

AIEEE 2009 Solved Paper

Mathematics

Q. 1. If the roots of the equation $bx^2 + cx + a = 0$ are imaginary, then for all real values of x , the expression is

1. less than $-4ab$
2. greater than $4ab$
3. less than $4ab$
4. greater than $-4ab$

Sol.:

Given $c^2 < 4ab$

$$3b^2x^2 - 6bcx + 2c^2 = (bx + c)^2 - c^2$$

$$\text{Now, } 3(bx + c)^2 - c^2 \geq -c^2 > -4ab$$

Answer: (4)

Q. 2. For real x , let $f(x) = x^3 + 5x + 1$ then

1. f is neither one-one nor onto \mathbf{R}
2. f is one-one but not onto \mathbf{R}
3. f is onto \mathbf{R} but not one-one
4. f is one-one and onto \mathbf{R}

Sol:

$f'(x) = 3x^2 + 5$, which is positive.

$\Rightarrow f(x)$ is strictly increasing hence it is one-one.

Also, $f(\infty) \rightarrow \infty$ and $f(-\infty) \rightarrow -\infty$

Therefore range of $f(x)$ is \mathbf{R}

Answer: (4)

Q. 3. Let a, b, c be such that

$$b(a+c) \neq 0. \text{ If } \begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix} + \begin{vmatrix} a+1 & b+1 & c-1 \\ a-1 & b-1 & c+1 \\ (-1)^{n+2}a & (-1)^{n+1}b & (-1)^n c \end{vmatrix} = 0$$

, then the value of n is

1. any integer
2. zero
3. any even integer

4. any odd integer

Sol: The given equation can be written as

$$\begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix} + (-1)^n \begin{vmatrix} a & a+1 & a-1 \\ -b & b+1 & b-1 \\ c & c-1 & c+1 \end{vmatrix} = 0$$

$\Rightarrow n$ has to be any odd integer.

Answer: (4)

Q. 4. The lines $p(p^2 + 1)x - y + q = 0$ and $(p^2 + 1)x + (p^2 + 1)y + 2q = 0$ are perpendicular to a common line for

1. more than two values of p
2. no value of p
3. exactly one value of p
4. exactly two values of p

Sol:

$$p(p^2 + 1) = \frac{(p^2 + 1)}{(p^2 + 1)} \text{ as the given lines will be parallel.}$$

$$\Rightarrow p = -1$$

Answer: (3)

$$B\left(n, p = \frac{1}{4}\right)$$

Q. 5. In a binomial distribution, if the probability of at least one success is greater than or equal

$$\frac{9}{10}$$

to $\frac{9}{10}$, then n is greater than

$$\frac{4}{\log_{10}^4 - \log_{10}^3}$$

1.

$$\frac{1}{\log_{10}^4 - \log_{10}^3}$$

2.

$$\frac{4}{\log_{10}^4 + \log_{10}^3}$$

3.

$$\frac{9}{\log_{10}^4 - \log_{10}^3}$$

4.

Sol:

$$p(\text{at least 1 success}) = 1 - p(\text{all failures})$$

$$\text{Given that } 1 - \left(\frac{3}{4}\right)^n \geq \frac{9}{10} \quad \left[p(\text{at least 1 success}) = 1 - \left(\frac{3}{4}\right)^n \right]$$

$$\Rightarrow \frac{1}{10} \geq \left(\frac{3}{4}\right)^n \Rightarrow -1 \geq (\log_{10}^3 - \log_{10}^4) \Rightarrow n \geq \frac{1}{\log_{10}^4 - \log_{10}^3}$$

Answer: (2)

$$y = c_1 e^{c_2 x}, \text{ where } c_1 \text{ and } c_2$$

Q. 6. The differential equation which represents the family of curves , where and are arbitrary constants, is

$$yy' = (y')^2$$

1.

$$y' = y^2$$

2.

$$yy' = y'y$$

3.

$$yy' = y'$$

4.

Sol:

$$y = c_1 e^{c_2 x} \Rightarrow y' = c_1 e^{c_2 x} = c_2 y \Rightarrow \frac{y'}{y} = c_2$$

$$\text{Differentiating again we get } y''y = (y')^2$$

Answer: (1)

Q. 7. If the mean deviation of the numbers 1, 1 + d, 1 + 2d,....., 1 + 100d from their mean is 255, then the d is equal to

1. 20.2

2. 10.0

3. 20.0

4. 10.1

Sol:

$$\text{Mean of given numbers, } \bar{x} = \frac{1 + (1+d) + \dots + (1+100d)}{101} = 1 + 50d$$

$$\text{Mean deviation} = \frac{\sum |x_i - \bar{x}|}{n} = \frac{\sum_{r=0}^{100} |(1+rd) - (1+50d)|}{101}$$

$$\Rightarrow \frac{\sum_{r=0}^{100} |(r-50)d|}{101} = \frac{d \cdot 50 \times 51}{101}$$

Given that mean deviation is 255

$$\Rightarrow \frac{d \cdot 50 \times 51}{101} = 255 \Rightarrow d = 10.1$$

Answer: (4)

Q. 8. Let A and B denote the statements

$A: \cos \alpha + \cos \beta + \cos \gamma = 0$, $B: \sin \alpha + \sin \beta + \sin \gamma = 0$.

If $\cos(\beta - \gamma) + \cos(\gamma - \alpha) + \cos(\alpha - \beta) = -\frac{3}{2}$, then

1. both A and B are false
2. A is true and B is false
3. A is false and B is true
4. both A and B are true

Sol:

$$\cos(\alpha - \beta) + \cos(\beta - \gamma) + \cos(\gamma - \alpha) = -\frac{3}{2}$$

$$\Rightarrow 3 + 2(\cos((\alpha - \beta) + \cos(\beta - \gamma) + \cos(\gamma - \alpha)) = 0$$

$$\Rightarrow (\cos \alpha + \cos \beta + \cos \gamma)^2 + (\sin \alpha + \sin \beta + \sin \gamma)^2 = 0$$

Answer: (4)

Q. 9.

Statement-1: $\sim(p \leftrightarrow \sim q)$ is equivalent to $p \leftrightarrow q$.

Statement-2: $\sim(p \leftrightarrow \sim q)$ is a tautology.

1. Statement-1 is false, Statement-2 is true.
2. Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.

3. Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.

4. Statement-1 is true, Statement-2 is false.

Sol.: Since, nothing has been stated about statements p and q we need to consider them as two independent statements i.e. they can be simultaneously true as well as false. Now, this can also be seen through the truth table:

P	Q	$p \leftrightarrow q$	$\sim q$	$p \leftrightarrow \sim q$	$\sim (p \leftrightarrow \sim q)$
T	T	F	F	F	T
T	F	T	T	T	F
F	T	F	F	T	F
F	F	T	T	F	T

Clearly column of $p \leftrightarrow q$ and $(\sim p \leftrightarrow \sim q)$ in truth table show equivalence.

Also $\sim (p \leftrightarrow \sim q)$ does not show tautology in this case.

Answer: (4)

However if we consider ' p ' and ' q ' as two statements which may be dependent on each other then the equivalence becomes meaningless. Nothing can be said about tautology in general.

Q. 10.

$$2 \times 2$$

Let A be a matrix

Statement 1: $\text{adj}(\text{adj } A) = A$.

$$|\text{adj } A| = |A|$$

Statement 2:

- Statement-1 is false, Statement-2 is true.
- Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.
- Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.
- Statement-1 is true, Statement-2 is false.

Sol:

$$\text{Consider } A = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \text{adj } A = \begin{bmatrix} d & -b \\ -c & a \end{bmatrix} \Rightarrow \text{adj}(\text{adj } A) = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$$

Also $|\text{adj } A| = |A|$ but this does not explain the statement - 1.

Answer: (3)

$$\frac{n^2 - 1}{4}$$

Q. 11. Statement-1: The variance of first n even natural numbers is

$$\frac{n(n+1)}{2}$$

Statement-2: The sum of first n natural numbers is

and the sum of squares of first n natural numbers

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

is

1. Statement-1 is false, Statement-2 is true.
2. Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.
3. Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.
4. Statement-1 is true, Statement-2 is false.

Variance, $\sigma = \frac{\sum (x_i - \bar{x})^2}{n}$, where \bar{x} is the mean. Let $2, 4, 6, \dots, 2n$ be the numbers.

$$\Rightarrow \bar{x} = \frac{2(n)(n+1)}{2n} = n+1$$

$$\begin{aligned} \sigma &= \frac{\sum 4r^2 - 4r(n+1) + (n+1)^2}{n} = \frac{4n(n+1)(2n+1)}{6n} - \frac{4n(n+1)^2}{2n} + (n+1)2 \\ &= \frac{2(2n^2 + 3n + 1)}{3} - (n+1)^2 = \frac{4n^2 + 6n + 2 - 3n^2 - 6n - 3}{3} = \frac{n^2 - 1}{3} \end{aligned}$$

Sol:

Answer: (1)

Q. 12.

Let $f(x) = (x+1)^2 - 1$, $x \geq -1$.

