

## ANSWER KEY : PAPER-1

### PART-1 : PHYSICS

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	A	B,C	C,D	B	A,C	A,C,D	A,D	A,D	B,D	B,D
SECTION-II	Q.1	A	B	C	D	Q.2	A	B	C	D	
		R	P,Q	P,Q	S,T		R,S	P,Q,T	P,R,S,T	Q,R,T	
SECTION-IV	Q.	1	2	3	4	5	6	7	8		
	A.	4	5	3	2	8	4	4	2		

### PART-2 : CHEMISTRY

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	A,B,D	A,B,C	B,C	A,B,C,D	B,D	B	A,B,C,D	B,D	A,B,D	A,B,C,D
SECTION-II	Q.1	A	B	C	D	Q.2	A	B	C	D	
		P,Q,S	Q,R,S	P,S	P,Q,S,T		Q,T	P	R,T	S,T	
SECTION-IV	Q.	1	2	3	4	5	6	7	8		
	A.	7	5	3	5	0	3	6	5		

### PART-3 : MATHEMATICS

SECTION-I	Q.	1	2	3	4	5	6	7	8	9	10
	A.	B,C,D	A,C,D	C,D	B,C,D	A,C,D	A,B	B,D	A,B,C,D	A,B	C,D
SECTION-II	Q.1	A	B	C	D	Q.2	A	B	C	D	
		T	R	Q	P		Q,T	P	R	Q,T	
SECTION-IV	Q.	1	2	3	4	5	6	7	8		
	A.	1	0	2	7	3	2	5	6		

## ANSWER KEY : PAPER-2

### PART-1 : PHYSICS

	Q.	1	2	3	4	5	6	7	8	9	10
SECTION-I	A.	C,D	A,B	A,C	B,C	A,D	B,C	A,B,C	A,D	A	B,D
	Q.	11	12								
	A.	B,D	A,B								
SECTION-IV	Q.	1	2	3	4	5	6	7	8		
	A.	6	2	4	4	5	5	3	2		

### PART-2 : CHEMISTRY

	Q.	1	2	3	4	5	6	7	8	9	10
SECTION-I	A.	A,C	C,D	B,C,D	A,B	A	A,B,C,D	B,D	B,C,D	A,C,D	B
	Q.	11	12								
	A.	A	A,B,C,D								
SECTION-IV	Q.	1	2	3	4	5	6	7	8		
	A.	2	2	3	0	0	3	3	3		

### PART-3 : MATHEMATICS

	Q.	1	2	3	4	5	6	7	8	9	10
SECTION-I	A.	A,D	A,C,D	A,B,C	A,D	A,D	A,D	A,B,C,D	A,C	B,C,D	A,D
	Q.	1	2								
	A.	B,C	A,B,D								
SECTION-IV	Q.	1	2	3	4	5	6	7	8		
	A.	5	6	2	5	3	3	4	6		

## PAPER-1

### PART-1 : PHYSICS

## SOLUTION

### SECTION-I

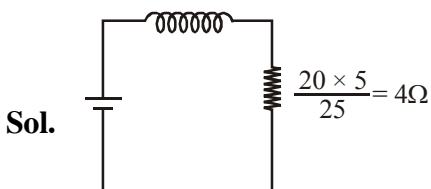
1. **Ans. (A)**

**Sol.**  $F = \frac{dU}{dr} = k = \frac{mv^2}{r}$

$$K = \frac{kr}{2}$$

$$E = U + K = kr + \frac{kr}{2} = \frac{3kr}{2}$$

2. **Ans. (B, C)**



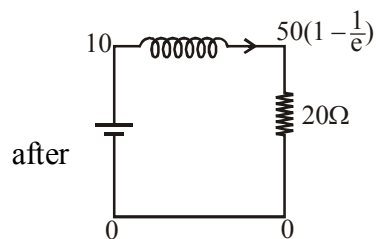
$$i = \frac{V}{R} \left( 1 - e^{-\frac{Rt}{L}} \right) = \frac{10}{4} \left( 1 - e^{-\frac{4 \times 0.25}{1}} \right)$$

$$= 2.5 \left( 1 - \frac{1}{e} \right)$$

$$V_L + 4i = 10$$

$$V_L + 10 \left( 1 - \frac{1}{e} \right) = 10$$

$$V_L = \frac{10}{e}$$



$$V_R = 2.5 \times 20 \left( 1 - \frac{1}{e} \right)$$

$$= 50 \left( 1 - \frac{1}{e} \right)$$

3. **Ans. (C, D)**

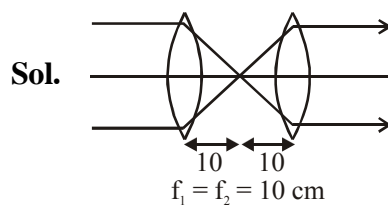
**Sol.** Magnetic field due to sheet is  $\frac{\mu_0 Jt}{2}$  & is constant.

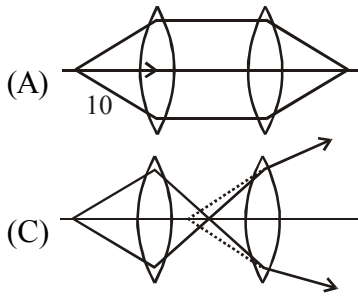
4. **Ans. (B)**

**Sol.** Total energy of hydrogen atom in ground state = -13.6 eV

$$\therefore M_H = M_p + M_e - \frac{13.6 \text{ eV}}{C^2}$$

5. **Ans. (A, C)**





$$\frac{1}{v} - \frac{1}{-30} = \frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{30} = \frac{3-1}{30}$$

$$v = 15$$

$$\frac{1}{v} - \frac{1}{-5} = \frac{1}{10}$$

$$\frac{1}{v} = \frac{1}{10} - \frac{1}{5} = \frac{1-2}{10}$$

$$v = -10$$

6. **Ans. (A, C, D)**

**Sol.**  $E = \frac{1240}{248} \text{ eV}$   
 $E_1 = 5 - 2.2 = 2.8 \text{ eV}$   
 $E_2 = 5 \times 0.8 - 2.2 = 1.8 \text{ eV}$   
 $E_3 = 5 \times 0.8^2 - 2.2 = 1 \text{ eV}$   
 $E_4 = 5 \times 0.8^3 - 2.5 = 0.36 \text{ eV}$

7. **Ans. (A, D)**

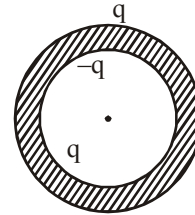
**Sol.**  $v = \frac{J}{m} = A\omega = A\sqrt{\frac{k}{m}}$   
 $A = \frac{J}{\sqrt{mk}}$   
 $x = \frac{J}{\sqrt{mk}} \sin\left(\sqrt{\frac{k}{m}}t\right)$   
 $v = \frac{J}{\sqrt{mk}} \times \sqrt{\frac{k}{m}} \cos\left(\sqrt{\frac{k}{m}}t\right)$   
 $= \frac{J}{m} \cos\left(\sqrt{\frac{k}{m}}t\right)$   
 $a = -\frac{J}{\sqrt{mk}} \frac{k}{m} \sin\left(\sqrt{\frac{k}{m}}t\right)$

8. **Ans. (A, D)**

**Sol.** (A)  $T_1^2 = C(R)^3$   
 $T_2^2 = C(4R)^3 \Rightarrow \frac{T_1}{T_2} = \frac{1}{8}$   
 (C)  $\frac{A}{T} = \frac{L}{2m}$  can't be commented

(D)  $E_1 = -\frac{GMm}{2R}$   
 $E_2 = \frac{-GMm}{2 \times 4R}$

9. **Ans. (B, D)**



**Sol.**

$$V_0 = \frac{kq}{d} - \frac{kq}{R_1} + \frac{kq}{R_2}$$

$$V_{\text{shell}} = \frac{kq}{R_2}$$

$$V_{\text{out}} = \frac{kq}{R}$$

10. **Ans. (B, D)**

### SECTION-II

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

**Sol.** For process-1,  
 Gas undergoes compression work done by gas is -ve

for DU & DQ nothing can be commented.

