^2 - 95t + 1 < 8t + 2 \Rightarrow t = 6$

and so, $n = 50$

15. Given, $6\cot\theta = \cot(\theta - \alpha) + \cot(\theta + \alpha)$

$$= \frac{\cos(\theta-\alpha)}{\sin(\theta-\alpha)} + \frac{\cos(\theta+\alpha)}{\sin(\theta+\alpha)}$$

$$= \frac{\sin(\theta+\alpha)\cos(\theta-\alpha) + \cos(\theta+\alpha)\sin(\theta-\alpha)}{\sin(\theta+\alpha)\sin(\theta-\alpha)}$$

$$= \frac{\sin 2\theta}{\sin(\theta+\alpha)\sin(\theta-\alpha)}$$

$$\Rightarrow \frac{6\cos\theta}{\sin\theta} = \frac{4\sin\theta\cos\theta}{2\sin(\theta+\alpha)\sin(\theta-\alpha)}$$

Since, $\cos\theta \ne \theta$

$$\Rightarrow \frac{3\cos\theta}{\sin\theta} = \frac{2\sin\theta\cos\theta}{\cos 2\alpha - \cos 2\theta}$$

$\therefore 3(\cos 2\alpha - \cos 2\theta) = 2\sin^2\theta$

$\Rightarrow 3\{(1 - 2\sin^2\alpha) - (1 - 2\sin^2\theta)\} = 2\sin^2\theta$

$\Rightarrow 3(2\sin^2\theta - 2\sin^2\alpha) = 2\sin^2\theta$

$$\Rightarrow 4\sin^2\theta = 6\sin^2\alpha = \frac{3}{2}\sin^2\alpha \Rightarrow \frac{2\sin^2\theta}{\sin^2\alpha} = 3$$

16. Given $A + B + C = \pi$

$$\therefore \cot\frac{A}{2}\cot\frac{B}{2}\cot\frac{C}{2} = \cot\frac{A}{2} + \cot\frac{B}{2} + \cot\frac{C}{2} \quad ...(i)$$

But $\tan\frac{A}{2}, \tan\frac{B}{2}, \tan\frac{C}{2}$ are in H.P.

$\Rightarrow \cot\frac{A}{2}, \cot\frac{B}{2}, \cot\frac{C}{2}$

are in A.P. $\Rightarrow \cot\frac{A}{2} + \cot\frac{C}{2} = 2\cot\frac{B}{2} \quad ...(ii)$

From (i) and (ii), we get $\cot\frac{A}{2}.\cot\frac{B}{2}.\cot\frac{C}{2} = 3\cot\frac{B}{2}$

$\therefore \cot\frac{A}{2}.\cot\frac{C}{2} = 3$

Now, $$\frac{\cot\frac{A}{2} + \cot\frac{C}{2}}{2} \ge \sqrt{\cot\frac{A}{2}\cot\frac{C}{2}} \Rightarrow \frac{2\cot\frac{B}{2}}{2} \ge \sqrt{3}$$

[From (ii) and (iii)] $\quad \therefore \cot\frac{B}{2} \ge \sqrt{3}$

17. We have $(a\tan\beta - \sqrt{a^2-1}\tan\alpha)^2 +$

$$(\sqrt{a^2+1}\tan\beta - \sqrt{a^2-1}\tan\gamma)^2$$

$$+ (a\tan\gamma - \sqrt{a^2+1}\tan\alpha)^2 \ge 0$$

$\Rightarrow \{a^2 + a^2 - 1 + a^2 + 1\}(\tan^2\alpha + \tan^2\beta + \tan^2\gamma)$

$- \{a\tan\alpha + \sqrt{a^2-1}\tan\beta + \sqrt{a^2+1}\tan\gamma\}^2 \ge 0$

$$\Rightarrow \tan^2\alpha + \tan^2\beta + \tan^2\gamma \ge \frac{4a^2}{3a^2} \Rightarrow 3\sum\tan^2\alpha \ge 4$$

