

**AIEEE 2005**  
**MATHEMATICS**

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1. The differential equation representing the family of curves  $y^2 = 2c(x + \sqrt{C})$ , where  $C > 0$ , is a parameter, is of order and degree as follows :
- (1) order 1, degree 3    (2) order 2, degree 2    (3) order 1, degree 2    (4) order 1, degree 1

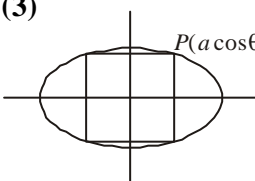
**Ans. (1)**

**Sol.:** The given equation is differentiated once and  $c$  is eliminated which gives  $y^2 + 4x^2y'^2 - 4xyy' = 4yy'^3$ . Hence the order is 1 and degree is 3.

2. Area of the greatest rectangle that can be inscribed in the ellipse  $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$  is

- (1)  $\sqrt{ab}$                       (2)  $\frac{a}{b}$                       (3)  $2ab$                       (4)  $ab$

**Ans. (3)**

**Sol.:**  From the figure, it is clear that area of the rectangle =  $4ab \cos \theta \sin \theta$   
 $= 2ab \sin 2\theta$   
Hence, maximum area =  $2ab$ .

3.  $\lim_{n \rightarrow \infty} \left[ \frac{1}{n^2} \sec^2 \frac{1}{n^2} + \frac{2}{n^2} \sec^2 \frac{2}{n^2} + \dots + \frac{1}{n} \sec^2 1 \right]$  equals

- (1)  $\tan 1$                       (2)  $\frac{1}{2} \tan 1$                       (3)  $\frac{1}{2} \sec 1$                       (4)  $\frac{1}{2} \operatorname{cosec} 1$

**Ans. (2)**

**Sol.:** The general term  $T_r = \frac{r}{n^2} \sec^2 \left( \frac{r}{n} \right)$ . Put  $\frac{r}{n} = x$  and  $\frac{1}{n} = dx$  which gives the value of limit

$$\int_0^1 x \sec^2 x^2 dx = \frac{\tan 1}{2}$$

4. If the cube root of unity are  $1, w, w^2$  then roots of equation  $(x - 1)^3 + 8 = 0$ , are
- (1)  $-1, 1 - 2w, 1 - 2w^2$                       (2)  $-1, 1 + 2w, 1 + 2w^2$   
(3)  $-1, -1 + 2w, -1 - 2w^2$                       (4)  $-1, -1, -1$

**Ans. (1)**

**Sol.:** The given equation is  $(x - 1)^3 + 8 = 0$

This implies  $\left(\frac{x-1}{2}\right)^3 = -1 \Rightarrow \left(\frac{x-1}{2}\right) = -1, -\omega \text{ and } -\omega^2$

$\Rightarrow x = -1, 1 - 2\omega \text{ and } 1 - 2\omega^2$

5. If  $A^2 - A + I = 0$ , then the inverse of  $A$  is

- (1)  $A - I$                       (2)  $I - A$                       (3)  $A + I$                       (4)  $A$

**Ans. (2)**

**Sol.:** Multiplying the given equation by  $A^{-1}$ , we get  $A - I + A^{-1} = 0 \Rightarrow A^{-1} = I - A$ .

6. Let  $R = \{(3, 3), (6, 6), (9, 9), (12, 12), (6, 12), (3, 9), (3, 12), (3, 6)\}$  be a relation on the set  $A = \{3, 6, 9, 12\}$ . The relation is

- (1) an equivalence relation                      (2) reflexive and symmetric only  
 (3) reflexive and transitive only                      (4) reflexive only

**Ans. (3)**

**Sol.:** Since  $(3, 3), (6, 6), (9, 9), (12, 12)$  are the members of  $R \Rightarrow R$  is reflexive.

Again,  $(a, b) \in R$  and  $(b, c) \in R \Rightarrow (a, c) \in R \Rightarrow R$  is transitive.

7. If in a frequency distribution, the mean and median are 21 and 22 respectively, then its mode is approximately

- (1) 25.5                      (2) 24.0                      (3) 22.0                      (4) 20.5

**Ans. (3)**

**Sol.:** mode =  $\frac{\text{mean} + 2\text{median}}{3} = \frac{21 + 2 \times 22}{3} = 21.66 \approx 22$ .

8. Let  $P$  be the point  $(1, 0)$  and  $Q$  a point on the locus  $y^2 = 8x$ . The locus of mid point of  $PQ$  is

- (1)  $x^2 + 4y + 2 = 0$       (2)  $x^2 - 4y + 2 = 0$       (3)  $y^2 - 4x + 2 = 0$       (4)  $y^2 + 4x + 2 = 0$

**Ans. (3)**

**Sol.:** Let the point  $Q$  be  $(2t^2, 4t)$  and mid point of  $PQ$  be  $(h, k)$  then  $h = \frac{1 + 2t^2}{2}$  and  $k = \frac{0 + 4t}{2}$

Eliminating  $t$ , we get  $y^2 - 4x + 2 = 0$ .

9. If  $C$  is the mid point of  $AB$  and  $P$  is any point outside  $AB$ , then

- (1)  $\vec{PA} + \vec{PB} + 2\vec{PC} = \vec{0}$    (2)  $\vec{PA} + \vec{PB} + \vec{PC} = \vec{0}$    (3)  $\vec{PA} + \vec{PB} = 2\vec{PC}$    (4)  $\vec{PA} + \vec{PB} = \vec{PC}$

**Ans. (3)**

**Sol.:** The position vector of mid point of  $AB$  is  $\vec{PC} = \frac{\vec{PA} + \vec{PB}}{2}$

10.  $ABC$  is a triangle. Forces  $P, Q, R$  acting along  $IA, IB$  and  $IC$  respectively are in equilibrium, where  $I$  is the incentre of  $\triangle ABC$ . Then  $P : Q : R$  is

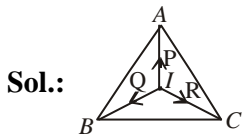
(1)  $\cos \frac{A}{2} : \cos \frac{B}{2} : \cos \frac{C}{2}$

(2)  $\cos A : \cos B : \cos C$

(3)  $\sin A : \sin B : \sin C$

(4)  $\sin \frac{A}{2} : \sin \frac{B}{2} : \sin \frac{C}{2}$

Ans. (1)



$$\angle BIC = \pi - \left( \frac{B+C}{2} \right), \angle AIB = \pi - \left( \frac{A+B}{2} \right), \angle AIC = \pi - \left( \frac{A+C}{2} \right)$$

Applying Lami's theorem, we get,  $\frac{P}{\sin \frac{B+C}{2}} = \frac{Q}{\sin \frac{A+C}{2}} = \frac{R}{\sin \frac{A+B}{2}}$

$$\Rightarrow \frac{P}{\cos \frac{A}{2}} = \frac{Q}{\cos \frac{B}{2}} = \frac{R}{\cos \frac{C}{2}}$$

11. In a triangle  $PQR$ ,  $\angle R = \frac{\pi}{2}$ . If  $\tan\left(\frac{P}{2}\right)$  and  $\tan\left(\frac{Q}{2}\right)$  are the roots of  $ax^2 + bx + c = 0, a \neq 0$  then

(1)  $b = c$

(2)  $b = a + c$

(3)  $a = b + c$

(4)  $c = a + b$

Ans. (4)

Sol.:  $\tan \frac{P}{2} + \tan \frac{Q}{2} = -\frac{b}{a}$  and  $\tan \frac{P}{2} \tan \frac{Q}{2} = \frac{c}{a}, \tan\left(\frac{P+Q}{2}\right) = 1$  gives  $a + b = c$ .

12. If the coefficient of  $r$ th,  $(r + 1)$ th and  $(r + 1)$ th and  $(r + 2)$ th terms in the binomial expansion of  $(1 + y)^m$  are in A.P., then  $m$  and  $r$  satisfy the equation

(1)  $m^2 - m(4r + 1) + 4r^2 - 2 = 0$

(2)  $m^2 - m(4r - 1) + 4r^2 + 2 = 0$

(3)  $m^2 - m(4r - 1) + 4r^2 - 2 = 0$

(4)  $m^2 - m(4r + 1) + 4r^2 + 2 = 0$

Ans. (1)

Sol.: Since  ${}^m C_{r-1}, {}^m C_r, {}^m C_{r+1}$  are in A.P.  $\Rightarrow 2 {}^m C_r = {}^m C_{r-1} + {}^m C_{r+1}$

which gives  $m^2 - m(4r + 1) + 4r^2 - 2 = 0$

13. Let  $f : (-1, 1) \rightarrow B$ , be a function defined by  $f(x) = \tan^{-1} \frac{2x}{1-x^2}$ , then  $f$  is both one-one and onto when  $B$  is interval

- (1)  $\left[-\frac{\pi}{2}, \frac{\pi}{2}\right]$       (2)  $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$       (3)  $\left(0, \frac{\pi}{2}\right)$       (4)  $\left[0, \frac{\pi}{2}\right]$

Ans. (2)

Sol.: Since  $\tan^{-1} \frac{2x}{1-x^2}$  is an increasing function so the range  $B$  will be  $\left(-\frac{\pi}{2}, \frac{\pi}{2}\right)$ .

14. If the coefficient of  $x^7$  in  $\left[ax^2 + \left(\frac{1}{bx}\right)\right]^{11}$  equals the coefficient of  $x^{-7}$  in  $\left[ax - \left(\frac{1}{bx^2}\right)\right]^{11}$ , then  $a$  and  $b$  satisfy the relation

- (1)  $\frac{a}{b} = 1$       (2)  $ab = 1$       (3)  $a - b = 1$       (4)  $a + b = 1$

Ans. (1)

Sol.: The coefficient of  $x^7$  in the expansion of  $\left[ax^2 + \left(\frac{1}{bx}\right)\right]^{11} = {}^{11}C_5 a^6 b^{-5}$  and coefficient of  $x^{-7}$  in the expansion of  $\left[ax - \left(\frac{1}{bx^2}\right)\right]^{11} = {}^{11}C_6 a^5 b^{-6}$ . On equating, we get  $a/b = 1$ .

15. If  $w = \frac{z}{z - \frac{1}{3}i}$  and  $|w| = 1$ , then  $z$  lies on

- (1) a straight line      (2) a parabola      (3) an ellipse      (4) a circle

Ans. (1)

Sol.:  $w = \frac{z}{z - \frac{1}{3}i} \Rightarrow \frac{|z|}{\left|z - \frac{i}{3}\right|} = 1 \Rightarrow |z| = \left|z - \frac{i}{3}\right|$  which is bisector of the line joining origin and the point  $(i/3)$ .

16. If  $a^2 + b^2 + c^2 = -2$  and  $f(x) = \begin{vmatrix} 1+a^2x & (1+b^2)x & (1+c^2)x \\ (1+a^2)x & 1+b^2x & (1+c^2)x \\ (1+a^2)x & (1+b^2)x & 1+c^2x \end{vmatrix}$ , then  $f(x)$  is a polynomial of degree

- (1) 3      (2) 2      (3) 1      (4) 0

Ans. (2)

**Sol.:**  $f(x) = \begin{vmatrix} 1+a^2x & (1+b^2)x & (1+c^2)x \\ (1+a^2)x & 1+b^2x & (1+c^2)x \\ (1+a^2)x & (1+b^2)x & 1+c^2x \end{vmatrix}$ , Applying  $C_1 \rightarrow C_1 + C_2 + C_3$ , we get

$$\begin{vmatrix} 1 & x+b^2x & x+c^2x \\ 1 & 1+b^2x & x+c^2x \\ 1 & x+b^2x & 1+c^2x \end{vmatrix} = (1-x)^2$$

17. If  $z_1$  and  $z_2$  are two non-zero complex numbers such that  $|z_1 + z_2| = |z_1| + |z_2|$ , then  $\arg z_1 - \arg z_2$  is equal to

- (1) 0                                      (2)  $\frac{-\pi}{2}$                                       (3)  $\frac{\pi}{2}$                                       (4)  $-\pi$

**Ans. (1)**

**Sol.:** Given that  $|z_1 + z_2| = |z_1| + |z_2|$  which is possible when  $\text{Arg } z_1 = \text{Arg } z_2 \Rightarrow \text{Arg } z_1 - \text{Arg } z_2 = 0$ .

18. The value of  $a$  for which the sum of the squares of the roots of the equation

$$x^2 - (a - 2)x - a - 1 = 0 \text{ assume the least value is}$$

- (1) 3                                      (2) 2                                      (3) 1                                      (4) 0

**Ans. (3)**

**Sol.:** Let  $\alpha$  and  $\beta$  be roots of equation, then  $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta = (a - 1)^2 + 5$  which gives  $a = 1$ .

19. If the roots of the equation  $x^2 - bx + c = 0$  be two consecutive integers, then  $b^2 - 4c$  equals

- (1) 2                                      (2) 1                                      (3) -2                                      (4) 3

**Ans. (2)**

**Sol.:** The difference of roots = 1  $\Rightarrow b^2 - 4c = 1$ .

20. The system of equations

$$\alpha x + y + z = \alpha - 1$$

$$x + \alpha y + z = \alpha - 1$$

$$x + y + \alpha z = \alpha - 1$$

has no solution, if  $\alpha$  is

- (1) not -2                                      (2) 1                                      (3) -2                                      (4) either -2 or 1

**Ans. (3)**

**Sol.:** The value of the coefficient determinant  $D = \begin{vmatrix} \alpha & 1 & 1 \\ 1 & \alpha & 1 \\ 1 & 1 & \alpha \end{vmatrix} = 0$  which gives  $(\alpha - 1)^2 [\alpha + 2] = 0$ . So,

$\alpha = 1$  or  $\alpha = -2$  but for  $\alpha = 1$  there are infinite number of solutions of the given system.

21. The value of  ${}^{50}C_4 + \sum_{r=1}^6 {}^{56-r}C_3$  is

- (1)  ${}^{56}C_3$                       (2)  ${}^{56}C_4$                       (3)  ${}^{55}C_4$                       (4)  ${}^{55}C_3$

Ans. (2)

Sol.:  ${}^{50}C_4 + \sum_{r=1}^6 {}^{56-r}C_3 = {}^{50}C_4 + {}^{55}C_3 + {}^{54}C_3 + {}^{53}C_3 + {}^{52}C_3 + {}^{51}C_3 + {}^{50}C_3.$

$$= {}^{50}C_3 + {}^{50}C_4 + {}^{51}C_3 + {}^{52}C_3 + {}^{53}C_3 + {}^{54}C_3 + {}^{55}C_3 = {}^{56}C_4.$$

22. If  $A = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$  and  $I = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$ , then which one of the following holds for all  $n \geq 1$ , by the principle of mathematical induction

- (1)  $A^n = nA + (n - 1)I$                       (2)  $A^n = 2^{n-1}A + (n - 1)I$   
 (3)  $A^n = nA - (n - 1)I$                       (4)  $A^n = 2^{n-1}A - (n - 1)I$

Ans. (3)

Sol.:  $A = I + \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix}$ . The two matrices on the right commute, hence by the Binomial theorem

$$A^n = I + n \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix} \text{ because powers higher than or equal to 2 of the matrix } \begin{bmatrix} 0 & 0 \\ 1 & 0 \end{bmatrix} \text{ are 0.}$$

23. If the letters of word SACHIN are arranged in all possible ways and these words are written out as in dictionary, then the word SACHIN appears at serial number

- (1) 603                      (2) 602                      (3) 601                      (4) 600

Ans. (3)

Sol.: The alphabetical order of letters is A, C, H, I, N, S. The number of words which begin with any of the five letters A, C, H, I, N are  $120 \times 5 = 600$ . The next word will be SACHIN so its rank. is 601.

24. If  $x = \sum_{n=0}^{\infty} a^n$ ,  $y = \sum_{n=0}^{\infty} b^n$ ,  $z = \sum_{n=0}^{\infty} c^n$  where  $a, b, c$  are in A.P. and  $|a| < 1$ ,  $|b| < 1$ ,  $|c| < 1$  then  $x, y, z$

are in

- (1) Arithmetic – Geometric Progression                      (2) HP  
 (3) GP                      (4) AP

Ans. (2)

Sol.:  $x = \sum_{n=0}^{\infty} a^n$ ,  $y = \sum_{n=0}^{\infty} b^n$ ,  $z = \sum_{n=0}^{\infty} c^n \Rightarrow x = \frac{1}{1-a}$ ,  $y = \frac{1}{1-b}$  and  $z = \frac{1}{1-c}$

Since  $a, b, c$  are in A.P.  $x, y, z$  are in A.P.

