Solutions to AIEEE–2006

MATHEMATICS

PART–A

1. ABC is a triangle, right angled at A. The resultant of the forces acting along $\overrightarrow{AB}, \overrightarrow{AC}$ with magnitudes $\frac{1}{AB}$ and $\frac{1}{AC}$ respectively is the force along $\overrightarrow{AD}$, where D is the foot of the perpendicular from A onto BC. The magnitude of the resultant is

(1) $\frac{AB^2 + AC^2}{(AB)^2(AC)^2}$ (2) $\frac{(AB)(AC)}{AB + AC}$

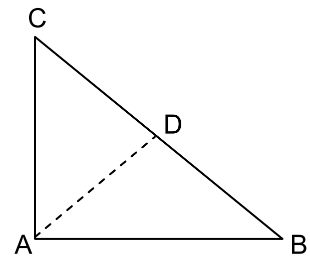
(3) $\frac{1}{AB} + \frac{1}{AC}$ (4) $\frac{1}{AD}$

Ans. (4)

Sol: Magnitude of resultant

$$= \sqrt{\left(\frac{1}{AB}\right)^2 + \left(\frac{1}{AC}\right)^2} = \frac{\sqrt{AB^2 + AC^2}}{AB \cdot AC}$$

$$= \frac{BC}{AB \cdot AC} = \frac{BC}{AD \cdot BC} = \frac{1}{AD}$$



2. Suppose a population A has 100 observations 101, 102, … , 200, and another population B has 100 observations 151, 152, … , 250. If V_A and V_B represent the variances of the two populations, respectively, then $\frac{V_A}{V_B}$ is

(1) 1 (2) 9/4

(3) 4/9 (4) 2/3

Ans. (1)

Sol: $\sigma_x^2 = \frac{\sum d_i^2}{n}$. (Here deviations are taken from the mean)

Since A and B both has 100 consecutive integers, therefore both have same standard deviation and hence the variance.

$\therefore \frac{V_A}{V_B} = 1$ $\left(\text{As } \sum d_i^2 \text{ is same in both the cases}\right)$.

3. If the roots of the quadratic equation $x^2 + px + q = 0$ are tan30° and tan15°, respectively then the value of $2 + q - p$ is

(3) 2 (2) 3

(3) 0 (4) 1

Ans. (2)

Sol: $x^2 + px + q = 0$

$\tan 30° + \tan 15° = -p$

$\tan 30° \cdot \tan 15° = q$

$\tan 45° = \dfrac{\tan 30° + \tan 15°}{1 - \tan 30° \tan 15°} = \dfrac{-p}{1-q} = 1$

$\Rightarrow -p = 1 - q$

$\Rightarrow q - p = 1 \quad \therefore\ 2 + q - p = 3.$

4. The value of the integral, $\int_3^6 \frac{\sqrt{x}}{\sqrt{9-x}+\sqrt{x}}dx$ is

(1) 1/2 (2) 3/2

(3) 2 (4) 1

Ans. (2)

Sol: $I = \int_3^6 \frac{\sqrt{x}}{\sqrt{9-x}+\sqrt{x}}dx$

$I = \int_3^6 \frac{\sqrt{9-x}}{\sqrt{9-x}+\sqrt{x}}dx$

$2I = \int_3^6 dx = 3 \Rightarrow I = \frac{3}{2}.$

5. The number of values of x in the interval [0, 3π] satisfying the equation $2\sin^2 x + 5\sin x - 3 = 0$ is

(1) 4 (2) 6

(3) 1 (4) 2

Ans. (1)

Sol: $2\sin^2 x + 5\sin x - 3 = 0$

$\Rightarrow (\sin x + 3)(2\sin x - 1) = 0$

$\Rightarrow \sin x = \frac{1}{2} \quad \therefore$ In (0, 3π), x has 4 values

6. If $(\bar{a}\times\bar{b})\times\bar{c} = \bar{a}\times(\bar{b}\times\bar{c})$, where $\bar{a}, \bar{b}$ and $\bar{c}$ are any three vectors such that $\bar{a}\cdot\bar{b} \neq 0$, $\bar{b}\cdot\bar{c} \neq 0$, then $\bar{a}$ and $\bar{c}$ are

(1) inclined at an angle of π/3 between them

(2) inclined at an angle of π/6 between them

(3) perpendicular

(4) parallel

Ans. (4)

Sol: $(\bar{a}\times\bar{b})\times\bar{c} = \bar{a}\times(\bar{b}\times\bar{c}),\ \bar{a}\cdot\bar{b} \neq 0,\ \bar{b}\cdot\bar{c} \neq 0$

$\Rightarrow (\bar{a}\cdot\bar{c})\bar{b} - (\bar{b}\cdot\bar{c})\bar{a} = (\bar{a}\cdot\bar{c})\bar{b} - (\bar{a}\cdot\bar{b})\bar{c}$

$(\bar{a}\cdot\bar{b})\bar{c} = (\bar{b}\cdot\bar{c})\bar{a}$

$\bar{a} \parallel \bar{c}$

7. Let W denote the words in the English dictionary. Define the relation R by :

$R = \{(x, y) \in W \times W \mid$ the words x and y have at least one letter in common$\}$. Then R is

(1) not reflexive, symmetric and transitive
(2) reflexive, symmetric and not transitive
(3) reflexive, symmetric and transitive
(4) reflexive, not symmetric and transitive

Ans. (2)

Sol: Clearly $(x, x) \in R\ \forall x \in W$. So, R is reflexive.
Let $(x, y) \in R$, then $(y, x) \in R$ as x and y have at least one letter in common. So, R is symmetric.
But R is not transitive for example
Let x = DELHI, y = DWARKA and z = PARK
then $(x, y) \in R$ and $(y, z) \in R$ but $(x, z) \notin R$.

8. If A and B are square matrices of size $n \times n$ such that $A^2 - B^2 = (A - B)(A + B)$, then which of the following will be always true ?

(1) A = B
(2) AB = BA
(3) either of A or B is a zero matrix
(4) either of A or B is an identity matrix

Ans. (2)

Sol: $A^2 - B^2 = (A - B)(A + B)$
$A^2 - B^2 = A^2 + AB - BA - B^2$
$\Rightarrow AB = BA$.

9. The value of $\sum_{k=1}^{10}\left(\sin\frac{2k\pi}{11} + i\cos\frac{2k\pi}{11}\right)$ is

(1) i
(2) 1
(3) –1
(4) –i

Ans. (4)

Sol: $\sum_{k=1}^{10}\left(\sin\frac{2k\pi}{11} + i\cos\frac{2k\pi}{11}\right) = \sum_{k=1}^{10}\sin\frac{2k\pi}{11} + i\sum_{k=1}^{10}\cos\frac{2k\pi}{11}$
$= 0 + i(-1) = -i$.

10. All the values of m for which both roots of the equations $x^2 - 2mx + m^2 - 1 = 0$ are greater than –2 but less than 4, lie in the interval

(1) $-2 < m < 0$
(2) $m > 3$
(3) $-1 < m < 3$
(4) $1 < m < 4$

Ans. (3)

Sol: Equation $x^2 - 2mx + m^2 - 1 = 0$
$(x - m)^2 - 1 = 0$
$(x - m + 1)(x - m - 1) = 0$
$x = m - 1, m + 1$
$-2 < m - 1$ and $m + 1 < 4$
$m > -1$ and $m < 3$
$-1 < m < 3$.

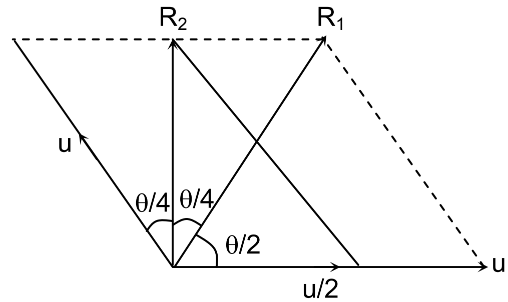
11. A particle has two velocities of equal magnitude inclined to each other at an angle θ. If one of them is halved, the angle between the other and the original resultant velocity is bisected by the new resultant. Then θ is

(1) 90° (2) 120°

(3) 45° (4) 60°

Ans. (2)

Sol: $\tan\frac{\theta}{4} = \frac{\frac{u}{2}\sin\theta}{u + \frac{u}{2}\cos\theta}$



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

$\therefore 2\sin\frac{\theta}{4} = \sin\frac{3\theta}{4} = 3\sin\frac{\theta}{4} - 4\sin^3\frac{\theta}{4}$

$\therefore \sin^2\frac{\theta}{4} = \frac{1}{4} \Rightarrow \frac{\theta}{4} = 30°$ or θ = 120°.

12. At a telephone enquiry system the number of phone cells regarding relevant enquiry follow Poisson distribution with an average of 5 phone calls during 10-minute time intervals. The probability that there is at the most one phone call during a 10-minute time period is

(1) $\frac{6}{5^e}$ (2) $\frac{5}{6}$

(3) $\frac{6}{55}$ (4) $\frac{6}{e^5}$

Ans. (4)

Sol: $P(X = r) = \frac{e^{-m}m^r}{r!}$

$P(X \le 1) = P(X = 0) + P(X = 1)$

$= e^{-5} + 5 \times e^{-5} = \frac{6}{e^5}$.

13. A body falling from rest under gravity passes a certain point P. It was at a distance of 400 m from P, 4s prior to passing through P. If g = 10 m/s^2, then the height above the point P from where the body began to fall is

(1) 720 m (2) 900 m

(3) 320 m (4) 680 m

Ans. (1)

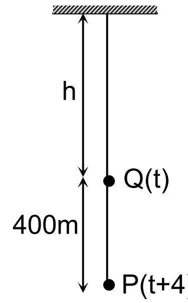
Sol: We have $h = \frac{1}{2}gt^2$ and h + 400 = $\frac{1}{2}g(t+4)^2$.

Subtracting we get 400 = 8g + 4gt

$\Rightarrow$ t = 8 sec

$\therefore\ h = \frac{1}{2} \times 10 \times 64 = 320m$

$\therefore$ Desired height = 320 + 400 = 720 m.



14. $\int_0^{\pi} xf(\sin x)dx$ is equal to

(1) $\pi\int_0^{\pi} f(\cos x)dx$ (2) $\pi\int_0^{\pi} f(\sin x)dx$

(3) $\frac{\pi}{2}\int_0^{\pi/2} f(\sin x)dx$ (4) $\pi\int_0^{\pi/2} f(\cos x)dx$

Ans. (4)

Sol: I = $\int_0^{\pi} xf(\sin x)\,dx = \int_0^{\pi} (\pi - x)f(\sin x)\,dx$

= $\pi\int_0^{\pi} f(\sin x)\,dx - I$

2I = $\pi\int_0^{\pi} f(\sin x)\,dx$

I = $\frac{\pi}{2}\int_0^{\pi} f(\sin x)\,dx = \pi\int_0^{\pi/2} f(\sin x)\,dx$

= $\pi\int_0^{\pi/2} f(\cos x)\,dx$.