18. LHS: $S = \sin 5 + \sin 10 + \sin 15 + \ldots\ldots\ldots + \sin 170 + \sin 175$

$$S\left(2\sin\frac{5}{2}\right) = 2\sin\frac{5}{2}[\sin 5 + \sin 10 + \ldots\ldots + \sin 175]$$

$$T_1 = \cos\frac{5}{2} - \cos\frac{15}{2};\ T_2 = \cos\frac{15}{2} - \cos\frac{25}{2}\ \ldots\ldots\ldots;$$

$$T_{35} = \cos\frac{345}{2} - \cos\frac{355}{2}$$

$$\left(2\sin\frac{5}{2}\right) S = \cos\frac{5}{2} - \cos\frac{355}{2} = 2\sin\frac{180}{2}\sin\frac{175}{2}$$

$$= 2\sin\frac{175}{2}$$

$$S = \frac{\sin\frac{175}{2}}{\sin\frac{5}{2}} = \frac{\sin\frac{175}{2}}{\cos\left(90 - \frac{5}{2}\right)} = \frac{\sin\frac{175}{2}}{\cos\frac{175}{2}}$$

$$= \tan\left(\frac{175}{2}\right) = \tan\left(\frac{m}{n}\right)$$

$\therefore \quad m = 175$ and $n = 2 \quad \Rightarrow \quad \frac{mn}{50} = 7$

19. Given $\sin x$, $\sin^2 2x$ and $\cos x \cdot \sin 4x$ are in G.P.

(r > 1 as G.P. is increasing)

$\Rightarrow \sin^4 2x = (\sin x)(\cos x)(\sin 4x)$

$\Rightarrow 16\sin^4 x\cos^4 x = \sin x\cos x\sin 4x$

$\Rightarrow 16\sin^3 x\cos^3 x = \sin 4x$

$(\sin x \ne 0, \cos x \ne 0)$

$\Rightarrow 16(\sin x\cos x)^3 = 2\sin 2x \cdot \cos 2x$

$\Rightarrow (\sin 2x)^3 = \sin 2x \cdot \cos 2x$

$\therefore \quad \sin^2 2x = \cos 2x \quad (\sin 2x \ne 0),$

$1 - \cos^2 2x = \cos 2x, \quad y^2 + y - 1 = 0$

$$\cos 2x = \frac{-1 \pm \sqrt{5}}{2};$$

$\cos 2x$ cannot be $\frac{-\sqrt{5}-1}{2}$ hence rejected

$$\therefore \quad \cos 2x = \frac{-1+\sqrt{5}}{2}$$

$$\sin x = \sqrt{\frac{1-\cos 2x}{2}} = \sqrt{\frac{1 - \frac{\sqrt{5}-1}{2}}{2}} = \frac{\sqrt{3-\sqrt{5}}}{2} = \frac{\sqrt{5}-1}{2\sqrt{2}}$$

$$\therefore \quad \cos 2x = \frac{\sqrt{5}-1}{2} \qquad r = \frac{\sin^2 2x}{\sin x}$$

$= 4\sin x\cos^2 x = 2\sin x(1 + \cos 2x)$

$$r = \frac{\sqrt{5}-1}{\sqrt{2}} \cdot \frac{\sqrt{5}+1}{2} = \frac{4}{2\sqrt{2}} = \sqrt{2} \qquad r^2 = 2 \text{ Ans.}$$

20. B
21. B
22. A
Since x – t curve gives velocity
Here at OA velocity increases
23. C
24. B,C
25. A
26. A,B,D

$$\frac{dv(t)}{6-3v(t)} = dt$$

$$\Rightarrow \quad -\frac{1}{3}\ln(6-3v(t)) = dt + C$$

$$-\frac{1}{3}\ln 6 = C \qquad [\therefore v(t) = d(t) = 0]$$

Now, $-\frac{1}{3}\ln(6-3v(t)) = t + c$

$\ln(6-3v(t)) = -3(t+c)$

$v(t) = 2(1-e^{-3t})$

27. B,C,D
28. A,C,D
$\vec{a}$ is perpendicular to the plane of circular motion and $\vec{v}$ lies in this plane
$\vec{\alpha}$ is perpendicular to the plane of circular motion and $\vec{a}_c$ also lies in this plane
$\vec{v}$ is tangential and $\vec{a}_c$ is radial hence perpendicular

29. (A) → Q,R,S ; (B) → P,S ; (C) → Q,S ; (D) → R
(A) For conical pendulum acceleration vertical direction is zero.
⇒ $T\cos\theta = mg$
(B) At an extreme radial acceleration is zero
⇒ $T = mg\cos\theta$
(C) Balls acceleration w.r.t ground = a
(D) Ball is moving with constant velocity w.r.t. ground.

