MOTION IIT-JEE

(Where Faith Counts the Success)

TARGET IIT-JEE

HINT & SOLUTIONS

ANSWER KEY WITH SOLUTION

PAPER-II CLASS XI (DATE 26-01-10)

MATHEMATICS

SECTION - I

1. D **2.** C **3.** A **4.** B

SECTION - II

1. B **2.** A, B **3.** A, D **4.** B **5.** B

SECTION III

1. (A) $\rightarrow$ (P), (B) $\rightarrow$ (Q), (C) $\rightarrow$ (R), (D) $\rightarrow$ (S) **2.** (A) $\rightarrow$ (S), (B) $\rightarrow$ (P), (C) $\rightarrow$ (R), (D) $\rightarrow$ (Q)

SECTION IV

1. 9 **2.** 11 **3.** 4 **4.** 2 **5.** 8 **6.** 10 **7.** 19 **8.** 2

PHYSICS

SECTION - I

1. B **2.** A **3.** B **4.** D

SECTION – II

1. A,C **2.** A,B **3.** A,B **4.** A,C,D **5.** B

SECTION - III

1. A $\rightarrow$ Q ; B $\rightarrow$ P,Q ; C $\rightarrow$ R ; D $\rightarrow$ S **2.** (A) $\rightarrow$ P,S ; (B) $\rightarrow$ R,S ; (C) $\rightarrow$ R,S ; (D) $\rightarrow$ P, S

SECTION – IV

1. 300 K **2.** 1 **3.** 2 **4.** 5 **5.** 2 **6.** 7 **7.** 5 **8.** v/4

CHEMISTRY

SECTION - I

1. B **2.** C **3.** C **4.** B

SECTION – II

1. A,B **2.** A,B,C,D **3.** A,B,C **4.** A,C,D **5.** B,D

SECTION - III

1. (A – Q,S) ; (B – P) ; (C – P) ; (D – R) **2.** (A – Q) ; (B – P) ; (C – S) ; (D – R)

SECTION - IV

1. 4 **2.** 16 **3.** 4814 OR 4815 **4.** 939 **5.** 0.7 **6.** 0.0357 **7.** 2 **8.** 1.53

SECTION - I

1. **D**

$$\frac{1+\sin 2\alpha}{\cos(2\alpha-2\pi)\tan\left(\alpha-\frac{3\pi}{4}\right)}-\frac{1}{4}\sin 2\alpha\left[\cot\frac{\alpha}{2}+\cot\left(\frac{3\pi}{2}+\frac{\alpha}{2}\right)\right]$$

$$=\frac{1+\sin 2\alpha}{\cos 2\alpha.\tan\left(\alpha-\frac{3\pi}{4}\right)}-\frac{1}{4}\sin 2\alpha\left[\cot\frac{\alpha}{2}-\tan\frac{\alpha}{2}\right]$$

$$=\frac{(\sin 2\alpha+\cos\alpha)^2}{(\cos^2\alpha-\sin^2\alpha)\left(\frac{1+\tan\alpha}{1-\tan\alpha}\right)}-\frac{1}{4}.2\sin\alpha\cos\alpha\frac{\left(\cos^2\frac{\alpha}{2}-\sin^2\frac{\alpha}{2}\right)}{\sin\frac{\alpha}{2}\cos\frac{\alpha}{2}}$$

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

2. **C**

Vertices of the given triangle are (0, 0), $\left(\frac{a}{m_1}, a\right)$ and $\left(\frac{a}{m_2}, a\right)$ so that the area of the triangle is equal to $\frac{a^2}{2}\left|\frac{(m_2-m_1)}{m_1 m_2}\right|$.

Since m_1, m_2 are the roots of $x^2 - ax - a - 1 = 0$, so

$m_1 + m_2 = a$, $m_1 m_2 = -(a + 1)$

$\Rightarrow$ $(m_1 - m_2)^2 = a^2 + 4(a + 1) = (a + 2)^2$

$\Rightarrow$ $|m_1 - m_2| = |(a + 2)|$

So, the required area is $\Delta = \frac{a^2}{2}\left|\frac{a+2}{-(a+1)}\right|$

$= \frac{a^2}{2}\left|\frac{a+2}{a+1}\right|$

Since, the area of Δ is a positive quantity.