15. A straight line through the point A(3, 4) is such that its intercept between the axes is bisected at A. Its equation is

(1) x + y = 7 (2) 3x – 4y + 7 = 0

(3) 4x + 3y = 24 (4) 3x + 4y = 25

Ans. (3)

Sol: The equation of axes is xy = 0

$\Rightarrow$ the equation of the line is

$\frac{x \cdot 4 + y \cdot 3}{2} = 12 \Rightarrow$ 4x + 3y = 24.

16. The two lines x = ay + b, z = cy + d; and x = a′y + b′, z = c′y + d′ are perpendicular to each other if

(1) aa′ + cc′ = –1 (2) aa′ + cc′ = 1

(3) $\frac{a}{a'} + \frac{c}{c'} = -1$ (4) $\frac{a}{a'} + \frac{c}{c'} = 1$

Ans. (1)

Sol: Equation of lines $\frac{x-b}{a} = y = \frac{z-d}{c}$

$\frac{x-b'}{a'} = y = \frac{z-d'}{c'}$

Lines are perpendicular $\Rightarrow$ aa′ + 1 + cc′ = 0.

17. The locus of the vertices of the family of parabolas $y = \frac{a^3x^2}{3} + \frac{a^2x}{2} - 2a$ is

(!) $xy = \frac{105}{64}$ (2) $xy = \frac{3}{4}$

(3) $xy = \frac{35}{16}$ (4) $xy = \frac{64}{105}$

Ans. (1)

Sol: Parabola: $y = \frac{a^3x^2}{3} + \frac{a^2x}{2} - 2a$

Vertex: (α, β)

$\alpha = \frac{-a^2/2}{2a^3/3} = -\frac{3}{4a}$, $\beta = \frac{-\left(\frac{a^4}{4} + 4\cdot\frac{a^3}{3}\cdot 2a\right)}{4\frac{a^3}{3}} = -\frac{-\left(\frac{1}{4}+\frac{8}{3}\right)a^4}{\frac{4}{3}a^3}$

$= -\frac{35}{12}\frac{a}{4}\times 3 = -\frac{35}{16}a$

$\alpha\beta = -\frac{3}{4a}\left(-\frac{35}{16}\right)a = \frac{105}{64}$.

18. The values of a, for which the points A, B, C with position vectors $2\hat{i} - \hat{j} + \hat{k}, \hat{i} - 3\hat{j} - 5\hat{k}$ and $a\hat{i} - 3\hat{j} + \hat{k}$ respectively are the vertices of a right-angled triangle with $C = \frac{\pi}{2}$ are

(1) 2 and 1 (2) –2 and –1

(3) –2 and 1 (4) 2 and –1

Ans. (1)

Sol: $\Rightarrow \overrightarrow{BA} = \hat{i} - 2\hat{j} + 6\hat{k}$

$\overrightarrow{CA} = (2-a)\hat{i} + 2\hat{j}$

$\overrightarrow{CB} = (1-a)\hat{i} - 6\hat{k}$

$\overrightarrow{CA}\cdot\overrightarrow{CB} = 0 \Rightarrow (2-a)(1-a) = 0$

$\Rightarrow a = 2, 1.$

19. $\int_{-3\pi/2}^{-\pi/2}\left[(x+\pi)^3+\cos^2(x+3\pi)\right]dx$ is equal to

(1) $\frac{\pi^4}{32}$ (2) $\frac{\pi^4}{32}+\frac{\pi}{2}$

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

Ans. (3)

Sol: $I = \int_{-3\pi/2}^{-\pi/2}\left[(x+\pi)^3+\cos^2(x+3\pi)\right]dx$

Put $x + \pi = t$

$I = \int_{-\pi/2}^{\pi/2}\left[t^3+\cos^2 t\right]dt = 2\int_{0}^{\pi/2}\cos^2 t\,dt$

$= \int_{0}^{\pi/2}(1+\cos 2t)\,dt = \frac{\pi}{2}+0$.

20. If x is real, the maximum value of $\frac{3x^2+9x+17}{3x^2+9x+7}$ is

(1) 1/4 (2) 41

(3) 1 (4) 17/7

Ans. (2)

Sol: $y=\frac{3x^2+9x+17}{3x^2+9x+7}$

$3x^2(y-1) + 9x(y-1) + 7y - 17 = 0$

$D \geq 0 \quad \because$ x is real

$81(y-1)^2 - 4x3(y-1)(7y-17) \geq 0$

$\Rightarrow (y-1)(y-41) \leq 0 \Rightarrow 1 \leq y \leq 41.$

21. In an ellipse, the distance between its foci is 6 and minor axis is 8. Then its eccentricity is

(1) $\frac{3}{5}$ (B) $\frac{1}{2}$

(C) $\frac{4}{5}$ (D) $\frac{1}{\sqrt{5}}$

Ans. (1)

Sol: $2ae = 6 \Rightarrow ae = 3$

$2b = 8 \Rightarrow b = 4$

$b^2 = a^2(1 - e^2)$

$16 = a^2 - a^2e^2$

$a^2 = 16 + 9 = 25$

$a = 5$

$\therefore e=\frac{3}{a}=\frac{3}{5}$

22. Let A = $\begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}$ and B = $\begin{pmatrix} a & 0 \\ 0 & b \end{pmatrix}$, $a, b \in N$. Then

(1) there cannot exist any B such that AB = BA
(2) there exist more than one but finite number of B's such that AB = BA
(3) there exists exactly one B such that AB = BA
(4) there exist infinitely many B's such that AB = BA

Ans. (4)

Sol: $A = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$ $\quad B = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}$

$AB = \begin{bmatrix} a & 2b \\ 3a & 4b \end{bmatrix}$

$BA = \begin{bmatrix} a & 0 \\ 0 & b \end{bmatrix}\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix} = \begin{bmatrix} a & 2a \\ 3b & 4b \end{bmatrix}$

AB = BA only when a = b

23. The function f(x) = $\frac{x}{2} + \frac{2}{x}$ has a local minimum at

(1) x = 2 (2) x = –2
(3) x = 0 (4) x = 1

Ans. (1)

Sol: $\frac{x}{2} + \frac{2}{x}$ is of the form $x + \frac{1}{x} \geq 2$ & equality holds for x = 1

24. Angle between the tangents to the curve $y = x^2 - 5x + 6$ at the points (2, 0) and (3, 0) is

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

Ans. (2)

Sol: $\frac{dy}{dx} = 2x - 5$

$\therefore m_1 = (2x - 5)_{(2, 0)} = -1$, $m_2 = (2x - 5)_{(3, 0)} = 1$
$\Rightarrow m_1 m_2 = -1$

25. Let $a_1, a_2, a_3, \ldots$ be terms of an A.P. If $\frac{a_1 + a_2 + \cdots a_p}{a_1 + a_2 + \cdots + a_q} = \frac{p^2}{q^2}, p \neq q$, then $\frac{a_6}{a_{21}}$ equals

(1) $\frac{41}{11}$ (2) $\frac{7}{2}$
(3) $\frac{2}{7}$ (4) $\frac{11}{41}$

Ans. (4)

Sol: $\dfrac{\frac{p}{2}\left[2a_1+(p-1)d\right]}{\frac{q}{2}\left[2a_1+(q-1)d\right]}=\dfrac{p^2}{q^2}\Rightarrow\dfrac{2a_1+(p-1)d}{2a_1+(q-1)d}=\dfrac{p}{q}$

$$\frac{a_1+\left(\frac{p-1}{2}\right)d}{a_1+\left(\frac{q-1}{2}\right)d}=\frac{p}{q}$$

For $\frac{a_6}{a_{21}}$, $p=11,\ q=41\ \rightarrow\frac{a_6}{a_{21}}\ =\frac{11}{41}$

26. The set of points where $f(x)=\dfrac{x}{1+|x|}$ is differentiable is

(1) $(-\infty, 0)\cup(0, \infty)$
(2) $(-\infty, -1)\cup(-1, \infty)$
(3) $(-\infty, \infty)$
(4) $(0, \infty)$

Ans. (3)

Sol: $f(x)=\begin{cases}\dfrac{x}{1-x}, & x<0\\ \dfrac{x}{1+x}, & x\ge 0\end{cases}\quad\Rightarrow\ f'(x)=\begin{cases}\dfrac{1}{(1-x)^2}, & x<0\\ \dfrac{1}{(1+x)^2}, & x\ge 0\end{cases}$

$\therefore$ $f'(x)$ exist at everywhere.

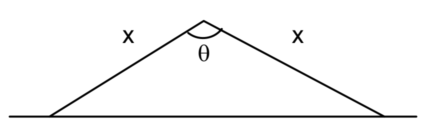
27. A triangular park is enclosed on two sides by a fence and on the third side by a straight river bank. The two sides having fence are of same length x. The maximum area enclosed by the park is

(1) $\frac{3}{2}x^2$
(2) $\sqrt{\frac{x^3}{8}}$
(3) $\frac{1}{2}x^2$
(4) πx^2

Ans. (3)

Sol: Area = $\frac{1}{2}x^2\sin\theta$

$A_{max}=\frac{1}{2}x^2\left(\text{at }\sin\theta=1,\quad\theta=\frac{\pi}{2}\right)$



28. At an election, a voter may vote for any number of candidates, not greater than the number to be elected. There are 10 candidates and 4 are of be elected. If a voter votes for at least one candidate, then the number of ways in which he can vote is

(1) 5040
(2) 6210
(3) 385
(4) 1110

Ans. (3)

Sol: ${}^{10}C_1 + {}^{10}C_2 + {}^{10}C_3 + {}^{10}C_4$
$= 10 + 45 + 120 + 210 = 385$

29. If the expansion in powers of x of the function $\frac{1}{(1-ax)(1-bx)}$ is $a_0 + a_1x + a_2x^2 + a_3x^3 + \dots$, then a_n is

(1) $\frac{b^n - a^n}{b-a}$ (2) $\frac{a^n - b^n}{b-a}$

(3) $\frac{a^{n+1} - b^{n+1}}{b-a}$ (4) $\frac{b^{n+1} - a^{n+1}}{b-a}$

Ans. (4)

Sol: $(1-ax)^{-1}(1-bx)^{-1} = \left(1+ax+a^2x^2+......\right)\left(1+bx+b^2x^2+....\right)$