25. If  $x$  is so small that  $x^3$  and higher powers of  $x$  may be neglected, then  $\frac{(1+x)^{\frac{3}{2}} - \left(1 + \frac{1}{2}x\right)^3}{(1-x)^{\frac{1}{2}}}$  may be approximated as

- (1)  $-\frac{3}{8}x^2$                       (2)  $\frac{x}{2} - \frac{3}{8}x^2$                       (3)  $1 - \frac{3}{8}x^2$                       (4)  $3x + \frac{3}{8}x^2$

Ans. (1)

Sol.: Upto terms of order  $x^2$

$$\frac{(1+x)^{\frac{3}{2}} - \left(1 + \frac{1}{2}x\right)^3}{(1-x)^{\frac{1}{2}}} = \left[1 + \frac{3}{2}x + \frac{3}{8}x^2 - 1 - \frac{3}{2}x - \frac{3}{4}x^2\right] \left[1 + \frac{1}{2}x + \frac{3}{8}x^2\right] = -\frac{3}{8}x^2$$

26. If  $\cos^{-1} x - \cos^{-1} \frac{y}{2} = \alpha$ , then  $4x^2 - 4xy \cos \alpha + y^2$  is equal to

- (1)  $4\sin^2 \alpha$                       (2)  $-4\sin^2 \alpha$                       (3)  $2\sin 2\alpha$                       (4)  $4$

Ans. (1)

Sol.: Given that  $\cos^{-1} x - \cos^{-1} \frac{y}{2} = \alpha \Rightarrow \cos(\cos^{-1} x - \cos^{-1} \frac{y}{2}) = \cos \alpha$

$$\Rightarrow \frac{xy}{2} + \sqrt{1-x^2} \sqrt{1-y^2/4} = \cos \alpha \Rightarrow 4x^2 + y^2 - 4xy \cos \alpha = 4 \sin^2 \alpha$$

27. If in a  $\Delta ABC$ , the altitudes from the vertices  $A, B, C$  on opposite sides are in H.P., then  $\sin A, \sin B, \sin C$  are in

- (1) Arithmetic – Geometric Progression                      (2) H.P.  
(3) G.P.                      (4) A.P.

Ans. (4)

Sol.: The altitudes of the triangle are  $\frac{2\Delta}{a}, \frac{2\Delta}{b}, \frac{2\Delta}{c}$  are given in H.P.

$$\Rightarrow \sin A, \sin B, \sin C \text{ are in A.P.}$$

28. In a triangle  $ABC$ , let  $\angle C = \frac{\pi}{2}$ . If  $r$  is the inradius and  $R$  is the circumradius of the triangle  $ABC$ , then  $2(r + R)$  equals

- (1)  $a + b + c$                       (2)  $c + a$                       (3)  $b + c$                       (4)  $a + b$

Ans. (4)

Sol.: For a right angled triangle  $R = c/2$  and  $r = \frac{ab}{a+b+c} \Rightarrow 2(r + R) = (a + b)$

29. A function is matched below against an interval where it is supposed to be increasing. Which of the following pairs is incorrectly matched?

- (1)  $\left(-\infty, \frac{1}{3}\right]$       (2)  $(-\infty, -4]$       (3)  $(-\infty, \infty)$       (4)  $[2, \infty)$

Ans. (1)

Sol.: Given that  $f(x) = 3x^2 - 2x + 1 \Rightarrow f'(x) = 6x - 2 \geq 0 \Rightarrow x \geq \frac{1}{3}$

30. Let  $\alpha$  and  $\beta$  be the distinct roots of  $ax^2 + bx + c = 0$ , then  $\lim_{x \rightarrow \alpha} \frac{1 - \cos(ax^2 + bx + c)}{(x - \alpha)^2}$  is equal to

- (1)  $\frac{-a^2}{2}(\alpha - \beta)^2$       (2)  $\frac{1}{2}(\alpha - \beta)^2$       (3)  $\frac{a^2}{2}(\alpha - \beta)^2$       (4) 0

Ans. (3)

Sol.:  $\lim_{x \rightarrow \alpha} \frac{1 - \cos(ax^2 + bx + c)}{(x - \alpha)^2} = \lim_{x \rightarrow \alpha} \frac{1 - \cos a(x - \alpha)(x - \beta)}{(x - \alpha)^2} = \frac{a^2}{2}(\alpha - \beta)^2$  because  $\lim_{x \rightarrow 0} \frac{1 - \cos x}{x^2} = \frac{1}{2}$ .

31. The normal to the curve  $x = a(\cos\theta + \theta\sin\theta)$ ,  $y = a(\sin\theta + \theta\cos\theta)$  at any point 'θ' is such that

- (1) it passes through  $\left(a\frac{\pi}{2}, -a\right)$       (2) it is at a constant distance from the origin  
 (3) it passes through the origin      (4) it makes angle  $\frac{\pi}{2} + \theta$  with the x-axis

Ans. (2)

Sol.: The equation of normal to the curve at any point is  $y \sin \theta + x \cos \theta = a$  which is at a constant distance from origin.

32. Let  $f$  be differentiable for all  $x$ . If  $f(1) = -2$  and  $f'(x) \geq 2$  for  $x \in [1, 6]$ , then

- (1)  $f(6) < 5$       (2)  $f(6) = 5$       (3)  $f(6) \geq 8$       (4)  $f(6) < 8$

Ans. (3)

Sol.: Applying Lagrange's mean value theorem,  $\frac{f(6) - f(1)}{6 - 1} = f'(c) \forall c \in (1, 6)$

$$\Rightarrow \frac{f(6) + 2}{5} \geq 2 \Rightarrow f(6) \geq 8$$



33. If  $f$  is a real-valued differentiable function satisfying  $|f(x) - f(y)| \leq (x - y)^2$ ,  $x, y \in R$  and  $f(0) = 0$ , then  $f(1)$  equals  
 (1) 2                                      (2) 1                                      (3) -1                                      (4) 0

Ans. (4)

Sol.:  $|f(x) - f(y)| \leq (x - y)^2$ ,  $x, y \in R$  taking the limit as  $x \rightarrow y$ , we get  $|f'(x)| \leq 0 \Rightarrow f'(x) = 0 \Rightarrow f(x)$  is a constant function  $\Rightarrow f(1) = 0$

34. Suppose  $f(x)$  is differentiable at  $x = 1$  and  $\lim_{h \rightarrow 0} \frac{1}{h} f(1 + h) = 5$ , then  $f'(1)$  equals  
 (1) 5                                      (2) 6                                      (3) 3                                      (4) 4

Ans. (1)

Sol.: Since  $\lim_{h \rightarrow 0} \frac{f(1 + h) - f(1)}{h}$  exists and  $\lim_{h \rightarrow 0} \frac{1}{h} f(1 + h)$  exists, it follows that  $\lim_{h \rightarrow 0} \frac{f(1)}{h}$  exists

Hence,  $f(1) = 0$  and  $f'(1) = \lim_{h \rightarrow 0} \frac{f(1 + h) - f(1)}{h} = \lim_{h \rightarrow 0} \frac{f(1 + h)}{h} = 5$ .

35.  $\int \left\{ \frac{(\log x - 1)}{1 + (\log x)^2} \right\}^2 dx$  is equal to  
 (1)  $\frac{xe^x}{1 + x^2} + C$                       (2)  $\frac{x}{(\log x)^2 + 1} + C$                       (3)  $\frac{\log x}{(\log x)^2 + 1} + C$                       (4)  $\frac{x}{x^2 + 1} + C$

Ans. (2)

Sol.: Let  $I = \int \left\{ \frac{(\log x - 1)}{1 + (\log x)^2} \right\}^2 dx$ . Put  $\log x = t$ , then  $I = \int e^t \left( \frac{1}{(1 + t^2)} - \frac{2t}{(1 + t^2)^2} \right) dt$   
 $= \frac{e^t}{1 + t^2} + C = \frac{x}{1 + (\log x)^2} + C$

36. A spherical ball 10 cm in radius is coated with a layer of ice of uniform thickness that melts at a rate of  $50 \text{ cm}^3/\text{min}$ . When the thickness of ice is 5 cm, then the rate at which the thickness of ice decreases, is  
 (1)  $\frac{1}{54\pi} \text{ cm/min}$ .                      (2)  $\frac{5}{6\pi} \text{ cm/min}$ .                      (3)  $\frac{5}{36\pi} \text{ cm/min}$ .                      (4)  $\frac{1}{18\pi} \text{ cm/min}$ .

Ans. (4)

Sol.: Let  $V = \frac{4}{3} \pi r^3 \Rightarrow \frac{dv}{dt} = 4\pi r^2 \frac{dr}{dt} \Rightarrow 50 = 4\pi(225) \frac{dr}{dt} \Rightarrow \frac{dr}{dt} = \frac{1}{18\pi} \text{ cm/m}$

37. Let  $f(x)$  be a non-negative continuous function such that the area bounded by the curve  $y = f(x)$ ,  $x$ -axis and the ordinates  $x = \frac{\pi}{4}$  and  $x = \beta > \frac{\pi}{4}$  is  $\left( \beta \sin \beta + \frac{\pi}{4} \cos \beta + \sqrt{2} \beta \right)$ . Then  $f\left(\frac{\pi}{2}\right)$  is

- (1)  $\left(1 - \frac{\pi}{4} - \sqrt{2}\right)$       (2)  $\left(1 - \frac{\pi}{4} + \sqrt{2}\right)$       (3)  $\left(\frac{\pi}{4} + \sqrt{2} - 1\right)$       (4)  $\left(\frac{\pi}{4} - \sqrt{2} + 1\right)$

Ans. (2)

Sol.: Let  $A = \int_{\pi/4}^{\beta} f(x) dx = \beta \sin \beta + \frac{\pi}{4} \cos \beta + \sqrt{2} \beta$ . Hence  $\frac{dA}{d\beta} = f(\beta) = \sin \beta + \beta \cos \beta - \frac{\pi}{4} \sin \beta + \sqrt{2}$

$$\Rightarrow f\left(\frac{\pi}{2}\right) = 1 - \frac{\pi}{4} + \sqrt{2}$$

38. Let  $f : R \rightarrow R$  be a differentiable function having  $f(2) = 6$ ,  $f'(2) = \left(\frac{1}{48}\right)$ . Then  $\lim_{x \rightarrow 2} \int_6^{f(x)} \frac{4t^3}{x-2} dt$  equals

- (1) 12      (2) 18      (3) 24      (4) 36

Ans. (2)

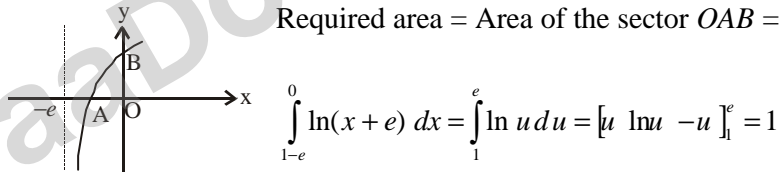
Sol.: By L'Hospital's rule  $\lim_{x \rightarrow 2} \int_6^{f(x)} \frac{4t^3}{x-2} dt = \lim_{x \rightarrow 2} f'(x) 4[f(x)]^3 = \frac{4}{48} \times 216 = 18$

39. The area enclosed between the curve  $y = \log_e(x + e)$  and the coordinate axes is

- (1) 3      (2) 4      (3) 1      (4) 2

Ans. (3)

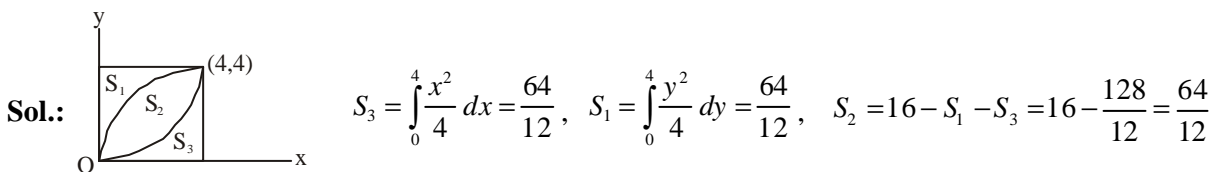
Sol.: Required area = Area of the sector  $OAB =$



40. The parabolas  $y^2 = 4x$  and  $x^2 = 4y$  divide the square region bounded by the lines  $x = 4$ ,  $y = 4$  and the coordinate axes. If  $S_1, S_2, S_3$  are respectively the areas of these parts numbered from top to bottom; then  $S_1 : S_2 : S_3$  is

- (1) 2 : 1 : 2      (2) 1 : 1 : 1      (3) 1 : 2 : 1      (4) 1 : 2 : 3

Ans. (2)



41. If  $I_1 = \int_0^1 2^{x^2} dx$ ,  $I_2 = \int_0^1 2^{x^3} dx$ ,  $I_3 = \int_1^2 2^{x^2} dx$ , and  $I_4 = \int_1^2 2^{x^3} dx$  then

- (1)  $I_3 = I_4$                       (2)  $I_3 > I_4$                       (3)  $I_2 > I_1$                       (4)  $I_1 > I_2$

Ans. (4)

Sol.:  $2^{x^2} > 2^{x^3}$  if  $0 < x < 1$ . Hence  $I_1 > I_2$ .

42. The line parallel to the  $x$ -axis and passing through the intersection of the lines  $ax + 2by + 3b = 0$  and  $bx - 2ay - 3a = 0$ , where  $(a, b) \neq (0, 0)$  is

- (1) above the  $x$ -axis at a distance of  $\frac{3}{2}$  from it      (2) above the  $x$ -axis at a distance of  $\frac{2}{3}$  from it  
 (3) below the  $x$ -axis at a distance of  $\frac{3}{2}$  from it      (4) below the  $x$ -axis at a distance of  $\frac{2}{3}$  from it

Ans. (3)

Sol.: The equation of the required line can be written as  $ax + 2by + 3b + \lambda(bx - 2ay - 3a) = 0$ . The coefficient of  $x$  must be zero which implies  $\lambda$  equals  $-a/b$ . Substituting this value the equation of the line is  $y = -3/2$ .

43. If  $x \frac{dy}{dx} = y(\log y - \log x + 1)$ , then the solution of the equation is

- (1)  $\log\left(\frac{y}{x}\right) = cx$       (2)  $\log\left(\frac{x}{y}\right) = cy$       (3)  $y \log\left(\frac{x}{y}\right) = cy$       (4)  $x \log\left(\frac{y}{x}\right) = cy$

Ans. (1)

Sol.: The given equation can be written as  $\frac{dy}{dx} = \frac{y}{x} \left( \ln \frac{y}{x} \right) + 1$ . Substituting  $u = \frac{y}{x}$  gives the differential

equation  $x \frac{du}{dx} = u \ln u$  whose solution is  $\ln u = cx$ .

44. If a vertex of a triangle is (1, 1) and the mid points of two sides through the vertex are (-1, 2) and (3, 2), then the centroid of the triangle is

- (1)  $\left(1, \frac{7}{3}\right)$       (2)  $\left(\frac{1}{3}, \frac{7}{3}\right)$       (3)  $\left(-1, \frac{7}{3}\right)$       (4)  $\left(\frac{-1}{3}, \frac{7}{3}\right)$

Ans. (1)

Sol.: The coordinates of the other two vertices are obtained using section formula and are (-3, 3) and (5, 3). Hence the centroid has coordinates (1, 7/3).

45. If the circles  $x^2 + y^2 + 2ax + cy + a = 0$  and  $x^2 + y^2 - 3ax + dy - 1 = 0$  intersect in two distinct points  $P$  and  $Q$  then the line  $5x + by - a = 0$  passes through  $P$  and  $Q$  for
- (1) infinitely many values of  $a$  (2) exactly two values of  $a$
- (3) exactly one value of  $a$  (4) no value of  $a$

Ans. (4)

Sol.: The equatin of the common chord is  $5ax + (c - d)y + a + 1 = 0$ . This should be the same as  $5x + by - a = 0$ . Hence  $\frac{5a}{5} = \frac{c - d}{b} = \frac{a + 1}{-a}$  which gives the quadratic  $a^2 + a + 1 = 0$  which has no real roots.

46. If non-zero numbers  $a, b, c$  are in H.P., then the straight line  $\frac{x}{a} + \frac{y}{b} + \frac{1}{c} = 0$  always passes through a fixed point. That point is
- (1)  $(1, -2)$  (2)  $(1, -\frac{1}{2})$  (3)  $(-1, 2)$  (4)  $(-1, -2)$

Ans. (1)

Sol.:  $\frac{1}{a} + \frac{1}{c} - \frac{2}{b} = 0$ . Comparing this with the equation  $\frac{x}{a} + \frac{y}{b} + \frac{1}{c} = 0$  the required point is  $(1, -2)$

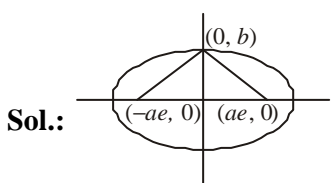
47. If a circle passes through the point  $(a, b)$  and cuts the circle  $x^2 + y^2 = p^2$  orthogonally, then the equation of the locus of its centre is
- (1)  $x^2 + y^2 - 2ax - 3by + (a^2 - b^2 - p^2) = 0$  (2)  $2ax + 2by - (a^2 + b^2 + p^2) = 0$
- (3)  $x^2 + y^2 - 3ax - 4by + (a^2 + b^2 - p^2) = 0$  (4)  $2ax + 2by - (a^2 - b^2 + p^2) = 0$

Ans. (2)

Sol.: Let the centre be  $(h, k)$  and suppose the equation of the circle is  $x^2 + y^2 - 2hx - 2ky + c = 0$ . The orthogonality condition gives  $c = p^2$ . Substituting this value of  $c$  and putting  $x = a, y = b$  in the equation of the circle gives the locus  $2ax + 2by - (a^2 + b^2 + p^2) = 0$ .