$\Delta = \frac{a^2(a+2)}{2(a+1)}$, if $a > -1$ or $a < -2$

and $\Delta = -\frac{a^2(a+2)}{2(a+1)}$, if $-2 < a < -1$

3. **A**

$\because$ $\frac{2}{1!9!}+\frac{2}{3!7!}+\frac{1}{5!5!}=\frac{2^m}{n!}$

$\frac{1}{10!}\left\{\frac{(2)10!}{1!9!}+\frac{(2)10!}{3!7!}+\frac{10!}{5!5!}\right\}=\frac{2^m}{n!}$

$\Rightarrow$ $\frac{1}{10!}\{2\ {}^{10}C_1 + 2\ {}^{10}C_3 + {}^{10}C_5\} = \frac{2^m}{n!}$

$\frac{1}{10!}\{{}^{10}C_1 + {}^{10}C_3 + {}^{10}C_5 + {}^{10}C_7 + {}^{10}C_9\} = \frac{2^m}{n!}$

$\Rightarrow$ $\frac{1}{10!}(2)^{10-1} = \frac{2^m}{n!}$

$\therefore$ m = 9 and n = 10

Hence x – y + 1 = 0 and x + y + 3 = 0 are perpendicular to each other then orthocentre is the point of intersection which is (–2, –1)

$\therefore$ $-2 = 2m - 2n$

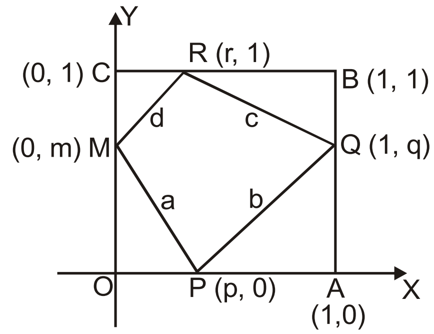
and $-1 = m - n$

point is $(2m - 2n, m - n)$

4. **B**

Given S be the area of square with vertices O (0, 0), A (1, 0), B (1, 1), C(0, 1).

Let PQRM be the quadrilateral with vertices P(p, 0), Q(1, q), R(r, 1) and M(0, m)



and sides MP = a, PQ = b, QR = c, RM = d

Then $a^2 = p^2 + m^2$

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

$c^2 = (1 - q)^2 + (1 - r)^2$

$d^2 = r^2 + (1 - m)^2$

$\therefore\ a^2 + b^2 + c^2 + d^2 = p^2 + (1 - p)^2 + q^2 + (1 - q)^2 + r^2 + (1 - r)^2 + m^2 + (1 - m)^2$

$= 2\ [p^2 + q^2 + r^2 + m^2 - p - q - r - m + 2]$

$= 2\left[\left(p-\frac{1}{2}\right)^2+\left(q-\frac{1}{2}\right)^2+\left(r-\frac{1}{2}\right)^2+\left(m-\frac{1}{2}\right)^2+1\right]\geq 2$

$\Rightarrow$ $a^2 + b^2 + c^2 + d^2 \geq 2$ ....(1)

also, since $0 \leq x \leq 1$

$\therefore$ $x^2 \leq 1$

$\therefore$ $a^2 \leq 1, b^2 \leq 1, c^2 \leq 1, d^2 \leq 1$

$\Rightarrow$ $a^2 + b^2 + c^2 + d^2 \leq 4$ ....(2)

from (1) & (2) we get

$2 \leq a^2 + b^2 + c^2 + d^2 \leq 4$

SECTION - II

1. **B**

2. **A, B**

$\because$ a > b > c and given lines are

ax + by + c = 0

bx + cy + a = 0

cx + ay + b = 0

$$\Delta = \begin{vmatrix} a & b & c \\ b & c & a \\ c & a & b \end{vmatrix} = 0$$

$3abc - (a^3 + b^3 + c^3) = 0$

$\therefore \quad a + b + c = 0$

$\Rightarrow$ one root of Q.E. is 1 & other root is c/a

if $a > b > c$ & $a + b + c = 0$

$\Rightarrow$ a & c must have opp. sign $\Rightarrow$ $c/a < 0$

3. **A, D**

GIven, $(3\sqrt{3} + 5)^{2n+1} = \alpha + \beta$ ....(i)

$\because \quad 0 < \beta < 1$

Let $\beta' = (3\sqrt{3} - 5)^{2n+1}$ ....(ii)

$\therefore \quad 0 < \beta' < 1$

From Eqs. (i) and (ii)

$\alpha + \beta - \beta' = (3\sqrt{3} + 5)^{2n+1} - (3\sqrt{3} - 5)^{2n+1}$

$\Rightarrow = 2[{}^{2n+1}C_1 (3\sqrt{3})^{2n} 5 + {}^{2n+1}C_3 (3\sqrt{3})^{2n-2} (5)^3 + \ldots\ldots + {}^{2n+1}C_{2n+1} 5^{2n+1}]$

$\alpha + \beta - \beta' = 10I$

But $-1 < \beta - \beta' < 1$

$\therefore$ $\beta - \beta'$ is an integer

$\therefore \quad \beta - \beta' = 0$

$\therefore \quad \alpha = 10\,I$

$\therefore$ α divisible by 10

$\Rightarrow$ α is an even integer.