Statement 1: The set $\{x : f(x) = f^{-1}(x)\} = \{0, -1\}$.

Statement-2: f is a bijection.

1. Statement-1 is false, Statement-2 is true.
2. Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.
3. Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.
4. Statement-1 is true, Statement-2 is false.

Sol:

$$f(x) = y = (x+1)^2 - 1, x \geq -1, y \geq -1$$

$$f^{-1}(x) = -1 + \sqrt{1+x}, x \geq -1 \quad [f^{-1}(x) \text{ exist only if } f(x) \text{ is bijective}]$$

$$\text{Also, } f^{-1}(x) = f(x)$$

$$\Rightarrow (x+1)^2 - 1 = -1 + \sqrt{1+x} \Rightarrow x = 0, -1$$

Answer: (3)

Q. 13. Let $f(x) = x|x|$ and $g(x) = \sin x$.

Statement-1: is differentiable at $x = 0$ and its derivative is continuous at that point.

Statement-2: is twice differentiable at $x = 0$.

1. Statement-1 is false, Statement-2 is true.
2. Statement-1 is true, Statement-2 is true; Statement-2 is a correct explanation for Statement-1.
3. Statement-1 is true, Statement-2 is true; Statement-2 is **not** a correct explanation for Statement-1.
4. Statement-1 is true, Statement-2 is false.

Sol:

$$h(x) = g(f(x)) = \sin x^2, x \geq 0$$

$$= -\sin x^2, x < 0$$

$$h'(x) = 2x \cos x^2, x < 0$$

$$\Rightarrow h'(0^+) = h'(0^-) = 0$$

$$h''(x) = -4x^2 \sin x^2 + 2 \cos x^2, x \geq 0$$

$$= -[-4x^2 \sin x^2 + 2 \cos x^2, x \geq 0], x < 0$$

$$\Rightarrow h''(0^+) = 2$$

$$h''(0^-) = -2$$

Answer: (4)

Q. 14. Given $p(x) = x^4 + ax^3 + bx^2 + cx + d$ such that $x = 0$ is the only real root of $p'(x) = 0$. If $p(-1) < p(1)$, then in the interval $[-1, 1]$

1. neither $p(-1)$ is the minimum nor $p(1)$ is the maximum of p
2. $p(-1)$ is the minimum and $p(1)$ is the maximum of p
3. $p(-1)$ is not minimum but $p(1)$ is the maximum of p
4. $p(-1)$ is the minimum but $p(1)$ is not the maximum of p

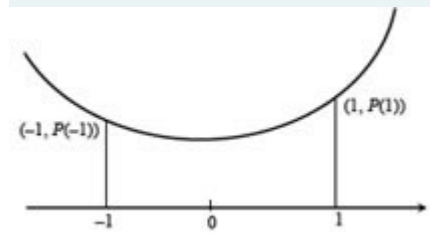
Sol:

$$p(x) = x^4 + ax^3 + bx^2 + cx + cx + d$$

$$\text{Now } p'(0) = 0 \Rightarrow c = 0$$

$$\Rightarrow p(x) = x^4 + ax^3 + bx^2 + d$$

Clearly $p(1)$ is maximum but $p(-1)$ is not minimum.



Answer: (3)

Q. 15. The shortest distance between the line $y - x = 1$ and curve $x = y^2$ is

1.

$$\frac{\sqrt{3}}{4}$$

2.

$$\frac{3\sqrt{2}}{8}$$

3.

$$\frac{2\sqrt{3}}{8}$$

4.

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

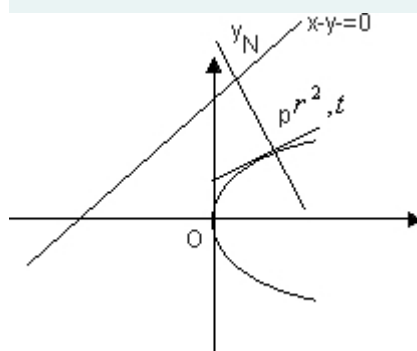
Sol:

$$x = y^2$$

$$\Rightarrow y' = \frac{2}{2y}$$

$$m = \frac{1}{2t} = 1 \Rightarrow t = \frac{1}{2}; p\left(\frac{1}{4}, \frac{1}{2}\right)$$

$$\text{so, } PN = \frac{\left|\frac{1}{4} - \frac{1}{2} + 1\right|}{\sqrt{2}} = \frac{3}{4\sqrt{2}} = \frac{3\sqrt{2}}{8}$$



Answer: (2)

Q. 16. The area of the region bounded by the parabola $(y - 2)^2 = x - 1$, the tangent to the parabola at the point $(2, 3)$ and the x-axis is

1. 12
2. 3
3. 6
4. 9

Sol:

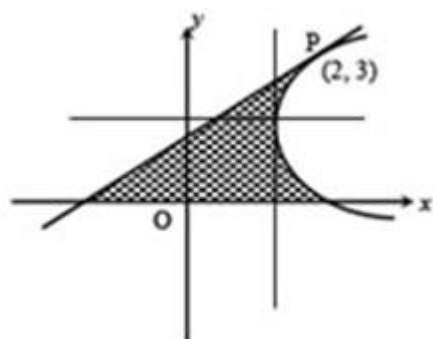
$$(y - 2)^2 = x - 1$$

$$2(y - 2)y' = 1 \Rightarrow y' = \frac{1}{2(y - 2)} \Rightarrow y' = \frac{1}{2} \text{ at } y = 3$$

$$\text{Equation of tangent } y - 3 = \frac{1}{2}(x - 2)$$

$$\Rightarrow 2y - 6 = x - 2 \Rightarrow x = 2y - 4$$

$$A = \int_0^3 ((y - 2)^2 + 1 - (2y - 4)) dy = \int_0^3 (y^2 - 6y + 9) dy = \frac{27}{3} = 9$$



Answer: (4)

$$1 + \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \frac{14}{3^4} + \dots \dots \dots \text{ is}$$

Q. 17. The sum to infinity of the series

1. 6
2. 2
3. 3
4. 4

Sol:

$$S = 1 + \frac{2}{3} + \frac{6}{3^2} + \frac{10}{3^3} + \frac{14}{3^4} + \dots \dots \dots \quad (i)$$

$$\frac{S}{3} = 1 + \frac{1}{3} + \frac{2}{3^2} + \frac{6}{3^3} + \frac{10}{3^4} + \dots \dots \dots \quad (ii)$$

Subtracting (ii) from (i) we get, $S \frac{2}{3} = 1 + \frac{1}{3} + \frac{4}{3^2} + \frac{4}{3^3} \dots \dots$

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

$$S = 3$$

Answer: (3)

Q. 18. The ellipse $x^2 + 4y^2 = 4$ is inscribed in a rectangle aligned with the coordinate axes, which in turn is inscribed in another ellipse that passes through the point (4, 0). Then the equation of the ellipse is

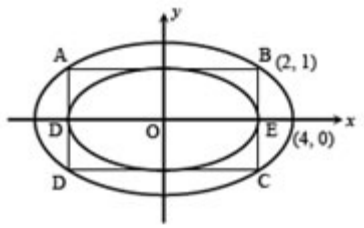
1. $4x^2 + 64y^2 = 48$
2. $x^2 + 16y^2 = 16$
3. $x^2 + 12y^2 = 16$

4. $4x^2 + 48y^2 = 48$

Sol:

Let the new ellipse be $\frac{x^2}{16} + \frac{y^2}{b^2} = 1$

Satisfying (2, 1) we get $b^2 = \frac{16}{12}$



Answer: (3)

Q. 19. The projections of a vector on the three coordinate axis are 6, -3, 2 respectively. The direction cosines of the vector are

$\frac{-6}{7}, \frac{-3}{7}, \frac{2}{7}$

1.

2. 6, -3, 2

$\frac{6}{5}, \frac{-3}{5}, \frac{2}{5}$

3.

$\frac{6}{7}, \frac{-3}{7}, \frac{2}{7}$

4.

Sol.: Direction ratios are: 6, -3, 2

$\frac{6}{7}, \frac{-3}{7}, \frac{2}{7}$

Direction cosines are:

Answer: (4)

Q. 20. From 6 different novels and 3 different dictionaries, 4 novels and 1 dictionary are to be selected and arranged in a row on a shelf so that the dictionary is always in the middle. Then the number of such arrangements is

1. at least 1000

2. less than 500

3. at least 500 but less than 750

4. at least 750 but less than 1000

Sol:

$$\begin{aligned} \text{Required number of arrangement} &= {}^6C_4 \times {}^3C_1 \times {}^4C_2 (2!)^2 \\ &= 15 \times 3 \times 6 \times 4 = 1080 \end{aligned}$$

Answer: (1)

If $\vec{u}, \vec{v}, \vec{w}$

Q. 21. are non-coplanar vectors and p, q are real numbers, then the

$$[3\vec{u} \ p\vec{v} \ p\vec{w}] - [p\vec{v} \ \vec{w} \ q\vec{u}] - [2\vec{w} \ q\vec{v} \ q\vec{u}] = 0 \text{ holds for}$$

equality

1. all values of (p, q)
2. exactly one value of (p, q)
3. exactly two values of (p, q)
4. more than two but not all values of (p, q)

Sol:

$$\begin{aligned} (3p^2 - pq + 2q^2)[\vec{u}, \vec{v}, \vec{w}] &= 0 \\ \Rightarrow 3p^2 - pq + 2q^2 &= 0 \text{ for real } p \\ D &\geq 0 \\ \Rightarrow q^2 - 4 \times 2 \times 3q^2 &\geq 0 \Rightarrow -23q^2 \geq 0 \Rightarrow q = 0 \\ \Rightarrow p &= 0 \\ \text{So exactly one value of } (p, q) \end{aligned}$$

Answer: (2)

Q. 22.

Let the line $\frac{x-2}{3} = \frac{y-1}{-5} = \frac{z+2}{2}$ lie in the plane $x + 3y - \alpha z + \beta = 0$.