$\therefore$ coefficient of $x^n = b^n + ab^{n-1} + a^2b^{n-2} + ... + a^{n-1}b + a^n = \frac{b^{n+1} - a^{n+1}}{b-a}$

$\therefore\ a_n = \frac{b^{n+1} - a^{n+1}}{b-a}$

30. For natural numbers m, n if $(1 - y)^m (1 + y)^n = 1 + a_1y + a_2y^2 + \dots$, and $a_1 = a_2 = 10$, then (m, n) is

(1) (20, 45) (2) (35, 20)

(3) (45, 35) (4) (35, 45)

Ans. (4)

Sol: $(1-y)^m(1+y)^n = \left[1-{}^mC_1y+{}^mC_2y^2-....\right]\left[1+{}^nC_1y+{}^nC_2y^2+...\right]$

$= 1+(n-m)+\left\{\frac{m(m-1)}{2}+\frac{n(n-1)}{2}-mn\right\}y^2+.....$

$\therefore a_1 = n-m = 10$ and $a_2 = \frac{m^2+n^2-m-n-2mn}{2} = 10$

So, $n - m = 10$ and $(m - n)^2 - (m + n) = 20 \quad \Rightarrow m + n = 80$

$\therefore$ m = 35, n = 45

31. The value of $\int_1^a [x]f'(x)dx$, a > 1, where [x] denotes the greatest integer not exceeding x is

(1) af(a) – {f(1) + f(2) + … + f([a])} (2) [a] f(a) – {f(1) + f(2) + … + f([a])}

(3) [a] f([a]) – {f(1) + f(2) + … + f(a)} (4) af([a]) – {f(1) + f(2) + … + f(a)}

Ans. (2)

Sol: Let a = k + h, where [a] = k and $0 \le h < 1$

$\therefore \int_1^a [x]f'(x)dx = \int_1^2 1f'(x)dx + \int_2^3 2f'(x)dx + ... \int_{k-1}^{k}(k-1)dx + \int_k^{k+h} kf'(x)dx$

{f(2) – f(1)} + 2{f(3) – f(2)} + 3{f(4) – f(3)}+…….+ (k–1) – {f(k) – f(k – 1)}
+ k{f(k + h) – f(k)}

= – f(1) – f(2) – f(3)……. – f(k) + k f(k + h)

= [a] f(a) – {f(1) + f(2) + f(3) + …. + f([a])}

32. If the lines $3x - 4y - 7 = 0$ and $2x - 3y - 5 = 0$ are two diameters of a circle of area 49π square units, the equation of the circle is

(1) $x^2 + y^2 + 2x - 2y - 47 = 0$ (2) $x^2 + y^2 + 2x - 2y - 62 = 0$

(3) $x^2 + y^2 - 2x + 2y - 62 = 0$ (4) $x^2 + y^2 - 2x + 2y - 47 = 0$

Ans. (4)

Sol: Point of intersection of $3x - 4y - 7 = 0$ and $2x - 3y - 5 = 0$ is $(1, -1)$, which is the centre of the circle and radius = 7.

$\therefore$ Equation is $(x - 1)^2 + (y + 1)^2 = 49 \Rightarrow x^2 + y^2 - 2x + 2y - 47 = 0$.

33. The differential equation whose solution is $Ax^2 + By^2 = 1$, where A and B are arbitrary constants is of

(1) second order and second degree (2) first order and second degree

(3) first order and first degree (4) second order and first degree

Ans. (4)

Sol: $Ax^2 + By^2 = 1$ … (1)

$Ax + By\frac{dy}{dx} = 0$ … (2)

$A + By\frac{d^2y}{dx^2} + B\left(\frac{dy}{dx}\right)^2 = 0$ … (3)

From (2) and (3)

$$x\left\{-By\frac{d^2y}{dx^2} - B\left(\frac{dy}{dx}\right)^2\right\} + By\frac{dy}{dx} = 0$$

$$\Rightarrow xy\frac{d^2y}{dx^2} + x\left(\frac{dy}{dx}\right)^2 - y\frac{dy}{dx} = 0$$

34. Let C be the circle with centre (0, 0) and radius 3 units. The equation of the locus of the mid points of the chords of the circle C that subtend an angle of $\frac{2\pi}{3}$ at its centre is

(1) $x^2 + y^2 = \frac{3}{2}$ (B) $x^2 + y^2 = 1$

(3) $x^2 + y^2 = \frac{27}{4}$ (D) $x^2 + y^2 = \frac{9}{4}$

Ans. (4)

Sol: $\cos\frac{\pi}{3} = \frac{\sqrt{h^2 + k^2}}{3} \Rightarrow h^2 + k^2 = \frac{9}{4}$

35. If (a, a^2) falls inside the angle made by the lines $y = \frac{x}{2}, x > 0$ and $y = 3x, x > 0$, then a belongs to

(1) $\left(0, \frac{1}{2}\right)$ (2) $(3, \infty)$

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

Ans. (3)

Sol: $a^2 - 3a < 0$ and $a^2 - \frac{a}{2} > 0 \Rightarrow \frac{1}{2} < a < 3$

36. The image of the point (–1, 3, 4) in the plane x – 2y = 0 is

(1) $\left(-\frac{17}{3}, -\frac{19}{3}, 4\right)$ (2) (15, 11, 4)

(3) $\left(-\frac{17}{3}, -\frac{19}{3}, 1\right)$ (4) (8, 4, 4)

Sol: If (α, β, γ) be the image then $\frac{\alpha-1}{2} - 2\left(\frac{\beta+3}{2}\right) = 0$

$\therefore \alpha - 1 - 2\beta - 6 \Rightarrow \alpha - 2\beta = 7$ … (1)

and $\frac{\alpha+1}{1} = \frac{\beta-3}{-2} = \frac{\gamma-4}{0}$ … (2)

From (1) and (2)

$\alpha = \frac{9}{5},\ \beta = -\frac{13}{5},\ \gamma = 4$

No option matches.

37. If $z^2 + z + 1 = 0$, where z is a complex number, then the value of

$\left(z+\frac{1}{z}\right)^2 + \left(z^2+\frac{1}{z^2}\right)^2 + \left(z^3+\frac{1}{z^3}\right)^2 + \cdots + \left(z^6+\frac{1}{z^6}\right)^2$ is

(1) 18 (2) 54

(3) 6 (4) 12

Ans. (4)

Sol: $z^2 + z + 1 = 0 \Rightarrow z = \omega$ or ω^2

so, $z+\frac{1}{z} = \omega + \omega^2 = -1,\ z^2 + \frac{1}{z^2} = \omega^2 + \omega = -1,\ z^3 + \frac{1}{z^3} = \omega^3 + \omega^3 = 2$

$z^4 + \frac{1}{z^4} = -1,\ z^5 + \frac{1}{z^5} = -1$ and $z^6 + \frac{1}{z^6} = 2$

$\therefore$ The given sum = 1 + 1 + 4 + 1 + 1 + 4 = 12

38. If $0 < x < \pi$ and $\cos x + \sin x = \frac{1}{2}$, then tanx is

(1) $\frac{(1-\sqrt{7})}{4}$ (B) $\frac{(4-\sqrt{7})}{3}$

(3) $-\frac{(4+\sqrt{7})}{3}$ (4) $\frac{(1+\sqrt{7})}{4}$

Ans. (3)

Sol: $\cos x + \sin x = \frac{1}{2} \Rightarrow 1 + \sin 2x = \frac{1}{4} \Rightarrow \sin 2x = -\frac{3}{4}$, so x is obtuse

and $\frac{2\tan x}{1+\tan^2 x} = -\frac{3}{4} \Rightarrow 3\tan^2 x + 8\tan x + 3 = 0$

$\therefore\ \tan x = \dfrac{-8 \pm \sqrt{64-36}}{6} = \dfrac{-4 \pm \sqrt{7}}{3}$

$\because \tan x < 0 \qquad \therefore \tan x = \dfrac{-4-\sqrt{7}}{3}$

39. If $a_1, a_2, \ldots, a_n$ are in H.P., then the expression $a_1a_2 + a_2a_3 + \ldots + a_{n-1}a_n$ is equal to

(1) $n(a_1 - a_n)$
(2) $(n - 1)(a_1 - a_n)$
(3) na_1a_n
(4) $(n - 1)a_1a_n$

Ans. (4)

Sol: $\dfrac{1}{a_2} - \dfrac{1}{a_1} = \dfrac{1}{a_3} - \dfrac{1}{a_2} = ... = \dfrac{1}{a_n} - \dfrac{1}{a_{n-1}} = d$ (say)

Then $a_1a_2 = \dfrac{a_1 - a_2}{d}$, $a_2a_3 = \dfrac{a_2 - a_3}{d}$,......., $a_{n-1}a_n = \dfrac{a_{n-1} - a_n}{d}$

$\therefore\ a_1a_2 + a_2a_3 + ... + a_{n-1}a_n = \dfrac{a_1 - a_n}{d}$ Also, $\dfrac{1}{a_n} = \dfrac{1}{a_1} + (n-1)d$

$\Rightarrow \dfrac{a_1 - a_n}{d} = (n-1)a_1a_n$

40. If $x^m \cdot y^n = (x+y)^{m+n}$, then $\dfrac{dy}{dx}$ is

(1) $\dfrac{y}{x}$
(2) $\dfrac{x+y}{xy}$
(3) xy
(4) $\dfrac{x}{y}$

Ans. (1)

Sol: $x^m.y^n = (x+y)^{m+n} \Rightarrow m\ln x + n\ln y = (m+n)\ln(x+y)$

$\therefore\ \dfrac{m}{x} + \dfrac{n}{y}\dfrac{dy}{dx} = \dfrac{m+n}{x+y}\left(1+\dfrac{dy}{dx}\right) \Rightarrow \left(\dfrac{m}{x} - \dfrac{m+n}{x+y}\right) = \left(\dfrac{m+n}{x+y} - \dfrac{n}{y}\right)\dfrac{dy}{dx}$

$\Rightarrow \dfrac{my-nx}{x(x+y)} = \left(\dfrac{my-nx}{y(x+y)}\right)\dfrac{dy}{dx} \quad \Rightarrow \dfrac{dy}{dx} = \dfrac{y}{x}$

41. A particle located at x = 0 at time t = 0, starts moving along the positive x-direction with a velocity 'v' that varies as $v = \alpha\sqrt{x}$. The displacement of the particle varies with time as

(1) t^3 (2) t^2
(3) t (4) $t^{1/2}$

Ans: (2)

Sol. $\frac{dx}{dt} = \alpha \int \frac{dx}{\sqrt{x}} = \int \alpha dt \Rightarrow x \; \alpha \; t^2$

42. A mass of M kg is suspended by a weightless string. The horizontal force that is required to displace it until the string makes an angle of 45° with the initial vertical direction is

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

Ans: (1)

Sol. $F \ell \sin 45 = Mg (\ell - \ell \cos 45)$
$F = Mg (\sqrt{2} - 1)$

43. A bomb of mass 16 kg at rest explodes into two pieces of masses of 4 kg and 12 kg. The velocity of the 12 kg mass is 4 ms^{-1}. The kinetic energy of the other mass is

(1) 96 J (2) 144 J
(3) 288 J (4) 192 J

Ans: (3)

Sol. $m_1v_1 = m_2v_2$
$KE = \frac{1}{2}m_2v_2^2 = \frac{1}{2} \times 4 \times 144 = 288\,J$

44. A particle of mass 100 g is thrown vertically upwards with a speed of 5 m/s. the work done by the force of gravity during the time the particle goes up is

(1) 0.5 J (2) –0.5 J
(3) –1.25 J (4) 1.25 J

Ans: (3)

Sol. $-mgh = -mg\left(\frac{v^2}{2g}\right) = -1.25\,J$.