$\Rightarrow \quad (\alpha + \beta)^2 = [(3\sqrt{3} + 5)^2]^{2n+1}$

$= (52 + 30\sqrt{3})^{2n+1}$

$= 2^{2n+1}(26 + 15\sqrt{3})^{2n+1}$

$\therefore$ $(\alpha + \beta)^2$ is not divisible by 2^{2n+1}.

4. **B**

5. **B**

SECTION III

1. **(A) → (P), (B) → (Q), (C) → (R), (D) → (S)**

(A) ${}^mC_{r-1}, {}^mC_r, {}^mC_{r+1}$ are in A.P.

$\Rightarrow {}^mC_{r-1} + {}^mC_{r+1} = 2.\,{}^mC_r$

$\Rightarrow (m - 2r)^2 = m + 2$

$\Rightarrow m = 7, 14, 23, \ldots\ldots\ldots\ldots$

m is of the form $(i + 2)^2 - 2$, i = 1, 2, 3, ... , n

$$an^3 + bn^2 + cn + d = \sum_{i=1}^{n} \{(i+2)^2 - 2\}$$

Put n = 1

$a + b + c + d = 9 - 2 = 7$

(B) exponent of 7 in ${}^{100}C_{50} = \dfrac{100!}{50!\,50!}$

$\because$ exponent of 7 in 100! is $\left[\dfrac{100}{7}\right] + \left[\dfrac{100}{49}\right] = 16$

exponent of 7 in 50! is $\left[\dfrac{50}{7}\right] + \left[\dfrac{50}{49}\right] = 8$

$\therefore$ required value = 16 – 2(8) = 0

(C) $\dfrac{x^2 + 1 + \frac{1}{x} + \frac{1}{x}}{4} \ge 1 \quad \Rightarrow \dfrac{x^3 + x + 2}{x} \ge 4$

(D) $|A_r| = r^2 - (r-1)^2 = 2r - 1$

$A_1 + A_2 + A_3 + \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + A_{2006}$

$$= \sum_{r=1}^{2006} (2r - 1) = (2006)^2$$

2. **(A) → (S), (B) → (P), (C) → (R), (D) → (Q)**

(A) $2b = a + c$

$C = A + 90$

$2 \sin B = \sin A + \sin C$

$= 2 \sin \left(\dfrac{A+C}{2}\right) \cos\left(\dfrac{A-C}{2}\right) \sin B = \cos \dfrac{B}{2} \dfrac{1}{\sqrt{2}}$ 2 sin

$\dfrac{B}{2} \cos\dfrac{B}{2} = \cos\dfrac{B}{2}\dfrac{1}{\sqrt{2}} \sin\dfrac{B}{2} =$

$\dfrac{1}{2\sqrt{2}} \cos\dfrac{B}{2} = \dfrac{\sqrt{7}}{2\sqrt{2}} \sin B = \dfrac{2\sqrt{7}}{8} = \sqrt{7}/4$

(B) Applying the formula $OP^2 = R^2 (1 - 8 \cos A \cos B \cos C)$

$OI^2 = R^2 \left(1 - 8 \sin \dfrac{A}{2} \sin\dfrac{B}{2} \sin\dfrac{C}{2}\right)$

(C) $\because a^2 + b^2 + 2ab + 2a^2 - 2ab = (a + b)^2 + 2a$

$(a - b) \Rightarrow a - b < a + b < \sqrt{3a^2 + b^2}$

$\therefore n = \sqrt{3a^2 + b^2}$

$m = a + b$

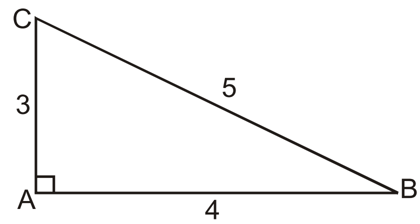
$\ell = a - b$, assume so $\cos N = \dfrac{\ell^2 + m^2 - n^2}{2\ell m}$

Substiting ℓ, m, n we get, cos N = –1/2

$\therefore N = 120^o$

$\therefore \sin N = \dfrac{\sqrt{3}}{2}$

(D) $R = \dfrac{a}{2\sin A} = \dfrac{5}{2\sin 90^o} = \dfrac{5}{2}$



$r = \dfrac{\Delta}{S} = \dfrac{\frac{1}{2}4.3}{\left(\frac{4+3+5}{2}\right)} = 1$