30. (A) → R; (B) → S ; (C) → P ; (D) → Q

31. $\frac{15}{32}$

32. t = 3.5 sec = 3500 ms

$(n-2)\,l = \frac{1}{2}at^2$

$(n-1)\,l = \frac{1}{2}a(t+3)^2$

$n\,l = \frac{1}{2}a(t+5)^2$

$$l = \frac{1}{2}a[(t+3)^2 - t^2] = \frac{1}{2}a[(t+5)^2 - (t+3)^2]$$

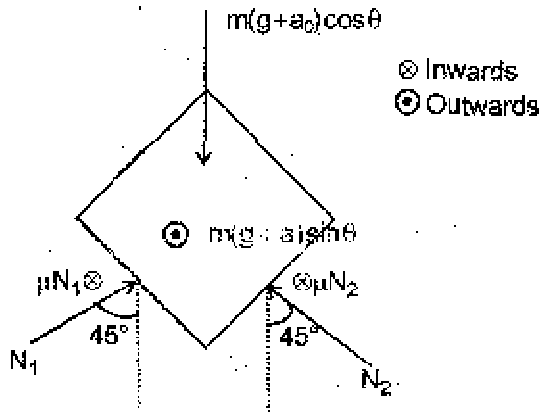
$t^2 + 9 + 6t - t^2 = t^2 + 25 + 10t - t^2 - 9 - 6t$

$9 + 6t = 16 + 4t$

$2t = 7$

t = 3.5 sec. 3500 ms

33.



For horizontal equilibrium,
$N_1 \sin 45° = N_2 \sin 45°$
$N_1 = N_2$
or
For vertical equilibrium
$N_1\cos 45° + N_2\cos 45° = m(g+a_0)\cos\theta$

or $\quad N_1 = N_2 = \frac{1}{\sqrt{2}}m(g+a_0)\cos\theta$

For equilibrium along normal to plane of this paper.
$\mu N_1 + \mu N_2 = m(g+a_0)\sin\theta$

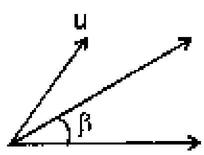
or $\quad \mu = \frac{1}{\sqrt{2}}\tan\theta$

34. β = 30°

$$R_{max} = \frac{u^2}{g(1+\sin\beta)}$$

$$250 = \frac{u^2}{g(1+\sin\beta)}$$

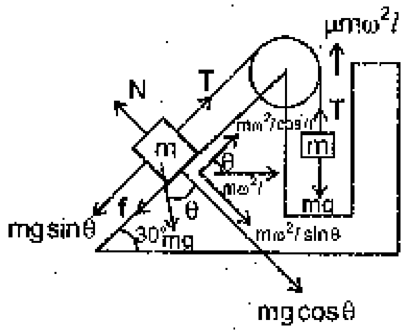
$$750 = \frac{u^2}{g(1-\sin\beta)}$$



$$\frac{1}{3}=\frac{1-\sin\beta}{1+\sin\beta}$$

$$\sin\beta = \frac{1}{2} \Rightarrow \beta = 30^\circ$$

35. $\frac{1}{\sqrt{3}}$



$f = \mu N = \mu(mg\cos\theta + m\omega^2\ell\sin\theta)$

In equilibrium

$mg = T + \mu m\omega^2\ell$ ...(1)

$T + m\omega^2\ell\cos\theta = mg\sin\theta + \mu(mg\cos\theta + m\omega^2 l\sin\theta)$...(2)

From (1) & (2)

$$\mu = \frac{1}{\sqrt{3}}$$

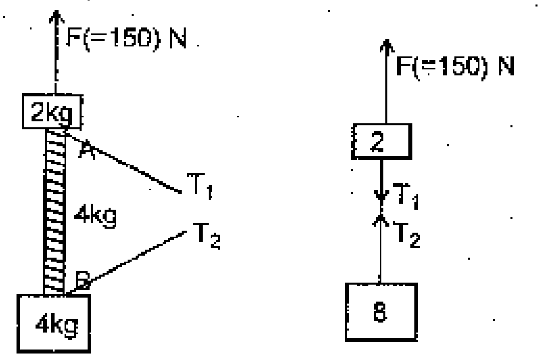
36. **2**

$a_A\cos 60^\circ = a_B$, $T\cos 60^\circ = ma_A$

$mg - T = ma_B$, $a_B = g/5 = 2$

37. **2**

Sol.



$150 - 20 - T_1 = 2a$

$T_1 - 80 = 8a$

$150 - 20 - 80 = 10a$

$a = 5$

$T_1 = 80 + 40 = 120$

$150 - 20 - 40 - T_2 = 6a$

$T_2 - 40 = 4a$

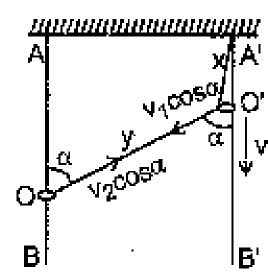
$150 - 100 = 10a$

$a = 5$

$T_2 = 40 + 20 = 60$

$$\frac{T_1}{T_2} = \frac{120}{60} = 2$$

38. $v_2 = \frac{v_1(1-\cos\alpha)}{\cos\alpha}$



Rate of decrease of length y

= Rate of increase of length x

$v_2\cos\alpha + v_1\cos\alpha = v_1$

39. **D**

$$m_1 = \frac{1/3 \times 1000}{2/3 \times M}$$

$$m_2 = \frac{1/2}{1/2M} \times 1000 \Rightarrow \frac{m_1}{m_2} = \frac{1}{2}$$

40 **C**

$$Mg + \frac{1}{2}O_2 \longrightarrow MgO, \quad 3Mg + N_2 \longrightarrow Mg_3N_2$$