Then (α, β) equals

1. $(-5, 5)$
2. $(6, -17)$
3. $(-6, 7)$
4. $(5, -15)$

Sol:

$$(2, 1, -2) \text{ lies on } x + 3y - \alpha z + \beta = 0$$

$$\Rightarrow 2\alpha + \beta + -5$$

$$\text{Also } 3 - 15 - 2\alpha = 0 \Rightarrow \alpha = -6, \beta = 7$$

$$(\alpha, \beta) \equiv (-6, 7)$$

Answer: (3)

Q. 23.

If $\left| Z - \frac{4}{Z} \right| = 2$, then the maximum value of $|Z|$ is equal to

1. $2 + \sqrt{2}$
2. $\sqrt{2} + 1$
3. $\sqrt{5} + 1$
4. 2

Sol:

$$\left| |Z_1| - |Z_2| \right| \leq |Z_1 - Z_2|$$

$$\Rightarrow \left| |Z| - \frac{4}{|Z|} \right| \leq 2$$

$$\Rightarrow |Z|^2 - 2|Z| - 4 \leq 0 \Rightarrow |Z|_{\max} = \sqrt{5} + 1$$

Answer: (3)

$$8^{2n} - (62)^{2n+1}$$

Q. 24. The remainder left out when _____ is divided by 9 is

1. 8
2. 0
3. 2
4. 7

Sol:

$$8^{2n} - (62)^{2n+1}$$

$$\Rightarrow (9-1)^{2n} - (63-1)^{2n+1} \Rightarrow \left({}^{2n}C_0 9^{2n} - {}^{2n}C_1 9^{2n-1} + \dots + 1 \right) - \left({}^{2n+1}C_0 63^{2n+1} - {}^{2n+1}C_1 63^{2n} + \dots - 1 \right)$$

$$\Rightarrow 9K + 2$$

So the remainder is 2

Answer: (3)

$$A \cap B = A \cap C \text{ and } A \cup B = A \cup C, \text{ then}$$

Q. 25. If A, B and C are three sets such that

$$A \cap B = \phi$$

- 1.
2. $A = B$
3. $A = C$
4. $B = C$

Sol:

$$A \cap B = A \cap C \text{ and } A \cup B = A \cup C \\ \Rightarrow B = C$$

Answer: (4)

$$\int_0^x [\cot x] dx, \text{ where } [.]$$

Q. 26. denotes the greatest integer function, is equal to

$$-\frac{\pi}{2}$$

1.

$$\frac{\pi}{2}$$

2.

3. 1

4. -1

Sol:

$$I \int_0^{\pi} [\cot x] dx$$

$$I = \int_0^{\pi} [-\cot x] dx \Rightarrow dx \quad 2I = \int_0^{\pi} ([\cot x] + [-\cot x]) dx = -\pi \Rightarrow I = \frac{\pi}{2}$$

Answer: (1)

Q. 27. If P and Q are the points of intersection of the circles $x^2 + y^2 + 3x - 7y + 2p - 5 = 0$ and $x^2 + y^2 + 2x + 2y - p^2 = 0$, then there is a circle passing through P , Q and $(1, 1)$ for

1. exactly one value of p
2. all values of p
3. all except one value of p
4. all except two values of p

Sol:

Let the circle be $S_1 + \lambda S_2 = 0$

$x^2 + y^2 + 3x + 7y + 2p - 5 + \lambda (x^2 + y^2 + 2x + 2y - p^2) = 0$ passes through $(1, 1)$

$7 + 2p + \lambda (6 - p^2) = 0$, where $p = \pm \sqrt{6}$ required circle become $s_2 = 0$

Answer: (2)

Q. 28. Three distinct points A , B and C are given in the 2-dimensional coordinate plane such that the ratio of the

$$\frac{1}{3}$$

distance of any one of them from the point $(1, 0)$ to the distance from the point $(-1, 0)$ is equal to $\frac{1}{3}$. Then the circumcentre of the triangle ABC is at the point

1. $\left(\frac{5}{3}, 0\right)$
2. $(0, 0)$
3. $\left(\frac{5}{4}, 0\right)$

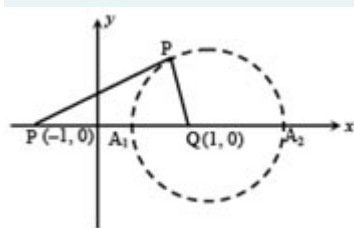
4.

$$\left(\frac{5}{2}, 0\right)$$

Sol:

$$A_1 \equiv \left(\frac{1}{2}, 0\right); A_2 \equiv (2, 0)$$

$$\text{Circumcentre} \equiv \left(\frac{5}{4}, 0\right)$$



Answer: (3)

Q. 29. One ticket is selected at random from 50 tickets numbered 00, 01, 02,, 49. Then the probability that the sum of the digits on the selected ticket is 8, given that the product of these digits is zero, equals

1.

$$\frac{1}{50}$$

2.

$$\frac{1}{14}$$

3.

$$\frac{1}{7}$$

4.

$$\frac{5}{14}$$

Sol:

00 10 20 30 40
 01 11 21 31 40

 09 19 29 39 49
 $n(S) = 14, n(A) = 1$
 $\Rightarrow P(A) = \frac{1}{14}$

Answer: (2)

Q. 30. Let be an implicit function of x defined $x^{2x} - 2x^x \cot y - 1 = 0$. Then $y'(1)$ equals

1. $-\log 2$
2. -1
3. 1
4. $\log 2$

Sol:

$$\text{At } x=1 \Rightarrow \cot y = 0$$

$$y' = \frac{2(\cot y - 1)}{2 \operatorname{cosec}^2 y} = \frac{-2}{2} = -1$$

Answer: (2)

AIEEE 2009 Solved Paper

Physics

Q.1. Three sound waves of equal amplitudes have frequencies $(\nu - 1)$, ν , $(\nu + 1)$. They *superpose* to give beats. The number of beats produced per second will be:

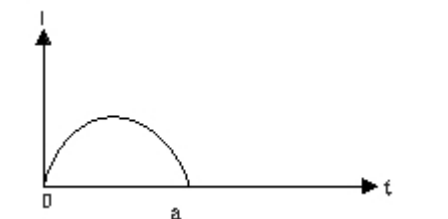
1. 1

2. 4

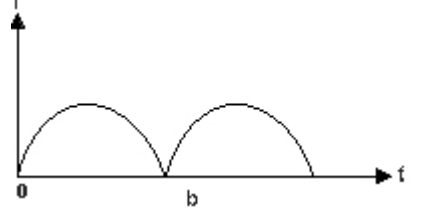
3. 3

4. 2

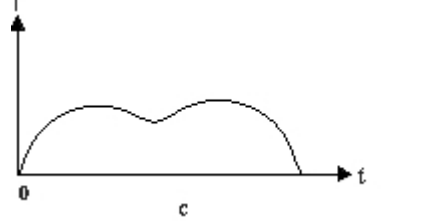
Sol: Variation of intensity due to superposition of waves having frequencies $\nu - 1$ & ν and ν & $\nu + 1$ is as shown



Variation of intensity due to superposition of waves having frequencies $\nu - 1$ and $\nu + 1$ is as shown



Resultant of (a) and (b) be as shown So number of beats/s = 2



Answer: (4)

$$\frac{g}{9}$$

Q.2. The height at which the acceleration due to gravity becomes $\frac{g}{9}$ (where g = the acceleration due to gravity on the surface of the earth) in terms of R , the radius of the earth is:

$$\sqrt{2} R$$

1.

2. $2R$

$$\frac{R}{\sqrt{2}}$$

3.