For process-2,

Gas undergoes expansion P work done by gas is +ve

Also temperature of gas increases.

∴ ΔQ is +ve & ΔU is +ve

For process-3

Process is isobaric

For process-4

Process is iso-choric

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

**Sol.** For P,

$$u = +\frac{f}{2} \quad \therefore \frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

For Q,

$$u = -15 \text{ cm} \quad \therefore \frac{1}{v} + \frac{1}{u} = \frac{1}{-10}$$

For R

$$u = -50 \text{ cm} \quad \therefore$$

$$\frac{1.5}{v} - \frac{1}{(-50)} = \frac{1.5-1}{100}$$

For S

Object is real  $\Rightarrow$  image will be virtual

For T

$$u = +\frac{f}{2} \quad \therefore \frac{1}{v} - \frac{1}{u} = \frac{1}{-f}$$

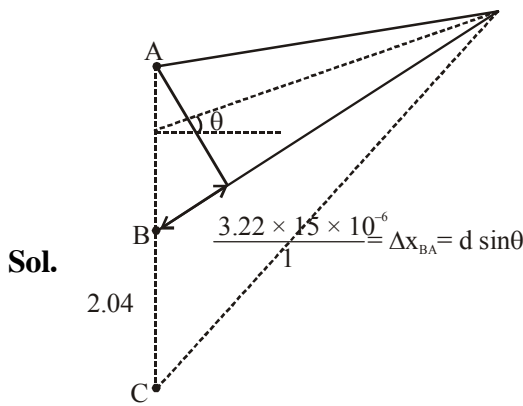
### SECTION-IV

1. **Ans. 4**

**Sol.**  $E \times 2\pi r = \frac{d\phi}{d\tau} = \pi r^2 \times 0.4$

$$E = \frac{r}{2} \times 0.4 = 4 \times 10^{-3}$$

2. **Ans. 5**



$$\Delta\phi_{BA} = \frac{2\pi}{\lambda} \Delta x$$

$$= \frac{2\pi}{600 \times 10^{-9}} \times 3.22 \times 15 \times 10^{-6} = 161 \pi \equiv \pi$$

A & B cancel  $\Rightarrow I = I_C = 5 \text{ } \omega/\text{m}^2$

3. **Ans. 3**

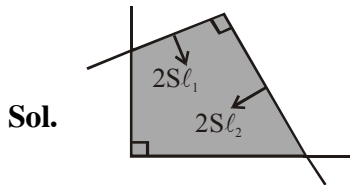
**Sol.**  $3 - 0.1 \times 2 \times 10 = 2a$

$$a = 0.5 \text{ m/s}^2$$

$$v^2 = 2as = 2 \times 0.5 \times 9$$

$$v = 3 \text{ m/s}$$

4. **Ans. 2**



$$F_{\text{net}} = \sqrt{(2S\ell_1)^2 + (2S\ell_2)^2} = ma$$

$$a = \frac{2S\sqrt{\ell_1^2 + \ell_2^2}}{m} = \frac{2 \times 0.1 \times \sqrt{1.5^2 + 2^2}}{0.25}$$

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

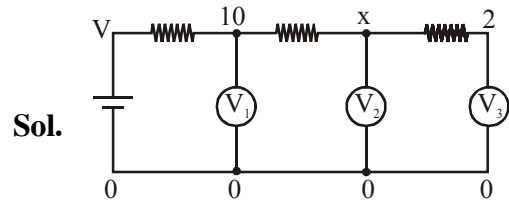
5. **Ans. 8**

**Sol.**  $B_1 = \rho_{\text{air}} Vg - \rho_{\text{H}_2} Vg = Vg (1.08)$

$$B_2 = \rho_{\text{air}} Vg - \rho_{\text{H}_2} Vg = Vg (1.00)$$

$$\frac{B_1 - B_2}{B_1} = 8\%$$

6. **Ans. 4**



$$\frac{x-10}{R} + \frac{x-2}{R} + \frac{x-0}{r} = 0 \quad \dots(1)$$

$$\frac{2-x}{R} + \frac{2-0}{r} = 0 \quad \dots(2)$$

$$\frac{2}{r} = \frac{x-2}{R}$$

$$\frac{R}{r} = \frac{x}{2} - 1$$

from (1)  $2x - 12 + \frac{xR}{r} = 0$

$$(2x - 12) + x \left( \frac{x}{2} - 1 \right) = 0$$

$$4x - 24 + x^2 - 2x = 0$$

$$x^2 + 2x - 24 = 0$$

$$x = -6, 4 \Rightarrow x = 4$$

7. **Ans. 4**

**Sol.**  $\Delta\ell_1 = \alpha\ell \Delta T = 4 \times 0.01 = \alpha \times 2.44 \times 20$

$$\alpha = \frac{1}{244 \times 5}$$

$$\Delta\ell_2 = \frac{1}{244 \times 5} \times 2.44 \times 50 = 0.1 \text{ cm}$$

$$L = (2.44 + 0.1) \text{ cm} = 2.54 \text{ cm}$$

Therefore division coinciding at  $50^\circ\text{C}$  is 4<sup>th</sup> division

8. **Ans. 2**

**Sol.**  $n_1 C_{v_1} dT + n_2 C_{v_2} dT + PdV = 0$

$$\frac{1}{2} \times 2RdT + 4 \times \frac{7R}{4} dT + 4RT \frac{dV}{V} = 0$$

$$2 \int \frac{dT}{T} + \int \frac{dV}{V} = 0$$

$$2 \ln \left( \frac{T}{300} \right) + \ln \left( \frac{1}{4} \right) = 0$$

$$\ln \frac{T}{300} = \ln 2$$

$$T = 600 \text{ K}$$

$$\Delta U = \frac{1}{2} \times 2R \times (600 - 300)$$

$$+ 4 \times \frac{7R}{4} (600 - 300)$$

$$= 8R \times 300$$

$$= 8 \times \frac{25}{3} \times 300 = 2 \times 10^4 \text{ J}$$

## PART-2 : CHEMISTRY

### SOLUTION

#### SECTION-I

1. **Ans. (A,B,D)**
2. **Ans. (A,B,C)**  

$$A(\text{H}_2\text{O})_8(\text{s}) \rightleftharpoons A(\text{g}) + 8\text{H}_2\text{O}(\text{g}) ; K_{p_1}$$

$$(x+y) \quad 8x$$
  

$$A(\text{H}_2\text{O})_8(\text{s}) \rightleftharpoons A(\text{g}) + 8\text{H}_2\text{O}(\text{s}) ; K_{p_2}$$

$$(x+y)$$
  

$$x+y=0.2$$

$$8x=0.001$$

$$K_{p_1} = (x+y)(8x)^8 = 0.2 \times (10^{-3})^8 = 2 \times 10^{-25}$$

$$K_{p_2} = (x+y) = 0.2$$
  

$$\text{H}_2\text{O}(\text{s}) \rightleftharpoons \text{H}_2\text{O}(\text{g}) ; \left( \frac{K_{p_1}}{K_{p_2}} \right)^{1/8}$$

$$\text{V.P.} = \left( \frac{2 \times 10^{-25}}{2 \times 10^{-1}} \right)^{1/8} = 10^{-3} \text{ bar}$$
3. **Ans. (B,C)**
4. **Ans. (A,B,C,D)**
5. **Ans. (B, D)**
6. **Ans. (B)**
7. **Ans. (A,B,C,D)**
8. **Ans. (B,D)**
9. **Ans. (A,B,D)**
10. **Ans. (A,B,C,D)**