45. A whistle producing sound waves of frequencies 9500 Hz and above is approaching a stationary person with speed v ms^{-1}. The velocity of sound in air is 300 ms^{-1}. If the person can hear frequencies upto a maximum of 10,000 Hz, the maximum value of v upto which he can hear the whistle is

(1) 30 ms^{-1} (2) $15\sqrt{2}$ ms^{-1}
(3) $15/\sqrt{2}$ ms^{-1} (4) 15 ms^{-1}

Ans: (4)

Sol. $f_{app} = \frac{f(300)}{300 - v} \Rightarrow v = 15\,m/s$

46. A electric dipole is placed at an angle of 30° to a non-uniform electric field. The dipole will experience

(1) a torque only
(2) a translational force only in the direction of the field
(3) a translational force only in a direction normal to the direction of the field
(4) a torque as well as a translational force

Ans: **(4)**

Sol. A torque as well as a translational force

47. A material 'B' has twice the specific resistance of 'A'. A circular wire made of 'B' has twice the diameter of a wire made of 'A'. Then for the two wires to have the same resistance, the ratio ℓ_A/ℓ_B of their respective lengths must be

(1) 2 (2) 1

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

Ans: **(1)**

Sol. $R_1 = \frac{\rho_A \ell_A}{\pi R_A^2}$ $R_2 = \frac{\rho_B \ell_B}{\pi R_B^2}$

$$\frac{\ell_A}{\ell_B} = \frac{\rho_B R_A^2}{\rho_A R_B^2} = \frac{2\rho_A R_A^2}{\rho_A \cdot 4R_A^2} \Rightarrow \frac{\ell_B}{\ell_A} = 2$$

48. The Kirchhoff's first law $(\sum i = 0)$ and second law $\left(\sum iR = \sum E\right)$, where the symbols have their usual meanings, are respectively based on

(1) conservation of charge, conservation of energy
(2) conservation of charge, conservation of momentum
(3) conservation of energy, conservation of charge
(4) conservation of momentum, conservation of charge

Ans: **(1)**

Sol. Conservation of charge, conservation of energy

49. In a region, steady and uniform electric and magnetic fields are present. These two fields are parallel to each other. A charged particle is released from rest in this region. The path of the particle will be a

(1) circle (2) helix
(3) straight line (4) ellipse

Ans: **(3)**

Sol. Straight line

50. Needles N_1, N_2 and N_3 are made of a ferromagnetic, a paramagnetic and a diamagnetic substance respectively. A magnet when brought close to them will

(1) attract all three of them
(2) attract N_1 and N_2 strongly but repel N_3
(3) attract N_1 strongly, N_2 weakly and repel N_3 weakly
(4) attract N_1 strongly, but repel N_2 and N_3 weakly

Ans: **(3)**

Sol. attracts N_1 strongly, N_2 weakly and Repel N_3 weakly

51. Which of the following units denotes the dimensions ML^2/Q^2, where Q denotes the electric charge?

(1) Weber (Wb)
(2) Wb/m^2
(3) Henry (H)
(4) H/m^2

Ans: (3)

Sol. Henry (H)

52. A player caught a cricket ball of mass 150 g moving at a rate of 20 m/s. If the catching process is completed in 0.1 s, the force of the blow exerted by the ball on the hand of the player is equal to

(1) 300 N
(2) 150 N
(3) 3 N
(4) 30 N

Ans: (4)

Sol. $(mv - 0) \Rightarrow 0.15 \times 20$

$$F = \frac{3}{0.1} = 30 N$$

53. A ball of mass 0.2 kg is thrown vertically upwards by applying a force by hand. If the hand moves 0.2 m which applying the force and the ball goes upto 2 m height further, find the magnitude of the force. Consider g = 10 m/s^2

(1) 22 N
(2) 4 N
(3) 16 N
(4) 20 N

Ans: (4)

Sol. mgh = Fs
F = 20 N

54. Consider a two particle system with particles having masses m_1 and m_2. If the first particle is pushed towards the centre of mass through a distance d, by what distance should the second particle be moved, so as to keep the centre of mass at the same position?

(1) d
(2) $\frac{m_2}{m_1}d$
(3) $\frac{m_1}{m_1 + m_2}d$
(4) $\frac{m_1}{m_2}d$

Ans: (4)

Sol. $m_1 d + m_2 x = 0$

$$x = \frac{m_1 d}{m_2}$$

55. Starting from the origin, a body oscillates simple harmonically with a period of 2 s. After what time will its kinetic energy be 75% of the total energy?

(1) $\frac{1}{12}s$
(2) $\frac{1}{6}s$
(3) $\frac{1}{4}s$
(4) $\frac{1}{3}s$

Ans: (2)

Sol. $\frac{1}{2}mv^2 = \frac{3}{4}\left(\frac{1}{2}mv_{max}^2\right)$

$$A^2\omega^2 \cos^2 \omega t \Rightarrow \frac{3}{4}A^2\omega^2$$

$$\cos\omega t = \frac{\sqrt{3}}{2}$$

$$\omega t = \frac{\pi}{6} \Rightarrow t = \frac{1}{6}\sec$$

56. The maximum velocity of a particle, executing simple harmonic motion with an amplitude 7 mm, is 4.4 m/s. The period of oscillation is

(1) 100 s (2) 0.01 s
(3) 10 s (4) 0.1 s

Ans: (2)

Sol. $A\omega = v_{max}$

$$T = \frac{2\pi}{\omega} = \frac{2\pi A}{v_{max}} = 0.01\sec$$

57. A string is stretched between fixed points separated by 75 cm. It is observed to have resonant frequencies of 420 Hz and 315 Hz. There are no other resonant frequencies between these two. Then, the lowest resonant frequency for this string is

(1) 10.5 Hz (2) 105 Hz
(3) 1.05 Hz (4) 1050 Hz

Ans: (2)

Sol. $\frac{n}{2\ell}(v) = 315,\ \frac{(n+1)}{2\ell}v = 420$

Solving $\frac{v}{2\ell} = 105$

58. Assuming the sun to be a spherical body of radius R at a temperature of T K, evaluate the total radiant power, incident on Earth, at a distance r from the Sun.

(1) $\frac{R^2\sigma T^4}{r^2}$ (2) $\frac{4\pi r_0^2 R^2\sigma T^4}{r^2}$
(3) $\frac{\pi r_0^2 R^2\sigma T^4}{r^2}$ (4) $\frac{r_0^2 R^2\sigma T^4}{4\pi r^2}$

where r_0 is the radius of the Earth and σ is Stefan's constant.

Ans: (3)

Sol. $\frac{\pi r_0^2}{4\pi r^2}(\sigma T^4 \cdot 4\pi R^2) = \frac{\sigma\pi T^4 R^2 r_0^2}{r^2}$

59. The refractive index of glass is 1.520 for red light and 1.525 for blue light. Let D_1 and D_2 be an of minimum deviation for red and blue light respectively in a prism of this glass. Then

(1) $D_1 > D_2$
(2) $D_1 < D_2$
(3) $D_1 = D_2$
(4) D_1 can be less than or greater than depending upon the angle of prism

Ans: (2)

Sol. $D = (\mu - 1)A$

$D_2 > D_1$

60. In a Wheatstone's bridge, there resistances P, Q and R connected in the three arms and the fourth arm is formed by two resistances S_1 and S_2 connected in parallel. The condition for bridge to be balanced will be

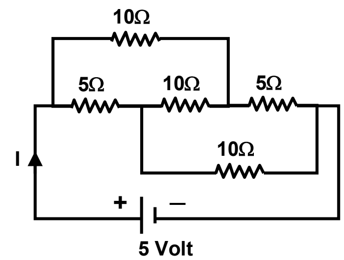
(1) $\frac{P}{Q} = \frac{R}{S_1 + S_2}$ (2) $\frac{P}{Q} = \frac{2R}{S_1 + S_2}$

(3) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{S_1S_2}$ (4) $\frac{P}{Q} = \frac{R(S_1 + S_2)}{2S_1S_2}$

Ans: **(3)**

Sol. $\frac{P}{Q} = \frac{R(S_1 + S_2)}{S_1S_2}$

61. The current I drawn from the 5 volt source will be



(1) 0.17 A (2) 0.33 A

(3) 0.5 A (4) 0.67 A

Ans: **(3)**

Sol. $i = \frac{5}{10} = 0.5$

62. In a series resonant LCR circuit, the voltage across R is 100 volts and R = 1 kΩ with C = 2μF. The resonant frequency ω is 200 rad/s. At resonance the voltage across L is

(1) 4×10^{-3} V (2) 2.5×10^{-2} V

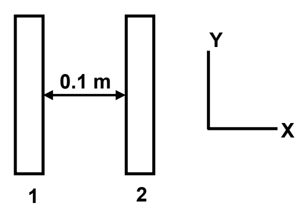
(3) 40 V (4) 250 V

Ans: **(4)**

Sol. $i = \frac{100}{1000} = 0.1\text{ A}$

$V_L = V_C = \frac{0.1}{200 \times 2 \times 10^{-6}} = 250\text{ V}$

63 Two insulating plates are both uniformly charged in such a way that the potential difference between them is $V_2 - V_1 = 20$ V. (i.e. plate 2 is at a higher potential). The plates are separated by d = 0.1 m and can be treated as infinitely large. An electron is released from rest on the inner surface of plate 1. What is its speed when it hits plate 2?
($e = 1.6 \times 10^{-19}$ C, $m_e = 9.11 \times 10^{-31}$ kg)