4. $R/2$

Sol:

$$g' = \frac{g}{\left(1 + \frac{h}{R}\right)^2}; \quad \frac{g}{9} = \frac{g}{\left(1 + \frac{h}{R}\right)^2}; \quad 1 + \frac{h}{R} = 3; \quad h = 2R$$

Answer: (2)

$$8 \times 10^4 \text{ N/m}^2.$$

Q.3. One kg of a diatomic gas is at a pressure of

The density of the gas is 4 kg/m^3 . What is the energy of the gas due to its thermal motion?

$$8 \times 10^4 \text{ J.}$$

1.

$$3 \times 10^4 \text{ J.}$$

2.

$$5 \times 10^4 \text{ J.}$$

3.

$$6 \times 10^4 \text{ J.}$$

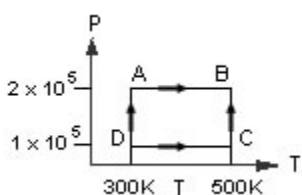
4.

Sol:

$$K = \frac{5}{2} pV = \frac{5}{2} \times 8 \times 10^4 \times \frac{1}{4} = 5 \times 10^4 \text{ J}$$

Directions: Question numbers 34, 35 and 36 are based on the following paragraph.

Two moles of helium gas are taken over the cycle ABCDA, as shown in the P-T diagram.



Q.4. Assuming the gas to be ideal the work done on the gas in taking it from A to B is:

1. $500 R$

2. $200 R$

3. $300 R$

4. $400 R$

$$W_{AB} = P \Delta V = n R \Delta T = 2 \times R \times (500 - 300) = 400R$$

Sol:

Q.5. The work done on the gas in taking it from D to A is:

1. + 690 R
2. - 414 R
3. + 414 R
4. - 690 R

Sol:

$$W_{DB} = 2.3nRT \log \frac{P_1}{P_2} = (2.302) (2) (R) (300) \log \left(\frac{1 \times 10^5}{2 \times 10^5} \right)$$

$$= - (2.3) (600R) (0.3) = - 414R$$

Q.6. The net work done on the gas in the cycle ABCDA is:

1. 1904 R
2. Zero
3. 276 R
4. 1076 R

Sol:

$$W_{BC} = (2.3) (2) (R) (500) \log 2 = 690R$$

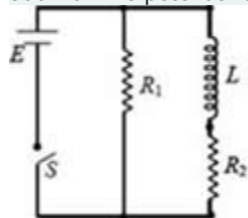
$$W_{cd} = - 400R$$

$$W_{total} = (690 - 414) R = 276R$$

$$R_1 = 2\Omega$$

$$R_2 = 2\Omega$$

Q.7. An inductor of inductance $L = 400 \text{ mH}$ and resistors of resistances and are connected to a battery of emf 12V as shown in the figure. The internal resistance of the battery is negligible. The switch S is closed at $t = 0$. The potential drop across L as a function of time is:



$$12e^{-st}V$$

1.

$$6e^{-st}V$$

2.

$$\frac{12}{t} e^{-3t} V$$

3.

$$6 (1 - e^{-t/0.2}) V$$

4.

Sol:

Current in LR_2 branch

$$i = \frac{e}{R_2} [1 - e^{-R_2 t / L}] \quad \frac{di}{dt} = \frac{E}{R_2} \frac{R_2}{L} e^{-R_2 t / L}$$

$$\text{Drop across } L = \left(\frac{E}{L} e^{-R_2 t / L} \right) L = 12 e^{-2t / 400 \times 10^{-3}} = 12 e^{-5t} V$$

Answer: (1)

Q.8. A mixture of light, consisting of wavelength 590 nm and an unknown wavelength, illuminates Young's double slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both lights coincide. Further, it is observed that the third bright fringe of known light coincides with the 4th bright fringe of the unknown light. From this data, the wavelength of the unknown light is:

1. 776.8 nm
2. 393.4 nm
3. 885.0 nm
4. 442.5 nm

Sol:

$$\frac{3\lambda_1 D}{d} = \frac{4\lambda_2 D}{d}; \quad 3 \times 590 = 4 \times \lambda_2; \quad \lambda_2 = 442.5 \text{ nm}$$

Answer: (4)

Q.9. A charge Q is placed at each of the opposite corners of a square. A charge q is placed at each of the other two corners. If the net electric force on Q is zero, then Q/q equals:

$$-\frac{1}{\sqrt{2}}$$

1.

$$-2\sqrt{2}$$

2.

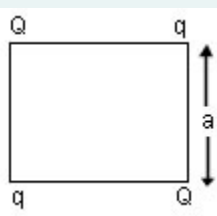
3. -1

4. 1

Sol:

$$\frac{Q^2}{4\pi\epsilon_0 (2a^2)} + \frac{qQ\sqrt{2}}{4\pi\epsilon_0 a^2} = 0$$

$$\frac{Q}{q} = -2\sqrt{2}$$



Answer: (2)

Q.10. In an optics experiment, with the position of the object fixed, a student varies the position of a convex lens and for each position, the screen is adjusted to get a clear image of the object. A graph between the object distance u and the image distance v , from the lens, is plotted using the same scale for the two axes. A straight line passing through the origin and making an angle of 45° with the x-axis meets the experimental curve at P . The coordinates of P will be

1. $(4f, 4f)$
2. $(2f, 2f)$

$$\left(\frac{f}{2}, \frac{f}{2}\right)$$

- 3.
4. (f, f)

Sol:

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

Coordinates are $(2f, 2f)$

Answer: (2)

Q.11. A thin uniform rod of length l and mass m is swinging freely about a horizontal axis passing through its end. Its maximum angular speed is ω . Its centre of mass rises to a maximum height of :

$$\frac{1}{6} \frac{l^2 \omega^2}{g}$$

- 1.

$$\frac{1}{3} \frac{I^2 \omega^2}{g}$$

2.

$$\frac{1}{6} \frac{I \omega}{g}$$

3.

$$\frac{1}{2} \frac{I^2 \omega^2}{g}$$

4.

Answer: (1)

$$\text{Let } P(r) = \frac{Q}{\pi R^4} r$$

Q.12. be the charge density distribution for a solid sphere of radius R and total charge Q. For a point 'p' inside the sphere at distance r₁ from the centre of the sphere, the magnitude of electric field is:

$$\frac{Q r_1^2}{3\pi \epsilon_0 R^4}$$

1.

2. 0

$$\frac{Q}{4\pi \epsilon_0 R_1^2}$$

3.

$$\frac{Q r_1^2}{4\pi \epsilon_0 R^4}$$

4.

Sol:

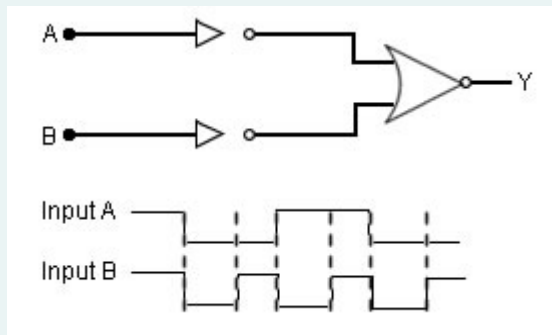
$$\text{Charge enclosed in a radius } r_1 = \int_0^{r_1} \frac{Q}{\pi R^4} r \cdot 4\pi r^2 dr = \frac{Q r_1^4}{R^4}$$

$$\text{Using Gauss's law } E \cdot 4\pi r_1^2 = \left(\frac{Q r_1^4}{R^4} \right) \frac{1}{\epsilon_0}$$

$$E = \frac{Q r_1^2}{4\pi \epsilon_0 R^4}$$

Answer: (4)

Q.13. The logic circuit shown below has the input waveforms 'A' and 'B' as shown. Pick out the correct output waveform.



Output is

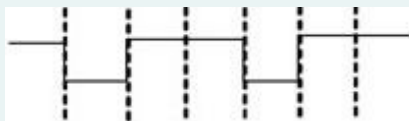
1.



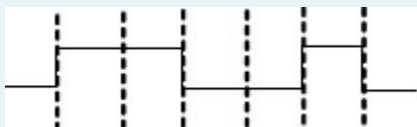
2.



3.



4.



Answer: (2)

Q.14. If x , v and a denote the displacement, the velocity and the acceleration of particle executing simple harmonic motion of time period T , then, which of the following does **not** change with time?

1. aT/v

$$a^2 T^2 + 4\pi^2 v^2$$

2.

3. aT/x

$$aT + 2\pi v$$

4.

$$x = A \sin (ax + \phi), \quad v = A\omega \cos (ax + \phi)$$

$$a = -A\omega^2 \sin (ax + \phi),$$

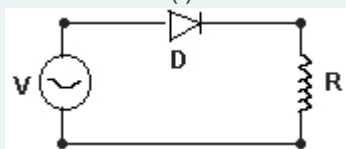
$$aT = -A\omega^2 \sin (ax + \phi) = A\omega^2 \frac{2\pi}{\omega} \sin (ax + \phi) = -2\pi A\omega \sin (ax + \phi)$$

$$\frac{aT}{x} = -2\pi\omega = \text{const} \tan t$$

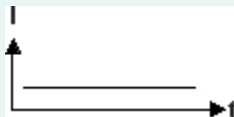
Sol:

Answer: (3)

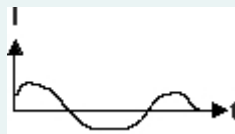
Q.15. A p - n junction (D) shown in the figure can act as a rectifier. An alternating current source (V) is connected in the circuit. The current (I) in the resistor (R) can be shown by



1.