#### SECTION-II

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

#### SECTION-IV

1. **Ans. (10<sup>-7</sup>M) OMR ANS (7)**  

$$k_1 \times k_2 = \frac{[\text{H}^+]^2[\text{S}^{2-}]}{[\text{H}_2\text{S}]}$$

$$10^{-20} = \frac{(10^{-3})^2[\text{S}^{2-}]}{0.1}$$

$$[\text{S}^{2-}] = 10^{-15}$$

$$K_{sp} = [\text{Mn}^{2+}][\text{S}^{2-}] = [\text{Mn}^{2+}][10^{-15}]$$

$$[\text{Mn}^{2+}] = 10^{-7}$$
2. **Ans. (5)**  

$$\bar{v} = R_H Z^2 \left( \frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

$$\bar{v}_1 = R_H \times 1 \left( \frac{1}{1^2} - \frac{1}{2^2} \right) = R_H \times \frac{3}{4}$$

$$\bar{v}_2 = R_H \times 9 \left( \frac{1}{2^2} - \frac{1}{3^2} \right) = R_H \times \frac{9 \times 5}{36}$$

$$\frac{\bar{v}_1}{\bar{v}_2} = \frac{3}{4} \times \frac{36}{9 \times 5} = \frac{3}{5}$$
3. **Ans(3)**  

$$2\text{CH}_3\text{COOH}(\text{g}) \longrightarrow (\text{CH}_3\text{COOH})_2(\text{g})$$

$$\Delta H^0 = -2 \times 7.5 = -15 \text{ kcal}$$

$$\Delta G^0 = -RT \ln K_{eq} = -2 \times 300 \ln e^{10} = -6000 \text{ cal.}$$

$$\Delta G^0 = \Delta H^0 - T\Delta S^0$$

$$-6000 = -15000 - 300 \Delta S^0$$

$$\Delta S^0 = \frac{-9000}{300} = -30 \text{ cal./k}$$
4. **Ans. 5**
5. **Ans. 0**
6. **Ans. 3**
7. **Ans. 6**
8. **Ans. 5**

**SOLUTION**

**SECTION-I**

1. **Ans. (B,C,D)**

$$I = \int_{-1}^1 (e^{x^3} + e^{-x^3}) dx = 2 \int_0^1 (e^{x^3} + e^{-x^3}) dx > 2$$

Since  $e^{x^3} + e^{-x^3}$  is concave upwards

$$I < f(0) + f(1)$$

$$I < 2 + e + \frac{1}{e}$$

2. **Ans. (A,C,D)**

$$\begin{aligned} a^3 + b^3 + (-2c)^3 - 3ab(-2c) \\ = (a + b - 2c)(a + b\omega - 2c\omega^2) \\ (a + b\omega^2 - 2c\omega) = 0 \end{aligned}$$

3. **Ans. (C,D)**

(A)  $(ABA^T)^T = (A^T)^T B^T A^T = AB^T A^T$

Need not be symmetric

(B)  $(AB - BA)^T = B^T A^T - A^T B^T$  Need not be skew symmetric

(C)  $B = |A| \frac{\text{adj}A}{|A|} \Rightarrow B = \text{adj}A$

Now,  $c = \text{adj}(A^T) - \text{adj}A$

$\therefore c^T = (\text{adj}A^T)^T - (\text{adj}A)^T$

$= \text{adj}A - \text{adj}A^T = -c$

$\therefore$  skew, symmetric matrix.

(D)  $A^T = -B$  &  $A^T = -A$

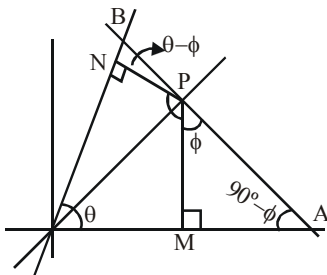
$\therefore A = -B$

Now  $B^{15} = -A^{15}$

Let  $c = B^{15}$

$\therefore C^T = (B^T)^{15} = (-A)^{15} = -A^{15} = B^{15}$

4. **Ans. (B,C,D)**



$$PA \cdot PB = \frac{PM \cdot PN}{\cos \phi \cos(\theta - \phi)}$$

$$\Delta = \frac{2PM \cdot PN}{\cos \theta + \cos(2\phi - \theta)}$$

for PA. PB to be

minimum  $2\phi - \theta = 0 \Rightarrow \theta = 2\phi$

$\therefore OA = OB \Rightarrow \Delta OAB$  is isosceles

slope of PA =  $\tan(90^\circ + \phi) = -\cot \phi = -\cot \frac{\theta}{2}$

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

$3t^2 + 2t - 3 = 0$

$t = \frac{-2 \pm \sqrt{4+36}}{6} = \frac{-1 \pm \sqrt{10}}{3}$

5. **Ans. (A,C,D)**

$$f(x) = e^{-\frac{1}{x^2}} + \int_0^{\frac{\pi x}{2}} \sqrt{1 + \sin t} dt$$

$$f'(x) = e^{-\frac{1}{x^2}} \cdot \frac{2}{x^3} + \frac{\pi}{2} \sqrt{1 + \sin \frac{\pi x}{2}}$$

Now  $\lim_{x \rightarrow 0^+} \frac{e^{-1/x^2}}{x^3} = \lim_{x \rightarrow \infty} \frac{x^3}{e^{x^2}} = 0$  (By L'Hôpital's Rule)

hence  $f'(x)$  exists and continuous for all  $x \in (0, \infty)$

$f'(x)$  is bounded

Also,  $\lim_{x \rightarrow \infty} f(x) = \infty \Rightarrow f(x)$  is unbounded

$\Rightarrow \exists \alpha > 0$  such that  $|f(x)| > |f'(x)| \forall x \in (\alpha, \infty)$

$$\text{and } f''(x) = \frac{6e^{-1/x^2}}{x^4} + \frac{4}{x^6} e^{-\frac{1}{x^2}} + \frac{\pi^2}{8} \frac{\cos \frac{\pi x}{2}}{\sqrt{1 + \sin \frac{\pi x}{2}}}$$

Clearly  $f''(x)$  does not exist at  $x = 3, 7, 11, \dots$

6. **Ans. (A,B)**

$$\text{Put } x = y + \frac{1}{2}$$

$$\Rightarrow 8y^4 + 4y^2 + a - \frac{3}{2} = 0$$

$$\text{Put } y^2 = z$$

$$\therefore 8z^2 + 4z + \left(a - \frac{3}{2}\right) = 0$$

Case-I If  $a > \frac{3}{2} \Rightarrow$  All roots are non real

$$\therefore \text{sum of roots} = 2$$

Case-II If  $a = \frac{3}{2}$

$$\Rightarrow z = 0 \text{ or } -\frac{1}{2}$$

$$\therefore y = 0, 0 \text{ or } r = \frac{1}{2}, \frac{1}{2}$$

If  $z = -\frac{1}{2} \Rightarrow 2$  non real roots

$$\therefore z = \frac{1}{2} + \frac{1}{2} + \alpha + \beta \Rightarrow \alpha + \beta = 1$$