48. An ellipse has  $OB$  as semi minor axis,  $F$  and  $F'$  its focii and the angle  $FBF'$  is a right angle. Then the eccentricity of the ellipse is
- (1)  $\frac{1}{4}$  (2)  $\frac{1}{\sqrt{3}}$  (3)  $\frac{1}{\sqrt{2}}$  (4)  $\frac{1}{2}$

Ans. (3)



Sol.: By Pythagoras theorem  $2(b^2 + a^2e^2) = 4a^2e^2$ . Hence  $b^2 / a^2 = e^2$ . For an

ellipse  $b^2/a^2 = 1 - e^2$  which gives  $e = 1/\sqrt{2}$ .

49. A circle touches the  $x$ -axis and also touches the circle with centre at  $(0, 3)$  and radius 2. The locus of the centre of the circle is  
 (1) a hyperbola                      (2) a parabola                      (3) an ellipse                      (4) a circle

Ans. (2)

Sol.: A circle which touches the  $x$  axis has equation  $x^2 + y^2 + 2gx + 2fy + g^2 = 0$ . This touches the given circle if  $g^2 + f^2 + 6f + 9 = (f \pm 2)^2$ . Hence the locus is parabola.

50. The angle between the lines  $2x = 3y = -z$  and  $6x = -y = -4z$  is  
 (1)  $45^\circ$                       (2)  $30^\circ$                       (3)  $0^\circ$                       (4)  $90^\circ$

Ans. (4)

Sol.: The direction ratios of the two lines are  $(\frac{1}{2}, \frac{1}{3}, -1)$  and  $(\frac{1}{6}, -1, -\frac{1}{4})$ . The dot product of these two vectors is zero. Hence the angle is  $90^\circ$ .

51. If the angle  $\theta$  between the line  $\frac{x+1}{1} = \frac{y-1}{2} = \frac{z-2}{2}$  and the plane  $2x - y + \sqrt{\lambda}z + 4 = 0$  is such that  $\sin \theta = \frac{1}{3}$  the value of  $\lambda$  is  
 (1)  $\frac{3}{4}$                       (2)  $\frac{-4}{3}$                       (3)  $\frac{5}{3}$                       (4)  $\frac{-3}{5}$

Ans. (3)

Sol.: The direction ratio of the line is  $\mathbf{e} = (1, 2, 2)$ . The direction ratio of the normal to the plane is  $(2, -1, \sqrt{\lambda})$   
 $\mathbf{n} \cdot \mathbf{e} = 3\sqrt{5+\lambda} \sin \theta$  gives  $2\sqrt{\lambda} = \sqrt{5+\lambda}$ . So  $\lambda = \frac{5}{3}$

52. The locus of a point  $P(\alpha, \beta)$  moving under the condition that the line  $y = \alpha x + \beta$  is a tangent to the hyperbola  $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$  is  
 (1) a parabola                      (2) a hyperbola                      (3) an ellipse                      (4) a circle

Ans. (2)

Sol.: Condition for tangency gives  $\beta^2 = a^2 \alpha^2 - b^2$ . Hence the locus is the hyperbola.

53. The distance between the line  $\mathbf{r} = 2\mathbf{i} - 2\mathbf{j} + 3\mathbf{k} + \lambda(\mathbf{i} - \mathbf{j} + 4\mathbf{k})$  and the plane  $\mathbf{r} \cdot (\mathbf{i} + 5\mathbf{j} + \mathbf{k}) = 5$  is  
 (1)  $\frac{3}{10}$                       (2)  $\frac{10}{3}$                       (3)  $\frac{10}{9}$                       (4)  $\frac{10}{3\sqrt{3}}$

Ans. (4)

Sol.: The distance can be obtained by taking any point on the line and any point on the plane and projecting the vector joining these two points along the unit normal to the plane. A point on the line is  $2\mathbf{i} - 2\mathbf{j} + 3\mathbf{k}$  and the point on the plane is  $\mathbf{j}$ . The unit normal is  $\frac{\mathbf{i} + 5\mathbf{j} + \mathbf{k}}{3\sqrt{3}}$ . The required distance is  $\frac{10}{3\sqrt{3}}$ .

54. For any vector  $\mathbf{a}$ , the value of  $(\mathbf{a} \times \mathbf{i})^2 + (\mathbf{a} \times \mathbf{j})^2 + (\mathbf{a} \times \mathbf{k})^2$  is equal to

- (1)  $2\mathbf{a}^2$                       (2)  $4\mathbf{a}^2$                       (3)  $3\mathbf{a}^2$                       (4)  $\mathbf{a}^2$

Ans. (1)

Sol.: Use  $|\mathbf{a} \times \mathbf{i}|^2 = |\mathbf{a}|^2 - (\mathbf{a} \cdot \mathbf{i})^2$  etc. gives  $2|\mathbf{a}|^2$ .

55. If the plane  $2ax - 3ay + 4az + 6 = 0$  passes through the midpoint of the line joining the centres of the spheres  $x^2 + y^2 + z^2 + 6x - 8y - 2z = 13$  and  $x^2 + y^2 + z^2 - 10x + 4y - 2z = 8$  then  $a$  equals

- (1)  $-2$                       (2)  $2$                       (3)  $-1$                       (4)  $1$

Ans. (1)

Sol.: The centres of the two spheres are  $(-3, 4, 1)$  and  $(5, -2, 1)$  whose mid point is  $(1, 1, 1)$ . This lies on the plane. We get  $a = -2$ .

56. Let  $a, b$  and  $c$  be distinct non-negative numbers. If the vectors  $a\mathbf{i} + a\mathbf{j} + c\mathbf{k}$ ,  $\mathbf{i} + \mathbf{k}$  and  $c\mathbf{i} + c\mathbf{j} + b\mathbf{k}$  lie in a plane, then  $c$  is

- (1) equal to zero                      (2) the Harmonic Mean of  $a$  and  $b$   
 (3) the Geometric Mean  $a$  and  $b$                       (4) the Arithmetic Mean of  $a$  and  $b$

Ans. (3)

Sol.: The scalar triple product of the three vectors must be zero which gives 
$$\begin{vmatrix} a & a & c \\ 1 & 0 & 1 \\ c & c & b \end{vmatrix} = 0$$

implying  $ab = c^2$

57. If  $\mathbf{a}, \mathbf{b}, \mathbf{c}$  are non-coplanar vectors and  $\lambda$  is a real number then  $[\lambda(\mathbf{a} + \mathbf{b}) \lambda^2 \mathbf{b} \lambda \mathbf{c}] = [\mathbf{a} \mathbf{b} + \mathbf{c} \mathbf{b}]$  for

- (1) exactly three values of  $\lambda$                       (2) exactly two values of  $\lambda$   
 (3) exactly one value of  $\lambda$                       (4) no value of  $\lambda$

Ans. (4)

Sol.:  $[\lambda(\mathbf{a} + \mathbf{b}) \lambda^2 \mathbf{b} \lambda \mathbf{c}] = \lambda^4 [\mathbf{a} \mathbf{b} \mathbf{c}]$ ,  $[\mathbf{a} \mathbf{b} + \mathbf{c} \mathbf{b}] = -[\mathbf{a} \mathbf{b} \mathbf{c}]$ . Hence the equation has no solution for  $\lambda$ .

58. Let  $\mathbf{a} = \mathbf{i} - \mathbf{k}$ ,  $\mathbf{b} = x\mathbf{i} + \mathbf{j} + (1 - x)\mathbf{k}$  and  $\mathbf{c} = y\mathbf{i} + x\mathbf{j} + (1 + x - y)\mathbf{k}$ . Then  $[\mathbf{a}, \mathbf{b}, \mathbf{c}]$  depends on

- (1) both  $x$  and  $y$                       (2) neither  $x$  nor  $y$                       (3) only  $y$                       (4) only  $x$

Ans. (4)

Sol.:  $[\mathbf{a} \mathbf{b} \mathbf{c}] = \begin{vmatrix} 1 & 0 & -1 \\ x & 1 & 1 - x \\ y & x & 1 + x - y \end{vmatrix} = 1 + 2x$

59. Three houses are available in a locality. Three persons apply for the houses. Each applies for one house without consulting others. The probability that all the three apply for the same house is

- (1)  $\frac{8}{9}$                       (2)  $\frac{7}{9}$                       (3)  $\frac{2}{9}$                       (4)  $\frac{1}{9}$

Ans. (4)

Sol.: Number of points in the sample space is 27 and the number of points favourable to the event is 3. Hence, the required probability is  $\frac{1}{9}$ .

60. A random variable  $X$  has Poisson distribution with mean 2. Then  $P(X > 1.5)$  equals

- (1)  $1 - \frac{3}{e^2}$                       (2)  $\frac{3}{e^2}$                       (3)  $\frac{2}{e^2}$                       (4) 0

Ans. (1)

Sol.:  $P(X > 1.5) = 1 - P(X = 0) - P(X = 1) = 1 - \frac{3}{e^2}$

61. Let  $A$  and  $B$  be two events such that  $P(\overline{A \cup B}) = \frac{1}{6}$ ,  $P(A \cap B) = \frac{1}{4}$  and  $P(\overline{A}) = \frac{1}{4}$ , where  $\overline{A}$  stands for complement of event  $A$ . Then events  $A$  and  $B$  are

- (1) independent but not equally likely                      (2) mutually exclusive and independent  
 (3) equally likely and mutually exclusive                      (4) equally likely but not independent

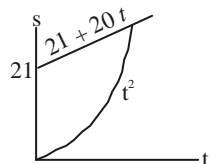
Ans. (1)

Sol.:  $P(A) = \frac{3}{4}$ ,  $P(A \cup B) = \frac{5}{6}$ ,  $P(A \cap B) = \frac{1}{4} \Rightarrow P(B) = \frac{1}{3}$ . So,  $P(A \cap B) = P(A)P(B)$ .

62. A lizard, at initial distance of 21 cm behind an insect, moves from rest with an acceleration of 2 cm/s<sup>2</sup> and pursues the insect which is crawling uniformly along a straight line at a speed of 20 cm/s. Then the lizard catch the insect after

- (1) 21 s                      (2) 24 s                      (3) 20 s                      (4) 1 s

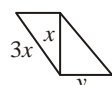
Ans. (1)

Sol.:   $t^2 = 21 + 20t$  gives  $t = 21$  s.

63. The resultant  $R$  of two forces acting on a particle is at right angles to one of them and its magnitude is one third of the other force. The ratio of larger force to smaller one is

- (1) 3 : 2                      (2)  $3 : 2\sqrt{2}$                       (3) 2 : 1                      (4)  $3 : \sqrt{2}$

Ans. (2)

Sol.:  By Pythagoras theorem,  $9x^2 = x^2 + y^2$ . So,  $\frac{3x}{y} = \frac{3}{\sqrt{8}}$

64. Two points  $A$  and  $B$  move from rest along a straight line with constant acceleration  $f$  and  $f'$  respectively. If  $A$  takes  $m$  sec. more than  $B$  and describes ' $n$ ' units more than  $B$  in acquiring the same speed then

(1)  $\frac{1}{2}(f + f')m = ff'n^2$

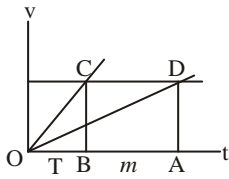
(2)  $(f' - f)n = \frac{1}{2}ff'm^2$

(3)  $(f - f')m^2 = ff'n$

(4)  $(f + f')m^2 = ff'n$

Ans. (2)

Sol.:



Area of triangle  $OAD$  – Area of triangle  $OCB = n$  gives  $n = \frac{1}{2} f'T$

$f(m + T) = f'T \Rightarrow (f' - f)T = fm$ . Using the first equation, we get,

$2n(f' - f) = ffm^2$

65.  $A$  and  $B$  are two like parallel forces. A couple of moment  $H$  lies in the plane of  $A$  and  $B$  and is contained with the. The resultant of  $A$  and  $B$  after combining is displaced through a distance

(1)  $\frac{H}{2(A + B)}$

(2)  $\frac{H}{A - B}$

(3)  $\frac{2H}{A - B}$

(4)  $\frac{H}{A + B}$

Ans. (4)

Sol.: When the forces  $A$  and  $B$  are acting on the plane, the distance of resultant from the force  $A$  is equal

to  $\frac{dB}{A + B}$  where  $d$  is the distance between the points of action of the forces  $A$  and  $B$ . When the couple of moment  $H$  is also acting on the plane, then distance of the resultant force from the force

$A = \frac{dB}{A + B} - \frac{H}{A + B}$ . Thus the position of resultant is shifted by  $\frac{H}{A + B}$ .

66. The sum of the series :  $1 + \frac{1}{4.2!} + \frac{1}{16.4!} + \frac{1}{64.4!} + \dots$  ad inf. is

(1)  $\frac{e - 1}{2\sqrt{e}}$

(2)  $\frac{e + 1}{2\sqrt{e}}$

(3)  $\frac{e - 1}{\sqrt{e}}$

(4)  $\frac{e + 1}{\sqrt{e}}$

Ans. (2)

Sol.: General term =  $\frac{1}{2^n n!}, n = 0, 2, 4$

$$\sum_{n \text{ even}} \frac{x^n}{n!} = \frac{e^x + e^{-x}}{2}$$



67. If  $a_1, a_2, a_3, \dots, a_n$  are in G.P., then the determinant  $\Delta = \begin{vmatrix} \log a_n & \log a_{n+1} & \log a_{n+2} \\ \log a_{n+3} & \log a_{n+4} & \log a_{n+5} \\ \log a_{n+6} & \log a_{n+7} & \log a_{n+8} \end{vmatrix}$  is equal to  
 (1) 4                                      (2) 2                                      (3) 1                                      (4) 0

Ans. (4)

Sol.:  $\log a_n, \log a_{n+1}, \log a_{n+2}$  are in A.P.

68. If both the roots of the quadratic equation  $x^2 - 2kx + k^2 + k - 5 = 0$  are less than 5, then  $k$  lies in the interval

- (1)  $(-\infty, 4)$                               (2)  $[4, 5]$                               (3)  $(5, 6]$                               (4)  $(6, \infty)$

Ans. (1)

Sol.: Discriminant equals  $-4(k - 5) \geq 0 \Rightarrow k \leq 5$ . The quadratic equation at  $x = 5$  must be +ve and sum of the roots must be less than 10. These conditions implice  $k^2 - 9k + 20 > 0$ . So,  $k < 4$ .

69. If the equation  $a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x = 0, a_1 \neq 0, n \geq 2$ , has a positive root  $x = \alpha$ , then the equation  $na_n x^{n-1} + (n-1)a_{n-1} x^{n-2} + \dots + a_1 = 0$  has a positive root, which is

- (1) greater than or equal to  $\alpha$                               (2) equal to  $\alpha$   
 (3) greater than  $\alpha$                               (4) smaller than  $\alpha$

Ans. (4)

Sol.: The expression  $na_n x^{n-1} + (n-1)a_{n-1} x^{n-2} + \dots + a_1$  is the derivative of  $a_n x^n + a_{n-1} x^{n-1} + \dots + a_1 x$ . So, by Rolle's theorem, the derivative is 0 at some point between 0 and  $\alpha$ .

70. A real valued function  $f(x)$  satisfies the functional equation  $f(x - y) = f(x)f(y) - f(a - x)f(a + y)$ , where  $a$  is a given constant and  $f(0) = 1, f(2a - x)$  is equal to

- (1)  $f(a) + f(a - x)$                               (2)  $f(-x)$                               (3)  $-f(x)$                               (4)  $f(x)$

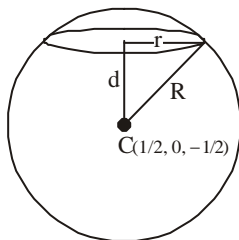
Ans. (3)

Sol.: Put  $y = 0$  in the given functional equation to get  $f(a) = 0$ . Next put  $x = 0$  to get  $f(-y) = f(y)$ . Next, put  $x = y = a$  to get  $f(2a) = -1$ . Finally, put  $x = 2a$  and replace  $y$  by  $x$  to get  $f(2a - x) = -f(x)$ .

71. The plane  $x + 2y - z = 4$  cuts the sphere  $x^2 + y^2 + z^2 - x + z - 2 = 0$  in a circle of radius

- (1) 2                                      (2)  $\sqrt{2}$                                       (3) 3                                      (4) 1

Ans. (4)



Sol.:

$$r^2 = R^2 - d^2 = \frac{5}{2} - \frac{9}{6} = 1$$



## AIEEE Entrance Test - 2005

### CHEMISTRY SOLUTION

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76. Which of the following oxides is amphoteric in character ?

- (1) CaO                      (2) CO<sub>2</sub>                      (3) SiO<sub>2</sub>                      (4) SnO<sub>2</sub>

**Sol: Ans [4]**

77. Which one of the following species is diamagnetic in nature ?

- (1) He<sup>+</sup>                      (2) H<sub>2</sub>                      (3) H<sub>2</sub><sup>+</sup>                      (4) H<sub>2</sub><sup>-</sup>

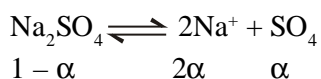
**Sol: Ans [2]**

According to M.O. theory.

78. If  $\alpha$  is the degree of dissociation of Na<sub>2</sub>SO<sub>4</sub> the vant Hoff's factor (i) used for calculating the molecular mass is

- (1) 1 +  $\alpha$                       (2) 1 -  $\alpha$                       (3) 1 + 2 $\alpha$                       (4) 1 - 2 $\alpha$

**Sol: Ans [3]**



Particles after dissociation  $1 - \alpha + 2\alpha + \alpha = 1 + 2\alpha$ .