$OI^2 = R^2 - 2Rr = \left(\dfrac{5}{2}\right)^2 - 2\left(\dfrac{5}{2}\right).1 = \dfrac{5}{4} OI = \dfrac{\sqrt{5}}{2}$

SECTION IV

1. **Ans.** 9

$\angle EAD = \angle DCB$ and $\angle AED = \angle B$ ....
(angles on same segment)
using sine law for ΔAED

$$\frac{DE}{\sin\frac{C}{2}} = \frac{AD}{\sin B}$$

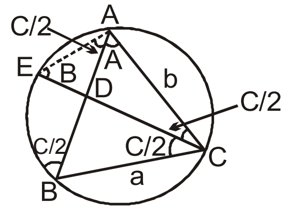
we know that

$$\frac{AD}{BD} = \frac{b}{a} \text{ and } AD + BD = c \qquad \Rightarrow AD = \frac{bc}{b+a}$$

$$\Rightarrow DE = \frac{cb\sin\frac{C}{2}}{(b+a)\sin B}$$

similarly applying sine law for ΔACE

$$\frac{CE}{\sin\left(A+\frac{C}{2}\right)} = \frac{b}{\sin B} \Rightarrow CE = \frac{b\sin\left(A+\frac{C}{2}\right)}{\sin B}$$



$$\text{Now } \frac{CE}{DE} = \frac{\sin\left(A+\frac{C}{2}\right)(b+a)}{c\sin\frac{C}{2}}$$

$$\Rightarrow \frac{CE}{DE} = \frac{(b+a)}{c}.\frac{\sin\left(A+\frac{C}{2}\right)}{\sin\frac{C}{2}} \times \left(\frac{2\cos\frac{c}{2}}{2\cos\frac{c}{2}}\right)$$

$$= \frac{(a+b)}{c}.\frac{[\sin(A+C)+\sin A]}{\sin C} = \left(\frac{a+b}{c}\right)\left(\frac{\sin A+\sin B}{\sin C}\right) = \frac{(a+b)^2}{c^2}$$

$$= \frac{(4+5)^2}{3^2} = 9$$

2. **Ans.** 11

Let $x^2 - x - 21 = y$
$E = y\,(y - 18y)$
$= y^2 - 18y = (y-9)^2 - 81$
$= (x^2 - x - 30)^2 - 81$
$= [(x-6)(x+5)]^2 - 81$ will be minimum for
$x = 6, -5$
difference $= |6 - (-5)| = 11$ **Ans.**

3. **Ans.** 4

$$\sum_{\alpha=4}^{n+3} 4(\alpha - 3) = An^2 + Bn + C$$

$$\Rightarrow \sum_{\alpha=1}^{n} 4 = An^2 + Bn + C$$

$\Rightarrow 2n\,(n+1) = An^2 + Bn + C$
$\Rightarrow A = 2, B = 2, C = 0$

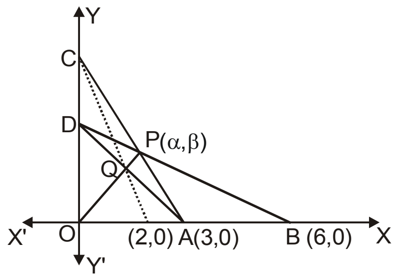
$\Rightarrow A + B + C = 4$ Ans.

4. **Ans.** 2

The equation of BP is

$$y - \beta = \frac{0-\beta}{6-\alpha}(x-\alpha)$$

so that the coordinates of D are $\left(0, \frac{6\beta}{6-\alpha}\right)$



Similarly the coordinates of C are $\left(0, \frac{3\beta}{3-\alpha}\right)$

Now, the equation of AD is

$$\frac{x}{3} + \frac{(6-\alpha)}{6\beta}y = 1$$

........(1)
and the equation of OP is $\beta x = \alpha y$ ....(2)
Solving (1) and (2), we get

$$x = \frac{6\alpha}{6+\alpha},\ y = \frac{6\beta}{6+\alpha}$$

Hence coordinates of Q are $\left(\frac{6\alpha}{6+\alpha}, \frac{6\beta}{6+\alpha}\right)$

Then the equation of CQ is

$$y - \frac{3\beta}{3-\alpha} = \frac{\frac{6\beta}{6+\alpha} - \frac{3\beta}{3-\alpha}}{\frac{6\alpha}{6+\alpha} - 0}(x-0)$$

$$\Rightarrow \quad y - \frac{3\beta}{3-\alpha} = \frac{-9\alpha\beta}{6\alpha(3-\alpha)}x$$

$$\Rightarrow \quad y = \frac{3\beta}{(3-\alpha)}\left(1 - \frac{x}{2}\right)$$

which pass through the point (2, 0) for all values of (α, β).