(1) 32×10^{-19} m/s (2) 2.65×10^{6} m/s

(3) 7.02×10^{12} m/s (4) 1.87×10^{6} m/s

Ans: **(2)**

Sol. $\frac{1}{2}mv^2 = eV$

$v = \sqrt{\frac{2eV}{m}} = 2.65 \times 10^{6}$ m/s

64. The resistance of a bulb filament is 100 Ω at a temperature of 100°C. If its temperature coefficient of resistance be 0.005 per °C, its resistance will become 200 Ω at a temperature of

(1) 200°C (2) 300°C

(3) 400°C (4) 500°C

Ans: **(2)**

Sol. $200 = 100[1 + (0.005 \times \Delta t)]$

$T - 100 = 200$

$T = 300° C$

65. In an AC generator, a coil with N turns, all of the same area A and total resistance R, rotates with frequency ω in a magnetic field B. The maximum value of emf generated in the coil is '
(1) N.A.B.ω
(2) N.A.B.R.ω
(3) N.A.B
(4) N.A.B.R

Ans: **(1)**

Sol. NBAω

66. The flux linked with a coil at any instant 't' is given by
$$\phi = 10t^2 - 50t + 250$$
The induced emf at t = 3 s is
(1) 190 V
(2) –190 V
(3) –10 V
(4) 10 V

Ans: **(3)**

Sol. $e = -\frac{d\phi}{dt} = -(20\,t - 50) = -10$ volt

67. A thermocouple is made from two metals, Antimony and Bismuth. If one junction of the couple is kept hot and the other is kept cold then, an electric current will
(1) flow from Antimony to Bismuth at the cold junction
(2) flow from Antimony to Bismuth at the hot junction
(3) flow from Bismuth to Antimony at the cold junction
(4) not flow through the thermocouple

Ans: **(1)**

Sol. Flow from Antimony to Bismuth at cold junction

68. The time by a photoelectron to come out after the photon strikes is approximately
(1) 10^{-1} s
(2) 10^{-4} s
(3) 10^{-10} s
(4) 10^{-16} s

Ans: **(3)**

Sol. 10^{-10} sec.

69. An alpha nucleus of energy $\frac{1}{2}mv^2$ bombards a heavy nuclear target of charge Ze. Then the distance of closest approach for the alpha nucleus will be proportional to
(1) $\frac{1}{Ze}$
(2) v^2
(3) $\frac{1}{m}$
(4) $\frac{1}{v^4}$

Ans: **(3)**

Sol. $\frac{1}{m}$

70. The threshold frequency for a metallic surface corresponds to an energy of 6.2 eV, and the stopping potential for a radiation incident on this surface 5 V. The incident radiation lies in
(1) X-ray region (2) ultra-violet region
(3) infra-red region (4) visible region

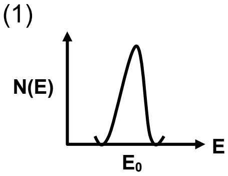
Ans: **(2)**

Sol. $\lambda = \frac{1242 eVnm}{11.2} \approx 1100 \text{ Å}$

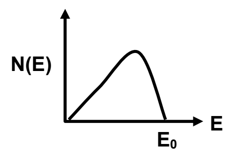
Ultraviolet region

71. The energy spectrum of β-particles [number N(E) as a function of β-energy E] emitted from a radioactive source is

(1)



(2)



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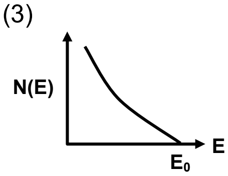
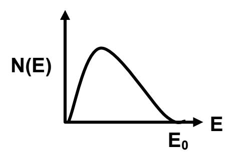
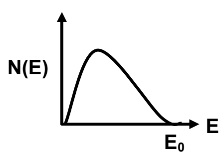


(4)



Ans: **(4)**

Sol.



72. When $_3Li^7$ nuclei are bombarded by protons, and the resultant nuclei are $_4Be^8$, the emitted particles will be
(1) neutrons (2) alpha particles
(3) beta particles (4) gamma photons

Ans: **(4)**

Sol. Gamma-photon

73. A solid which is transparent to visible light and whose conductivity increases with temperature is formed by
(1) Metallic binding (2) Ionic binding
(3) Covalent binding (4) Van der Waals binding

Ans: **(3)**

Sol. Covalent binding

74. If the ratio of the concentration of electrons that of holes in a semiconductor is $\frac{7}{5}$ and the ratio of currents is $\frac{7}{4}$, then what is the ratio of their drift velocities?

(1) $\frac{4}{7}$ (2) $\frac{5}{8}$

(3) $\frac{4}{5}$ (4) $\frac{5}{4}$

Ans: (4)

Sol. $\frac{n_e}{n_n} = \frac{7}{5}$ $\frac{I_e}{I_n} = \frac{7}{4}$

$\frac{(V_d)_e}{(V_d)_n} \Rightarrow \frac{I_e}{I_n} \times \frac{n_n}{n_e} = \frac{5}{4}$

75. In a common base mode of a transistor, t collector current is 5.488 mA for an emit current of 5.60 mA. The value of the base current amplification factor (β) will be

(1) 48 (2) 49

(3) 50 (4) 51

Ans: (2)

Sol. $I_b = I_e - I_c$

$\beta = \frac{I_c}{I_b} = 49$

76. The potential energy of a 1 kg particle free move along the x-axis is given by

$$V(x) = \left(\frac{x^4}{4} - \frac{x^2}{2}\right) J$$

The total mechanical energy of the particle 2 J. Then, the maximum speed (in m/s) is

(1) 2 (2) $3/\sqrt{2}$

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

Ans: (2)

Sol. k $E_{max} = E_T - U_{min}$

U_{min} ($\pm$1) = –1/4 J

KE_{max} = 9/4 J $\Rightarrow$ U = $\frac{3}{\sqrt{2}}$ J

77. A force of $-F\hat{k}$ acts on O, the origin of the coordinate system. The torque about the point (1, –1) is

(1) $-F(\hat{i} - \hat{j})$ (2) $F(\hat{i} - \hat{j})$

(3) $-F(\hat{i} + \hat{j})$ (4) $F(\hat{i} + \hat{j})$

Ans: (3)

Sol. $\vec{\tau} = (-\hat{i} + \hat{j}) \times (-F\hat{k})$

$= - F(\hat{i} + \hat{j})$

78. A thin circular ring of mass m and radius R is rotating about its axis with a constant angular velocity ω. Two objects each of mass M are attached gently to the opposite ends of a diameter of the ring. The ring now rotates with an angular velocity ω' =

(1) $\frac{\omega m}{(m+2M)}$ (2) $\frac{\omega(m+2M)}{m}$

(3) $\frac{\omega(m-2M)}{(m+2M)}$ (4) $\frac{\omega m}{(m+M)}$

Ans: (1)

Sol. $L_i = L_f$

$mR^2\omega = (mR^2 + 2MR^2)\omega'$

$\omega' = \left(\frac{m\omega}{m+2M}\right)$

79. If the terminal speed of a sphere of gold (density = 19.5 kg/m^3) is 0.2 m/s in a viscous liquid (density = 1.5 kg/m^3) of the same size in the same liquid.

(1) 0.2 m/s (2) 0.4 m/s

(3) 0.133 m/s (4) 0.1 m/s

Ans: (4)

Sol. $\frac{v_s}{v_g} = \frac{(\rho_s - \rho_\ell)}{(\rho_g - \rho_\ell)}$

$v_s = 0.1$ m/s

80. The work of 146 kJ is performed in order to compress one kilo mole of gas adiabatically and in this process the temperature of the gas increases by 7° C. The gas is

($R = 8.3$ J mol^{-1} K^{-1})

(1) monoatomic (2) diatomic

(3) triatomic (4) a mixture of monoatomic and diatomic

Ans: (2)

Sol. $146 = C_v\Delta T$

$\Rightarrow C_v = 21$ J/mol K

81. The rms value of the electric field of the light coming from the Sun is 720 N/C. The average total energy density of the electromagnetic wave is

(1) 3.3×10^{-3} J/m^3 (2) 4.58×10^{-6} J/m^3

(3) 6.37×10^{-9} J/m^3 (4) 81.35×10^{-12} J/m^3

Ans: (2)

Sol. $U_{av} = \varepsilon_0 E_{rms}^2 = 4.58 \times 10^{-6}$ J/m^3

$E_{rms}^2 = 4.58 \times 10^{-6}$ J/m^3

82. A coin is placed on a horizontal platform which undergoes vertical simple harmonic motion of angular frequency ω. The amplitude of oscillation is gradually increased. The coin will leave contact with the platform for the first time

(1) at the highest position of the platform (2) at the mean position of the platform

(3) for an amplitude of $\frac{g}{\omega^2}$ (4) for an amplitude of $\frac{g^2}{\omega^2}$

Ans: (3)

Sol. $A\omega^2 = g$

$\Rightarrow A = g/\omega^2$

83. An electric bulb is rated 220 volt – 100 watt. The power consumed by it when operated on 110 volt will be

(1) 50 watt (2) 75 watt

(3) 40 watt (4) 25 watt

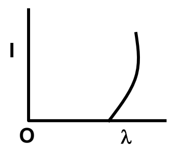
Ans: (4)

Sol. $\frac{V_1^2}{P_1} = \frac{V_2^2}{P_2} = \text{Resistance}$

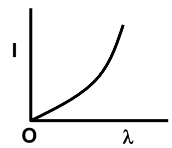
$\Rightarrow P_2 = 25$ W

84. The anode voltage of a photocell is kept fixed. The wavelength λ of the light falling on the cathode is gradually changed. The plate current I of the photocell varies as follows :

(1)



(2)



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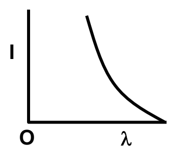
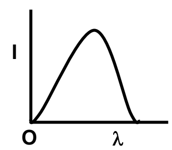


(4)



Ans: (3)

85. The 'rad' is the correct unit used to report the measurement of

(1) the rate of decay of radioactive source

(2) the ability of a beam of gamma ray photons to produce ions in a target

(3) the energy delivered by radiation to a target.