79. The oxidation state of Cr in [Cr(NH<sub>3</sub>)<sub>4</sub>Cl<sub>2</sub>]<sup>+</sup> is

- (1) +3                      (2) +2                      (3) +1                      (4) 0

**Sol: Ans [1]**

80. Hydrogen bomb is based on the principle of

- (1) nuclear fission                      (2) natural radioactivity  
(3) nuclear fusion                      (4) artificial radioactivity

**Sol: Ans [3]**

81. An ionic compound has a unit cell consisting of A ions at the corners of a cube and B ions on the centres of the faces of the cube. The empirical formula for this compound would be

- (1) AB                      (2) A<sub>2</sub>B                      (3) AB<sub>3</sub>                      (4) A<sub>3</sub>B

**Sol: Ans [3]**

$$\text{For A} = 8 \times \frac{1}{8} = 1$$

$$\text{For B} = 6 \times \frac{1}{2} = 3 \quad \text{hence AB}_3$$

82. For a spontaneous reaction, the  $\Delta G$ , equilibrium constant (K) and  $E_{\text{cell}}^\circ$  will be respectively

- (1) -ve, >1, +ve                      (2) +ve, >1, -ve                      (3) -ve, <1, -ve                      (4) -ve, >1, -ve

**Sol: Ans [1]**

---

83. Which of the following is a polyamide?  
(1) Teflon (2) Nylon-66 (3) Terylene (4) Bakelite

Sol: Ans [2]

Nylon - 66, it has  $-\text{NH}-\overset{\text{O}}{\parallel}{\text{C}}-$  group

84. Which one of the following types of drugs reduces fever ?  
(1) Analgesic (2) Antipyretic (3) Antibiotic (4) Tranquiliser

Sol: Ans [2]

85. Due to the presence of an unpaired electron, free radicals are :  
(1) Chemically reactive (2) Chemically inactive (3) Anions (4) Cations

Sol: Ans [1]

86. Lattice energy of an ionic compound depends upon  
(1) Charge on the ion only (2) Size of the ion only  
(3) Packing of ions only (4) Charge on the ion and size of the ion

Sol: Ans [4]

87. The highest electrical conductivity of the following aqueous solutions is of  
(1) 0.1 M acetic acid (2) 0.1 M chloroacetic acid  
(3) 0.1 M fluoroacetic acid (4) 0.1 M difluoroacetic acid

Sol: Ans [4]

88. Aluminium oxide may be electrolysed at  $1000^\circ\text{C}$  to furnish aluminium metal (at. mass = 27 amu; 1 Faraday = 96,500 Coulombs). The cathode reaction is



To prepare 5.12 kg of aluminium metal by this method would require

- (1)  $5.49 \times 10^7$  C of electricity (2)  $1.83 \times 10^7$  C of electricity  
(3)  $5.49 \times 10^4$  C of electricity (4)  $5.49 \times 10^1$  C of electricity

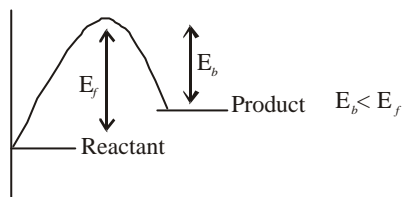
Sol: Ans [1]

According to Faraday's law of equivalence.

89. Consider an endothermic reaction  $\text{X} \rightarrow \text{Y}$  with the activation energies  $E_b$  and  $E_f$  for the backward and forward reactions, respectively. In general

- (1)  $E_b < E_f$   
(2)  $E_b > E_f$   
(3)  $E_b = E_f$   
(4) there is no definite relation between  $E_b$  and  $E_f$

Sol: Ans [1]



90. Consider the reaction :  $N_2 + 3H_2 \rightarrow 2NH_3$  carried out at constant temperature and pressure. If  $\Delta H$  and  $\Delta U$  are the enthalpy and internal energy changes for the reaction, which of the following expressions is true ?

- (1)  $\Delta H = 0$                       (2)  $\Delta H = \Delta U$                       (3)  $\Delta H < \Delta U$                       (4)  $\Delta H > \Delta U$

**Sol: Ans [3]**

$$\Delta H = \Delta U + \Delta n_g RT = 0 - 2RT$$

$$\text{Hence } \Delta H < \Delta U$$

91. Which one of the following statements is NOT true about the effect of an increase in temperature on the distribution of molecular speeds in a gas ?

- (1) The most probable speed increases  
 (2) The fraction of the molecules with the most probable speed increases  
 (3) The distribution becomes broader  
 (4) The area under the distribution curve remains the same as under the lower temperature

**Sol: Ans [2]**

92. The volume of a colloidal particle,  $V_c$  as compared to the volume of a solute particle in a true solution  $V_s$ , could be

- (1)  $\frac{V_c}{V_s} \approx 1$                       (2)  $\frac{V_c}{V_s} \approx 10^{23}$                       (3)  $\frac{V_c}{V_s} \approx 10^{-3}$                       (4)  $\frac{V_c}{V_s} \approx 10^3$

**Sol: Ans [4]**

$$\frac{V_c}{V_s} \approx \frac{10^{-4}}{10^{-7}} \approx 10^3$$

93. The solubility product of a salt having general formula  $MX_2$ , in water is :  $4 \times 10^{-12}$ . The concentration of  $M^{2+}$  ions in the aqueous solution of the salt is

- (1)  $2.0 \times 10^{-6} \text{ M}$                       (2)  $1.0 \times 10^{-4} \text{ M}$                       (3)  $1.6 \times 10^{-4} \text{ M}$                       (4)  $4.0 \times 10^{-10} \text{ M}$

**Sol: Ans [2]**

$$K_{sp} = 4S^3 ; \quad S = 1.0 \times 10^{-4} \text{ M}$$

94. Benzene and toluene form nearly ideal solutions. At  $20^\circ\text{C}$ , the vapour pressure of benzene is 75 torr and that of toluene is 22 torr. The partial vapour pressure of benzene at  $20^\circ\text{C}$  for a solution containing 78 g of benzene and 46 g of toluene in torr is

- (1) 50                                      (2) 25                                      (3) 37.5                                      (4) 53.5

**Sol: Ans [1]**

According to Raoult's law, partial pressure of benzene =  $p^\circ \cdot X$

95. The exothermic formation of  $CF_3$  is represented by the equation :



Which of the following will increase the quantity of  $CF_3$  in an equilibrium mixture of  $Cl_2$ ,  $F_2$  and  $CF_3$ ?

- (1) Increasing the temperature                      (2) Removing  $Cl_2$   
 (3) Increasing the volume of the container        (4) Adding  $F_2$

**Sol: Ans [4]**

According to Le-Chatellier's principle

96. Two solutions of a substance (non electrolyte) are mixed in the following manner. 480 ml of 1.5 M first solution + 520 mL of 1.2 M second solution. What is the molarity of the final mixture ?

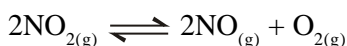
- (1) 1.20 M                      (2) 1.50 M                      (3) 1.344 M                      (4) 2.70 M

**Sol: Ans [3]**

$$\text{Applying } M_1V_1 + M_2V_2 = M_3V_3$$

$$M_3 = 1.344 \text{ M}$$

97. For the reaction



$$(K_C = 1.8 \times 10^{-6} \text{ at } 184^\circ\text{C})$$

$$(R = 0.0831 \text{ kJ / (mol.K)})$$

When  $K_p$  and  $K_C$  are compared at  $184^\circ\text{C}$  it is found that

- (1)  $K_p$  is greater than  $K_C$   
 (2)  $K_p$  is less than  $K_C$   
 (3)  $K_p = K_C$   
 (4) Whether  $K_p$  is greater than, less than or equal to  $K_C$  depends upon the total gas pressure

**Sol: Ans [1]**

$$\text{Applying } K_p = K_C(RT)^{\Delta n}, K_p = K_C(RT) = K_C = \frac{K_p}{RT}$$

98. Hydrogen ion concentration in mol/L in a solution of pH = 5.4 will be :

- (1)  $3.98 \times 10^8$                       (2)  $3.88 \times 10^6$                       (3)  $3.68 \times 10^{-6}$                       (4)  $3.98 \times 10^{-6}$

**Sol: Ans [4]**

$$\text{pH} = 5.4 \quad H^+ = 10^{-5.4} = 3.98 \times 10^{-6}$$

99. A reaction involving two different reactants can never be

- (1) unimolecular reaction                      (2) first order reaction  
 (3) second order reaction                      (4) bimolecular reaction

**Sol: Ans [1]**

**100.** If we consider that  $1/6$ , in place of  $1/12$ , mass of carbon atom is taken to be the relative atomic mass unit, the mass of one mole of substance will

- (1) decrease twice
- (2) increase two fold
- (3) remain unchanged
- (4) be a function of the molecular mass of the substance

**Sol: Ans [2]**

**101.** In a multi-electron atom, which of the following orbitals described by the three quantum number will have the same energy in the absence of magnetic and electric fields ?

- |                           |                           |
|---------------------------|---------------------------|
| (a) $n = 1, l = 0, m = 0$ | (b) $n = 2, l = 0, m = 0$ |
| (c) $n = 2, l = 1, m = 1$ | (d) $n = 3, l = 2, m = 0$ |
| (e) $n = 3, l = 2, m = 0$ |                           |
- (1) (a) and (b)      (2) (b) and (c)      (3) (c) and (d)      (4) (d) and (e)

**Sol: Ans [4]**

**102.** During the process of electrolytic refining of copper, some metals present as impurity settle as 'anode mud'. These are

- (1) Sn and Ag      (2) Pb and Zn      (3) Ag and Au      (4) Fe and Ni

**Sol: Ans [3]**

	Electrolyte	KCl	KNO <sub>3</sub>	HCl	NaOAc	NaCl
<b>103.</b>	$\Lambda^\infty$ (S cm <sup>2</sup> mol <sup>-1</sup> )	149.9	145.0	426.2	91.0	126.5

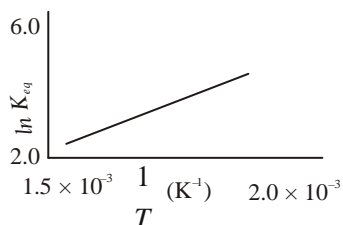
Calculate  $\Delta_{HOAc}^\infty$  using appropriate molar conductances of the electrolytes listed above at infinite dilution in H<sub>2</sub>O at 25°C

- (1) 517.2      (2) 552.7      (3) 390.7      (4) 217.5

**Sol: Ans [3]**

Applying Kohlrausch's law

**104.** A schematic plot of  $\ln K_{eq}$  versus inverse of temperature for a reaction is shown below



The reaction must be

- |   |  |
|---|--|
| (1) exothermic                          | (2) endothermic                                |
| (3) one with negligible enthalpy change | (4) highly spontaneous at ordinary temperature |

**Sol: Ans [1]**

This is applied for Exothermic reaction

105. The disperse phase in colloidal iron (III) hydroxide and colloidal gold is positively and negatively charged, respectively. Which of the following statements is NOT correct?

- (1) Magnesium chloride solution coagulates, the gold sol more readily than the iron (III) hydroxide sol.
- (2) Sodium sulphate solution causes coagulation in both sols
- (3) Mixing the sols has no effect
- (4) Coagulation in both sols can be brought about by electrophoresis

Sol: Ans [3]

106. Based on lattice energy and other considerations which one of the following alkali metal chlorides is expected to have the highest melting point ?

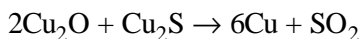
- (1) LiCl
- (2) NaCl
- (3) KCl
- (4) RbCl

Sol: Ans [1]

107. Heating mixture of  $\text{Cu}_2\text{O}$  and  $\text{Cu}_2\text{S}$  will give

- (1)  $\text{Cu} + \text{SO}_2$
- (2)  $\text{Cu} + \text{SO}_3$
- (3)  $\text{CuO} + \text{CuS}$
- (4)  $\text{Cu}_2\text{SO}_3$

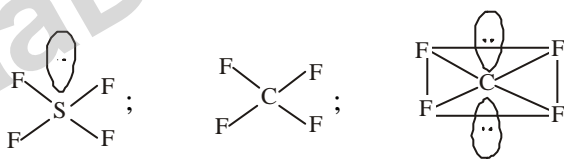
Sol: Ans [1]



108. The molecular shapes of  $\text{SF}_4$ ,  $\text{CF}_4$  and  $\text{XeF}_4$  are

- (1) the same with 2, 0 and 1 lone pairs of electrons
- (2) the same with 1, 1 and 1 lone pair of electrons on the central atoms, respectively
- (3) different with 0, 1 and 2 lone pairs of electrons on the central atom, respectively
- (4) different with 1, 0 and 2 lone pairs of electrons on the central atom, respectively

Sol: Ans [4]



109. The number and type of bonds between two carbon atoms in calcium carbide are

- (1) One sigma, one pi
- (2) One sigma, two pi
- (3) Two sigma, one pi
- (4) Two sigma, two pi

Sol: Ans [2]



110. The oxidation state of chromium in the final product formed by the reaction between KI and acidified potassium dichromate solution is

- (1) +4
- (2) +6
- (3) +2
- (4) +3

Sol: Ans [4]

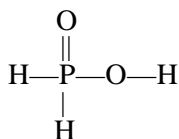
Acidic  $\text{K}_2\text{Cr}_2\text{O}_7$  acts as oxidising agent itself reduced from Cr(+6) to Cr(+3).



111. The number of hydrogen atom(s) attached to phosphorus atom in hypophosphorous acid is

- (1) zero                      (2) two                      (3) one                      (4) three

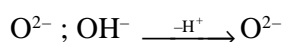
Sol: Ans [2]



112. What is the conjugate base of  $\text{OH}^-$  ?

- (1)  $\text{O}_2$                       (2)  $\text{H}_2\text{O}$                       (3)  $\text{O}^-$                       (4)  $\text{O}^{2-}$

Sol: Ans [4]



113. The correct order of the thermal stability of hydrogen halides ( $\text{H}-\text{X}$ ) is

- (1)  $\text{HI} > \text{HBr} > \text{HCl} > \text{HF}$                       (2)  $\text{HF} > \text{HCl} > \text{HBr} > \text{HI}$   
 (3)  $\text{HCl} < \text{HF} > \text{HBr} < \text{HI}$                       (4)  $\text{HI} > \text{HCl} < \text{HF} > \text{HBr}$

Sol: Ans [2]

114. Heating an aqueous solution of aluminium chloride to dryness will give

- (1)  $\text{AlCl}_3$                       (2)  $\text{Al}_2\text{Cl}_6$                       (3)  $\text{Al}_2\text{O}_3$                       (4)  $\text{Al}(\text{OH})\text{Cl}_2$

Sol: Ans [3]

115. Calomel ( $\text{Hg}_2\text{Cl}_2$ ) on reaction with ammonium hydroxide gives

- (1)  $\text{HgNH}_2\text{Cl}$                       (2)  $\text{NH}_2-\text{Hg}-\text{Hg}-\text{Cl}$                       (3)  $\text{Hg}_2\text{O}$                       (4)  $\text{HgO}$

Sol: Ans [1]

116. In which of the following arrangements the order is NOT according to the property indicated against it ?

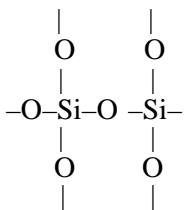
- (1)  $\text{Al}^{3+} < \text{Mg}^{2+} < \text{Na}^+ < \text{F}^-$  :  
 Increasing ionic size                      (2)  $\text{B} < \text{C} < \text{N} < \text{O}$  :  
 Increasing first ionization enthalpy  
 (3)  $\text{I} < \text{Br} < \text{F} < \text{Cl}$  :  
 Increasing electron gain enthalpy  
 (with negative sign)                      (4)  $\text{Li} < \text{Na} < \text{K} < \text{Rb}$  :  
 Increasing metallic radius

Sol: Ans [2]

117. In silicon dioxide

- (1) each silicon atom is surrounded by four oxygen atoms and each oxygen atom is bonded to two silicon atoms  
 (2) each silicon atom is surrounded by two oxygen atoms and each oxygen atom is bonded to two silicon atoms  
 (3) silicon atom is bonded to two oxygen atoms  
 (4) there are double bonds between silicon and oxygen atoms

**Sol: Ans [1]**



**118.** Of the following sets which one does NOT contain isoelectronic species ?

- |   |   |
|---|---|
| (1) $\text{PO}_4^{3-}$ , $\text{SO}_4^{2-}$ , $\text{Cl}_4^-$ | (2) $\text{CN}^-$ , $\text{N}_2$ , $\text{C}_2^{2-}$ ,        |
| (3) $\text{SO}_3^{2-}$ , $\text{CO}_3^{2-}$ , $\text{NO}_3^-$ | (4) $\text{BO}_3^{3-}$ , $\text{CO}_3^{3-}$ , $\text{NO}_3^-$ |

**Sol: Ans [3]**

Odd atom S belongs to third period.