2.



3.



4.



Sol.: Current will flow when diode is forward biased.

Answer: (4)

Q.16. A motor cycle starts from rest and accelerates along a straight path at 2 m/s^2 . At the starting point of the motor cycle there is a stationary electric siren. How far has the motor cycle gone when the driver hears the frequency of the siren at 94% of its value when the motor cycle was at rest? (Speed of sound = 330 ms^{-1})

1. 196 m
2. 49 m
3. 98 m
4. 147 m

Sol:

$$\frac{94}{100} v = \frac{V - V_0}{V} v; \quad 0.9V = V - V_0$$

$$V_0 = 0.064V = 0.06 \times 330 = 19.8 \text{ m/s}$$

$$V_0^2 = u^2 + 2as$$

$$(19.8)^2 = 0^2 + (2)(2)s$$

$$s = 98 \text{ m}$$

Answer: (3)

Q.17. Two points P and Q are maintained at the potentials of 10V and -4V , respectively. The work done in moving 100 electrons from P to Q is :

1. $2.24 \times 10^{-16} \text{ J}$
2. $-9.60 \times 10^{-17} \text{ J}$
3. $9.60 \times 10^{-17} \text{ J}$
4. $-2.24 \times 10^{-16} \text{ J}$

$$W_{\text{ext}} = q (V_f - V_i) (-100 \times 1.6 \times 10^{-19}) (-4 - 10) = -16 \times 10^{-17} \times (-14) = 2.24 \times 10^{-16} \text{ J}$$

Sol:

Answer: (1)

Q.18. In an experiment the angles are required to be measured using an instrument. 29 divisions of the main scale exactly coincide with the 30 divisions of the vernier scale. If the smallest division of the main scale is half-a- degree (= 0.5°), then the least count of the instrument is:

1. half degree
2. one minute

3. half minute

4. one degree

Sol:

$$\text{Least count} = 1 \text{ MSD} - \text{VSD}$$

$$= 1 \text{ MSD} - \frac{29}{30} \text{ MSD} = \frac{1}{30} \text{ MSD} = \frac{0.5^\circ}{30} = \frac{30 \text{ min utes}}{30} = \text{one min ute}$$

Answer: (2)

Q.19. The surface of a metal is illuminated with the light of 400 nm. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV. The work function of the metal is: ($hc = 1240 \text{ eV.nm}$)

1. 1.68 eV

2. 3.09 eV

3. 1.41 eV

4. 1.51 eV

Sol:

$$W = \frac{hc}{\lambda} - K_{\text{max}} = \frac{1240}{400} - 1.68 = 1.42 \text{ eV}$$

Answer: (3)

Q.20. A particle has an initial velocity of $3\hat{i} + 4\hat{j}$ and an acceleration of $4\hat{i} + 0.3\hat{j}$. Its speed after 10 s is:

1. 8.5 units

2. 10 units

$$7\sqrt{2} \text{ units}$$

3.

4. 7 units

Sol:

$$V_x = 3 + (0.4)(10) = 7 \text{ units}$$

$$V_y = 4 + (0.3)(10) = 7 \text{ units}$$

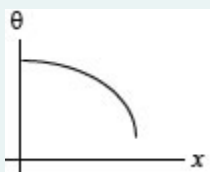
$$\text{Speed} = 7\sqrt{2} \text{ units}$$

Answer: (3)

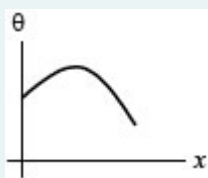
Q.21. A long metallic bar is carrying heat from one of its ends to the other end under steady-state. The variation of temperature θ

along the length x of the bar from its hot end is best described by which of the following figures?

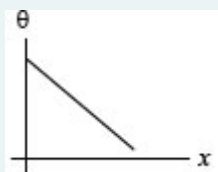
1.



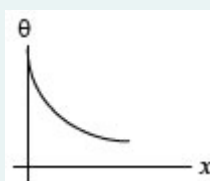
2.



3.



4.



Sol:

$$r = -KA \frac{d\theta}{dx}$$

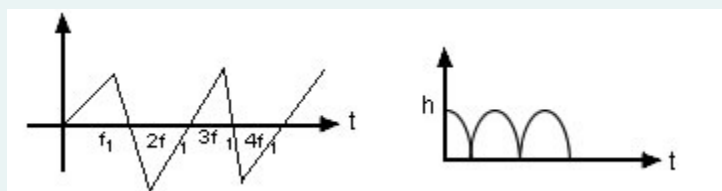
In steady state $r = \text{constant}$

$$\frac{d\theta}{dx} = -\frac{KA}{r}; d\theta = -\frac{KA}{r} dx, \theta = C - \frac{KA}{r} x$$

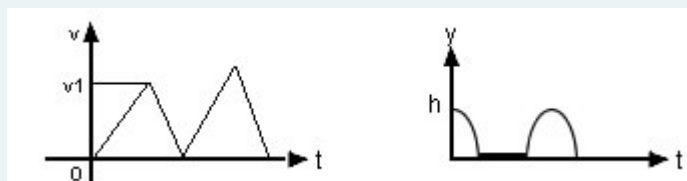
Answer: (3)

Q.22. Consider a rubber ball freely falling from a height $h = 4.9 \text{ m}$ onto a horizontal elastic plate. Assume that the duration of collision is negligible and the collision with the plate is totally elastic. Then the velocity as a function of time and the height as a function of time will be

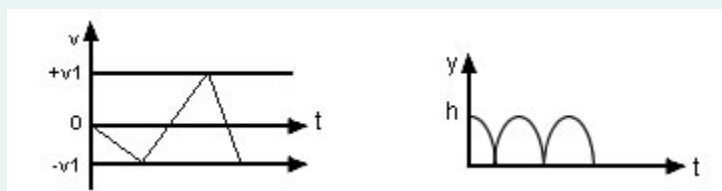
1.



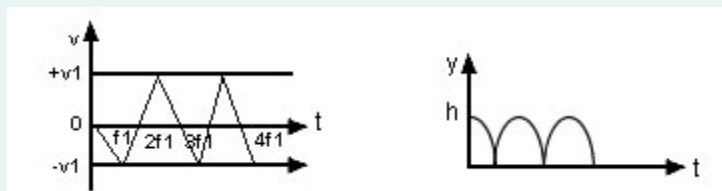
2.



3.



4.



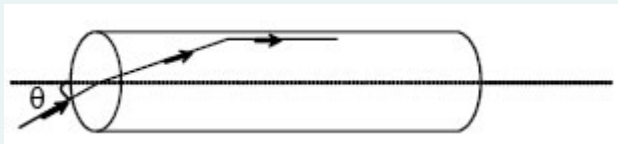
Sol.: Slope of velocity-time graph will remain constant except during collision where it will not be defined. Also variation of height with time will be parabolic.

Answer: (4)

$$\frac{2}{\sqrt{3}}$$

Q.23. A transparent solid cylindrical rod has a refractive index of $\frac{2}{\sqrt{3}}$. It is surrounded by air. A light ray is incident at

the mid point of one end of the rod as shown in the figure. The incident angle θ for which the light ray grazes along the wall of the rod is :



1.

$$\sin^{-1} \left(\frac{1}{\sqrt{3}} \right)$$

2.

$$\sin^{-1} \left(\frac{1}{2} \right)$$

3.

$$\sin^{-1} \left(\frac{\sqrt{3}}{2} \right)$$

4.

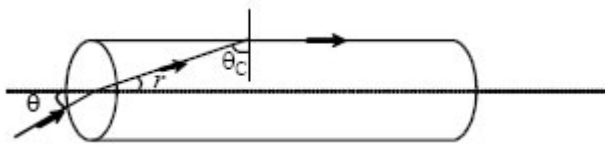
$$\sin^{-1} \left(\frac{2}{\sqrt{3}} \right)$$

Sol:

$$\sin \theta_c = \frac{\sqrt{3}}{2}$$

$$1 \sin \theta = \mu \sin r = \frac{2}{\sqrt{3}} \sin (90 - \theta_c) = \frac{2}{\sqrt{3}} \sqrt{1 - \frac{3}{4}} = \frac{2}{\sqrt{3}} \times \frac{1}{2}$$

$$\theta = \sin^{-1} \frac{1}{\sqrt{3}}$$



Correct choice: (1)

This question contains Statement-1 and Statement -2. Of the four choices given after the statements, choose the one that best describes the two statements.

Q.24. Statement –1: For a charged particle moving from point P to point Q, the net work done by an electrostatic field on the particle is independent of the path connecting point P to point Q.

Statement –2: The net work done by a conservative force on an object moving along a closed loop is zero.