(4) the biological effect of radiation

Ans: (4)

86. If the binding energy per nucleon in ${}_3^7\text{Li}$ and ${}_2^4\text{He}$ nuclei are 5.60 MeV and 7.06 MeV respectively, then in the reaction

$p + {}_3^7\text{Li} \rightarrow 2\ {}_2^4\text{He}$

energy of proton must be

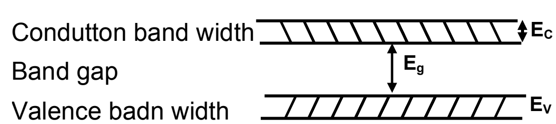
(1) 39.2 MeV (2) 28.24 MeV

(3) 17.28 MeV (4) 1.46 MeV

Ans: (3)

Sol. $E_P = (8 \times 7.06 - 7 \times 5.60)$ MeV $= 17.28$ MeV

87. If the lattice constant of this semiconductor is decreased, then which of the following is correct?



(1) All E_c, E_g, E_v decrease

(2) All E_c, E_g, E_v increase

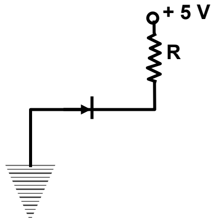
(3) E_c, and E_v increase but E_g decreases

(4) E_c, and E_v, decrease E_g increases

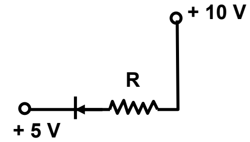
Ans: (4)

88. In the following, which one of the diodes is reverse biased?

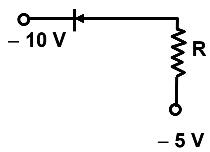
(1)



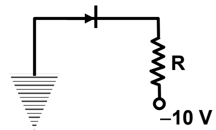
(2)



(3)

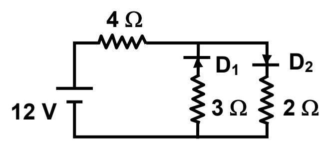


(4)



Ans: (1)

89. The circuit has two oppositely connect ideal diodes in parallel. What is the current following in the circuit?



(1) 1.33 A (2) 1.71 A
(3) 2.00 A (4) 2.31 A

Ans: (3)

Sol. D_1 is reverse biased therefore it will act like an open circuit.

$$i = \frac{12}{6} = 2.00\text{ A}$$

90. A long solenoid has 200 turns per cm and carries a current i. The magnetic field at its centre is 6.28×10^{-2} Weber/m^2. Another long solenoid has 100 turns per cm and it carries a current i/3. The value of the magnetic field at its centre is

(1) 1.05×10^{-4} Weber/m^2 (2) 1.05×10^{-2} Weber/m^2
(3) 1.05×10^{-5} Weber/m^2 (4) 1.05×10^{-3} Weber/m^2

Ans: (2)

Sol. $$B_2 = \frac{B_1 n_2 i_2}{n_1 i_1} = \frac{(6.28 \times 10^{-2})(100 \times i/3)}{200(i)} = 1.05 \times 10^{-2}\ \text{W/m}^2$$

91. Four point masses, each of value m, are placed at the corners of a square ABCD of side ℓ. The moment of inertia through A and parallel to BD is

(1) $m\ell^2$ (2) $2\,m\ell^2$
(3) $\sqrt{3}\,m\ell^2$ (4) $3\,m\ell^2$

Ans: (4)

Sol. $I = 2m\,(\ell/\sqrt{2}\,)^2 = 3\,m\ell^2$

92. A wire elongates by ℓ mm when a load W is hanged from it. If the wire goes over a pulley and two weights W each are hung at the two ends, the elongation of the wire will be (in mm)

(1) $\ell/2$ (2) ℓ
(3) 2ℓ (4) zero

Ans: (2)

93. Two rigid boxes containing different ideal gases are placed on a table. Box A contains one mole of nitrogen at temperature T_0, while Box B contains one mole of helium at temperature (7/3) T_0. The boxes are then put into thermal contact with each other and heat flows between them until the gases reach a common final temperature. (Ignore the heat capacity of boxes). Then, the final temperature of the gases, T_f, in terms of T_0 is

(1) $T_f = \frac{5}{2}T_0$ (2) $T_f = \frac{3}{7}T_0$

(3) $T_f = \frac{7}{3}T_0$ (4) $T_f = \frac{3}{2}T_0$

Ans: (4)

Sol. $\Delta U = 0$

$$\Rightarrow \frac{3}{2}R(T_f - T_0) + 1\times\frac{5}{2}R(T_f - \frac{7}{3}T_0) = 0$$

$$T_f = \frac{3}{2}T_0$$

94. Two spherical conductors A and B of radii 1 mm and 2 mm are separated by a distance of 5 cm and are uniformly charged. If the spheres are connected by a conducting wire then in equilibrium condition, the ratio of the magnitude of the electric fields at the surface of spheres A and B is

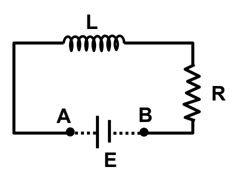
(1) 1 : 4 (2) 4 : 1

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

Ans: (4)

Sol. $\frac{E_A}{E_B} = \frac{r_B}{r_A} = \frac{2}{1}$

95. An inductor (L = 100 mH), a resistor (R = 100 Ω) and a battery (E = 100 V) are initially connected in series as shown in the figure. After a long time the battery is disconnected after short circuiting the points A and B. The current in the circuit 1 mm after the circuit is



(1) 1 A (2) 1/e A

(3) e A (4) 0.1 A

Ans: (2)

Sol. $I = I_0\ e^{-Rt/L} = \frac{1}{e}A$

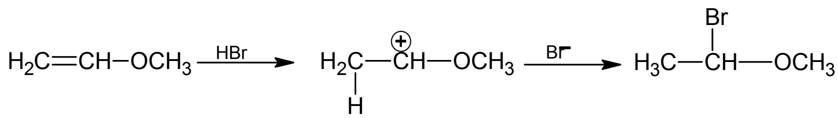
CHEMISTRY
PART – C

96. HBr reacts with $CH_2 = CH - OCH_3$ under anhydrous conditions at room temperature to give

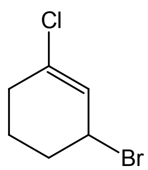
(1) CH_3CHO and CH_3Br
(2) $BrCH_2CHO$ and CH_3OH
(3) $BrCH_2 - CH_2 - OCH_3$
(4) $H_3C - CHBr - OCH_3$

Ans. **(4)**

Sol. Electrophilic addition reaction more favourable.



97. The IUPAC name of the compound shown below is



(1) 2-bromo-6-chlorocyclohex-1-ene
(2) 6-bromo-2-chlorocyclohexene
(3) 3-bromo-1-chlorocyclohexene
(4) 1-bromo-3-chlorocyclohexene

Ans. **(3)**

98. The increasing order of the rate of HCN addition to compounds A – D is

(A) HCHO
(B) CH_3COCH_3
(C) $PhCOCH_3$
(D) PhCOPh

(1) A < B < C < D
(2) D < B < C < A
(3) D < C < B < A
(4) C < D < B < A

Ans. **(3)**

99. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms?

(1) 0.02
(2) 3.125×10^{-2}
(3) 1.25×10^{-2}
(4) 2.5×10^{-2}

Ans. **(2)**

Sol. $Mg_3(PO_4)_2$

'n' moles

$8n = 0.25$

$$n = \frac{0.25}{8}$$

$$= \frac{25}{8 \times 100} = 3.125 \times 10^{-2}$$

100. According to Bohr's theory, the angular momentum of an electron in 5th orbit is

(1) $25\frac{h}{\pi}$
(2) $1.0\frac{h}{\pi}$
(3) $10\frac{h}{\pi}$
(4) $2.5\frac{h}{\pi}$

Ans. **(4)**

Sol. $$mvr = \frac{nh}{2\pi}$$

$$= \frac{5h}{2\pi} = 2.5\frac{h}{\pi}$$

101. Which of the following molecules/ions does not contain unpaired electrons?

(1) O_2^{2-} (2) B_2

(3) N_2^+ (4) O_2

Ans. (1)

102. Total volume of atoms present in a face-centre cubic unit cell of a metal is (r is atomic radius)

(1) $\frac{20}{3}\pi r^3$ (2) $\frac{24}{3}\pi r^3$

(3) $\frac{12}{3}\pi r^3$ (4) $\frac{16}{3}\pi r^3$

Ans. (4)

Sol. $V = n \times \left(\frac{4}{3}\pi r^3\right)$

$= 4 \times \left(\frac{4}{3}\pi r^3\right)$

$= \frac{16}{3}\pi r^3$

103. A reaction was found to be second order with respect to the concentration of carbon monoxide. If the concentration of carbon monoxide is doubled, with everything else kept the same, the rate of reaction will

(1) remain unchanged (2) triple

(3) increase by a factor of 4 (4) double

Ans. (3)

Sol. $R \propto [W]^2$

$R' \propto [2CO]^2$

$R \propto 4[W]^2$

$R \propto 4M$

104. Which of the following chemical reactions depicts the oxidizing behaviour of H_2SO_4?

(1) $2HI + H_2SO_4 \longrightarrow I_2 + SO_2 + 2H_2O$ (2) $Ca(OH)_2 + H_2SO_4 \longrightarrow CaSO_4 + 2H_2O$

(3) $NaCl + H_2SO_4 \longrightarrow NaHSO_4 + HCl$ (4) $2PCl_5 + H_2SO_4 \longrightarrow 2POCl_3 + 2HCl + SO_2Cl_2$

Ans. (1)

105. The IUPAC name for the complex $[Co(NO_2)(NH_3)_5]Cl_2$ is

(1) nitrito-N-pentaamminecobalt (III) chloride (2) nitrito-N-pentaamminecobalt (II) chloride

(3) pentaammine nitrito-N-cobalt (II) chloride (4) pentaammine nitrito-N-cobalt (III) chloride

Ans. (4)

106. The term anomers of glucose refers to

(1) isomers of glucose that differ in configurations at carbons one and four (C-1 and C-4)

(2) a mixture of (D)-glucose and (L)-glucose

(3) enantiomers of glucose

(4) isomers of glucose that differ in configuration at carbon one (C-1)

Ans. (4)

107. In the transformation of ${}^{238}_{92}U$ to ${}^{234}_{92}U$, if one emission is an α-particle, what should be the other emission(s)?