**119.** The lanthanide contraction is responsible for the fact that

- |  |   |
|--|---|
| (1) Zr and Y have about the same radius  | (2) Zr and Nb have similar oxidation state  |
| (3) Zr and Hf have about the same radius | (4) Zr and Zn have the same oxidation state |

**Sol: Ans [3]**

Zr and Hf have about the same radius

**120.** The IUPAC name of the coordination compound  $\text{K}_3[\text{Fe}(\text{CN})_6]$  is

- |                                     |                                      |
|-------------------------------------|--------------------------------------|
| (1) Potassium hexacyanoferrate (II) | (2) Potassium hexacyanoferrate (III) |
| (3) Potassium hexacyanoiron (II)    | (4) Tripotassium hexacyanoiron (II)  |

**Sol: Ans [2]**

**121.** Which of the following compounds shows optical isomerism ?

- |                                       |                            |  |                                     |
|---------------------------------------|----------------------------|--|-------------------------------------|
| (1) $[\text{Cu}(\text{NH}_3)_4]^{2+}$ | (2) $[\text{ZnCl}_4]^{2-}$ | (3) $[\text{Cr}(\text{C}_2\text{O}_4)_3]^{3-}$ | (4) $[\text{Co}(\text{CN})_6]^{3-}$ |
|---------------------------------------|----------------------------|--|-------------------------------------|

**Sol: Ans [3]**

**122.** Which one of the following cyano complexes would exhibit the lowest value of paramagnetic behaviour?

- |                                     |                                     |                                     |                                    |
|-------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|
| (1) $[\text{Cr}(\text{CN})_6]^{3-}$ | (2) $[\text{Mn}(\text{CN})_6]^{3-}$ | (3) $[\text{Fe}(\text{CN})_6]^{3-}$ | (4) $\text{Co}(\text{CN})_6]^{3-}$ |
|-------------------------------------|-------------------------------------|-------------------------------------|------------------------------------|

(At. Nos : Cr = 24, Mn = 25, Fe = 26, Co = 27)

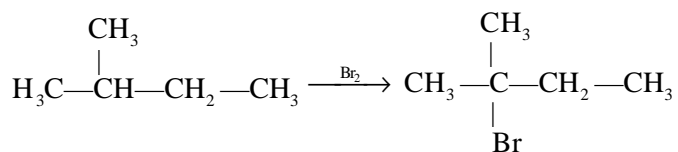
**Sol: Ans [4]**

$[\text{Co}(\text{CN})_6]^{3-}$ ; central metal atom Co has no unpaired electrons.

**123.** 2-Methylbutane on reacting with bromine in the presence of sunlight gives mainly

- |                            |                            |
|----------------------------|----------------------------|
| (1) 1-bromo-2-methylbutane | (2) 2-bromo-2-methylbutane |
| (3) 2-bromo-3-methylbutane | (4) 1-bromo-3-methylbutane |

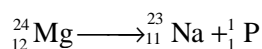
**Sol: Ans [2]**



**124.** A photon of hard gamma radiation knocks a proton out of  ${}^{24}_{12}\text{Mg}$  nucleus to form

- (1) the isotope of parent nucleus                      (2) the isobear of parent nucleus  
 (3) the nuclide  ${}^{23}_{11}\text{Na}$                                       (4) the isobar of  ${}^{23}_{11}\text{Na}$

**Sol: Ans [3]**



**125.** The best reagent to convert pent-3-en-2-ol into pent-3-en-2-one is

- (1) Acidic permanganate                                      (2) Acidic dichromate  
 (3) Chromic anhydride in glacial acetic acid              (4) Pyridinium chloro-chromate

**Sol: Ans [4]**

**126.** Tertiary alkyl halides are practically inert to substitution by  $S_N2$  mechanism because of

- (1) insolubility                      (2) instability              (3) inductive effect              (4) steric hindrance

**Sol: Ans [4]**

**127.** In both DNA and RNA, heterocyclic base and phosphate ester linkages are at

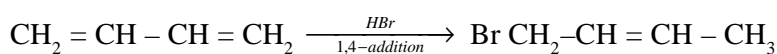
- (1)  $\text{C}'_5$  and  $\text{C}'_2$  respectively of the sugar molecule  
 (2)  $\text{C}'_2$  and  $\text{C}'_5$  respectively of the sugar molecule  
 (3)  $\text{C}'_1$  and  $\text{C}'_5$  respectively of the sugar molecule  
 (4)  $\text{C}'_5$  and  $\text{C}'_1$  respectively of the sugar molecule

**Sol: Ans [3]**

**128.** Reaction of one molecule of HBr with one molecule of 1, 3-butadiene at  $40^\circ\text{C}$  gives predominantly

- (1) 3-bromobutene under kinetically controlled conditions  
 (2) 1-bromo-2-butene under thermodynamically controlled conditions  
 (3) 3-bromobutene under thermodynamically controlled conditions  
 (4) 1-bromo-2-butene under kinetically controlled conditions

**Sol: Ans [2]**



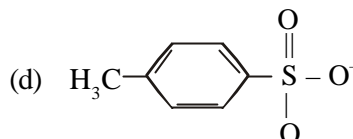
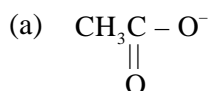
**129.** Among the following acids which has the lowest  $\text{pK}_a$  value ?

- (1)  $\text{CH}_3\text{COOH}$     (2)  $\text{HCOOH}$   
 (3)  $(\text{CH}_3)_2\text{CH} - \text{COOH}$                                       (4)  $\text{CH}_3\text{CH}_2\text{COOH}$

**Sol: Ans [2]**

$\begin{array}{c} \text{O} \\ || \\ \text{H}-\text{C}-\text{OH} \end{array}$  is strongest among the given acids hence lowest  $\text{pK}_a$  value.

**130.** The decreasing order of nucleophilicity among the nucleophiles



- (1) (a), (b), (c), (d)      (2) (d), (c), (b), (a)      (3) (b), (c), (a), (d)      (4) (c), (b), (a), (d)

**Sol: Ans [3]**

**131.** Which one of the following methods is neither meant for the synthesis nor for separation of amines ?

- (1) Hinsberg method      (2) Hofmann method      (3) Wurtz reaction      (4) Curtius reaction

**Sol: Ans [3]**

Wurtz reaction is used for synthesis of alkanes.

**132.** Which of the following is fully fluorinated polymer ?

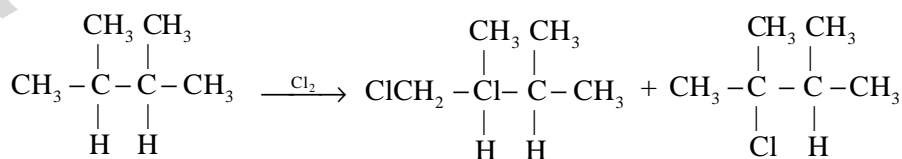
- (1) Neoprene      (2) Teflon      (3) Thiokol      (4) PVC

**Sol: Ans [2]**

**133.** Of the five isomeric hexanes, the isomer which can give two monochlorinated compounds is

- (1) n-hexane      (2) 2, 3-dimethylbutane      (3) 2, 2-dimethylbutane      (4) 2-methylpentane

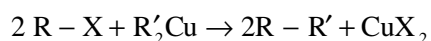
**Sol: Ans [2]**



**134.** Alkyl halides react with dialkyl copper reagents to give

- (1) alkenes      (2) alkyl copper halides      (3) alkanes      (4) alkenyl halides

**Sol: Ans [3]**



**135.** Acid catalyzed hydration of alkenes except ethene leads to the formation of

- (1) primary alcohol      (2) secondary or tertiary alcohol  
 (3) mixture of primary and secondary alcohols      (4) mixture of secondary and tertiary alcohols

**Sol: Ans [2]**

Except ethene, other alkenes on acid catalysed hydration form 2° or 3° alcohols, due to the formation of more stable carbocation

**136.** Amongst the following the most basic compound is

- (1) benzylamine      (2) aniline      (3) acetanilide      (4) p-nitroaniline

**Sol: Ans [1]**

In benzyl amine  $\left( \text{C}_6\text{H}_5\text{CH}_2\text{NH}_2 \right)$  the lone pair of electrons is not involved in resonance with phenyl ring as in all other cases.

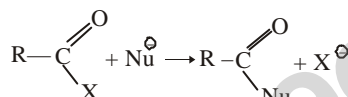
**137.** Which types of isomerism is shown by 2, 3-dichlorobutane ?

- (1) Diastereo      (2) Optical      (3) Geometric      (4) Structural

**Sol: Ans [2]**

The given compound has 2 chiral centres and forms 3 stereoisomers *d*, *l* and meso.

**138.** The reaction



is fastest when X is

- (1) Cl      (2) NH<sub>2</sub>      (3) OC<sub>2</sub>H<sub>5</sub>      (4) OCOR

**Sol: Ans [1]**

-Cl being weakest base is a good leaving group.

**139.** Elimination of bromine from 2-bromobutane results in the formation of

- (1) equimolar mixture of 1 and 2-butene      (2) predominantly 2-butene  
(3) predominantly 1-butene      (4) predominantly 2-butyne

**Sol: Ans [2]**

Saytzeff rule

**140.** Equimolar solutions in the same solvent have

- (1) Same boiling point but different freezing point      (2) Same freezing point but different boiling point  
(3) Same boiling and same freezing points      (4) Different boiling and different freezing points

**Sol: Ans [3]**

Factual, based on the fact that colligative properties depend upon the number of particles

**141.** Which of the following statements in relation to the hydrogen atom is correct ?

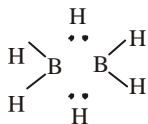
- (1) 3s orbital is lower in energy than 3p orbital  
(2) 3p orbital is lower in energy than 3d orbital  
(3) 3s and 3p orbitals are of lower energy than 3d orbital  
(4) 3s, 3p and 3d orbitals all have the same energy

**Sol: Ans [1]**

142. The structure of diborane ( $B_2H_6$ ) contains

- (1) four 2c-2e bonds and two 3c-2e bonds      (2) two 2c-2e bonds and four 3c-2e bonds  
 (3) two 2c-2e bonds and two 3c-3e bonds      (4) four 2c-2e bonds and four 3c-2e bonds

Sol: Ans [1]



Diborane has 4 two centre-two electron bonds and 2 three centre-two electron bonds.

143. The value of the 'spin only' magnetic moment for one of the following configurations is 2.84 BM. The correct one is

- (1)  $d^4$  (in strong ligand field)      (2)  $d^4$  (in weak ligand field)  
 (3)  $d^3$  (in weak as well as in strong fields)      (4)  $d^5$  (in strong ligand field)

Sol: Ans [1]

According to CFT, splitting between  $t_{2g}$  and  $e_g$  groups is large in strong field and fourth electron gets paired with 3rd electron corresponding to 2 unpaired electrons.



144. Which of the following factors may be regarded as the main cause of lanthanide contraction ?

- (1) Poor shielding of one of 4f electron by another in the subshell  
 (2) Effective shielding of one of 4f electrons by another in the subshell  
 (3) Poorer shielding of 5d electrons by 4f electrons  
 (4) Greater shielding of 5d electron by 4f electrons

Sol: Ans [3]

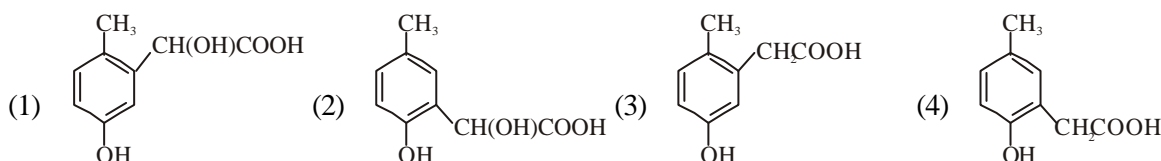
$f$  orbitals have poor shielding effect.

145. Reaction of cyclohexanone with dimethylamine in the presence of catalytic amount of an acid forms a compound if water during the reaction is continuously removed. The compound formed is generally known as

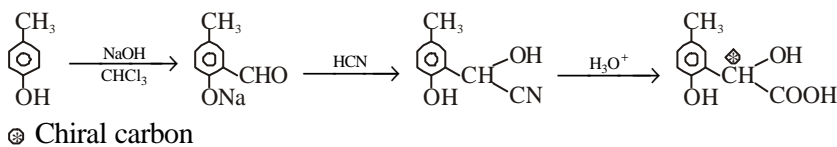
- (1) a Schiff's base      (2) an enamine      (3) an imine      (4) an amine

Sol: Ans [2]

146. *p*-cresol reacts with chloroform in alkaline medium to give the compound A which adds hydrogen cyanide to form, the compound B. The latter on acidic hydrolysis gives chiral carboxylic acid. The structure of the carboxylic acid is



**Sol: Ans [2]**



**147.** An organic compound having molecular mass 60 is found to contain C = 20%, H = 6.67% heating it gives  $\text{NH}_3$  alongwith a solid residue. the solid residue give violet colour with alkaline copper sulphate solution. The compound is

- (1)  $\text{CH}_3\text{NCO}$       (2)  $\text{CH}_3\text{CONH}_2$       (3)  $(\text{NH}_2)_2\text{CO}$       (4)  $\text{CH}_3\text{CH}_2\text{CONH}_2$

**Sol: Ans [3]**

Ammonia satisfies all the aforesaid data and also the emperical formula is  $\text{CH}_4\text{N}_2\text{O}$

**148.** If the bond dissociation energies of  $\text{XY}$ ,  $\text{X}_2$  and  $\text{Y}_2$  (all diatomic molecules) are in the ratio of 1 : 1 : 0.5 and  $\Delta_f H$  for the formation of  $\text{XY}$  is  $-200 \text{ kJ mole}^{-1}$ . The bond dissociation energy of  $\text{X}_2$  will be

- (1)  $100 \text{ kJ mol}^{-1}$       (2)  $200 \text{ kJ mol}^{-1}$       (3)  $300 \text{ kJ mol}^{-1}$       (4)  $400 \text{ kJ mol}^{-1}$

**Sol: Ans [2]**

$\text{XY}$  and  $\text{X}_2$  have dissociation energies in the ratio 1 : 1 hence heat of formation of  $\text{XY}$  = dissociation enregy of  $\text{X}_2$  (with opp. sign).

**149.**  $t_{1/4}$  can be taken as the time taken for the concentration of a reactant to drop to  $\frac{3}{4}$  of its initial value. If

the rate constant for a first order reaction is  $K$ , the  $t_{1/4}$  can be written as

- (1)  $0.10 / K$       (2)  $0.29 / K$       (3)  $0.69 / K$       (4)  $0.75 / K$

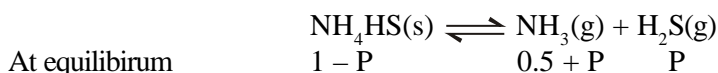
**Sol: Ans [2]**

$$Kt_{1/4} = 2.303 \log \frac{1}{3/4}$$

**150.** An amount of solid  $\text{NH}_4\text{HS}$  is placed in a flask already containing ammonia gas at a certain temperature and 0.50 atm. pressure. Ammonium hydrogen sulphide deocomposes to yield  $\text{NH}_3$  and  $\text{H}_2\text{S}$  gases in the flask. When the decomposition reaction reaches equilibrium, the total pressure in the flask rises to 0.84 atm. The equilibrium constant for  $\text{NH}_4\text{HS}$  decomposition at this temperature is

- (1) 0.30      (2) 0.18      (3) 0.17      (4) 0.11

**Sol: Ans [4]**



At equilibrium

$$1 - P \qquad 0.5 + P \qquad P$$

Total pressure at equilibrium

$$0.5 + P + P = 0.84$$

or  $P = 0.17$

$$K_p = (0.5 + P) P = 0.17 \times 0.67 = 0.11$$



## AIEEE Entrance Test - 2005

### PHYSICS SOLUTIONS

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1. Out of the following pair, which one does not have identical dimensions is

- (1) moment of inertia and moment of a force      (2) work and torque  
 (3) angular momentum and Planck's constant      (4) impulse and momentum

**Sol: Ans [1]**

$$\tau = I\alpha \quad \Rightarrow \quad \text{moment of force and moment of inertia will not have same dimensions.}$$

2. The relation between time  $t$  and distance  $x$  is  $t = ax^2 + bx$  where  $a$  and  $b$  are constants. The acceleration is

- (1)  $-2av^3$                       (2)  $2av^2$                       (3)  $-2abv^2$                       (4)  $2bv^3$

**Sol: Ans [1]**

$$\frac{dt}{dx} = 2ax + b \quad \Rightarrow \quad \frac{dx}{dt} = \frac{1}{(2ax + b)}$$

$$\frac{d^2x}{dt^2} = -(2ax + b)^{-2} \cdot 2a \frac{dx}{dt} = -2av^3$$

3. A car starting from rest, accelerates at the rate  $f$  through a distance  $S$ , then continues at constant speed for time  $t$  and then decelerates at the rate  $\frac{f}{2}$  to come to rest. If the total distance traversed is  $15S$ , then

- (1)  $S = \frac{1}{2}ft^2$                       (2)  $S = \frac{1}{2}ft^2$                       (3)  $S = \frac{1}{4}ft$                       (4)  $S = \frac{1}{6}ft^2$

**Sol: Ans [1]**

$$S = \frac{V^2}{2f}$$

$$S_2 = BC = V \cdot t$$

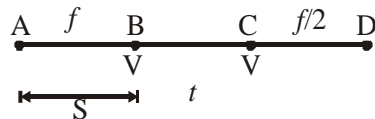
$$CD = S_3 = \frac{V^2}{f} = 2S$$

$$\Rightarrow S_2 = 15S - [AB + CD] = 12S$$

$$\text{Solving (i) - (iv), } S = \frac{f}{72}t^2$$

There is no alternative matching

(i)