Case III: If  $a < \frac{3}{2}$

$$\Rightarrow z \rightarrow x_1, -x_2$$

$$y = \pm\sqrt{x_1} \quad \therefore x = \frac{1}{2} \pm \sqrt{x_1}$$

Again  $\alpha + \beta = 1$

7. **Ans. (B,D)**

$$\lim_{n \rightarrow \infty} \frac{\left(\sum_{x=1}^n x^4\right)\left(\sum_{x=1}^n x^5\right)}{\left(\sum_{x=1}^n x^t\right)\left(\sum_{x=1}^n x^{9-t}\right)} = \frac{\frac{1}{5} \cdot \frac{1}{6}}{\frac{1}{t+1} \cdot \frac{1}{10-t}} = \frac{4}{5}$$

$$\therefore t = 2, 7$$

8. **Ans. (A,B,C,D)**

Either the line L is parallel to the angle bisector of given lines.

$$\therefore m = \pm 1 \text{ or } \tan\theta_1 = \tan\theta_2 \text{ (in same sense)}$$

$$\therefore m = -\frac{11}{2} \text{ or } -\frac{2}{11}$$

9. **Ans. (A,B)**

$$\frac{\Delta}{s(s-a)} \cdot \frac{\Delta}{s(s-c)} = \frac{1}{3} \Rightarrow \frac{s(s-a)(s-b)(s-c)}{s^2(s-a)(s-c)} = \frac{1}{3}$$

$$\Rightarrow 3s - 3b = s$$

$$2s = 3b \Rightarrow a + c = 2b$$

$\therefore a, b, c$  are in A.P

$$\text{Also } a + c \geq 2\sqrt{ac}$$

$$\text{Also } \Sigma \tan \frac{A}{2} \tan \frac{B}{2} = 1$$

$$\Rightarrow \tan \frac{B}{2} \left( \tan \frac{A}{2} + \tan \frac{C}{2} \right) = \frac{2}{3}$$

10. **Ans. (C,D)**

Put  $\tan^2\alpha = x$  &  $\tan^2\beta = y$

$$\therefore \frac{(x+1)^2}{y} + \frac{(y+1)^2}{x} = \frac{x^2}{y} + \frac{y^2}{x} + \frac{1}{y} + \frac{1}{x} + 2\left(\frac{x}{y} + \frac{y}{x}\right)$$

Apply A.M.  $\geq$  G.M to get minimum value as 8.

**SECTION - II**

1. **Ans. (A)  $\rightarrow$  (T); (B)  $\rightarrow$  (R); (C)  $\rightarrow$  (Q); (D)  $\rightarrow$  (P)**

(A) Give sum

$$= \tan \frac{\pi}{15} + \tan \frac{4\pi}{15} + \tan \frac{7\pi}{15} + \tan \frac{10\pi}{15} + \tan \frac{13\pi}{15}$$

$$= (\tan 12^\circ + \tan 48^\circ) + (\tan 84^\circ - \tan 24^\circ) - \sqrt{3}$$

$$= \frac{\sin 60^\circ}{\cos 12^\circ \cos 48^\circ} + \frac{\sin 60^\circ}{\cos 24^\circ \cos 84^\circ} - \sqrt{3}$$

$$= \sqrt{3} \left[ \frac{1}{\cos 60^\circ + \cos 36^\circ} + \frac{1}{\cos 108^\circ + \cos 60^\circ} - 1 \right]$$

$$= \sqrt{3} \left[ \frac{1}{\frac{1}{2} + \frac{\sqrt{5}+1}{4}} + \frac{1}{\frac{1}{2} - \frac{\sqrt{5}-1}{4}} - 1 \right] = 5\sqrt{3}$$

$$\Rightarrow k = 3$$

(B) Give sum =  $\sum_{r=0}^{n-1} \frac{(n+1) - (r+1)}{(r+1)(r+2)(r+3)}$

$$= (n+1) \sum_{r=0}^{n-1} \frac{1}{(r+1)(r+2)(r+3)} - \sum_{r=0}^{n-1} \frac{1}{(r+2)(r+3)}$$

$$= \frac{(n+1)}{2} \sum_{r=0}^{n-1} \left( \frac{1}{(r+1)(r+2)} - \frac{1}{(r+2)(r+3)} \right)$$

$$- \sum_{r=0}^{n-1} \left( \frac{1}{r+2} - \frac{1}{r+3} \right)$$

$$= \frac{55}{24} \text{ for } n = 10 \quad \therefore k = 8$$



(C) tangent of slope 2 of ellipse is

$$y = 2x \pm \sqrt{4a^2 + b^2} \text{ which passes through } (-2, 0)$$

$$\Rightarrow 4a^2 + b^2 = 16$$

Now using A.M. - G.M.

$$4a^2 + b^2 \geq 4ab$$

$$\Rightarrow ab \leq 4 \Rightarrow \pi ab < 4\pi$$

$$\Rightarrow k = 4$$

(D)  $\tan k = \frac{2\sqrt{7+5}}{4} = \sqrt{3} \Rightarrow k = \frac{\pi}{3}$

$$\therefore \tan^2 k = \tan^2 \frac{\pi}{3} = 3$$

2. **Ans.** (A)→(Q,T); (B)→(P); (C)→(R); (D)→(Q,T)

Do yourself by using simple properties

#### SECTION - IV

1. **Ans. 1**

$$\frac{1}{a_{n+1}} = \frac{1}{a_n(a_n+1)} = \frac{1}{a_n} - \frac{1}{a_n+1}$$

$$\therefore \frac{1}{a_n+1} = \frac{1}{a_n} - \frac{1}{a_{n+1}}$$

$$\therefore s = \frac{1}{a_1} - \frac{1}{a_{101}} = z - \frac{1}{a_{101}} \text{ also } a_{101} > 1$$

$$\therefore [s] = 1$$

2. **Ans. 0**

$$g(x) = \int \left( 1 - \frac{f'(x) + f''(x) + f'''(x)}{f(x) + f'(x) + f''(x) + f'''(x)} \right) dx$$

$$= x - \ln |f(x) + f'(x) + f''(x) + f'''(x)| + c$$

$$= x - 3 \ln |x| + c$$

$$\text{Now, } g(1) = 1 \Rightarrow c = 0$$

$$\therefore g(e) = e - 3 \Rightarrow |g(e)| = 3 - e$$

$$[|g(e)|] = 0$$

3. **Ans. 2**

$$\text{Let } 2^x > 3x \Rightarrow 2^{x+1} > 2^x + 3x$$

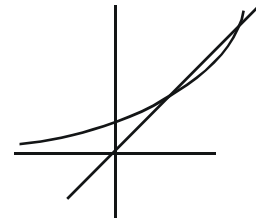
$$\therefore (x-2) + 2\log_2(2^x + 3x) < (x-2) + 2\log_2(2^{x+1})$$