5. **Ans.** 8

$\cos 2\theta = \frac{1}{3} \Rightarrow \frac{1-\tan^2\theta}{1+\tan^2\theta} = \frac{1}{3} \Rightarrow 3 - 3\tan^2\theta$

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

Now $2\cos^2\alpha - 3\cos\alpha = 32.\ \frac{1}{2^4} = 2$

$\Rightarrow\ 2\cos^2\alpha - 4\cos\alpha + \cos\alpha - 2 = 0$

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

$\frac{2\pi}{3} + \frac{4\pi}{3} + \frac{8\pi}{3} + \frac{10\pi}{3} = \frac{24\pi}{3} = 8\pi \Rightarrow K = 8$

6. **Ans.** 10

Let $p(x) = ax^2 + bx + c$

given $p(1) = 0 \Rightarrow a + b + c = 0$ ....(i)

$p(2) = 2 \Rightarrow 4a + 2b + c = 2$ ...(ii)

Now, given $p(x) \geq 0$, so $d \leq 0$ and $a > 0$

$b^2 - 4ac \leq 0$

$(a + c)^2 - 4ac \leq 0$ $(\because b = -(a + c))$

$(a - c)^2 \leq 0$

$a = c$ ...(iii)

putting (iii) in (i) and (ii), we get

$a = 2$, $c = 2$ and $b = -4$

$\Rightarrow p(0) + p(3) = 10$

7. **Ans.** 19

Consider 4 positive terms

$$\frac{r_1}{2}, \frac{r_2}{4}, \frac{r_3}{5}, \frac{r_4}{8}$$

A.M. $= \frac{1}{4}\left(\frac{r_1}{2} + \frac{r_2}{4} + \frac{r_3}{5} + \frac{r_4}{8}\right) = \frac{1}{4} \times 1 = \frac{1}{4}$

G.M. $= \left(\frac{r_1}{2}\cdot\frac{r_2}{4}\cdot\frac{r_3}{5}\cdot\frac{r_4}{8}\right)^{1/4} = \left(\frac{r_1 \cdot r_2 \cdot r_3 \cdot r_4}{2\cdot 4\cdot 5\cdot 8}\right)^{1/4}$

now, $r_1r_2r_3r_4 = \frac{5}{4}$

$\therefore$ G.M. $= \left[\frac{5}{4(2\cdot 4\cdot 5\cdot 8)}\right]^{1/4} = \left(\frac{1}{2^8}\right)^{1/4} = \frac{1}{4}$

hence A.M. = G.M.

$\Rightarrow$ All numbers are equal

$\frac{r_1}{2} = \frac{r_2}{4} = \frac{r_3}{5} = \frac{r_4}{8} = k$

$r_1 = 2k;\ r_2 = 4k;\ r_3 = 5k;\ r_4 = 8k$

$\Rightarrow \prod r_1 = (2 \cdot 4 \cdot 5 \cdot 8)k^4$

$\frac{5}{4} = (2 \cdot 4 \cdot 5 \cdot 8)k^4$

$\therefore$ $k = 1/4$

hence $r_1 = \frac{1}{2};\ r_2 = 1;\ r_3 = \frac{5}{4};\ r_4 = 2$

$\Rightarrow \sum r_1 = \frac{19}{4}$ but $r_1 + r_2 + r_3 + r_4 = \frac{a}{4}$

$\Rightarrow \frac{19}{4} = \frac{a}{4} \Rightarrow a = 19$

8. **Ans.** 2

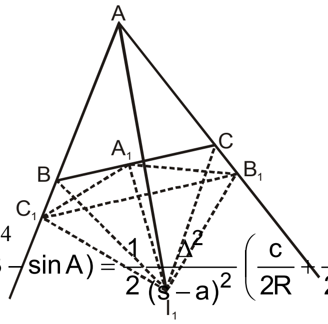
Let A_1, B_1 and C_1 be the points of contact of the excircle opposite to vertex A, with the side AC, BC and AB respecitvely.