(ii)

(iii)

(iv)

4. A particle is moving eastwards with a velocity of  $5 \text{ ms}^{-1}$ . In 10 seconds the velocity changes to

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$5 \text{ ms}^{-1}$  northwards. The average acceleration in this time is

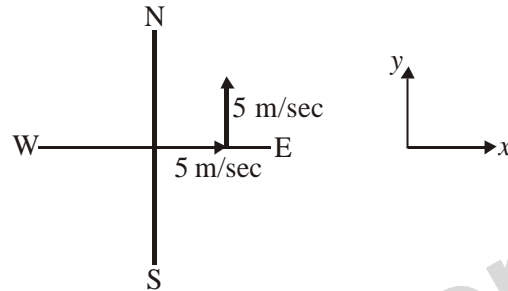
- (1) zero (2)  $\frac{1}{\sqrt{2}} \text{ ms}^{-2}$  towards north-west  
 (3)  $\frac{1}{\sqrt{2}} \text{ ms}^{-2}$  towards north-east (4)  $\frac{1}{2} \text{ ms}^{-2}$  towards north

**Sol: Ans [2]**

$$\mathbf{a}_{\text{avg}} = \frac{\mathbf{v}_f - \mathbf{v}_i}{\Delta t} = \frac{5\mathbf{j} - 5\mathbf{i}}{10} = \frac{1}{2}(-\mathbf{i} + \mathbf{j})$$

Average acceleration will be  $\frac{1}{\sqrt{2}} \text{ m/sec}^2$  in

North-West direction



5. A projectile can have the same range  $R$  for two angles of projection. If  $t_1$  and  $t_2$  be the times of flights in the two cases, then the product of the two time of flights is proportional to

- (1)  $\frac{1}{R}$  (2)  $R$  (3)  $R^2$  (4)  $\frac{1}{R^2}$

**Sol: Ans [2]**

At complementary angle of projection i.e.,  $\theta_1 + \theta_2 = 90^\circ$ , ranges are same.

$$t_1 = \frac{2u \sin \theta_1}{g}; t_2 = \frac{2u \sin \theta_2}{g} = \frac{2u \sin(90 - \theta_1)}{g} = \frac{2u \cos \theta_1}{g}$$

$$t_1 t_2 = \frac{4u^2 \sin \theta_1 \cos \theta_1}{g} = \frac{2R}{g}$$

6. An angular ring with inner and outer radii  $R_1$  and  $R_2$  is rolling without slipping with a uniform angular speed. The ratio of the forces experienced by the two particles situated on the inner and outer parts

of the ring,  $\frac{F_1}{F_2}$  is

- (1) 1 (2)  $\frac{R_1}{R_2}$  (3)  $\frac{R_2}{R_1}$  (4)  $\left(\frac{R_1}{R_2}\right)^2$

**Sol: Ans [2]**

There will be only centrifugal acceleration of all particles because angular speed is constant

$$F_1 = ma_A = mR_1 \omega^2$$

$$F_2 = ma_B = mR_2 \omega^2$$

$$\Rightarrow \frac{F_1}{F_2} = \frac{R_1}{R_2}$$

(Masses of particles are not mentioned in the question. This answer is subject to mass of particles is same)

7. A smooth block is released at rest on a  $45^\circ$  incline and then slides a distance  $d$ . The time taken to slide is  $n$  times as much to slide on rough incline than on a smooth incline. The coefficient of friction is

(1)  $\mu_s = 1 - \frac{1}{n^2}$       (2)  $\mu_s = \sqrt{1 - \frac{1}{n^2}}$       (3)  $\mu_k = 1 - \frac{1}{n^2}$       (4)  $\mu_k = \sqrt{1 - \frac{1}{n^2}}$

Sol: Ans [3]

Let length of incline is  $d$

For smooth inclined plane  $d = 0 + \frac{1}{2} \times g \sin 45^\circ t_1^2$  (i)

For rough inclined plane  $d = 0 + \frac{1}{2} (g \sin 45^\circ - \mu_k g \cos 45^\circ) \cdot t_2^2$  (ii)

Using (i) & (ii),  $\frac{1}{2} g \sin 45^\circ t_1^2 = \frac{1}{2} g (\sin 45^\circ - \mu_k \cos 45^\circ) t_2^2$

$$\frac{1}{\sqrt{2}} t_1^2 = \frac{1}{\sqrt{2}} (1 - \mu_k) \cdot n t_1^2$$

$$\Rightarrow (1 - \mu_k) = \frac{1}{n^2}$$

$$\Rightarrow \mu_k = \left( 1 - \frac{1}{n^2} \right)$$

8. The upper half of an inclined plane with inclination  $\phi$  is perfectly smooth while the lower half is rough. A body starting from rest at the top will again come to rest at the bottom if the coefficient of friction for the lower half is given by

(1)  $2 \tan \phi$       (2)  $\tan \phi$       (3)  $2 \sin \phi$       (4)  $2 \cos \phi$

Sol: Ans [1]

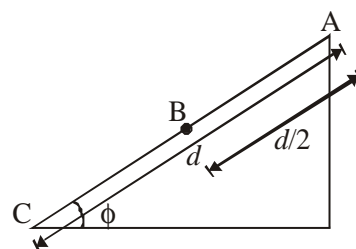
Let AB is smooth, BS is rough

Applying work energy theorem between A and C

$$KE_i = 0, KE_f = 0 \Rightarrow \Delta KE = 0$$

$$W_{mg} = mgd \cdot \sin \phi$$

$$W_{friction} = -(\mu mg \cos \phi) \times \frac{d}{2}$$



$$\Rightarrow mgd \sin \phi - \mu mg \cos \phi \frac{d}{2} = 0, \quad 2 \tan \phi = \mu$$

9. A bullet fired into a fixed target loses half of its velocity after penetrating 3 cm. How much further it will penetrate before coming to rest assuming that it faces constant resistance to motion?

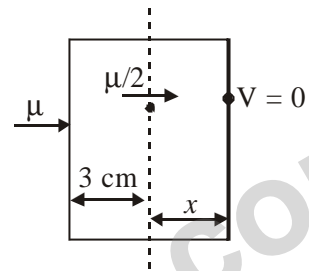
- (1) 1.5 cm                      (2) 1.0 cm                      (3) 3.0 cm                      (4) 2.0 cm

**Sol: Ans [2]**

Using work energy theorem

$$\frac{1}{2} m \left( \frac{u}{2} \right)^2 - \frac{1}{2} mu^2 = -F \times 3$$

or  $\frac{3}{8} mu^2 = F \times 3$                       (i)



Also

$$\frac{1}{2} m(0)^2 - \frac{1}{2} m \left( \frac{u}{2} \right)^2 = -Fx \quad \text{or} \quad \frac{mu^2}{8} = -Fx \quad \text{(ii)}$$

Using equation (i) & (ii)

$$\frac{3}{1} = \frac{3}{x} \quad \Rightarrow \quad x = 1 \text{ cm}$$

10. A parachutist after bailing out falls 50 m without friction. When parachute opens, it decelerates at  $2 \text{ m/s}^2$ . he reaches the ground with a speed of  $3 \text{ m/s}$ . At what height, did he bail out?

- (1) 293 m                      (2) 111 m                      (3) 91 m                      (4) 182 m

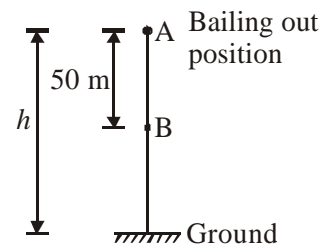
**Sol: Ans [1]**

Applying work energy theorem

$$W_{\text{net}} = mg \times 50 - m \times 2 \times (h - 50)$$

$$\Delta KE = \frac{1}{2} m(2)^2 - 0$$

$$\Rightarrow mg \times 50 - m \times 2(h - 50) = \frac{1}{2} m(2)^2 \Rightarrow h = 293 \text{ m}$$



11. A particle of mass  $0.3 \text{ kg}$  is subjected to a force  $F = -kx$  with  $k = 15 \text{ N/m}$ . What will be its initial acceleration if it is released from a point  $20 \text{ cm}$  away from the origin?

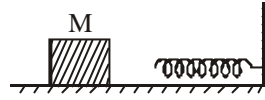
- (1)  $5 \text{ m/s}^2$                       (2)  $10 \text{ m/s}^2$                       (3)  $3 \text{ m/s}^2$                       (4)  $15 \text{ m/s}^2$

**Sol: Ans [2]**

At  $x = 20 \text{ cm}$ ,  $a = \frac{15 \times 0.2}{0.3} = 10 \text{ m/sec}^2$

12. The block of mass  $M$  moving on the frictionless horizontal surface collides with the spring of spring constant  $K$  and compresses it by length  $L$ . The maximum momentum of the block after collision is

- (1) zero                      (2)  $\frac{ML^2}{K}$
- (3)  $\sqrt{MK} L$               (4)  $\frac{KL^2}{2M}$

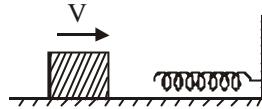


**Sol: Ans [3]**

Using conservation of energy

$$\frac{1}{2} mv^2 = \frac{1}{2} Kx^2$$

$$\Rightarrow \frac{(mv)^2}{2m} = \frac{1}{2} K x^2$$



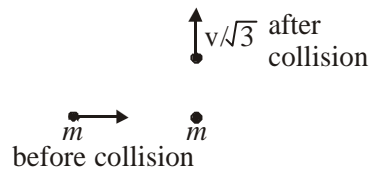
Maximum momentum

$$mv = \sqrt{KM} L \text{ (given } x = L)$$

13. A mass  $m$  moves with a velocity  $v$  and collides inelastically with another identical mass. After collision the 1<sup>st</sup> mass moves with velocity  $\frac{v}{\sqrt{3}}$  in a direction perpendicular to the initial direction of motion.

Find the speed of the 2<sup>nd</sup> mass after collision

- (1)  $\frac{2}{\sqrt{3}} v$                   (2)  $\frac{v}{\sqrt{3}}$
- (3)  $v$                           (4)  $\sqrt{3} v$



**Sol: Ans [1]**

Since there is no external force acting therefore momentum will be conserved in all direction

Conserving momentum along  $x$ -axis :

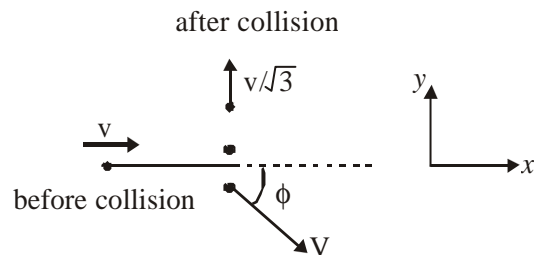
$$mv = mV \cos \phi$$

$$\Rightarrow V \cos \phi = v \tag{i}$$

Conserving momentum along  $y$ -axis :

$$m \frac{v}{\sqrt{3}} = mV \sin \phi$$

$$\Rightarrow V \sin \phi = \frac{v}{\sqrt{3}} \tag{ii}$$



From (i) & (ii)

$$V^2 = \frac{4v^2}{3} \Rightarrow V = \frac{2v}{\sqrt{3}}$$

14. A spherical ball of mass 20 kg is stationary at the top of a hill of height 100 m. It rolls down a smooth surface to the ground, then climbs up another hill of height 30 m and finally rolls down to a horizontal base at a height of 20 m above the ground. The velocity attained by the ball is

- (1) 10 m/s                      (2)  $10\sqrt{30}$  m/s                      (3) 40 m/s                      (4) 20 m/s

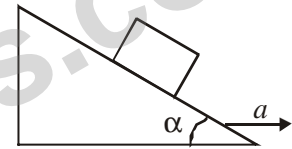
**Sol: Ans [3]**

Applying conservation of mechanical energy

$$\frac{1}{2}mv^2 = mg \times 80, \quad v = 40 \text{ m/sec}$$

15. A block is kept on a frictionless inclined surface with angle of inclination  $\alpha$ . The incline is given an acceleration  $a$  to keep the block stationary. Then  $a$  is equal to

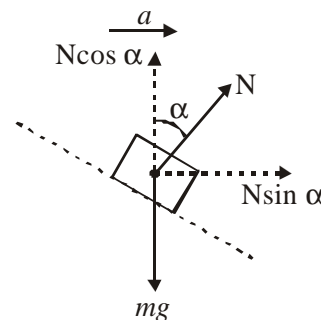
- (1)  $g$                                       (2)  $g \tan \alpha$   
 (3)  $g / \tan \alpha$                               (4)  $g \operatorname{cosec} \alpha$



**Sol: Ans [2]**

Net acceleration of block is in horizontal direction

$$\begin{aligned} N \cos \alpha &= mg \\ N \sin \alpha &= ma \\ \Rightarrow \tan \alpha &= a/g \\ \Rightarrow a &= g \tan \alpha \end{aligned}$$

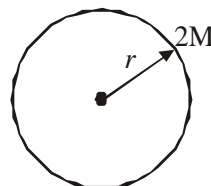


16. The moment of inertia of a uniform semicircular disc of mass  $M$  and radius  $r$  about a line perpendicular to the plane of the disc through the centre is

- (1)  $Mr^2$                                       (2)  $\frac{1}{2}Mr^2$                                       (3)  $\frac{1}{4}Mr^2$                                       (4)  $\frac{2}{5}Mr^2$

**Sol: Ans [2]**

$$I = \frac{\frac{1}{2}(2M)r^2}{2} = \frac{1}{2}Mr^2$$



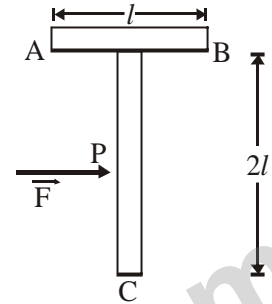
17. A body A of mass  $M$  while falling vertically downwards under gravity breaks into two parts: a body B of mass  $\frac{1}{3}M$  and a body C of mass  $\frac{2}{3}M$ . The centre of mass of bodies B and C taken together shifts compared to that of body A towards

- (1) body C
- (2) body B
- (3) depends on height of breaking
- (4) does not shift

**Sol: Ans [4]**

When body A breaks into B & C there is no change in external forces and internal forces play no role for motion of centre of mass.

18. A T shaped object with dimensions shown in the figure, is lying on a smooth floor. A force  $\vec{F}$  is applied at the point P parallel to AB, such that the object has only the translational motion without rotation. Find the location of P with respect to C.



- (1)  $\frac{4}{3}l$
- (2)  $l$
- (3)  $\frac{2}{3}l$
- (4)  $\frac{3}{2}l$

**Sol: Ans [1]**

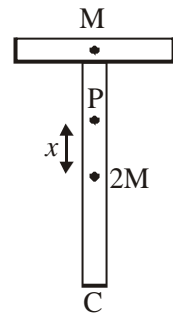
To have pure translatory motion, F must act at the centre of mass of the body.

Distance of centre of mass from mid-point O.

$$x = \frac{M}{3M} \cdot l = \frac{l}{3}$$

⇒ distance of P from C

$$= l + \frac{l}{3} = \frac{4l}{3}$$



19. The change in the value of  $g$  at a height  $h$  above the surface of the earth is the same as at a depth  $d$  below the surface of earth. When both  $d$  and  $h$  are much smaller than the radius of earth, then which one of the following is correct?