$$= x - 2 + 2x + 2 = 3x$$

$$\therefore 2^x < 3x$$

which is contradiction

$$\therefore 2^x = 3x$$

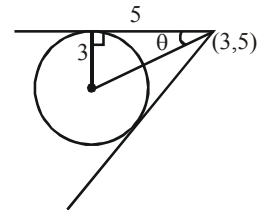


$\therefore$  Two solutions

4. **Ans. 7**

Clearly (3,5) is focus of parabola

$$\therefore \tan \theta = \frac{3}{5}$$



$$2 \tan 2\theta = \frac{15}{8}$$

$$\therefore a - b = 7$$

5. **Ans. 3**

$$\alpha = \tan^{-1} \left( \frac{4}{3} \right) + \tan^{-1} \left( \frac{3}{4} \right) = \frac{\pi}{2}$$

$$\beta = \tan^{-1} \left( \frac{12}{5} \right) + \tan^{-1} \left( \frac{3}{4} \right) + \tan^{-1} \frac{63}{16}$$

$$= \pi - \tan^{-1} \left( \frac{63}{16} \right) + \tan^{-1} \frac{63}{16} = \pi$$

$$\therefore 2 \sin \alpha = 2 \quad \& \quad \cos \pi = -1$$

$$\therefore \text{equation } x^2 - x - 2 = 0$$

$$p=1 \quad \& \quad q=-2 \Rightarrow p - q = 3$$

6. **Ans. 2**

$$\sum_{i=1}^{\infty} a_i = \frac{2 \cot x}{1 - \sin^2 x} = \frac{2}{\cos x \sin x}$$

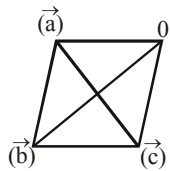
$$\sum_{j=1}^{\infty} b_j = \frac{\sin 2x}{1 - \sin^2 x} = \frac{2 \sin x}{\cos x}$$

$$\therefore \sum_{i=1}^{\infty} a_i - \sum_{j=1}^{\infty} b_j = \frac{2}{\cos x \cdot \sin x} - \frac{2 \sin x}{\cos x}$$

$$= \frac{2(1 - \sin^2 x)}{\cos x \sin x} = 2 \cot x$$

$$\therefore \text{minimum value} = 2$$

7. **Ans. 5**



$$\vec{a} \cdot \vec{b} = \frac{1}{2} \quad \vec{b} \cdot \vec{c} = \frac{1}{2} \quad \vec{c} \cdot \vec{a} = \frac{1}{2}$$

$$\text{Now, } \vec{c} = \alpha(\vec{a} + \vec{b}) + \beta(\vec{a} \times \vec{b})$$

Take dot product with  $\vec{a}$

$$\frac{1}{2} = \alpha \left( 1 + \frac{1}{2} \right)$$

$$\therefore \alpha = \frac{1}{3}$$

Now, take dot with  $\vec{a} \times \vec{b}$

$$\therefore [\vec{a} \ \vec{b} \ \vec{c}] = \beta |\vec{a} \times \vec{b}|^2 = \beta \cdot \frac{3}{4}$$

$$[\vec{a} \ \vec{b} \ \vec{c}]^2 = \begin{vmatrix} 1 & \frac{1}{2} & \frac{1}{2} \\ \frac{1}{2} & 1 & \frac{1}{2} \\ \frac{1}{2} & \frac{1}{2} & 1 \end{vmatrix} = \frac{3}{4} - \frac{1}{8} - \frac{1}{8} = \frac{1}{2}$$

$$\therefore \beta = \frac{4}{3\sqrt{2}}$$

$$\therefore \alpha^2 \beta^2 = \frac{1}{9} \cdot \frac{16}{9 \cdot 2} = \frac{8}{81}$$

$$\therefore \left[ \frac{81}{16} \right] = 5$$

8. **Ans. 6**

$$\text{Use } \int_a^b f(x) dx + \int_c^d g(y) dy = bd - ac$$

where  $f$  &  $g$  are inverse of each other.

## PAPER-2

### PART-1 : PHYSICS

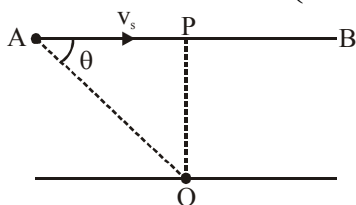
## SOLUTION

### SECTION-I

1. **Ans. (C,D)**

**Sol.** The graph shows the situation shown in figure below. The observed frequency will initially be more than the natural frequency. When the source is at P, observed frequency is equal to its natural frequency i.e., 2000 Hz.

For region AP :  $f = f_0 \left( \frac{v}{v - v_s \cos \theta} \right)$



For PB :  $f = f_0 \left( \frac{v}{v + v_s \cos \theta} \right)$

Minimum value of f will be:

$$f_{\min} = f_0 \left( \frac{v}{v + v_s} \right) \text{ when } \cos \theta = 1$$

$$\text{or } 1800 = 2000 \left( \frac{300}{300 + v_s} \right)$$

Solving this we get,  $v_s = 33.33 \text{ m/s}$   
and maximum value of f can be

$$f_{\max} = f_0 \left( \frac{v}{v - v_s} \right) \text{ when } \cos \theta = 1$$

$$\text{or } f_{\max} = 2000 \left( \frac{300}{300 - 33.33} \right) = 2250 \text{ Hz}$$

2. **Ans. (A, B)**

**Sol.**  $y = x \tan \theta - \frac{1}{2} \frac{gx^2}{u^2 \cos^2 \theta}$

$$(A) 2 = 4 \times 1 - \frac{1}{2} \times \frac{10^2 \times 4^2}{16 \times 5 \times \frac{1}{2}}$$

$$(B) 2 = 4 \times 3 - \frac{1}{2} \times \frac{10^2 \times 4^2}{16 \times 5 \times \frac{1}{10}}$$

$$(C) 2 = 4 \times 1 - \frac{1}{2} \times \frac{10^2 \times 4^2}{4 \times 5 \times 1} = 0$$

$$(D) 2 = 4 \times 3 - \frac{1}{2} \times \frac{10^5 \times 16}{16 \times 5 \times \frac{1}{10}}$$

3. **Ans. (A,C)**

**Sol.** From conservation of linear momentum, velocity of 1 kg block just after the collision is 2m/sec.



After the collision relative velocity of approach = 6 m/sec,  
Relative velocity of separation = 6 m/sec

4. **Ans. (B,C)**

5. **Ans. (A, D)**

**Sol.** Net force towards centre of earth

$$= mg' = \frac{mgx}{R}$$

$$\text{Normal force } N = mg' \sin \theta$$

$$\text{Thus pressing force } N = \frac{mgx}{R} \frac{R}{2X}$$

$$N = \frac{mg}{2} \text{ Constant and independent of } X$$

$$\text{tangential force } F = ma = mg' \cos \theta$$

$$a = g' \cos \theta = \frac{gx}{R} \sqrt{\frac{R^2}{4} - X^2}$$

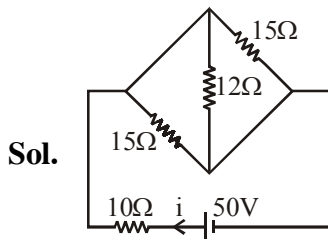
$$a = \frac{gx}{R} \sqrt{R^2 - 4x^2}$$

curve is parabolic and at  $X = R/2$ ,  $a = 0$

6. **Ans. (B, C)**

7. **Ans. (A,B,C)**

8. **Ans. (A,D)**



Just after closing of switch S

$$\frac{1}{R_{eq}} = \frac{1}{15} + \frac{1}{15} + \frac{1}{12}$$

$$\frac{1}{R_{eq}} = \frac{2}{15} + \frac{1}{12}$$

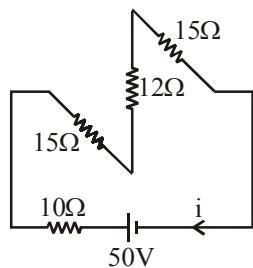
$$= 4.61 + 10$$

$$= 14.61$$

$$\therefore i = \frac{50}{14.61} = 3.42 \text{ A}$$

After long time of closing of switch S

$$i = \frac{50}{10+15+12+15} = 0.962 \text{ Amp}$$



9. **Ans. (A)**

$$\text{Sol. } f = \frac{n}{2L} \times C$$

$$\& n = \frac{2Lf}{C}$$

$$n + dn = \frac{2L(f + df)}{C}$$

$$dn = \frac{2L}{C} df$$

10. **Ans. (B, D)**

$$\text{Sol. } P = \int_0^\infty \frac{hf}{\ell \frac{hf}{T} - 1} \times \frac{2L}{C} df$$