1. Statement –1 is false, Statement- 2 is true

2. Statement –1 is true, Statement- 2 is false

3. Statement -1 is true, Statement- 2 is true; Statement -2 is the correct explanation for Statement-1
4. Statement -1 is true, Statement- 2 is true; Statement -2 is not the correct explanation for Statement-1

Answer: (3)

Q.24. The transition from the state $n = 4$ to $n = 3$ in hydrogen like atom results in ultraviolet radiation. Infrared radiation will be obtained in the transition from:

$$5 \rightarrow 4$$

1.

$$2 \rightarrow 1$$

2.

$$3 \rightarrow 2$$

3.

$$4 \rightarrow 2$$

4.

Sol: Energy of I – R radiation < energy of U – V radiation

Answer: (1)

This question contains Statement-1 and Statement -2. Of the four choices given after the statements, choose the one that best describes the two statements.

$$R = R_0 (1 + \alpha \Delta t)$$

Q.26. Statement –1: The temperature dependence of resistance is usually given as . The

resistance of a wire changes from 100Ω to 150Ω when its temperature is increased from 270°C to 2270°C . This

$$\alpha = 2.5 \times 10^{-3} / ^\circ\text{C}.$$

implies that

$$\alpha = 2.5 \times 10^{-3} / ^\circ\text{C}.$$

Statement –2: is valid only when the change in the temperature ΔT is small

$$\Delta R = (R - R_0) < < R_0.$$

and

1. Statement –1 is false, Statement- 2 is true
2. Statement –1 is true, Statement- 2 is false
3. Statement –1 is true, Statement- 2 is true; Statement -2 is the correct explanation for Statement-1
4. Statement –1 is true, Statement- 2 is true; Statement -2 is not the correct explanation for Statement-1

Answer: (1)

Q.27. Two wires are made of the same material and have the same volume. However wire 1 has cross-sectional area A

and wire 2 has cross-sectional area $3A$. If the length of wire 1 increases by x on applying force F , how much force is needed to stretch wire 2 by the same amount?

1. $9F$

2. F
3. $4F$
4. $6F$

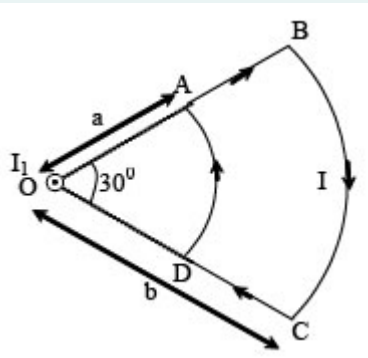
Sol:

$$Y = \frac{\frac{F}{A}}{\frac{\Delta I}{I}} \Rightarrow Y \frac{\Delta I}{I} = \frac{F}{A}; \Delta I = \frac{F}{AY}; \frac{F_1 I_1}{A_1 Y_1} = \frac{F_2 I_2}{A_2 Y_2} \Rightarrow \frac{F(I)}{AY} = \frac{F' \left(\frac{I}{3} \right)}{3AY} \Rightarrow F' = 9F$$

Answer: (1)

Directions: Question numbers 58 and 59 are based on the following paragraph

A current loop ABCD is held fixed on the plane of the paper as shown in the figure. The arcs BC (radius = b) and DA (radius = a) of the loop are joined by two straight wires AB and CD. A steady current I is flowing in the loop. Angle made by AB and CD at the origin O is 30° . Another straight thin wire with steady current I_1 flowing out of the plane of the paper is kept at the origin.



Q.28. The magnitude of the magnetic field (B) due to the loop ABCD at the origin (O) is:

$$\frac{\mu_0 I}{4\pi} \left[2(b-a) + \frac{\pi}{3}(a+b) \right]$$

- 1.
2. Zero

$$\frac{\mu_0 I (b-a)}{24ab}$$

- 3.

$$\frac{\mu_0 I}{4\pi} \left[\frac{b-a}{ab} \right]$$

- 4.

Sol:

$$B_{\text{due to } ABCD} \left[\frac{\mu_0 I}{2a} - \frac{\mu_0 I}{2b} \right] \times \frac{1}{12} = \frac{\mu_0 I (b-a)}{24ab}$$

Answer: (3)

Q.29. Due to the presence of the current I_1 at the origin :

$$\frac{\mu_0 I_1}{24ab} (b-a)$$

1. The magnitude of the net force on the loop is given by
2. The forces on AB and DC are zero
3. The forces on AD and BC are zero

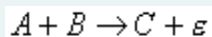
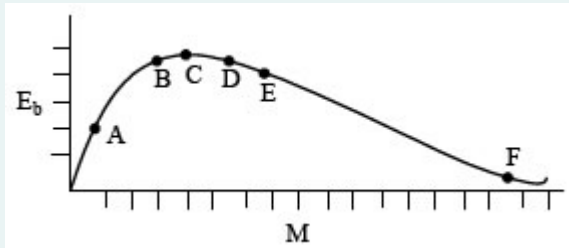
$$\frac{I_1 I}{4\pi} \mu_0 \left[2(b-a) + \frac{\pi}{3}(a+b) \right]$$

4. The magnitude of the net force on the loop is given by

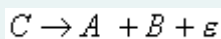
Sol.: Due to current I_1 , force on DA and BC will be zero

Answer: (3)

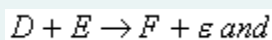
Q.30. The above is a plot of binding energy per nucleon E_b , against the nuclear mass M ; A, B, C, D, E, F correspond to different nuclei. Consider four reactions:



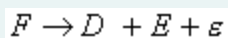
1.



2.



3.



4.

ε

ε

Where ε is the energy released? In which reactions is ε positive?

1. (ii) and (iii)

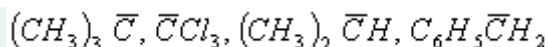
2. (i) and (iv)

3. (i) and (iii)

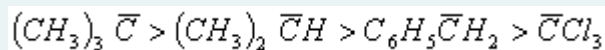
4. (ii) and (iv)

Answer: (2)

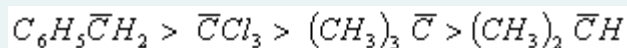
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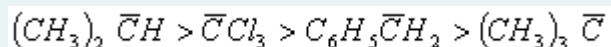
Q. 1. Arrange the carbanions , in order of their decreasing stability:



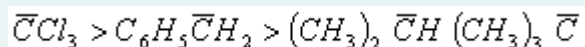
1.



2.

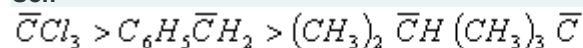


3.



4.

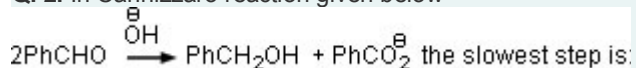
Sol:



(\bar{CCl}_3 is stabilized due to -I effect of Cl $p\pi - d\pi$ delocalization)

Answer : (4)

Q. 2. In Cannizzaro reaction given below



1. the deprotonation of $PhCH_2OH$



2. the attack of at the carboxyl group

3. the transfer of hydride of the carbonyl group

4. the abstraction of proton from the carboxylic group

Sol.: Cannizzaro reaction involves hydride transfer as the rate limiting step.

Answer : (3)

Q. 3. Two liquids X and Y form an ideal solution. At 300 K, vapour pressure of the solution containing 1 mol of X and 3 mol of Y is 550 mmHg. At the same temperature, if 1 mol of Y is further added to this solution, vapour pressure of the solution increases by 10 mmHg. Vapour pressure (in mmHg) of X and Y in their pure states will be, respectively:

1. 500 and 600

2. 200 and 300

3. 300 and 400

4. 400 and 600

Sol:

$$\left. \begin{array}{l} x_X = \frac{1}{4} \\ x_Y = \frac{3}{4} \end{array} \right\} P = p_X^0 x_X + p_Y^0 x_Y$$

$$550 = \frac{p_X^0}{4} + p_Y^0 \times \frac{3}{4} \dots (i)$$

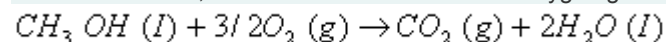
After addition of 1 mole of Y further,

$$560 = \frac{p_X^0}{5} + p_Y^0 \times \frac{4}{5} \dots (ii); \quad (2) \text{ By solving equation (i) and (ii)}$$

$$p_X^0 = 400 \text{ mm Hg}; \quad p_Y^0 = 600 \text{ mm Hg}$$

Answer : (4)

Q. 4. In a fuel cell, methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is



; At 298 K standard Gibb's energies of formation for $CH_3OH(l)$, $H_2O(l)$ and $CO_2(g)$ are -166.2 , -237.2 and $-394.4 \text{ kJ mol}^{-1}$ respectively. If standard enthalpy of combustion of methanol is -726 kJ mol^{-1} , efficiency of the fuel cell will be

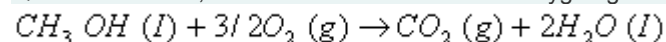
1. 97%
2. 80%
3. 87%
4. 90%

Sol:

$$\text{Efficiency of fuel cell } (\eta) = \frac{\Delta G^0}{\Delta H^0} = \frac{-702.6}{-726} \times 100 \cong 97\%$$

Answer : (1)