- (1)  $d = 2h$
- (2)  $d = h$
- (3)  $d = \frac{h}{2}$
- (4)  $d = \frac{3h}{2}$

**Sol: Ans [1]**

$$g\left(1 - \frac{2h}{R}\right) = g\left(1 - \frac{d}{R}\right)$$

⇒  $d = 2h$

20. A particle of mass 10 g is kept on the surface of a uniform sphere of mass 100 kg and radius 10 cm. Find the work to be done against the gravitational force between them to take the particle far away from the sphere (you may take  $G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2$ )

- (1)  $6.67 \times 10^{-9} \text{ J}$
- (2)  $6.67 \times 10^{-10} \text{ J}$
- (3)  $13.34 \times 10^{-10} \text{ J}$
- (4)  $3.33 \times 10^{-10} \text{ J}$

**Sol: Ans [2]**

Work done = change in potential energy

$$= 0 - \left[ \frac{G \times 100 \times 10 \times 10^{-3}}{0.1} \right]$$

$$= 6.67 \times 10^{-10} \text{ J}$$

**21.** A 20 cm long capillary tube is dipped in water. The water rises up to 8 cm. If the entire arrangement is put in a freely falling elevator the length of water column in the capillary tube will be

- (1) 4 cm                      (2) 20 cm                      (3) 8 cm                      (4) 10 cm

**Sol: Ans [3]**

In freely falling elevator effect of gravity will disappear and also angle of contact will become 90°

**22.** If S is stress and Y is Young's modulus of material of a wire, the energy stored in the wire per unit volume is

- (1)  $\frac{2Y}{S^2}$                       (2)  $\frac{S}{2Y}$                       (3)  $2S^2Y$                       (4)  $\frac{S^2}{2Y}$

**Sol: Ans [4]**

Formula

**23.** Average density of the earth

- (1) is directly proportional to  $g$                       (2) is inversely proportionally to  $g$   
 (3) does not depend on  $g$                       (4) is a complex function of  $g$

**Sol: Ans [1]**

$$\rho = \frac{M}{\frac{4}{3}\pi R^3} \times \frac{G}{G} = \frac{3g}{4\pi GR}$$

**24.** A body of mass  $m$  is accelerated uniform from rest to a speed  $v$  in a time  $T$ . The instantaneous power delivered to the body as a function of time is given by

- (1)  $\frac{1}{2} \frac{m v^2}{T^2} \cdot t$                       (2)  $\frac{1}{2} \frac{m v^2}{T^2} \cdot t^2$                       (3)  $\frac{m v^2}{T^2} \cdot t$                       (4)  $\frac{m v^2}{T^2} \cdot t^2$

**Sol: Ans [3]**

$$v = 0 + aT \Rightarrow a = \left( \frac{v}{T} \right)$$

Velocity at any time  $t = \left( \frac{v}{T} \cdot t \right)$

$$P = F \cdot v = \frac{m v}{T} \cdot \frac{v}{T} \cdot t = \frac{m v^2}{T^2} \cdot t$$

25. Consider a car moving on a straight road with a speed of 100 m/s. The distance at which car can be stopped is [ $\mu_k = 0.5$ ]

- (1) 100 m                      (2) 400 m                      (3) 800 m                      (4) 1000 m

Sol: Ans [4]

$$\text{Maximum retardation} = -\frac{\mu_k m g}{m} = -\mu_k g$$

$$0 = (100)^2 - 2 \times \mu_k \times 10 \times S$$

$$S = 1000 \text{ m}$$

26. Which of the following is incorrect regarding the first law of thermodynamics?

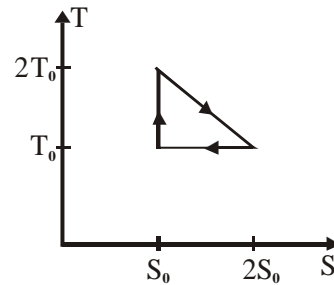
- (1) It introduces the concept of the internal energy
- (2) It introduces the concept of the entropy
- (3) It is not applicable to any cyclic process
- (4) It is a restatement of the principle of conservation of energy

Sol: Ans [2]

Second law of thermodynamics introduces the concept of entropy

27. The temperature-entropy diagram of a reversible engine cycle is given in the figure. Its efficiency is

- (1)  $\frac{1}{3}$                       (2)  $\frac{2}{3}$
- (3)  $\frac{1}{2}$                       (4)  $\frac{1}{4}$

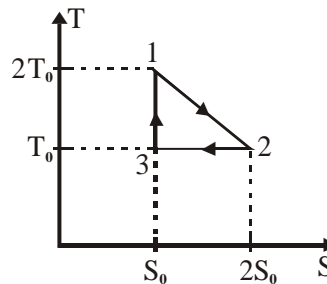


Sol: Ans [1]

$$\text{Heat taken from source} = \text{Area under curve } 1 - 2 = \frac{3}{2} S_0 T_0$$

$$\text{Work done} = \text{Area of closed path} = \frac{1}{2} S_0 T_0$$

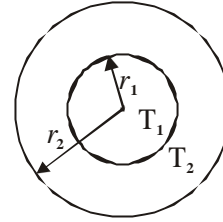
$$\eta = \frac{\frac{1}{2} S_0 T_0}{\frac{3}{2} S_0 T_0} = \frac{1}{3}$$





28. The figure shows a system of two concentric spheres of radii  $r_1$  and  $r_2$  and kept at temperature  $T_1$  and  $T_2$  respectively. The radial rate of flow of heat in a substance between the two concentric spheres is proportional to

- (1)  $\frac{r_1 r_2}{(r_2 - r_1)}$                       (2)  $(r_2 - r_1)$   
 (3)  $\frac{(r_2 - r_1)}{r_1 r_2}$                       (4)  $\ln \frac{r_2}{r_1}$



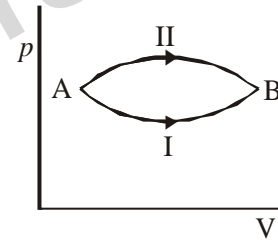
**Sol: Ans [1]**

$$\frac{dQ}{dt} = \frac{4\pi K(T_1 - T_2)}{(r_2 - r_1)} \cdot r_1 r_2$$

$$\Rightarrow \frac{dQ}{dt} \propto \frac{r_1 r_2}{(r_2 - r_1)}$$

29. A system goes from A to B via two processes I and II as shown in figure. If  $\Delta U_1$  and  $\Delta U_2$  are the changes in internal energies in the process I and II respectively, then

- (1)  $\Delta U_2 > \Delta U_1$   
 (2)  $\Delta U_2 < \Delta U_1$   
 (3)  $\Delta U_1 = \Delta U_2$   
 (4) relation between  $\Delta U_1$  and  $\Delta U_2$  can not be determined



**Sol: Ans [3]**

Change in internal energy is independent of path

30. A gaseous mixture consists of 16 g of helium and 16 g of oxygen. The ratio  $\frac{C_p}{C_v}$  of the mixture is

- (1) 1.4                      (2) 1.54                      (3) 1.59                      (4) 1.62

**Sol: Ans [4]**

$$\frac{n_1 + n_2}{\gamma - 1} = \frac{n_1}{\gamma_1 - 1} + \frac{n_2}{\gamma_2 - 1}$$

where  $r$  is for mixture

$$n_1 = \frac{16}{4} = 4; \quad n_2 = \frac{16}{32} = 0.5$$

$$\Rightarrow \frac{4 + \frac{1}{2}}{\gamma - 1} = \frac{4}{\frac{5}{3} - 1} + \frac{\frac{1}{2}}{\frac{7}{5} - 1}; \quad \gamma = 1.62$$

31. The intensity of gamma radiation from a given source is I. On passing through 36 mm of lead, it is reduced to  $\frac{I}{8}$ . The thickness of lead which will reduce the intensity to  $\frac{I}{2}$  will be

- (1) 18 mm                      (2) 12 mm                      (3) 6 mm                      (4) 9 mm

Sol: Ans [2]

$$I' = Ie^{-\mu x}$$

where  $\mu$  is coefficient of penetration

$$\frac{I}{8} = Ie^{-\mu \times 36}$$

$$\frac{I}{2} = Ie^{-\mu \cdot x}$$

Solving  $x = 12$  mm

32. The electrical conductivity of a semiconductor increases when electromagnetic radiation of wavelength shorter than 2480 nm is incident on it. The band gap in (eV) for the semiconductor is

- (1) 0.5 eV                      (2) 0.7 eV                      (3) 1.1 eV                      (4) 2.5 eV

Sol: Ans [1]

$$\text{Band gap} = \frac{hc}{\lambda} = \frac{6.6 \times 10^{-34} \times 3 \times 10^8}{2580 \times 10^{-9} \times 1.6 \times 10^{-19}} = 0.5 \text{ eV}$$

33. A photocell is illuminated by a small bright source placed 1 m away. When the same source of light is placed  $\frac{1}{2}$  m away, the number of electrons emitted by photocathode would

- (1) decrease by a factor of 2                      (2) increase by a factor of 2  
 (3) decrease by a factor of 4                      (4) increase by a factor of 4

Sol: Ans [4]

$$\text{No of electrons emitted } (n) \propto \frac{1}{d^2}$$

$$\Rightarrow \frac{n_1}{n_2} = \frac{d_2^2}{d_1^2}$$

$$n_2 = n_1 \frac{d_1^2}{d_2^2} = n_1 \times \frac{1^2}{(1/2)^2} = 4n_1$$

34. Starting with a sample of pure  $^{66}\text{Cu}$ ,  $\frac{7}{8}$  of it decays into Zn in 15 minutes. The corresponding half-life is

- (1) 5 minutes                      (2)  $7\frac{1}{2}$  minutes                      (3) 10 minutes                      (4) 15 minutes

**Sol: Ans [1]**

Applying

$$N = N_0 e^{-\lambda t}$$

$$\Rightarrow \frac{1}{8} N_0 = N_0 e^{-\lambda \times 15}$$

$$\Rightarrow \lambda \times 15 = \log_e 8$$

$$\lambda = \frac{3 \times 0.693}{15}$$

$$T_{1/2} = \frac{0.693}{\lambda} = 5 \text{ min}$$

35. If radius of the  $^{27}_{13}\text{Al}$  nucleus is estimated to be 3.6 Fermi then the radius of  $^{125}_{52}\text{Te}$  nucleus be nearly

- (1) 4 fermi                      (2) 5 fermi                      (3) 6 fermi                      (4) 8 fermi

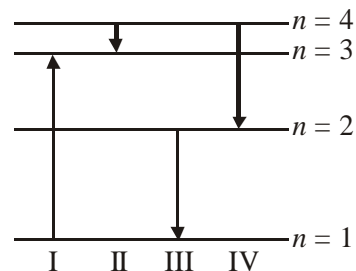
**Sol: Ans [3]**

$$\because A \propto r^3$$

$$\Rightarrow \frac{3.6}{r_{\text{Te}}} = \left(\frac{27}{125}\right)^{\frac{1}{3}} = \frac{3}{5} \Rightarrow r_{\text{Te}} = 6 \text{ fermi}$$

36. The diagram shows the energy levels for an electron in a certain atom. Which transition shown represents the emission of a photon with the most energy?

- (1) I                      (2) II  
(3) III                      (4) IV



**Sol: Ans [3]**

Maximum energy gap is for transition from  $n = 2 \rightarrow \text{I}$

37. If the kinetic energy of a free electron doubles, its deBroglie wavelength changes by the factor

- (1)  $\frac{1}{\sqrt{2}}$                       (2)  $\sqrt{2}$                       (3)  $\frac{1}{2}$                       (4) 2

**Sol: Ans [1]**

$$\lambda = \frac{h}{P} = \frac{h}{\sqrt{2mK}}; \quad \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{K_2}{K_1}}$$

$$\Rightarrow \lambda_2 = \frac{\lambda_1}{\sqrt{2}}$$

38. In a common base amplifier, the phase difference between the input signal voltage and output voltage is

- (1) 0                                      (2)  $\frac{\pi}{2}$                                       (3)  $\frac{\pi}{4}$                                       (4)  $\pi$

Sol: Ans [1]

39. In a full wave rectifier circuit operating from 50 Hz mains frequency, the fundamental frequency in the ripple would be

- (1) 100 Hz                                      (2) 70.7 Hz                                      (3) 50 Hz                                      (4) 25 Hz

Sol: Ans [1]

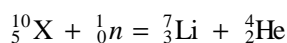


In full wave rectification frequency doubles

40. A nuclear transformation is denoted by  $X(n, \alpha)_3^7\text{Li}$ . Which of the following is the nucleus of element X?

- (1)  ${}_5^9\text{B}$                                       (2)  ${}_4^{11}\text{Be}$                                       (3)  ${}_{12}^{12}\text{C}_6$                                       (4)  ${}_5^{10}\text{B}$

Sol: Ans [4]



41. The function  $\sin^2(\omega t)$  represents

- (1) a simple harmonic motion with a period  $2\pi/\omega$   
 (2) a simple harmonic motion with a period  $\pi/\omega$   
 (3) a periodic, but not simple harmonic motion with a period  $2\pi/\omega$   
 (4) a periodic, but not simple harmonic motion with a period  $\pi/\omega$

Sol: Ans [2]

$$y = \sin^2(\omega t)$$

$$y = \frac{1}{2}(1 - \cos 2\omega t)$$

it represents S.H.M. with angular frequency  $2\omega$

$$\Rightarrow T = \frac{2\pi}{2\omega} = \frac{\pi}{\omega}$$

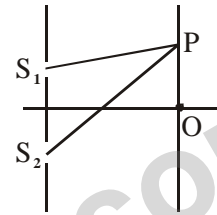
42. A Young's double slit experiment uses a monochromatic source. The shape of the interference fringes formed on a screen is

- (1) straight line                      (2) parabola                      (3) hyperbola                      (4) circle

Sol: Ans [3]

$$S_2P - S_1P = n\lambda$$

for a given  $n$ , difference of the distance of point P from two fixed points is constant therefore locus of any fringe will be hyperbola



43. Two simple harmonic motions are represented by the equation  $y_1 = 0.1 \sin\left(100\pi t + \frac{\pi}{3}\right)$  and

$y_2 = 0.1 \cos \pi t$ . The phase difference of the velocity of particle 1 with respect to the velocity of particle 2 is

- (1)  $-\frac{\pi}{3}$                       (2)  $\frac{\pi}{6}$                       (3)  $-\frac{\pi}{6}$                       (4)  $\frac{\pi}{3}$

Sol: Ans [3]

Velocity leads displacement by  $\pi/2$

$$\Rightarrow V_1 = 0.1 \sin\left(100\pi t + \frac{\pi}{3} + \frac{\pi}{2}\right); V_2 = 0.1 \sin\left(\pi t + \frac{\pi}{2} + \frac{\pi}{2}\right)$$

$$\Delta\phi_{12} = \left(\frac{\pi}{3} + \frac{\pi}{2}\right) - \left(\frac{\pi}{2} + \frac{\pi}{2}\right) = -\frac{\pi}{6}$$

44. A fish looking up through the water sees the outside world contained in a circular horizon. If the

refractive index of water is  $\frac{4}{3}$  and the fish is 12 cm below the surface, the radius of this circle in cm is

- (1)  $36\sqrt{5}$                       (2)  $4\sqrt{5}$                       (3)  $36\sqrt{7}$                       (4)  $36/\sqrt{7}$

Sol: Ans [4]

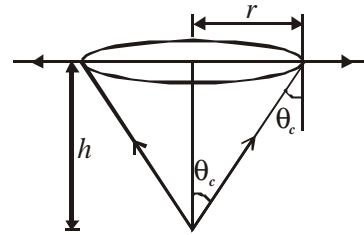
$$\tan \theta_c = \frac{r}{h}$$

$$\Rightarrow r = h \tan \theta_c$$

$$\therefore \sin \theta_c = \frac{1}{\mu}$$

$$\tan \theta_c = \frac{1}{\sqrt{\mu^2 - 1}}$$

$$\Rightarrow r = \frac{h}{\sqrt{\mu^2 - 1}} = \frac{12}{\sqrt{\frac{16}{9} - 1}} = \frac{36}{\sqrt{7}}$$



45. Two point white dots are 1 mm apart on a black paper. They are viewed by eye of pupil diameter 3 mm. Approximately, what is the maximum distance at which these dots can be resolved by the eye? [Take wavelength of light = 500 nm]

- (1) 6 m                      (2) 3 m                      (3) 5 m                      (4) 1 m

Sol: Ans []

46. A thin glass (refractive index 1.5) lens has optical power of 5 D in air. Its optical power in a liquid medium with refractive index 1.6 will be

- (1) 25 D                      (2) -25 D                      (3) 1 D                      (4) -1 D

Sol: Ans []

$$-5 = \left(\frac{3}{2} - 1\right) \left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{(i)}$$

$$P = \left(\frac{3/2}{8/5} - 1\right) \left(\frac{1}{R_1} - \frac{1}{R_2}\right) \quad \text{(ii)}$$

$$\Rightarrow -\frac{5}{P} = \frac{\frac{1}{2}}{-\frac{1}{16}} = -8$$

$$P = \frac{5}{8} \quad \text{There is no matching alternative}$$

47. When two tuning forks (fork 1 and fork 2) are sounded simultaneously, 4 beats per second are heard. Now, some tape is attached on the prong of the fork 2. When the tuning forks are sounded again, 6 beats per second are heard. If the frequency of fork 1 is 200 Hz, then what was the original frequency of fork 2?

(1) 196 Hz                      (2) 204 Hz                      (3) 200 Hz                      (4) 202 Hz

**Sol: Ans [1]**

When tape is attached to the tuning fork its frequency decreases, therefore frequency of 2, should be  
 $= 200 - 4 = 196 \text{ Hz}$ .

48. If a simple harmonic motion is represented by  $\frac{d^2x}{dt^2} + \alpha x = 0$ , its time period is

(1)  $2\pi\alpha$                       (2)  $2\pi\sqrt{\alpha}$                       (3)  $\frac{2\pi}{\alpha}$                       (4)  $\frac{2\pi}{\sqrt{\alpha}}$

**Sol: Ans [4]**

Comparing with  $\frac{d^2x}{dt^2} + \omega^2x = 0$

$$\omega^2 = \alpha \quad \Rightarrow \quad T = \frac{2\pi}{\sqrt{\alpha}}$$

49. The bob of a simple pendulum is a spherical hollow ball filled with water. A plugged hole near the bottom of the oscillating bob gets suddenly unplugged. During observation, till water is coming out, the time period of oscillation would

(1) remain unchanged  
 (2) increase towards a saturation value  
 (3) first increase and then decrease to the original value  
 (4) first decrease and then increase to the original value

**Sol: Ans [3]**

$$T = 2\pi\sqrt{\frac{l}{g}}$$

where  $l$  is distance between point of suspension and centre of mass of the body.

As water leaks out  $l$  increase and once ball is empty centre of mass comes to initial point.

50. An observer moves towards a stationary source of sound, with a velocity one-fifth of the velocity of sound. What is the percentage increase in the apparent frequency?