$$\text{Take } \frac{hf}{kT} = x$$

$$P = \int_0^\infty \frac{xkT}{\ell^x - 1} \times \frac{2L}{C} \times \frac{kT}{h} dx = \frac{2k^2T^2L}{Ch} \times \frac{\pi^2}{6}$$

$$= \frac{\pi^2 k^2T^2L}{3 Ch}$$

11. **Ans. (B, D)**

12. **Ans. (A, B)**

### SECTION-IV

1. **Ans. 6**

**Sol.** According to conservation of energy

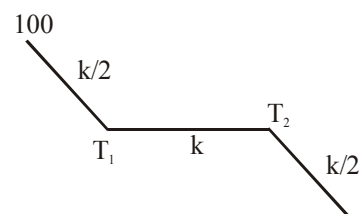
$$\frac{hc}{\lambda_1} + \frac{hc}{\lambda_2} = RchZ^2 \left( \frac{1}{l^2} - \frac{1}{n^2} \right)$$

$$n = 6.03$$

quantum number = 6

2. **Ans. 2**

$$\text{Sol. } R_{TH} = \frac{2L}{kA} + \frac{L}{kA} + \frac{2L}{kA} = \frac{5L}{kA}$$



$$\frac{dH}{dt} = \frac{100}{5L} kA = 20 \frac{kA}{L}$$

$$100 - T_1 = 40$$

$$\frac{dH}{dt} = \frac{T_2 - 0}{2L} = 20 \frac{kA}{L} \Rightarrow T_2 = 40$$

$$T_B = T_2, T_D = T_1 \Rightarrow \Delta T = 20$$

**3. Ans. 4**

**Sol.** As the voltage across the charging battery,

$$V = E + Ir = 30 + 15 \times 0 = 30V$$

So the potential difference across the resistance

$$V_R = 120 - 30 = 90 V$$

So the power wasted in heating the circuit

$$P = VI = 90 \times 15 = 1350 W$$

So the energy wasted as heat in time t

$$H = P \times t = (1350 \times t) \text{ joule} = \frac{1350}{4.2} \times t \text{ calorie}$$

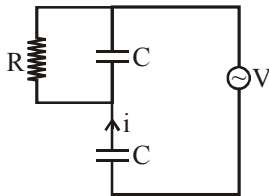
Now if this heat changes the temperature of 1 kg of water from 15°C to 100°C

$$\frac{1350t}{4.2} = mc\Delta\theta = 1 \times 10^3 \times 1 \times (100 - 15)$$

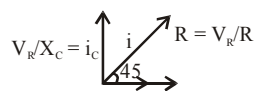
$$\text{i.e., } t = \frac{85 \times 4.2 \times 100}{135} = 264.4 \text{ s} = 4.4 \text{ minute}$$

**4. Ans. 4**

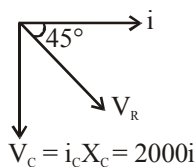
**Sol.**



$$X_C = \frac{10}{500} = 2000$$



$$i = \frac{V_R}{2000} \times \sqrt{2} \Rightarrow V_R = 1000\sqrt{2} i$$



$$V = \sqrt{(2000i)^2 + (1000\sqrt{2}i)^2}$$

$$+ 2 \times 2000 i \times 1000\sqrt{2} \times \frac{1}{\sqrt{2}}$$

$$= i \times 10^3 \sqrt{4+2+4}$$

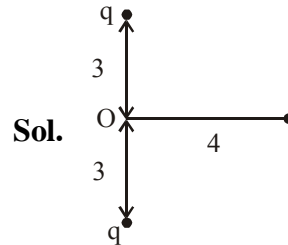
$$\Rightarrow i = \frac{200 \times 10^{-3}}{\sqrt{16}} = \frac{1}{5\sqrt{10}} A$$

$$i_R = i \cos 45 = \frac{1}{5\sqrt{20}}$$

$$P = \frac{1}{25 \times 20} \times 2000 = 4W$$

**5. Ans. 5**

**6. Ans. 5**



**Sol.**

$$\frac{2k \times 25 \times 10^{-10}}{5}$$

$$+ 1.5$$

$$= \frac{2k \times 25 \times 10^{-10}}{\sqrt{x^2 + 3^2}}$$

$$+ 7.5 = + \frac{5 \times 9}{\sqrt{x^2 + 9}}$$

$$\sqrt{x^2 + 9} = \frac{45}{7.5}$$

$$x^2 + 9 = 36$$

$$x^2 = 27$$

$$x = 3\sqrt{3} = 5.1$$

**7. Ans. 3**

**8. Ans. 2**

**Sol.**  $B = \frac{\mu_0 i}{2\pi a}$

$$\phi = \frac{\mu_0 i}{2\pi a} \times A \times N$$

$$\varepsilon = \frac{\mu_0 i_0 \omega AN}{2\pi a} \cos \omega t$$

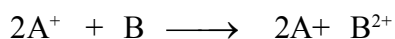
$$P = \left( \frac{\mu_0 i_0 \omega AN}{2\pi a} \right)^2 \times \frac{1}{2} \times \frac{1}{R} = \frac{2 \times 10^{-8}}{R}$$

**SOLUTION**

**SECTION-I**

1. **Ans. (A,C)**
2. **Ans. (C,D)**
3. **Ans. (B,C,D)**
4. **Ans. (A,B)**
5. **Ans. (A)**
6. **Ans. (A,B,C,D)**
7. **Ans. (B,D)**
8. **Ans. (B,C,D)**
9. **Ans. (A, C, D)**

Cell reaction is -



(0.1m)

(0.1m)

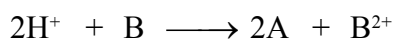
$$E_{\text{cell}}^{\circ} = E_{A^+/A}^{\circ} - E_{B^{2+}/B}^{\circ}$$

$$0.7 = 0.4 - E_{B^{2+}/B}^{\circ}$$

$$E_{B^{2+}/B}^{\circ} = -0.3V$$

$$E_{\text{cell}} = E_{\text{cell}}^{\circ} - \frac{0.06}{2} \log \frac{(0.1)}{(0.1)^2}$$

10. **Ans. (B)**



$10^{-1}$

$10^{-1}$

$$E = 0.3 - \frac{0.06}{2} \log \frac{10^{-1}}{(10^{-1})^2}$$

$$E = 0.27V$$

11. **Ans. (A)**

12. **Ans. (A,B,C,D)**

**SECTION-IV**

1. **Ans. 0.2 [OMR Ans. 2]**

$$\frac{\Delta P}{P_A^0} = \frac{n_B}{n_A + n_B} = \frac{15/60}{\frac{18}{18} + \frac{15}{60}} = 0.2$$