a a (5 – a) $\frac{(5-a)}{3}$

$$MgO + 2HCl \longrightarrow MgCl_2 + H_2O$$

a a

$$Mg_3N_2 + 8HCl \longrightarrow 2NH_4Cl + 3MgCl_2$$

$\frac{5-a}{3}$ $\frac{2(5-a)}{3}$ (5 – a)

∴ Total moles of $MgCl_2$ = a + (5 – a) = 5 moles

41. **A**

42. **B**

43. **A,B,C**

Molecular weight of mixture of NO_2 and N_2O_4
= 38.3 × 2 = 76.6

Let a mole of NO_2 are present in mixture
a × 46 + (100 – a) 92 = 100 × 76.6
a = 33.48

(A) is correct because moles of NO_2 in mixture is 33.48

(B) is correct because mole of N_2O_4 in mixture is
100 – 33.48 = 66.52

(C) is correct because weight of NO_2
= 33.48 × 46 =1540 g

(D) is incorrect because weight of N_2O_4
= 66.52 × 92 = 6119.84 g

44. **A,B**

$$2CO + O_2 \rightarrow 2CO_2$$

The residue gas is CO.

Volume of CO oxidised = 2 × 30 = 60 ml

Volume of CO = 60 + 10 = 70 ml

Volume of CO_2 initially present = 100 – 70 = 30 ml

Volume of CO_2 formed = 60 ml

Volume of CO_2 absorbed by KOH
= 30 + 60 = 90 ml

45. **A,C,D**

46. **A,B,C**

47. **C**

48. **A → P,Q,R,T ; B → P,Q,R,T ; C → Q,R; D → S**

49. **A → P,Q; B → P,Q; C → P,R; D → Q,S**

50.

$$AgNO_3 + NaCl \longrightarrow AgCl(s) + NaNO_3$$

initial m mole = 2 × v m. moles = v

moles of $AgNO_3$ left = 2v – v = v

Since AgCl will not be ionised in the solution (remain as ppt) hence $[Ag^+]$ will be provided only by remained $AgNO_3$

$$\therefore [Ag^+] = \frac{\text{total m.moles}}{\text{total volume}} = \frac{v}{2v}$$

$$\Rightarrow \frac{1}{x} = \frac{1}{2} \Rightarrow x = 2$$

51. (100 + x)% oleum

⇒ 100 gm of oleum can have maximum of x gm of water

$$SO_3 + H_2O \rightarrow H_2SO_4$$

x/18

⇒ wt. of free $SO_3 = \frac{x}{18} \times 80$

$$\Rightarrow \frac{x}{18} \times 80 = \frac{80}{3}$$

x = 6

52. Moles of Hydrocarbon $= \frac{4.3}{12n + 2n + 2} = \frac{4.3}{14n + 2}$

⇒ moles of C $= \frac{4.3}{14n+2} \times n$

As all the carbon has been converted in to CO_2

⇒ moles of C = moles of CO_2

⇒ moles of $CO_2 = \frac{4.3 \times n}{14n + 2}$

moles of NaOH = 300 × 2 × 10^{-3} = 0.6

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

∴ 2 mol NaOH reacts with 1 mol CO_2

∴ 0.6 — " —0.3 mol of CO_2

$$\Rightarrow 0.3 = \frac{4.3 \times n}{14n + 2} \Rightarrow n = 6$$

53. 7th Row

54. Chalk has Clay + $CaCO_3$ (Chalk)
ag bg

$\therefore$ $a + b = 5$ ...(i)

On heating (i) Clay loses water
(ii) $CaCO_3$ loses CO_2

Now Weight loss of water by a g clay = $\frac{14.5 \times a}{100}$

Weight loss of CO_2 by b g $CaCO_3$ = $\frac{44 \times b}{100}$

$\therefore$ $\frac{14.5 \times a}{100} + \frac{44 \times b}{100} = 1.507$ ...(ii)