(1) 5 %                      (2) 20 %                      (3) zero                      (4) 0.5 %

**Sol: Ans [2]**

$$f' = f \left( \frac{v - v_0}{v - v_s} \right)$$

$$f' = f \left( \frac{v + v/5}{v} \right) = \left( \frac{6f}{5} \right)$$

$$\frac{f'}{f} = \frac{6}{5} \Rightarrow \frac{\Delta f}{f} = \frac{1}{5}$$

$$\% \text{ change} = \frac{\Delta f}{f} \times 100 = 20\%$$

51. If  $I_0$  is the intensity of the principal maximum in the single slit diffraction pattern, then what will be its intensity when the slit width is doubled?

- (1)  $I_0$                       (2)  $I_0/2$                       (3)  $2I_0$                       (4)  $4I_0$

Sol: Ans [1]

Intensity is independent of width of slit

52. When an unpolarized light of intensity  $I_0$  is incident on a polarizing sheet, the intensity of the light which does not get transmitted is

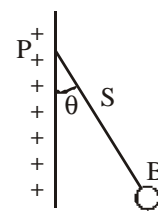
- (1) zero                      (2)  $I_0$                       (3)  $\frac{1}{2} I_0$                       (4)  $\frac{1}{4} I_0$

Sol: Ans [3]

Average intensity transmitted through polarizer is  $I_0/2$ , where  $I_0$  is intensity of unpolarized high.

53. A charged ball B hangs from a silk thread S, which makes an angle  $\theta$  with a large charged conducting sheet P, as shown in the figure. The surface charge density  $\sigma$  of the sheet is proportional to

- (1)  $\sin \theta$                       (2)  $\tan \theta$   
 (3)  $\cos \theta$                       (4)  $\cot \theta$



Sol: Ans [2]

For equilibrium

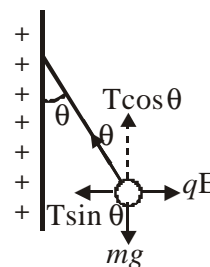
$$T \cos \theta = mg$$

$$T \sin \theta = qE$$

$$\Rightarrow \tan \theta = \frac{qE}{mg}$$

$$\Rightarrow mg \tan \theta = q \frac{\sigma}{2\epsilon_0}$$

$$\Rightarrow \sigma \propto \tan \theta$$





54. Two point charges  $+8q$  and  $-2q$  are located at  $x = 0$  and  $x = L$  respectively. The location of a point on the  $x$ -axis at which the net electric field due to these two point charges is zero is

- (1)  $8L$                       (2)  $4L$                       (3)  $2L$                       (4)  $\frac{L}{4}$

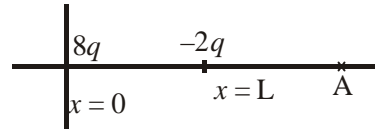
**Sol: Ans [3]**

Let  $E = 0$  at point A;

$$\Rightarrow \frac{K \times 8q}{x^2} = \frac{K \times 2q}{(x - L)^2}$$

$$\pm \frac{2}{x} = \frac{1}{x - L}$$

$$\Rightarrow x = 2L, \frac{2L}{3}$$



55. Two thin rings each having a radius  $R$  are placed at a distance  $d$  apart with their axes coinciding. The charges on the two rings are  $+q$  and  $-q$ . The potential difference between the centres of the two rings is

- (1) zero                      (2)  $\frac{Q}{4\pi\epsilon_0} \left[ \frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}} \right]$
- (3)  $\frac{Q}{4\pi\epsilon_0 d^2}$                       (4)  $\frac{Q}{2\pi\epsilon_0} \left[ \frac{1}{R} - \frac{1}{\sqrt{R^2 + d^2}} \right]$

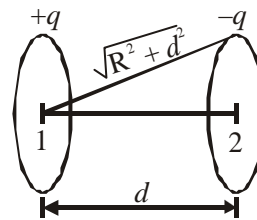
**Sol: Ans [4]**

Potential at 1

$$V_1 = \frac{Kq}{R} + \frac{-Kq}{\sqrt{R^2 + d^2}}$$

$$V_2 = \frac{-Kq}{R} + \frac{Kq}{\sqrt{R^2 + d^2}}$$

$$\Rightarrow V_1 - V_2 = \frac{2Kq}{R} - \frac{2Kq}{\sqrt{R^2 + d^2}}$$



56. A parallel plate capacitor is made by stacking  $n$  equally spaced plates connected alternatively. If the capacitance between any two adjacent plates is  $C$  then the resultant capacitance is

- (1)  $C$                       (2)  $nC$                       (3)  $(n - 1)C$                       (4)  $(n + 1)C$

**Sol: Ans [3]**

No of capacitor =  $(n - 1)$  connected in parallel

$$C_{eq} = (n - 1)C$$

57. A fully charged capacitor has a capacitance  $C$ . It is discharged through a small coil of resistance wire embedded in a thermally insulated block of specific heat capacity  $s$  and mass  $m$ . If the temperature of the block is raised by  $\Delta T$ , the potential difference  $V$  across the capacitance is

- (1)  $\frac{ms\Delta T}{C}$                       (2)  $\sqrt{\frac{2ms\Delta T}{C}}$                       (3)  $\sqrt{\frac{2mC\Delta T}{s}}$                       (4)  $\frac{mC\Delta T}{s}$

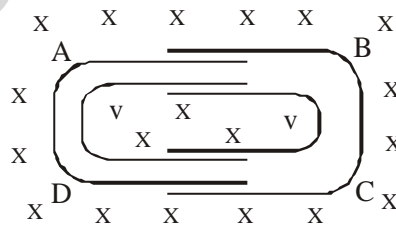
**Sol: Ans [2]**

Energy stored in capacitor is converted into heat by resistance, which further increases the temperature of block.

$$\Rightarrow \frac{1}{2} CV^2 = mS\Delta T$$

$$V = \sqrt{\frac{2mS\Delta T}{C}}$$

58. One conducting U tube can slide inside another as shown in figure, maintaining electrical contacts between the tubes. The magnetic field  $B$  is perpendicular to the plane of the figure. If each tube moves towards the other at a constant speed  $V$ , then the emf induced in the circuit in terms of  $B$ ,  $l$  and  $V$  where  $l$  is the width of each tube, will be



- (1) zero                      (2)  $2BlV$                       (3)  $B/V$                       (4)  $-B/V$

**Sol: Ans [2]**

Induction is due to change in area.

$$\begin{aligned} \frac{d\phi}{dt} &= B \frac{dA}{dt} \\ &= B \cdot 2 \cdot l \cdot V \quad (\text{Because relative velocity} = 2V) \end{aligned}$$

59. A heater coil is cut into two equal parts and only one part is now used in the heater. The heat generated will now be

- (1) one fourth                      (2) halved                      (3) doubled                      (4) four times

**Sol: Ans [3]**

$\therefore R \propto l$  therefore resistance will reduce to half

$$\therefore P = \frac{V^2}{R}$$

$\Rightarrow$  Power or heat will double

**60.** Two thin, long, parallel wires, separated by a distance  $d$  carry a current of  $i$  A in the same direction. They will

- (1) attract each other with a force of  $\mu_0 i^2 / (2\pi d^2)$  (2) repel each other with a force of  $\mu_0 i^2 / (2\pi d^2)$   
 (3) attract each other with a force of  $\mu_0 i^2 / (2\pi d)$  (4) repel each other with a force of  $\mu_0 i^2 / (2\pi d)$

**Sol: Ans [3]**

Formula (force is per unit length)

**61.** A moving coil galvanometer has 150 equal divisions. Its current sensitivity is 10 divisions per milliampere and voltage sensitivity is 2 divisions per millivolt. In order that each division reads 1 volt, the resistance in ohms needed to be connected in series with the coil will be

- (1) 99995 (2) 9995 (3)  $10^3$  (4)  $10^5$

**Sol: Ans [2]**

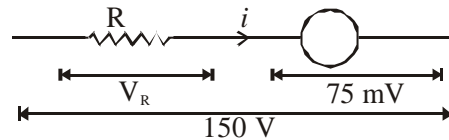
Maximum current through galvanometer = 15 mA (150/10)

Maximum voltage across galvanometer = 75 mV (150/2)

To have 1 division/volt, Range of galvanometer = 150 V

$$V_R = 150 - 0.075 = 149.925 \text{ volt}$$

$$\Rightarrow R = \frac{149.925}{15 \times 10^{-3}} = 9995 \Omega$$



**62.** Two voltmeters, one of copper and another of silver, are joined in parallel. When a total charge  $q$  flows through the voltmeters, equal amount of metals are deposited. If the electrochemical equivalents of copper and silver are  $z_1$  and  $z_2$  respectively the charge which flows through the silver voltmeter is

- (1)  $q \frac{z_1}{z_2}$  (2)  $q \frac{z_2}{z_1}$  (3)  $\frac{q}{1 + \frac{z_1}{z_2}}$  (4)  $\frac{q}{1 + \frac{z_2}{z_1}}$

**Sol: Ans [4]**

$$\therefore m = z q$$

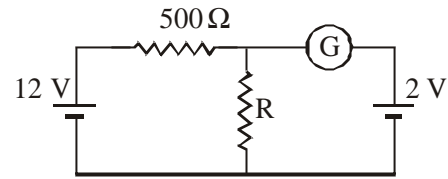
$$z_1 q_1 = z_2 q_2 \quad (\text{mass deposited is same})$$

$$\Rightarrow 1 + \frac{q_1}{q_2} = \frac{z_2}{z_1} + 1$$

$$\Rightarrow q_2 = \frac{z_1}{z_1 + z_2} q$$

63. In the circuit, the galvanometer G shows zero deflection. If the batteries A and B have negligible internal resistance, the value of the resistor R will be

- (1) 500 Ω                      (2) 1000 Ω  
 (3) 200 Ω                      (4) 100 Ω



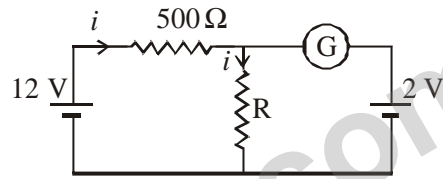
**Sol: Ans [4]**

If there is no current through 2 V battery voltage across R = 2 volt

$$i = \frac{12}{500 + R}$$

$$\Rightarrow R \times \frac{12}{500 + R} = 2$$

$$\Rightarrow R = 100 \Omega$$



64. Two sources of equal emf are connected to an external resistance R. The internal resistances of the two sources are R<sub>1</sub> and R<sub>2</sub> (R<sub>2</sub> > R<sub>1</sub>). If the potential difference across the source having internal resistance R<sub>2</sub> is zero, then

- (1)  $R = \frac{R_1 R_2}{(R_1 + R_2)}$                       (2)  $R = \frac{R_1 R_2}{(R_2 - R_1)}$   
 (3)  $R = R_2 \times \frac{(R_1 + R_2)}{(R_2 - R_1)}$                       (4)  $R = R_2 - R_1$

**Sol: Ans [4]**

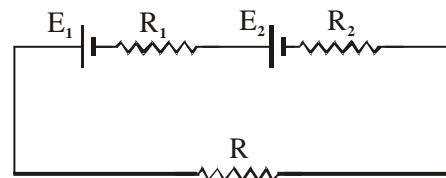
∴ Terminal voltage across E<sub>2</sub> = 0

$$\Rightarrow 0 = E_2 - iR_2 \quad \Rightarrow \quad i = E_2/R_2 = E/R_2$$

Also, 
$$i = \frac{E_1 + E_2}{R_1 + R_2 + R} = \frac{2E}{R_1 + R_2 + R}$$

$$\Rightarrow \frac{2E}{R_1 + R_2 + R} = \frac{E}{R_2}$$

$$\Rightarrow R = R_2 - R_1$$



65. Two concentric coils each of radius equal to 2π cm are placed at right angles to each other. 3 ampere and 4 ampere are the currents flowing in each coil respectively. The magnetic induction in Weber/m<sup>2</sup> at the centre of the coils will be (μ<sub>0</sub> = 4π × 10<sup>-7</sup> Wb/A·m)

- (1) 5 × 10<sup>-5</sup>                      (2) 7 × 10<sup>-5</sup>                      (3) 12 × 10<sup>-5</sup>                      (4) 10<sup>-5</sup>

**Sol: Ans [1]**

Magnetic induction at the centre of the coil is along axis of the coil, therefore B due to each coil will be perpendicular at their common centre

$$B = \sqrt{B_1^2 + B_2^2} = \sqrt{\left(\frac{\mu_0 \times 3}{2 \times 2\pi \times 10^{-2}}\right)^2 + \left(\frac{\mu_0 \times 4}{2 \times 2\pi \times 10^{-2}}\right)^2}$$

$$= 5 \times 10^{-5} \text{ W/m}^2$$

66. A charged particle of mass  $m$  and charge  $q$  travels on a circular path of radius  $r$  that is perpendicular to a magnetic field  $B$ . The time taken by the particle to complete one revolution is

- (1)  $\frac{2\pi q B}{m}$                       (2)  $\frac{2\pi m}{q B}$                       (3)  $\frac{2\pi m q}{B}$                       (4)  $\frac{2\pi q^2 B}{m}$

Sol: Ans [2]

Formula

67. In a potentiometer experiment the balancing with a cell is at length 240 cm. On shunting the cell with a resistance of  $2 \Omega$ , the balancing length becomes 120 cm. The internal resistance of the cell is

- (1)  $4 \Omega$                       (2)  $2 \Omega$                       (3)  $1 \Omega$                       (4)  $0.5 \Omega$

Sol: Ans [2]

$$r = R \left( \frac{l_1}{l_2} - 1 \right) = 2 \left( \frac{240}{120} - 1 \right) = 2 \Omega$$

68. The resistance of hot tungsten filament is about 10 times the cold resistance. What will be the resistance of 100 W and 200 V lamp when not in use?

- (1)  $400 \Omega$                       (2)  $200 \Omega$                       (3)  $40 \Omega$                       (4)  $20 \Omega$

Sol: Ans [3]

Resistance of lamp when in use

$$R = \frac{V^2}{P} = \frac{200 \times 200}{100} = 400 \Omega$$

Resistance when filament is cold (i.e. lamp is not in use) =  $\frac{400}{10} = 40 \Omega$

69. A magnetic needle is kept in a non-uniform magnetic field. It experiences

- (1) a force and a torque                      (2) a force but not a torque  
 (3) a torque but not a force                      (4) neither a force nor a torque

Sol: Ans [1]

Force on needle =  $M \frac{dB}{dl}$

Where  $\frac{dB}{dt}$  is rate of variation of B along magnetic moment

It shows that in non uniform field force is not zero. Torque acts irrespective of nature of field.

- 70.** A uniform electric field and a uniform magnetic field are acting the same direction in a certain region. If an electron is projected along the direction of the fields with a certain velocity then
- (1) it will turn towards right of direction of motion
  - (2) it will turn towards left of direction of motion
  - (3) its velocity will decrease
  - (4) its velocity will increase

**Sol: Ans [3]**

Magnetic force = 0

Electric force will be opposite to E i.e., opposite to velocity in this case therefore there will be retardation.

- 71.** A coil of inductance 300 mH and resistance 2  $\Omega$  is connected to a sources of voltage 2 V. The current reaches half of its steady state value in
- (1) 0.15 s
  - (2) 0.3 s
  - (3) 0.05 s
  - (4) 0.1 s

**Sol: Ans [4]**

$$i = i_0 e^{-\frac{R}{L}t}$$

$$\frac{1}{2} i_0 = i_0 e^{-\frac{2}{300 \times 10^{-3}}t}$$

$$\Rightarrow t = 0.1 \text{ sec.}$$

- 72.** The self inductance of the motor of an electric fan is 10 H. In order to impart maximum power at 50 Hz, it should be connected to a capacitance of
- (1) 1  $\mu\text{F}$
  - (2) 2  $\mu\text{F}$
  - (3) 4  $\mu\text{F}$
  - (4) 8  $\mu\text{F}$

**Sol: Ans [1]**

For maximum power:  $\omega = \frac{1}{\sqrt{LC}}$

$$\Rightarrow 2\pi \times 50 = \frac{1}{(10 \times C)^{1/2}}$$

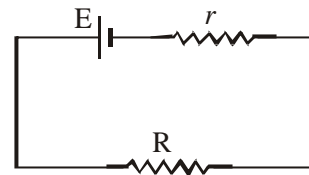
$$\Rightarrow C = 1 \mu\text{F}$$

- 73.** An energy source will supply a constant current into the load if its internal resistance is
- (1) zero
  - (2) non-zero but less than the resistance of the load

- (3) equal to the resistance of the load
- (4) very large as compared to the load resistance

**Sol: Ans [4]**

$$i = \frac{E}{R + r} = \frac{E}{r \left[ 1 + \frac{R}{r} \right]}$$



if  $r \gg R \Rightarrow i \approx \frac{E}{r}$  i.e., current is independent of load resistance.

**74.** A circuit has a resistance of 12 ohm and an impedance of 15 ohm. The power factor of the circuit will be

- (1) 1.25
- (2) 0.125
- (3) 0.8
- (4) 0.4

**Sol: Ans [3]**

$$\cos \phi = \frac{R}{z} = \frac{12}{15} = 0.8$$

**75.** The phase difference between the alternating current and emf is  $\frac{\pi}{2}$ . Which of the following cannot be the constituent of the circuit?

- (1) L, C
- (2) L along
- (3) C alone
- (4) R, L

**Sol: Ans [4]**

For non resistance circuit;  $\phi$  is always  $\pi/2$ .