2. **Ans. ( $2 \times 10^{-1}$ ) OMR ANS (2)**

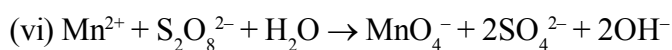
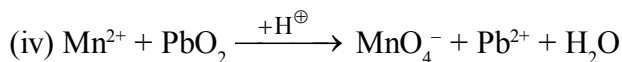
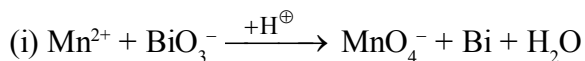
$$r_{A_2} = K[A]^2$$

$$K = \frac{r_{A_2}}{[A]^2} = \frac{10^{-5}}{(10^{-2})^2} = 10^{-1}$$

$$\frac{K_A}{2} = K \Rightarrow K_A = 2K = 2 \times 10^{-1}$$

3. **Ans. 3**

**Sol.**



4. **Ans. 0**

5. **Ans. 0**

6. **Ans. 3**

7. **Ans. 3**

8. **Ans. 3**

**SOLUTION**

**SECTION-I**

1. **Ans. (A,D)**

$$\int_1^{\sqrt[3]{2}} \frac{\left(\frac{1}{x^{10}} + \frac{1}{x^7}\right) dx}{\left(\frac{2}{x^9} + \frac{3}{x^6} + 1\right)^{1/3}} \quad \frac{2}{x^9} + \frac{3}{x^6} + 1 = t$$

$$-18 \left(\frac{1}{x^{10}} + \frac{1}{x^7}\right) dx = dt$$

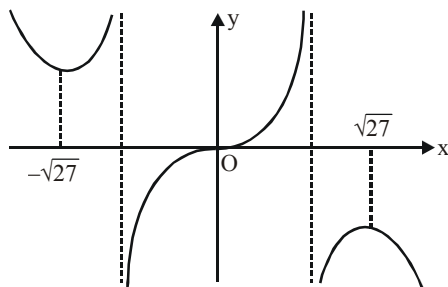
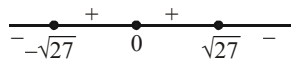
$$= -\frac{1}{18} \int_6^2 \frac{dt}{t^{1/3}} = -\frac{1}{12} (t^{2/3})_6^2 = \frac{1}{2} [\sqrt[3]{36} - \sqrt[3]{4}]$$

2. **Ans. (A,C,D)**

$$y = \frac{x^3}{9-x^2} \Rightarrow y' = \frac{(9-x^2)3x^2 + 2x \cdot x^3}{(9-x^2)^2}$$

$$y' = \frac{x^2 [27 - 3x^2 + 2x^2]}{(9-x^2)^2}$$

$$= -\frac{x^2 (x - \sqrt{27})(x + \sqrt{27})}{(9-x^2)^2}$$



$$f(-\sqrt{27}) = 7.8$$

$$\Rightarrow n = 8$$

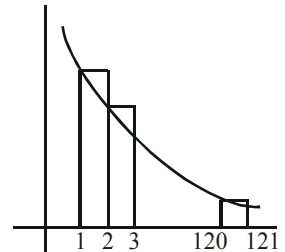
$$l = 9$$

$$m = 3$$

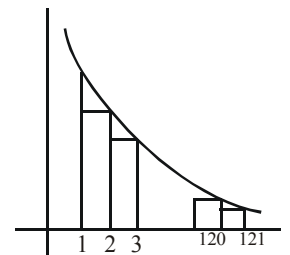
3. **Ans. (A,B,C)**

$$A > \int_1^{121} \frac{1}{\sqrt{x}} dx = 20$$

$$B < \int_1^{121} \frac{1}{\sqrt{x}} dx = 20$$



$$A - 20 > 20 - B$$



$$A + B > 40$$

4. **Ans. (A,D)**

$$|z + 3| - |z - 3| = 6 \Rightarrow \text{ray}$$



5. **Ans. (A,D)**

$$(A) \frac{2x^4 + 2y^4 + 4z^4 + 1}{4} \geq 2xyz$$

$$\Rightarrow 2x^4 + 2y^4 + 4z^4 - 8xyz \geq -1$$

$$\Rightarrow l_1 = -1$$

$$\Rightarrow \text{at } x = y = \left(\frac{1}{2}\right)^{1/4}, z = \frac{1}{\sqrt{2}}$$

$$(C) x^4y + xy^4 + \frac{4}{x^2y^3} + \frac{1}{x^3y^2} + 8 \geq 5.2$$

$$\text{but } x^4y = xy^4 = \frac{4}{x^2y^3} = \frac{1}{x^3y^2} = 8$$

is not possible

$$\therefore l_2 > 10$$

6. **Ans. (A,D)**

$$\cos x dy + y \sin x dx = \cos^4 x$$

$$\frac{dy}{dx} + y \tan x = \cos^3 x$$

$$y \sec x = \int \cos^2 x dx$$

$$= \frac{1}{2} \left( x + \frac{1}{2} \sin 2x \right) + C$$

$$\text{by } (0, 0), C = 0$$

$$\Rightarrow y = \frac{x}{2} \cos x + \frac{1}{4} \sin 2x \cos x$$

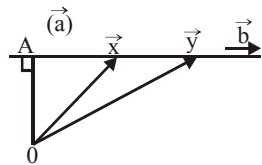
(A)  $f(x) = \frac{x}{2} \cos x + 1 \Rightarrow \sin 2x \cos x = 4$  not possible.

(B)  $f\left(\frac{\pi}{2}\right) = 0$

(C)  $f'\left(\frac{5\pi}{2}\right) = -\frac{5\pi}{4}$

(D)  $f'(0) = 1$

7. **Ans. (A,B,C,D)**



$$\vec{x} \cdot \vec{a} = 1 = \vec{y} \cdot \vec{a}$$

$$\vec{b} = \vec{x} - \vec{y}, 3\vec{c} = \vec{x} + \vec{y}$$

$$L: \vec{r} = \vec{a} + \lambda \vec{b}$$

8. **Ans. (A,C)**

$$\| |z|^2 - 1 \| \leq |z^2 - 1| \leq |z|^2 + 1$$

$$\| |z|^2 - 1 \| \leq |z| + 2 \leq |z|^2 + 1$$

I.  $|z|^2 - |z| - 1 \geq 0 \Rightarrow |z| \in \left[ \frac{1+\sqrt{5}}{2}, \infty \right)$

II.  $|z|^2 - |z| - 3 \leq 0 \Rightarrow |z| \in \left[ 0, \frac{1+\sqrt{13}}{2} \right]$

III.  $|z|^2 + |z| + 1 \geq 0 \Rightarrow$  always true

$$\Rightarrow |z| \in \left[ \frac{1+\sqrt{5}}{2}, \frac{1+\sqrt{13}}{2} \right]$$