Solving Eqs. (i) and (ii),

$a = 2.349$ g

$b = 2.651$ g

$\therefore$ % of chalk, i.e., $CaCO_3 = \frac{2.651}{5} \times 100 = 53\%$

55. $\underset{50\text{ mL}}{H_2} + \frac{1}{2}O_2 \longrightarrow H_2O$

$\underset{30\text{ mL}}{CH_4} + 2O_2 \longrightarrow CO_2 + 2H_2O$

$\underset{14\text{ mL}}{CO} + \frac{1}{2}O_2 \longrightarrow CO_2$

$\underset{6\text{ mL}}{C_2H_4} + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

Volume of O_2 required = $\underset{\text{for } H_2}{\frac{50}{2}} + \underset{\text{for } CH_4}{30 \times 2} + \underset{\text{for CO}}{\frac{14}{2}} + \underset{\text{for } C_2H_4}{6 \times 3}$

(According to volume ratio)

$= 25 + 60 + 7 + 18 = 110$ mL

$\therefore$ Volume of O_2 left = $150 - 110 = 40$ mL

Volume of CO_2 formed = $\underset{\text{from } CH_4}{30} + \underset{\text{from CO}}{14} + \underset{\text{from } C_2H_4}{6 \times 2} = 56$ mL

$\therefore$ Composition of mixture = 56 mL CO_2 + 40 mL O_2

56. For a gaseous mixture of C_2H_6 and C_2H_4

$PV = nRT$

$\therefore$ $1 \times 40 = n \times 0.08 \times 400$

$\therefore$ Total mole of $(C_2H_6 + C_2H_4) = 1.2195$

Let mole of C_2H_6 and C_2H_4 be a, b respectively

$a + b = 1.2195$ ...(i)

$C_2H_6 + (7/2)O_2 \rightarrow 2CO_2 + 3H_2O$

$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

$\therefore$ Mole of O_2 needed for complete reaction of mixture $= 7a/2 + 3b$

$\therefore$ $\frac{7a}{2} + 3b = \frac{130}{32}$ ...(ii)

By Eqs. (i) and (ii),

$a = 0.808$, $b = 0.4115$

$\therefore$ Mole fraction of $C_2H_6 = 0.808/1.2195 = 0.66$

and Mole fraction of $C_2H_4 = 0.34$

57. In the explosion the reactant CO_2 does not change, while CH_4 and C_2H_4 change to CO_2 and H_2O. The volume of H_2O is taken to be zero.

$\therefore$ vol. of CO_2 in the reactant + CO_2 produced = 14 mL

Let the volume of CH_4 and C_2H_4 in the mixture be respectively x and y mL.

$\therefore$ volume of CO_2 in the mixture = $(10 - x - y)$ and vol. of CO_2 produced on explosion

$= 14 - (10 - x - y) = (4 + x + y)$ mL

Now, we know,

CH_4	+ C_2H_4	+ O_2 $\rightarrow$	CO_2	+ H_2O
x mL	y mL		$(4 + x + y)$ mL	
x moles	y moles		$(4 + x + y)$ moles	

Applying POAC of C, H and O atoms, we get respectively,

1 × moles of CH_4 + 2 × moles of C_2H_4 = 1 × moles of CO_2,

$x + 2y = 4 + x + y$; $y = 4$ ...(i)

4 × moles of CH_4 + 4 × moles of C_2H_4 = 2 × moles of H_2O

$4x + 4y = 2 \times$ moles of H_2O ...(ii)

2 × moles of O_2 = 2 × moles of CO_2 + 1 × moles of H_2O

2 × moles of $O_2 = 2(4 + x + y)$ + moles of H_2O ...(iii)

From eqns. (ii) and (iii), eliminating moles of H_2O, we get

moles of $O_2 = (4 + 2x + 2y)$. (used in explosion)

Now, again consider the explosion reaction,

CH_4	+ C_2H_4	+ O_2	$\rightarrow$ CO_2	+ H_2O
x moles	y moles	$(4 + 2x + 2y)$ moles	$(4 + x + y)$ moles	
x mL	y mL	$(4 + 2x + 2y)$ mL	$(4 + x + y)$ mL	

$\because$ vol. of reactants – vol. of products = 17 ml (as given)

$\therefore$ $x + y + (4 + 2x + 2y) - (4 + x + y) = 17$

or $2x + 2y = 17$ ...(iv)

From eqns. (i) and (iv) we get

$x = 4.5$

$\therefore$ $\begin{cases} \text{vol. of } CH_4 = 4.5 \text{ mL} \\ \text{vol. of } C_2H_4 = 4.0 \text{ mL} \\ \text{vol. of } CO_2 = (10 - 4.5 - 4)\text{mL} = 1.5\text{mL} \end{cases}$