$\Rightarrow\ I_1A_1 = I_1B_1 = I_1C_1 = r_1$

$\angle B_1I_1A_1 = \pi = \angle B_1CA_1 = \pi - (\pi - C) = C$

Similiarly $\angle A_1I_1C_1 = B \Rightarrow \angle C_1I_1B_1 = (B + C)$

Now, $\Delta_1 = \Delta_{A_1I_1B_1} + \Delta_{A_1I_1C_1} - \Delta_{B_1I_1C_1}$



$= \frac{1}{2}r_1^2(\sin C + \sin B - \sin A) = \frac{1}{2}\frac{\Delta^2}{(s-a)^2}\left(\frac{c}{2R} + \frac{b}{2R} - \frac{a}{2R}\right)$

$= \frac{1}{2}\frac{\Delta^2}{(s-a)^2} - \frac{(2s-2a)}{2R} = \frac{\Delta^2}{2R(s-a)} = \frac{r_1\Delta}{2R} \Rightarrow \frac{\Delta_1}{\Delta} = \frac{r_1}{2R}$

Similarly $\frac{\Delta_2}{\Delta} = \frac{r_2}{2R}, \frac{\Delta_3}{\Delta} = \frac{r_3}{2R}$ and $\frac{\Delta_0}{\Delta} = \frac{r}{2R}$

Thus

$\frac{\Delta_1}{\Delta} + \frac{\Delta_2}{\Delta} + \frac{\Delta_3}{\Delta} - \frac{\Delta_0}{\Delta} = \frac{1}{2R}(r_1 + r_2 + r_3 - r) = \frac{1}{2R}(4R) = 2$

SECTION - I

1. **B**

Force on table due to collision of balls :

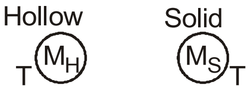
$F_{dynamic} = \frac{dp}{dt} = 2 \times 20 \times 20 \times 10^{-3} \times 5 \times 0.5 = 2$ N

Net force on one leg = $\frac{1}{4}$ (2 + 0.2 × 10) = 1 N

2. **A**
3. **B**
4. **D**

SECTION – II

1. **A,C,D**
2. **A,B**



$M_H < M_S$

$P_{emitted} = \sigma eAT^4$ since $T_1 = T_2$

$P_{absorb} = \sigma eAT_s^4$ So $P_1 = P_2$ at t = 0

cooling rate

since $M_H < M_S$, so cooling rate will be different since

cooling rate is not same so both will not have temp

at any instant t (except t = 0)

3. **A,B**
4. **A,C,D**

At the time of throwing the ball, it inherits velocity of platform at that moment. And, the horizontal velocity of the ball is constant in the air because no acceleration in horizontal direction for ball. If train is accelerting in forward direction then from frame of train, the ball has horizontal component of acceleration in backward direction and vice versa.

5. **B**

If the man is moving with a constant speed relative to cart towards right, then by conservation of linear momentum, the cart is moving with some constant speed towards left. Therefore, the man is moving with a constant speed **with respect to ground.** Newton's second law says that

$\vec{F}_{(Net)}$ = M (w.r.t inertial frame)

Since acceleration of man w.r.t. earth is zero. net force on it should also be zero. A spring force is acting on the man towards left. Therefore. **Frictional force should act righwards** for balancing the spring force.

SECTION - III

1. **A → Q ; B → P,Q ; C → R ; D → S**
2. **(A) → P,S ; (B) → R,S ; (C) → R,S ; (D) → P, S**

SECTION – IV

1. 300 K

Power absorbed by earth = power emitted by earth.

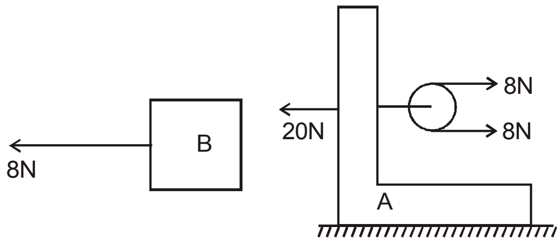
⇒

$e\sigma(4\pi R_s^2)T_s^4 \left(\frac{\pi R_e^2}{4\pi r^2}\right) = e\sigma(4\pi R_e^2)T_e^4$

⇒ $T_e = T_s\sqrt{\frac{R_s}{2T}} = T_s\sqrt{\frac{R_s}{2 \times 200 R_s}}$

⇒ $T_e = \frac{T_s}{20}$ = 300 K

2. 1



∴ $a_B = \frac{8}{1} = 8$

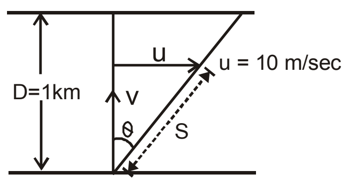
∴ $a_A = \frac{20-16}{1} = 4$

∴ a_{rel} [illegible]

$0.5 = \frac{1}{2} \times 4 \times t^2$ and $\frac{x}{2} = t$

x = 1 sec.