**Paragraph for Question 9 and 10**

P(4,3)  $4x - 3y = 7$

$$\frac{x-4}{\frac{3}{5}} = \frac{y-3}{\frac{4}{5}} = -\frac{5}{2} \Rightarrow Q\left(\frac{5}{2}, 1\right)$$

$$\frac{x-4}{\frac{3}{5}} = \frac{y-3}{\frac{4}{5}} = -5 \Rightarrow R(1, -1)$$

Let  $S_1: \frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$

&  $S_2: \frac{x^2}{A^2} + \frac{y^2}{B^2} = 1, A < B$

for  $S_1: \frac{5x}{2a^2} - \frac{y}{b^2} = 1$

$$\Rightarrow \frac{5}{2a^2} = \frac{4}{7}, \frac{1}{b^2} = \frac{3}{7}$$

$$S_1: \frac{x^2}{35/8} - \frac{y^2}{7/3} = 1 \Rightarrow e_1^2: \frac{7/3}{35/8} + 1 \Rightarrow e_1^2 = \frac{23}{15}$$

for  $S_2: \frac{x}{A^2} - \frac{y}{B^2} = 1 \Rightarrow A^2 = \frac{7}{4}, B^2 = \frac{7}{3}$

$$\frac{x^2}{7/4} + \frac{y^2}{7/3} = 1 \Rightarrow e_2^2 = 1 - \frac{7/4}{7/3} \Rightarrow e_2^2 = \frac{1}{4} \Rightarrow e_2 = \frac{1}{2}$$

$$S_1 \& S_2 \Rightarrow x^2 \left( \frac{4}{7} + \frac{8}{35} \right) = 2 \Rightarrow y \notin \mathbb{R}$$

$\Rightarrow$  4 common tangents

9. **Ans. (B,C,D)**

10. **Ans. (A,D)**

**Paragraph for Question 11 and 12**

11. **Ans. (B,C)**

$$\sum_{k=1}^n P(E_k) = 1 \Rightarrow k(1^2 + 2^2 \dots n^2) = 1$$

$$\Rightarrow k = \frac{6}{n(n+1)(2n+1)}$$



$$\begin{aligned}
 P(w) &= P(E_1 w \cup E_2 w \cup \dots \cup E_n w) \\
 &= k \frac{1}{2n} + k 2^2 \frac{2}{2n} + k 3^2 \frac{3}{3n} \dots + k n^2 \frac{n}{2n} \\
 &= \frac{k}{2n} [1^3 + 2^3 + \dots + n^3] = \frac{3}{n^2(n+1)(2n+1)} \left[ \frac{n(n+1)}{2} \right]^2 \\
 &= \frac{3(n+1)}{4(2n+1)}
 \end{aligned}$$

$$\begin{aligned}
 \lim_{n \rightarrow \infty} P(w) &= \frac{3}{8}, \quad \lim_{n \rightarrow \infty} nP(E_n) = nk n^2 \\
 &= n^3 \cdot \frac{6}{n(n+1)(2n+1)} = 3
 \end{aligned}$$

12. Ans. (A,B,D)

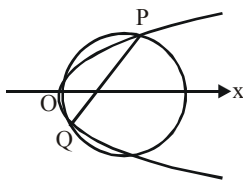
$$P(E_i) = ki, \quad k = \frac{2}{n(n+1)}$$

$$\begin{aligned}
 P(E_i / w) &= \frac{P(E_i w)}{P(w)} = \frac{ki \frac{i}{2n}}{k \frac{1}{2n} + 2k \frac{2}{2n} + \dots + nk \frac{n}{2n}} \\
 &= \frac{6i^2}{n(n+1)(2n+1)}
 \end{aligned}$$

### SECTION - IV

1. Ans. 5

$$P(t_1^2, 2t_1), Q(t_2^2, 2t_2), t_1 t_2 = -4$$



$$\left| \frac{1}{2} (2t_1 t_2^2 - 2t_2 t_1^2) \right| = 20$$

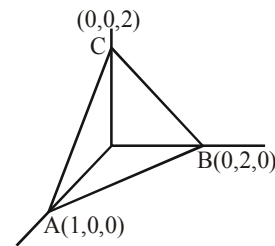
$$t_1 - t_2 = 5 \Rightarrow t_1 = 1, 4$$

$$\begin{aligned}
 \text{I. } & P(1,2), Q(16,-8) \\
 \text{II. } & P(16,8), Q(1,-2)
 \end{aligned} \Rightarrow d = \sqrt{325}$$

$$\frac{d^2}{65} = 5$$

2. Ans. 6

$$\Delta = \frac{1}{2} \sqrt{4+16+4} = \sqrt{6}$$



3. Ans. 2

$$x = \pi \Rightarrow y = \pi \Rightarrow p(\pi, \pi)$$

$$\text{diff. } x \cos y y' + \sin y + 1 = y' \Rightarrow y'(\pi) = \frac{1}{\pi+1}$$

diff. once again

$$\cos y y' - x \sin y (y')^2 + x \cos y y'' + \cos y y' = y''$$

$$\text{at } p, \quad -\frac{1}{\pi+1} - 0 - \pi y'' - \frac{1}{\pi+1} = y''$$

$$\Rightarrow y''(1+\pi) = -\frac{2}{(\pi+1)} \Rightarrow y'' = -\frac{2}{(\pi+1)^2}$$

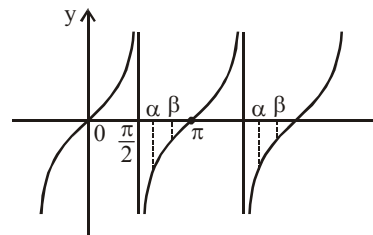
4. Ans. 5

$$\tan \theta = \frac{-8 \pm \sqrt{64-36}}{6} = \frac{-8 \pm \sqrt{28}}{6}$$

both negative  $\tan \alpha \tan \beta = 1$

$$\tan \beta = \cot \alpha$$

$$\beta = \frac{3\pi}{2} - \alpha, \quad \frac{7\pi}{2} - \alpha$$



$$\Rightarrow \alpha + \beta = \frac{3\pi}{2}, \quad \frac{7\pi}{2}$$

$$\Rightarrow \text{sum} = 5\pi$$

5. **Ans. 3**

Let  $x^2 + y^2 + 2gx + 2fy = 0$  is the circle

$$2g(0) + 2f(-4) = 12 \Rightarrow f = -\frac{3}{2}$$

$$2g(-2) + 2f(-3) = -3 \Rightarrow g = 3$$
$$\Rightarrow x^2 + y^2 + 6x - 3y = 0$$

$$R = \frac{3\sqrt{5}}{2}$$

6. **Ans. 3**

$$n = \frac{\sin 40^\circ}{2 \cos 20^\circ - \cos 40^\circ}$$

$$n = \frac{\sin 40^\circ}{\cos 20^\circ + \sin 10^\circ}$$

$$= \frac{\sin 40^\circ}{\sin 70^\circ + \sin 10^\circ} = \frac{\sin 40^\circ}{2 \sin 40^\circ \cos 30^\circ} = \frac{1}{\sqrt{3}}$$

$$\frac{1}{n^2} = 3$$

7. **Ans. 4**

Let  $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$

$$\left| \vec{r} \cdot \frac{2\hat{i} + \hat{j}}{\sqrt{5}} \right| = \left| \vec{r} \cdot \frac{(-2\hat{i} + \hat{j})}{\sqrt{5}} \right| = |\vec{r} \cdot \hat{k}|$$

$$\Rightarrow |2x + y| = |-2x + y| = \sqrt{5}|z|$$

$$\Rightarrow \vec{r} = \left(0, \frac{\sqrt{5}}{\sqrt{6}}, \frac{1}{\sqrt{6}}\right), \left(0, \frac{\sqrt{5}}{\sqrt{6}}, -\frac{1}{\sqrt{6}}\right), \left(\frac{\sqrt{5}}{3}, 0, \frac{2}{3}\right), \left(\frac{\sqrt{5}}{3}, 0, -\frac{2}{3}\right)$$

8. **Ans. 6**

$$x = 1, y = 5^3 - 4^3 = 61$$