Q. 4. In a fuel cell, methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is



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4. 90%

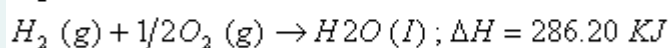
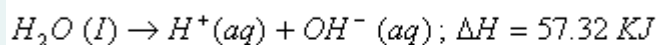
Sol:

$$\text{Efficiency of fuel cell } (\eta) = \frac{\Delta G^0}{\Delta H^0} = \frac{-702.6}{1-726} \times 100 \cong 97\%$$

Answer : (1)

Q. 5. On the basis of the following thermochemical

$$(\Delta_f G^0 H_{(aq)}^+ = 0)$$



The value of enthalpy of formation of OH^- ion at $25^\circ C$ is :

data:

1. -343.52 kJ

2. -22.88 kJ

3. -228.88 kJ

4. +228.88 kJ

Q. 6. The half life period of a first order chemical reaction is 6.93 minutes. The time required for the completion of 99% of the chemical reaction will be ($\log 2 = 0.301$):

1. 460.6 minutes

2. 230.3 minutes

3. 23.03 minutes

4. 46.06 minutes

Sol:

$$k = \frac{0.693}{6.930} = 0.1; t_{99} = \frac{2.303}{0.1} \log \frac{100}{1} = \frac{2.303 \times 2}{0.1} = 46.06 \text{ min utes.}$$

Answer : (4)

Q. 7. Copper crystallises in fcc with a unit cell length of 361 pm. What is the radius of copper atom?

1. 181 pm

2. 108 pm

3. 127 pm

4. 157 pm

Sol:

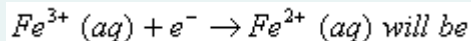
$$\text{For FCC, } 4r = \sqrt{2} a \text{ or } r = \frac{a}{2\sqrt{2}} = \frac{361}{2 \times 1.414} = \frac{361}{2.828} = 127.6 \text{ pm.}$$

Answer : (3)

$$E^0_{\text{Fe}^{3+}/\text{Fe}} = -0.036 \text{ V. } E^0_{\text{Fe}^{2+}/\text{Fe}} = -0.439 \text{ V.}$$

Q. 8. Given

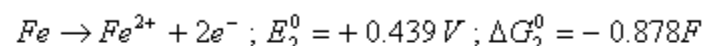
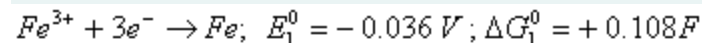
The value of standard electrode potential for the



change,

1. -0.270 V
2. -0.072 V
3. (3) 0.385 V
4. (4) 0.770 V

Sol:



$$\therefore \Delta G^0 = -n F E^0; \therefore E^0_3 = \frac{0.77F}{F} = 0.770 \text{ V.}$$

Answer : (4)

Q. 9. In which of the following arrangements, the sequence is **not** strictly according to the property written against it?

1. B < C < O < N; increasing first ionization enthalpy
2. CO₂ < SiO₂ < SnO₂ < PbO₂: increasing oxidising power
3. HF < HCl < HBr < HI: increasing acid strength
4. NH₃ < PH₃ < AsH₃ < SbH₃: increasing basic strength

Sol.: On moving down the group, the basic tendency of hydrides of group 15 decreases.

Answer : (4)

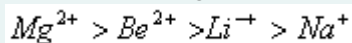
Q. 10. Knowing that the chemistry of lanthanoids (Ln) is dominated by its +3 oxidation state, which of the following statements is **incorrect**?

1. Ln (III) hydroxides are mainly basic in character.
2. Because of the large size of the Ln (III) ions the bonding in its compounds is predominantly ionic in character.

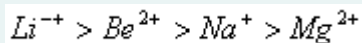
3. The ionic sizes of Ln (III) decrease in general with increasing atomic number.
4. Ln (III) compounds are generally colourless.

Answer : (4)

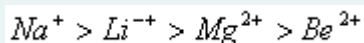
Q. 11. The set representing the **correct** order of ionic radius is:



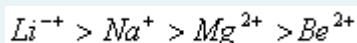
1.



2.



3.



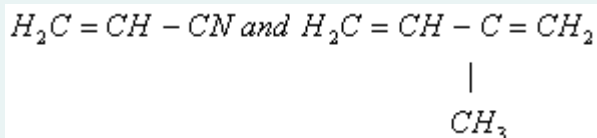
4.

Sol.: On moving down the group, the ionic radius increases. In case of isoelectronic ions, more the charge on the ion, smaller will be its size.

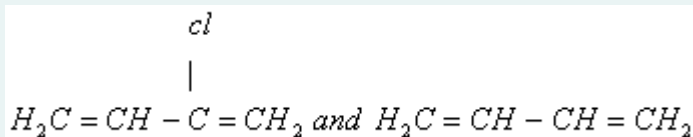
Answer : (3)

Q. 12. Buna-N synthetic rubber is a copolymer of:

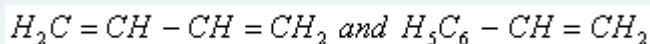
1.



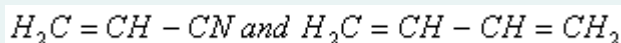
2.



3.



4.



Sol.: Buna-N is a copolymer of buta-1,3-diene and acrylonitrile.

Answer : (4)

Q. 7. The energy required to break one mole of Cl-Cl bonds in Cl_2 is 242 kJ mol^{-1} . The longest wavelength of light

$$\left(c = 3 \times 10^8 \text{ ms}^{-1} \text{ and } N_A = 6.02 \times 10^{23} \text{ mol}^{-1} \right)$$

capable of breaking a single Cl-Cl bond is

1. 594 nm
2. 640 nm
3. 700 nm

4. 494 nm

Sol :

$$E = \frac{242 \times 10^{23}}{6.023 \times 10^{23}} = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 10^9}{\lambda} \text{ J / molecule}$$

$$\lambda = \frac{6.626 \times 3 \times 6.023 \times 10^{-3}}{242 \times 10^3}$$

$$\lambda = 0.4947 \times 10^{-6} \text{ m}$$

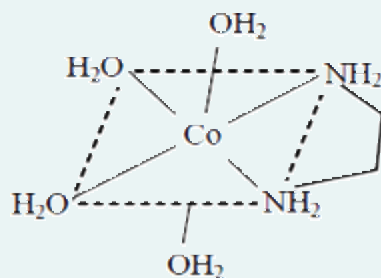
$$\lambda = 494 \text{ nm}$$

Answer: (4)

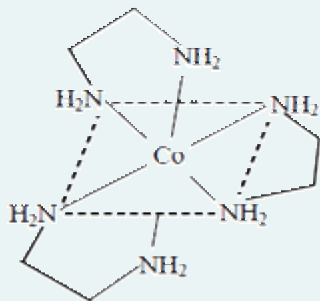
Q. 8. Which one of the following has an optical isomer?

1. $[\text{Zn}(\text{en})(\text{NH}_3)_2]^{+1}$
2. $[\text{Co}(\text{en})_3]^{3+}$
3. $[\text{Co}(\text{H}_2\text{O})_4(\text{en})]^{3+}$
4. $[\text{Zn}(\text{en})_4]^{2+}$ (en = ethylenediamine)

Sol :



Square planar complexes of Zn^{2+} cannot show optical isomerism. So, options (1) and (4) are ruled out.



will have two planes of symmetry, so it is optically inactive. Thus optically active compound is as it has no plane of symmetry.

Answer: (2)

Q. 15. The two functional groups present in a typical carbohydrate are:

1. $-\text{OH}$ and $-\text{CHO}$

2. $-\text{OH}$ and $-\text{COOH}$
3. $-\text{CHO}$ and $-\text{COOH}$
4. $>\text{C}=\text{O}$ and $-\text{OH}$

Sol.: Carbohydrate is a polyhydroxy aldehyde or polyhydroxy ketone or any compound which give these on hydrolysis. $>\text{C}=\text{O}$ group includes aldehydic as well as ketonic group.

Answer : (4)

Q. 16. Calculate the wavelength (in nanometer) associated with a proton moving

$1.0 \times 10^3 \text{ ms}^{-1}$ (Mass of proton = $1.67 \times 10^{-27} \text{ kg}$ and $h = 6.63 \times 10^{-34} \text{ Js}$):
at

1. 14.0 nm
2. 0.032 nm
3. 0.40 nm
4. 2.5 nm

Sol:

$$\lambda = \frac{h}{mv} = \frac{6.63 \times 10^{-34} \text{ Js}}{1.67 \times 10^{-27} \text{ kg} \times 1 \times 10^3 \text{ ms}^{-1}} = 3.97 \times 10^{-10} \text{ m} = 0.397 \text{ nm}.$$

Answer: (3)

Q. 17. The bond dissociation energy of B–F in BF_3 is 646 kJ mol^{-1} whereas that of C–F in CF_4 is 515 kJ mol^{-1} . The correct reason for higher B–F bond dissociation energy as compared to that of C–F is

1. lower degree of $p\pi - p\pi$ interaction between B and F in BF_3 than that between C and F in CF_4 .
2. smaller size of B atoms as compared to that of C atom.
3. stronger σ bond between B and F in BF_3 as compared to that between C and F in CF_4
4. significant $p\pi - p\pi$ interaction between B and F in BF_3 whereas there is no possibility of such interaction between C and F in CF_4 .