(1) Two β^-
(2) Two β^- and one β^+
(3) One β^- and one γ
(4) One β^+ and one β^-

Ans. (1)

Sol. ${}^{238}_{92}U \longrightarrow {}^{234}_{92}U + {}^{4}_{2}He + 2\,{}^{0}_{-1}e$

108. Phenyl magnesium bromide reacts with methanol to give

(1) a mixture of anisole and Mg(OH)Br
(2) a mixture of benzene and Mg(OMe)Br
(3) a mixture of toluene and Mg(OH)Br
(4) a mixture of phenol and Mg(Me)Br

Ans. (2)

109. $CH_3Br + Nu^- \longrightarrow CH_3 - Nu + Br^-$

The decreasing order of the rate of the above reaction with nucleophiles (Nu^-) A to D is

[Nu^- = (A) PhO^-, (B) AcO^-, (C) HO^-, (D) CH_3O^-]

(1) D > C > A > B
(2) D > C > B > A
(3) A > B > C > D
(4) B > D > C > A

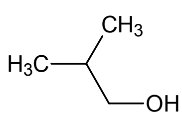
Ans. (1)

110. The pyrimidine bases present in DNA are

(1) cytosine and adenine
(2) cytosine and guanine
(3) cytosine and thymine
(4) cytosine and uracil

Ans. (3)

111. Among the following the one that gives positive iodoform test upon reaction with I_2 and NaOH is

(1) $CH_3CH_2CH(OH)CH_2CH_3$
(2) $C_6H_5CH_2CH_2OH$
(3) 

(4) $PhCHOHCH_3$

Ans. (4)

112. The increasing order of stability of the following free radicals is

(1) $(CH_3)_2\dot{C}H < (CH_3)_3\dot{C} < (C_6H_5)_2\dot{C}H < (C_6H_5)_3\dot{C}$

(2) $(C_6H_5)_3\dot{C} < (C_6H_5)_2\dot{C}H < (CH_3)_3\dot{C} < (CH_3)_2\dot{C}H$

(3) $(C_6H_5)_2\dot{C}H < (C_6H_5)_3\dot{C} < (CH_3)_3\dot{C} < (CH_3)_2\dot{C}H$

(4) $(CH_3)_2\dot{C}H < (CH_3)_3\dot{C} < (C_6H_5)_3\dot{C} < (C_6H_5)_2\dot{C}H$

Ans. (1)

113. Uncertainty in the position of an electron (mass = 9.1×10^{-31} kg) moving with a velocity 300 ms^{-1}, accurate upto 0.001%, will be

(1) 19.2×10^{-2} m
(2) 5.76×10^{-2} m
(3) 1.92×10^{-2} m
(4) 3.84×10^{-2} m

($h = 6.63 \times 10^{-34}$ Js)

Ans. **(3)**

Sol. $\Delta x.\Delta V \geq \dfrac{h}{4\pi m}$

$$\Delta x \geq \frac{h}{4\pi m\Delta V} = \frac{6.63\times10^{-34}}{4\times3.14\times9.1\times10^{-31}\times300\times\frac{0.001}{100}}$$

$$= \frac{6.63\times10^{-34}}{4\times3.14\times9.1\times3\times10^{-31}\times10^{-3}}$$

$= 0.01933$

$= 1.93 \times 10^{-2}$

114. Phosphorus pentachloride dissociates as follows, in a closed reaction vessel,

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

If total pressure at equilibrium of the reaction mixture is P and degree of dissociation of PCl_5 is x, the partial pressure of PCl_3 will be

(1) $\left(\dfrac{x}{x+1}\right)P$ (2) $\left(\dfrac{2x}{1-x}\right)P$

(3) $\left(\dfrac{x}{x-1}\right)P$ (4) $\left(\dfrac{x}{1-x}\right)P$

Ans. **(1)**

Sol.

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

$(1-x) \qquad x \qquad x$

$P_{PCl_3} = \left(\dfrac{x}{1+x}\right)\times P$

115. The standard enthalpy of formation $(\Delta_f H^o)$ at 298 K for methane, $CH_4(g)$, is –74.8 kJ mol^{-1}. The additional information required to determine the average energy for C – H bond formation would be

(1) the dissociation energy of H_2 and enthalpy of sublimation of carbon

(2) latent heat of vapourization of methane

(3) the first four ionization energies of carbon and electron gain enthalpy of hydrogen

(4) the dissociation energy of hydrogen molecule, H_2

Ans. **(1)**

116. Among the following mixtures, dipole-dipole as the major interaction, is present in

(1) benzene and ethanol (2) acetonitrile and acetone

(3) KCl and water (4) benzene and carbon tetrachloride

Ans. **(2)**

117. Fluorobenzene (C_6H_5F) can be synthesized in the laboratory

(1) by heating phenol with HF and KF

(2) from aniline by diazotisation followed by heating the diazonium salt with HBF_4

(3) by direct fluorination of benzene with F_2 gas

(4) by reacting bromobenzene with NaF solution

Ans. **(2)**

118. A metal, M forms chlorides in its +2 and +4 oxidation states. Which of the following statements about these chlorides is correct?

(1) MCl_2 is more volatile than MCl_4

(2) MCl_2 is more soluble in anhydrous ethanol than MCl_4

(3) MCl_2 is more ionic than MCl_4

(4) MCl_2 is more easily hydrolysed than MCl_4

Ans. **(3)**

119. Which of the following statements is true?
(1) H_3PO_3 is a stronger acid than H_2SO_3
(2) In aqueous medium HF is a stronger acid than HCl
(3) $HClO_4$ is a weaker acid than $HClO_3$
(4) HNO_3 is a stronger acid than HNO_2

Ans. (4)

120. The molar conductivities $\wedge^{o}_{NaOAc}$ and $\wedge^{o}_{HCl}$ at infinite dilution in water at 25°C are 91.0 and 426.2 S cm^2/mol respectively. To calculate $\wedge^{o}_{HOAc}$, the additional value required is

(1) $\wedge^{o}_{H_2O}$
(2) $\wedge^{o}_{KCl}$
(3) $\wedge^{o}_{NaOH}$
(4) $\wedge^{o}_{NaCl}$

Ans. (4)

Sol. $\lambda^{o}_{CH_3COONa} = \lambda^{o}_{CH_3COO^-} + \lambda^{o}_{Na^+}$ ………. (1)

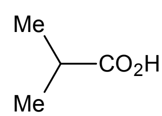
$\lambda^{o}_{HCl} = \lambda^{o}_{H^+} + \lambda^{o}_{Cl^-}$ ………………….. (2)

$\lambda^{o}_{NaCl} = \lambda^{o}_{Na} + \lambda^{o}_{Cl^-}$ …………………. (3)

$\lambda^{o}_{CH_3COOH} = (1) + (2) - (3)$

121. Which one of the following sets of ions represents a collection of isoelectronic species?
(1) K^+, Cl^-, Ca^{2+}, Sc^{3+}
(2) Ba^{2+}, Sr^{2+}, K^+, S^{2-}
(3) N^{3-}, O^{2-}, F^-, S^{2-}
(4) Li^+, Na^+, Mg^{2+}, Ca^{2+}

Ans. (1)

122. The correct order of increasing acid strength of the compounds
(a) CH_3CO_2H
(b) $MeOCH_2CO_2H$
(c) CF_3CO_2H
(d) 

is
(1) b < d < a < c
(2) d < a < c < b
(3) d < a < b < c
(4) a < d < c < b

Ans. (3)

123. In which of the following molecules/ions are all the bonds not equal?
(1) SF_4
(2) SiF_4
(3) XeF_4
(4) BF_4^-

Ans. (1)

124. What products are expected from the disproportionation reaction of hypochlorous acid?
(1) $HClO_3$ and Cl_2O
(2) $HClO_2$ and $HClO_4$
(3) HCl and Cl_2O
(4) HCl and $HClO_3$

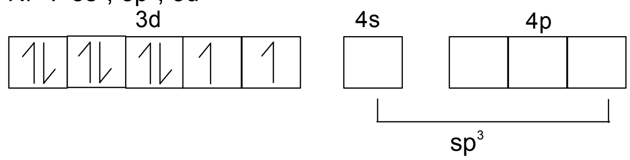
Ans. (4)

125. Nickel (Z = 28) combines with a uninegative monodentate ligand X^- to form a paramagnetic complex $[NiX_4]^{2-}$. The number of unpaired electron(s) in the nickel and geometry of this complex ion are, respectively
(1) one, tetrahedral
(2) two, tetrahedral
(3) one, square planar
(4) two, square planar

Ans. **(2)**

Sol. $_{28}Ni$: ……… $3s^2, 3p^6, 3d^8, 4s^2$

Ni^{2+}: $3s^2, 3p^6, 3d^8$



Tetrahedral geometry

126. In $Fe(CO)_5$, the Fe – C bond possesses

(1) π-character only
(2) both σ and π characters
(3) ionic character
(4) σ-character only

Ans. **(2)**

127. The increasing order of the first ionization enthalpies of the elements B, P, S and F (lowest first) is

(1) F < S < P < B
(2) P < S < B < F
(3) B < P < S < F
(4) B < S < P < F

Ans. **(4)**

128. An ideal gas is allowed to expand both reversibly and irreversibly in an isolated system. If T_i is the initial temperature and T_f is the final temperature, which of the following statements is correct?

(1) $(T_f)_{irrev} > (T_f)_{rev}$
(2) $T_f > T_i$ for reversible process but $T_f = T_i$ for irreversible process
(3) $(T_f)_{rev} = (T_f)_{irrev}$
(4) $T_f = T_i$ for both reversible and irreversible processes

Ans. **(1)**

129. In Langmuir's model of adsorption of a gas on a solid surface

(1) the rate of dissociation of adsorbed molecules from the surface does not depend on the surface covered
(2) the adsorption at a single site on the surface may involve multiple molecules at the same time
(3) the mass of gas striking a given area of surface is proportional to the pressure of the gas
(4) the mass of gas striking a given area of surface is independent of the pressure of the gas

Ans. **(3)**

130. Rate of a reaction can be expressed by Arrhenius equation as:

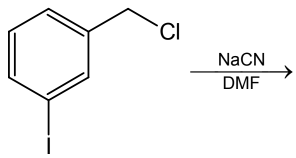
$k = A e^{-E/RT}$

In this equation, E represents

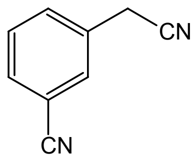
(1) the energy above which all the colliding molecules will react
(2) the energy below which colliding molecules will not react
(3) the total energy of the reacting molecules at a temperature, T
(4) the fraction of molecules with energy greater than the activation energy of the reaction

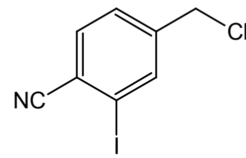
Ans. **(2)**

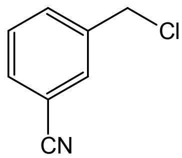
131. The structure of the major product formed in the following reaction

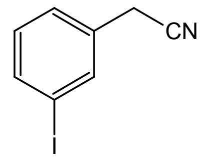


is

(1) 

(2) 

(3) 

(4) 

Ans. (4)

132. Reaction of trans-2-phenyl-1-bromocyclopentane on reaction with alcoholic KOH produces

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

Ans. (4)

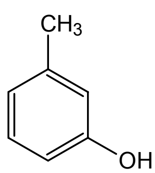
Sol. According to E_2 mechanism.