3. **2km**



A man stand on a bank of river

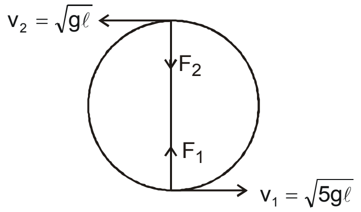
$\tan\theta = \frac{u}{v} = \frac{10}{10/\sqrt{3}} = \sqrt{3}$

$S = \frac{D}{\cos\theta} = \frac{1}{\cos 60^\circ} = 2\text{km}$

4. **5**

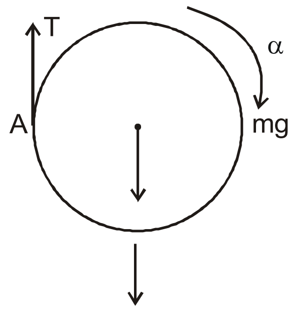
$F_1 = \dfrac{mv_1^2}{\ell}$

$F_2 = \dfrac{mv_2^2}{\ell}$



$\therefore \dfrac{F_1}{F_2} = 5$

5. **2**



$a_{cm} = 0$

$a_A = a = \alpha . R$ ...(i)

$T - mg = 0$ ...(ii)

$T.R = \dfrac{mR^2}{2}.\alpha$ ...(iii)

$\therefore g = \dfrac{a}{2}$

6. **7**

Since angular velocities of the particles are different, after some time, two particles may move parallel. In such case $|\vec{P}_A + \vec{P}_B|$ is maximum.

$|\vec{P}_A + \vec{P}_B|_{max}$ = (2 × 2 + 1 × 3) kg m/s = 7 kg m/s

7. **5**

$mg\sin\theta + mg\sin\theta > (\mu_1 mg\cos\theta + \mu_2 mg\cos\theta)$

$\Rightarrow 2\tan\theta > 0.6 + 0.2$

$\Rightarrow 2\cot\theta < \dfrac{4}{0.8} = 5$

8. v/4

COM

gives mv sin 30° = (2m) $v_\perp$ $\Rightarrow$ $v_\perp = v/4$

CHEMISTRY

SECTION - I

1. **B**
2. **C**
3. **C**

   + M of – OH > + M of – OCH_3
4. **B**

SECTION – II

1. **A,B**
2. **A,B,C,D**
3. **A,B,C**
4. **A,C,D**

   $CH_3 - \overset{\overset{O}{||}}{C} - \overset{\ominus}{O} > H - \overset{\overset{O}{||}}{C} - \overset{\ominus}{O}$
   (+I)

   $CH_2 = \overset{\ominus}{C}H sp^2 > H - C \equiv \overset{\ominus}{C}$ sp
5. **B,D**

SECTION - III

1. **(A – Q,S) ; (B – P) ; (C – P) ; (D – R)**
2. **(A – Q) ; (B – P) ; (C – S) ; (D – R)**

(A) inert gases exist as monoatomic molecule. They have highest IE_1 and IE_2 and positive electron gain enthalpies.

(B) Alkali metal – IE_1 is low because of bigger size of atom and IE_2 is high due to noble gas configuration. As it has low IE_1, it can lose one electron easily and thus more electropositive. So it acts as strong reducing agents and their oxides are basic in nature. They have low negative value of ΔH_{eg} because of large size.

(C) IE_1 and IE_2 both high and negative value of electron gain enthalpy is very high because of high nuclear charge and small size of atoms, so it has a greater tendency to accept an additional electron. So it (F) acts as a strong oxidising agent.

(D) As it has less negative value for ΔH_{eg} than (C) thus it will be least reactive non – metal (I).

SECTION IV

1. **4**

	A +	B $\rightleftharpoons$	2C
at t = 0	2a	a	0
t = t_{eq}	2a – x	a – x	2x

$\Rightarrow 2a - x = 2x \Rightarrow x = \dfrac{2}{3}a$

$$\Rightarrow \quad K_C = \frac{(2x)^2}{(2a-x)(a-x)} = \frac{4.\left(\frac{2}{3}\right)^2}{\left(2-\frac{2}{3}\right)\left(1-\frac{2}{3}\right)}$$

$$\Rightarrow \quad \frac{4\times4}{4\times1} = 4$$

2. **16**

Given $m_A = 2m_B$

$\therefore$ Mol. wt. of A = 2 × mol. wt. of B ....(i)

given u_{rms} of A = 2 × u_{rms} of B ...(ii)

Also number of molecules of A

= number of molecules of B ...(iii)

For gas A $\quad P_AV_A = \frac{1}{3} M_A u^2_{rms A}$

For gas B $\quad P_B\,V_B = \frac{1}{3} M_B u^2_{rms B}$

$$\therefore \quad \frac{P_AV_A}{P_BV_B} = \frac{M_A}{M_B} \times \frac{u_A^2}{u_B^2} \qquad ...(iv)$$