Sol: Boron in BF_3 has a vacant p-orbital, allowing $p\pi - p\pi$ back bonding while carbon in CF_4 has no vacant orbital, so no back bonding is feasible. Thus, B–F bond is stronger than CF_4 .

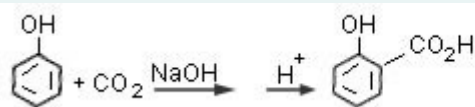
Answer: (4)

Q. 18. The major product obtained on interaction of phenol with sodium hydroxide and carbon dioxide is:

1. phthalic acid

2. benzoic acid
3. salicylaldehyde
4. salicylic acid

Sol:



This is kolbe's synthesis

Answer: (4)

$$1.0 \times 10^{-4} \text{ M Na}_2\text{CO}_3$$

Q. 19. Solid $\text{Ba}(\text{NO}_3)_2$ is gradually dissolved in

solution. At what concentration of Ba^{2+} will

$$(K_{sp} \text{ for } \text{BaCO}_3 = 5.1 \times 10^{-9}):$$

a precipitate begin to form?

$$8.1 \times 10^{-7} \text{ M}$$

1.

$$4.1 \times 10^{-5} \text{ M}$$

2.

$$5.1 \times 10^{-5} \text{ M}$$

3.

$$8.1 \times 10^{-8} \text{ M}$$

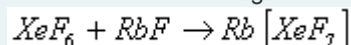
4.

$$\text{BaCO}_3 = \frac{K_{sp} \text{ of } \text{BaCO}_3}{[\text{CO}_3^{2-}]} = \frac{5.1 \times 10^{-9}}{1.0 \times 10^{-4}} = 5.1 \times 10^{-5} \text{ M}$$

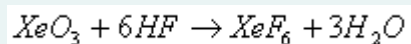
Sol: Concentration of Ba^{2+} needed to precipitate

Answer: (3)

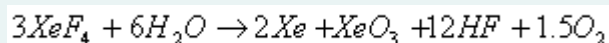
Q. 20. Which one of the following reactions of xenon compounds is **not** feasible?



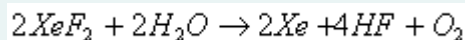
1.



2.

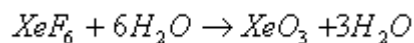


3.



4.

Sol: XeF_6 reacts violently with water and gets hydrolysed to give highly explosive XeO_3 .



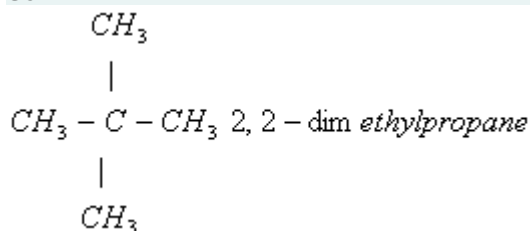
; Reaction (2) is reverse of this, so it is not feasible.

Answer: (2)

Q. 21. The IUPAC name of neopentane is:

1. 2,2-dimethylbutane
2. 2-methylbutane
3. 2,2-dimethylpropane
4. 2-methylpropane

Sol.:



Answer: (3)

Q. 22. In context with the transition elements, which of the following statements is **incorrect**?

1. Once the d^6 configuration is exceeded, the tendency to involve all the 3d electrons in bonding decreases.
2. In addition to the normal oxidation states, the zero oxidation state is also shown by these elements in complexes.
3. In the highest oxidation states, the transition metal show basic character and form cationic complexes.
4. In the highest oxidation states of the first five transition elements (Sc to Mn), all the 4s and 3d electrons are used for bonding.

Sol.: In highest oxidation state, the transition metal will form complexes which will have large degree of covalent character, which shows the acidic behaviour.

Answer: (3)

Q. 23. Which of the following pairs represents linkage isomers?

1. $[\text{PtCl}_2(\text{NH}_3)_4]\text{Br}_2$ and $[\text{PtBr}_2(\text{NH}_3)_4]\text{Cl}_2$
2. $[\text{Cu}(\text{NH}_3)_4][\text{PtCl}_4]$ and $[\text{Pt}(\text{NH}_3)_4][\text{CuCl}_4]$
3. $[\text{Pd}(\text{PPh}_3)_2(\text{NCS})_2]$ and $[\text{Pd}(\text{PPh}_3)_2(\text{SCN})_2]$
4. $[\text{Co}(\text{NH}_3)_5\text{NO}_3]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{NO}_3$

Sol: Linkage isomerism is shown by ambidentate ligands. (SCN⁻ and NCS⁻ are ambidentate groups).

Answer: (3)

Q. 24. In an atom, an electron is moving with a speed of 600 m/s with an accuracy of 0.005%. Certainty with which the position of the electron can be located

($h = 6.6 \times 10^{-34} \text{ Kg m}^2 \text{ s}^{-1}$, mass of electron, $= 9.1 \times 10^{-31} \text{ Kg}$):

is

1. $3.84 \times 10^{-3} \text{ m}$

2.

1.52 $\times 10^{-4} \text{ m}$

3.

5.10 $\times 10^{-3} \text{ m}$

4.

1.92 $\times 10^{-3} \text{ m}$

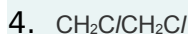
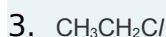
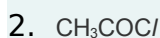
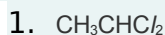
Sol:

$$\Delta v = 600 \times 5 \times 10^{-5} \text{ m/s} : \Delta x \geq \frac{h}{4\pi m \Delta v} \geq \frac{6.6 \times 10^{-34}}{4 \times 3.14 \times 9.1 \times 10^{-31} \times 600 \times 5 \times 10^{-5}}$$

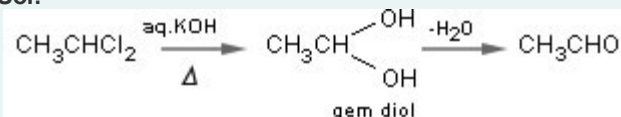
$$\approx 1.92 \times 10^{-3} \text{ m}$$

Answer: (4)

Q. 25. Which of the following on heating with aqueous KOH, produces acetaldehyde?

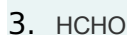
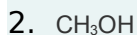
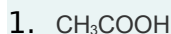


Sol:

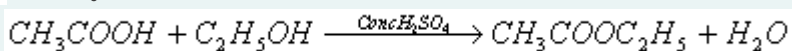


Answer: (1)

Q. 26. A liquid was mixed with ethanol and a drop of concentrated H_2SO_4 was added. A compound with a fruity smell was formed. The liquid was:



4. $\text{CH}_3\text{COCHb3}$



Sol:

Ethyl acetate (ester) has fruity smell.

Answer: (1)

Q. 27. Using MO theory predict which of the following species has the shortest bond length?

1. O_2^{2-}

2.

O_2^{2+}

3.

O_2^+

4.

O_2^-

5.

O_2^{2-}

O_2^{2+}

O_2^+

O_2^-

O_2^{2+}

Sol: The bond order of O_2^{2-} , O_2^{2+} , O_2^+ and O_2^- is 1, 3, 2.5 and 1.5 respectively. Since, O_2^{2+} has highest bond order, so it has shortest bond length.

Answer: (2)

Q. 28. A binary liquid solution is prepared by mixing n-heptane and ethanol. Which one of the following statements is **correct** regarding the behaviour of the solution?

1. n-heptane shows +ve deviation while ethanol shows –ve deviation from Raoult's Law.
2. The solution formed is an ideal solution.
3. The solution is non-ideal, showing +ve deviation from Raoult's law.
4. The solution is non-ideal, showing –ve deviation from Raoult's Law.

Sol: When n-heptane is added to ethanol, the H-bonding interaction between ethanol molecules is loosened, so weaker interaction among molecules leads to higher vapour pressure. Thus, it forms a non-ideal solution with positive deviation from Raoult's law.

Answer: (3)

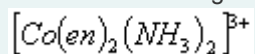
Q. 29. The alkene that exhibits geometrical isomerism is:

1. 2-methyl-2-butene
2. propene
3. 2-methyl propene
4. 2-butene

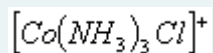
Sol: Terminal alkenes never show geometrical isomerism and non-terminal alkene with 2 different groups attached to each atom having restricted rotation is capable of showing geometrical isomerism.

Answer: (4)

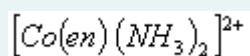
Q. 30. Which of the following has an optical isomer?



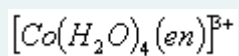
1.



2.

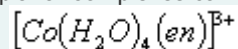


3.



4.

Sol: Square planar complexes can not show optical isomerism. So, option (2) and (3) are ruled out. Compound in



option (4) i.e.

has a plane of symmetry, so it is also optically inactive.

Answer: (1)