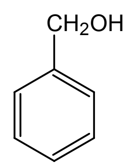
133. Increasing order of stability among the three main conformations (i.e. Eclipse, Anti, Gauche) of 2-fluoroethanol is

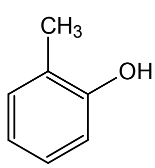
(1) Eclipse, Gauche, Anti
(2) Gauche, Eclipse, Anti
(3) Eclipse, Anti, Gauche
(4) Anti, Gauche, Eclipse

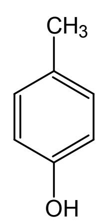
Ans. (3)

134. The structure of the compound that gives a tribromo derivative on treatment with bromine water is

(1) 

(2) 

(3) 

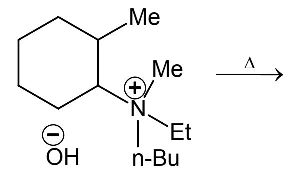
(4) 

Ans. (1)

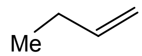
135. The decreasing values of bond angles from NH_3 (106°) to SbH_3 (101°) down group-15 of the periodic table is due to

(1) increasing bp-bp repulsion
(2) increasing p-orbital character in sp^3
(3) decreasing lp-bp repulsion
(4) decreasing electronegativity

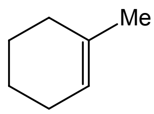
Ans. (4)

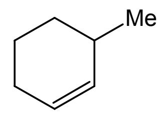
136. 

The alkene formed as a major product in the above elimination reaction is

(1) 

(2) $CH_2 = CH_2$

(3) 

(4) 

Ans. (2)

137. The "spin-only" magnetic moment [in units of Bohr magneton, (μ_B)] of Ni^{2+} in aqueous solution would be (Atomic number of Ni = 28)

(1) 2.84
(2) 4.90
(3) 0
(4) 1.73

Ans. (1)

138. The equilibrium constant for the reaction

$$SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$$

is $K_c = 4.9 \times 10^{-2}$. The value of K_c for the reaction

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

will be

(1) 416
(2) 2.40×10^{-3}
(3) 9.8×10^{-2}
(4) 4.9×10^{-2}

Ans. (1)

Sol. $K_c' = \left(\frac{1}{4.9 \times 10^{-2}}\right)^2$

$= \frac{10^4}{4.9 \times 4.9} = \frac{100 \times 100}{24.01}$

$= 4.1649 \times 100$

$= 416.49$

139. Following statements regarding the periodic trends of chemical reactivity of the alkali metals and the halogens are given. Which of these statements gives the correct picture?

(1) The reactivity decreases in the alkali metals but increases in the halogens with increase in atomic number down the group
(2) In both the alkali metals and the halogens the chemical reactivity decreases with increase in atomic number down the group
(3) Chemical reactivity increases with increase in atomic number down the group in both the alkali metals and halogens
(4) In alkali metals the reactivity increases but in the halogens it decreases with increase in atomic number down the group

Ans. (4)

140. Given the data at 25°C,

$$Ag + I^- \longrightarrow AgI + e^-; \; E^o = 0.152 \text{ V}$$

$$Ag \longrightarrow Ag^+ + e^-; \quad E^o = -0.800 \text{ V}$$

What is the value of log K_{sp} for AgI?

$$\left(2.303\frac{RT}{F} = 0.059 \text{ V}\right)$$

(1) –8.12 (2) +8.612
(3) –37.83 (4) –16.13

Ans. **(4)**

Sol.

$$AgI(s) + e^- \rightleftharpoons Ag(s) + I^-; \; E^\circ = -0.152$$

$$Ag(s) \longrightarrow Ag^+ + e^-; \quad E^\circ = -0.8$$

$$AgI(s) \longrightarrow Ag^+ + I^-; \quad E^\circ = -0.952$$

$$E^\circ_{cell} = \frac{0.059}{n}\log K$$

$$-0.952 = \frac{0.059}{1}\log K_{sp}$$

$$\log K_{sp} = -\frac{0.952}{0.059} = -16.135$$

141. The following mechanism has been proposed for the reaction of NO with Br_2 to form NOBr:

$$NO(g) + Br_2(g) \rightleftharpoons NOBr_2(g)$$

$$NOBr_2(g) + NO(g) \longrightarrow 2NOBr(g)$$

If the second step is the rate determining step, the order of the reaction with respect to NO(g) is

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

Ans. **(4)**

Sol.

$$NO(g) + Br_2(g) \rightleftharpoons NOBr_2(g)$$

$$NOBr_2(g) + NO(g) \longrightarrow 2NOBr(g)$$

$$R = K[NOBr_2]\,[NO]$$

$$= K.K_c\,[NO]\,[Br_2][NO], \text{ where } K_c = \frac{[NOBr_2]}{[NO]\,[Br_2]}$$

$$= K'[NO]^2\,[Br_2]$$

142. Lanthanoid contraction is caused due to

(1) the appreciable shielding on outer electrons by 4f electrons from the nuclear charge
(2) the appreciable shielding on outer electrons by 5d electrons from the nuclear charge
(3) the same effective nuclear charge from Ce to Lu
(4) the imperfect shielding on outer electrons by 4f electrons from the nuclear charge

Ans. **(4)**

143. Resistance of a conductivity cell filled with a solution of an electrolyte of concentration 0.1 M is 100 Ω. The conductivity of this solution is 1.29 S m^{-1}. Resistance of the same cell when filled with 0.2 M of the same solution is 520 Ω. The molar conductivity of 0.02 M solution of the electrolyte will be

(1) 124×10^{-4} S m^2 mol^{-1} (2) 1240×10^{-4} S m^2 mol^{-1}
(3) 1.24×10^{-4} S m^2 mol^{-1} (4) 12.4×10^{-4} S m^2 mol^{-1}

Ans. **(4)**

Sol. There is one mistake in Question paper.

Assuming concentration of solution is 0.2 M instead of 0.02 M. Since resistance of 0.2 M is 520 Ω.

R = 100 Ω

$$K = \frac{1}{R}\left(\frac{\ell}{a}\right)$$

$$1.29 = \frac{1}{100}\left(\frac{\ell}{a}\right)$$

$$\left(\frac{\ell}{a}\right) = 129\ m^{-1}$$

R = 520 Ω, C = 0.2 M

$$K = \frac{1}{R}\left(\frac{\ell}{a}\right) = \frac{1}{520}(129)\ \Omega^{-1}m^{-1}$$

$$\mu = K \times V_{\text{in cm}^3}$$

$$= \frac{1}{520} \times 129 \times \frac{1000}{0.2} \times 10^{-6}\ m^3$$

$$= \frac{129}{520} \times \frac{1000}{0.2} \times 10^{-6}$$

$$= 1.24 \times 10^{-3}$$

$$= 12.4 \times 10^{-4}$$

144. The ionic mobility of alkali metal ions in aqueous solution is maximum for

(1) K^+ (2) Rb^+

(3) Li^+ (4) Na^+

Ans. **(2)**

145. Density of a 2.05 M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is

(1) 1.14 mol kg^{-1} (2) 3.28 mol kg^{-1}

(3) 2.28 mol kg^{-1} (4) 0.44 mol kg^{-1}

Ans. **(3)**

146. The enthalpy changes for the following processes are listed below:

$Cl_2(g) = 2Cl(g)$, 242.3 kJ mol^{-1}

$I_2(g) = 2I(g)$, 151.0 kJ mol^{-1}

$ICl(g) = I(g) + Cl(g)$, 211.3 kJ mol^{-1}

$I_2(s) = I_2(g)$, 62.76 kJ mol^{-1}

Given that the standard states for iodine and chlorine are $I_2(s)$ and $Cl_2(g)$, the standard enthalpy of formation for ICl(g) is

(1) –14.6 kJ mol^{-1} (2) –16.8 kJ mol^{-1}

(3) +16.8 kJ mol^{-1} (4) +244.8 kJ mol^{-1}

Ans. **(3)**

Sol.
$$\frac{1}{2}I_2(s) + \frac{1}{2}Cl_2 \longrightarrow ICl(g)$$

$$\Delta H = \left[\frac{1}{2}\Delta H_{I_2(s)\to I_2(g)} + \frac{1}{2}\mu_{I-I} + \frac{1}{2}\mu_{Cl-Cl}\right] - [\mu_{I-Cl}]$$

$$= \left(\frac{1}{2} \times 62.76 + \frac{1}{2} \times 151.0 + \frac{1}{2} \times 242.3\right) - (211.3)$$

= 228.03 – 211.3

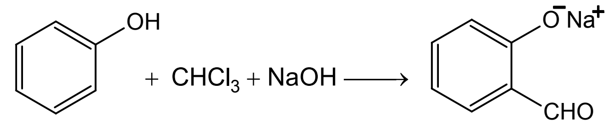
ΔH = 16.73

147. How many EDTA (ethylenediaminetetraacetic acid) molecules are required to make an octahedral complex with a Ca^{2+} ion?

(1) Six (2) Three

(3) One (4) Two

Ans. **(3)**

148. 

The electrophile involved in the above reaction is

(1) dichloromethyl cation ($\overset{\oplus}{C}HCl_2$)

(2) dichlorocarbene ($:CCl_2$)

(3) trichloromethyl anion ($\overset{\ominus}{C}Cl_3$)

(4) formyl cation ($\overset{\oplus}{C}HO$)

Ans. (2)

149. 18 g of glucose ($C_6H_{12}O_6$) is added to 178.2 g of water. The vapour pressure of water for this aqueous solution at 100°C is

(1) 759.00 Torr
(2) 7.60 Torr
(3) 76.00 Torr
(4) 752.40 Torr

Ans. (4)

Sol. $\frac{P^o - P_s}{P_s} = \frac{n}{N}$

$$\frac{760 - P_s}{P_s} = \frac{\frac{18}{180}}{\frac{178.2}{18}} = \frac{\frac{1}{10}}{9.9} = \frac{0.1}{9.9}$$

$$760 - P_s = \frac{1}{99}P_s$$

$760 \times 99 - P_s \times 99 = P_s$

$760 \times 99 = 100\ P_s$

$$P_s = \frac{760 \times 99}{100} = 752.4$$

150. $(\Delta H - \Delta U)$ for the formation of carbon monoxide (CO) from its elements at 298 K is

($R = 8.314\ J\ K^{-1}\ mol^{-1}$)

(1) $-1238.78\ J\ mol^{-1}$
(2) $1238.78\ J\ mol^{-1}$
(3) $-2477.57\ J\ mol^{-1}$
(4) $2477.57\ J\ mol^{-1}$

Ans. (1)

Sol. $\Delta H - \Delta U = \Delta n_g RT$

$$= -\frac{1}{2} \times 8.314 \times 298$$

$= -1238.78$