Given $\quad V_A = V_B$ ...(v)

$\therefore$ By equation (i), (ii), (iv) and (v)

$$\frac{P_A}{P_B} = 2\times(2)^2 = 8$$

$\therefore \quad P_A = 8P_B$

$P_A = 16$ atm

3. **(4814) OR (4815)**

For H_α line of Balmer series $n_1 = 2$, $n_2 = 3$

For H_β line of Balmer series $n_1 = 2$, $n_2 = 4$

$$\therefore \quad \frac{1}{\lambda_{H_\alpha}} = R_H\left[\frac{1}{2^2} - \frac{1}{3^2}\right] \qquad ...(1)$$

$$\text{and} \quad \frac{1}{\lambda_{H_\beta}} = R_H\left[\frac{1}{2^2} - \frac{1}{4^2}\right] \qquad ...(2)$$

By Eqs. (1) and (2)

$$\frac{\lambda_\beta}{\lambda_\alpha} = \frac{\frac{1}{4}-\frac{1}{9}}{\frac{1}{4}-\frac{1}{16}}$$

$$\therefore \quad \lambda_\beta = \lambda_\alpha \times \left[\frac{80}{108}\right] = 6500 \times \frac{80}{108} = 4814.8$$

Å

4. Volume of one molecule

$$= \frac{\sqrt{3}}{4}a^2h = \frac{\sqrt{3}}{4}(10^{-6})^2 \times 3 \times 10^{-6}\ cm^3 = \frac{3\sqrt{3}}{4} \times 10^{-18} cm^3$$

$$\text{Molar mass} = \frac{3\sqrt{3}}{4} \times 10^{-18} \times 6.023 \times 10^{23} \times 1.2$$

$$= 939 \times 10^3$$

5. Since, volume of container is 1.0 litre, concentrations of each species will be equal to their moles, Now, setting the equilibrium table

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

$1 - x \quad 3-3x \qquad 2x - y$

$NH_3(g) + H_2S(g) \rightleftharpoons NH_4HS(g)$,

$K_p = 8 \times 10^{-3} = K_c\,(RT)^{-1}$

$2x - y \quad 1 - y \qquad y \quad \Rightarrow K_c = 0.4592$

$$\Rightarrow K_c = 0.4592 = \frac{y}{(1-y)(2x-y)} \quad \text{also } 2x - y = 0.9$$

$$\Rightarrow \frac{1-y}{y} = 2.42 \Rightarrow y = 0.3 \text{ and } x = 0.6$$

$\Rightarrow$ eq. concentration of $H_2S = 1 - y = 1 - 0.3 = 0.7$

6. **0.0357**

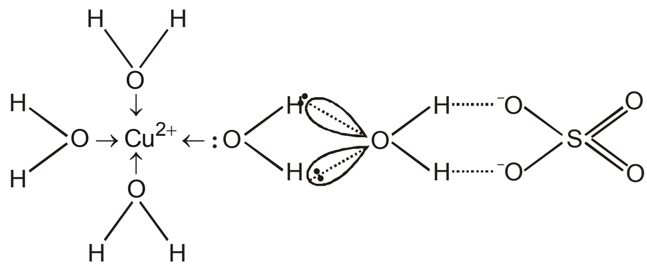
	$PCl_5(g)$	$\rightleftharpoons$ $PCl_3(g)$	+ $Cl_2(g)$
t = 0	5	0	0
$t = t_{eq}$	5 – 5 × 0.2	5 × 0.2	5 × 0.2
	4 mole	1 mole	1 mole

Total moles at equilibrium = 4 + 1 + 1 + 1 (N_2) = 7 moles

$$k_P = \frac{\left(\frac{1}{7}\times 1\,atm\right)\left(\frac{1}{7}\times 1\,atm\right)}{\left(\frac{4}{7}\times 1\,atm\right)} = \frac{1}{28} = 0.0357$$

atm

$\frac{116.4}{1.164}$ **7.** **2**



8. **1.53**

Mass of Na_2SO_4 solution = 100 × 1.5 = 150 g

1164 g Na_3PO_4 solution has 164 gm of Na_3PO_4

100 g of H_2O will have 16.4 g of Na_3PO_4

vol of Na_3PO_4 solution taken = = 100 ml

$$\text{Final volume of solution} = \frac{(150+116.4)}{1.2} = 222 \text{ ml}$$

$$[Na^+] = \frac{0.1\times0.2\times2+0.1\times1\times3}{0.222} = \frac{0.04+0.3}{0.222}$$

$$= \frac{170}{111} = 1.53\ M$$