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<th>S. No</th>
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<tr>
<td>Q.1</td>
<td>Statement 1: The ratio PR : RQ equals $2 \sqrt{2} : \sqrt{5}$. Statement 2: In any triangle, bisector of an angle divides the triangle into two similar triangles. (1) Statement 1 is true, Statement 2 is false. (2) Statement 1 is true, Statement 2 is false. (3) Statement 1 is false, Statement 2 is true. (4) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for Statement 1</td>
<td>Sol: 1 (b) P(-2, -2); Q = (1, -2) Equation of angular bisector $\overline{OR}$ is $(\sqrt{5} + 2\sqrt{2})x + (\sqrt{5} - \sqrt{2})y = 0$ $\therefore$ PR : RQ = $2\sqrt{2} : \sqrt{5}$</td>
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<tr>
<td>Q.2</td>
<td>If $A = \sin^2 x + \cos^2 x$, then for all real $x$ (a) $\frac{13}{16} \leq A \leq 1$ (b) $1 \leq A \leq 2$ (c) $\frac{3}{4} \leq A \leq \frac{13}{16}$ (d) $\frac{3}{4} \leq A \leq 1$</td>
<td>Sol: 2 (d) $\sin^2 x + \cos^4 x = \frac{3}{4}$</td>
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<td>Q.3</td>
<td>The coefficient of $x^7$ in the expansion of $(1 - x - x^2 + x^3)^6$ is (a) -132 (b) -144 (c) 132 (d) 144</td>
<td>Sol: 3 (b) $[1 - x - x^2(1 - x)]^6 = (1 - x)^6 (1 - x^2)^6$ $= [6 C_0 - 6 C_1 x + 6 C_2 x^2 - 6 C_3 x^3 + 6 C_4 x^4 - 6 C_5 x^5 + 6 C_6 x^6] \times [6 C_0 - 6 C_1 x^2 + 6 C_2 x^4 - 6 C_3 x^6 + \ldots]$ Coefficient of $x^7 = 6 C_1 6 C_3 - 6 C_2 6 C_4 + 6 C_3 6 C_5 = 120 - 300 + 36 = -144</td>
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<tr>
<td>Q.4</td>
<td>$\lim_{x \to \frac{1}{2}} \left( \frac{\sqrt{1 - \cos(2(x - 2))}}{x - 2} \right) = \frac{1}{\sqrt{2}}$ (1) equals $\frac{\sqrt{2}}{2}$ (2) equals $-\sqrt{2}$ (3) equals $\frac{1}{\sqrt{2}}$ (4) does not exist</td>
<td>Sol: 4 (d) $\lim_{x \to \frac{1}{2}} \frac{\sqrt{2} \sin^2 (x - 2)}{x - 2} = \frac{\sqrt{2}}{2} \sin (x - 2)$ $\lim_{x \to \frac{1}{2}} \frac{\sqrt{2}}{x - 2} = R.H.S \neq L.H.S$ Limit does not exist.</td>
</tr>
<tr>
<td>Q.5</td>
<td>Statement 1: The number of ways of distributing 10 identical balls in 4 distinct boxes such that no box is empty is $9 C_3$. Statement 2: The number of ways of choosing any 3 places from 9 different places is $9 C_3$. (a) Statement 1 is true, Statement 2 is true; Statement 2 is not a correct explanation for Statement 1 (b) Statement 1 is true, Statement 2 is false. (c) Statement 1 is false, Statement 2 is true. (d) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for Statement 1</td>
<td>Sol: 5 (d) $(n - 1) C_{r - 1} = (10 - 1) C_{4 - 1} = 9 C_3$ Statement 1 is correct Statement 2 is also correct From 9 we can select 3 in $9 C_3$ ways. A also correct explanation</td>
</tr>
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</table>
Q.6 \[ \frac{d^2x}{dy^2} \text{equals} \]

(a) \(-\frac{(\frac{d^2y}{dx^2})^{-1}}{(\frac{dy}{dx})^3}\)  
(b) \(\frac{(\frac{d^2y}{dx^2})}{(\frac{dy}{dx})^{-3}}\)  
(c) \(-\frac{(\frac{d^2y}{dx^2})^2}{(\frac{dy}{dx})^{-3}}\)  
(d) \(-\frac{(\frac{d^2y}{dx^2})}{(\frac{dy}{dx})^{-1}}\)

Sol: 6 (c) \[ \frac{dy}{dx} \frac{dy}{dx} = \frac{dy}{dx} \frac{1}{\frac{dy}{dx}} = \frac{dy}{dx} \frac{1}{\frac{dy}{dx}} = -\frac{dy}{dx} \]

Q.7 If \( \frac{dy}{dx} = y + 3 > 0 \) and \( y(0) = 2 \), then \( y(\ln 2) \) is equal to

(a) 5  
(b) 13  
(c) -2  
(d) 7

Sol: 7 (d) \[ \frac{dy}{dx} = y + 3 \Rightarrow \frac{dy}{y + 3} = dx \]

Q.8 Let \( R \) be the set of real numbers

Statement 1: \( A = \{(x, y) \in R \times R : y - x \text{ is an integer}\} \) is an equivalence relation on \( R \).

Statement 2: \( B = \{(x, y) \in R \times R : x = \alpha y \text{ for some rational number } \alpha\} \) is an equivalence relation on \( R \).

(1) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for Statement 1.

(2) Statement 1 is true, Statement 2 is false.

(3) Statement 1 is false, Statement 2 is true.

(4) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for Statement 1.

Sol: 8 (b)

Q.9 The value of \( \int_0^{\frac{\pi}{4}} \log(1 + \tan \theta) d\theta \) is

(a) \( \frac{\pi}{8} \log 2 \)  
(b) \( \frac{\pi}{2} \log 2 \)  
(c) \( \log 2 \)  
(d) \( \pi \log 2 \)

Sol: 9 (d) \[ I = \int_0^{\frac{\pi}{4}} \log(1 + \tan \theta) d\theta = \int_0^{\frac{\pi}{4}} \log \left(1 + \tan \left(\frac{\pi}{4} - \theta\right)\right) d\theta \]

Q.10 Let \( \alpha, \beta \) be real and \( z \) be a complex number. If \( z^2 + \alpha z + \beta = 0 \) has two distinct roots on the line \( \text{Re} z = 1 \), then it is necessary that

(a) \( \beta \in (-1, 0) \)  
(b) \( \beta = 1 \)  
(c) \( \beta \in (1, \infty) \)  
(d) \( \beta \in (0, 1) \)

Sol: 10 (c) Let roots are \( 1 + pi, 1 + qi \)

Q.6 \[ \frac{d^2x}{dy^2} \text{equals} \]

(a) \(-\frac{(\frac{d^2y}{dx^2})^{-1}}{(\frac{dy}{dx})^3}\)  
(b) \(\frac{(\frac{d^2y}{dx^2})}{(\frac{dy}{dx})^{-3}}\)  
(c) \(-\frac{(\frac{d^2y}{dx^2})^2}{(\frac{dy}{dx})^{-3}}\)  
(d) \(-\frac{(\frac{d^2y}{dx^2})}{(\frac{dy}{dx})^{-1}}\)

Sol: 6 (c) \[ \frac{dy}{dx} \frac{dy}{dx} = \frac{dy}{dx} \frac{1}{\frac{dy}{dx}} = \frac{dy}{dx} \frac{1}{\frac{dy}{dx}} = -\frac{dy}{dx} \]

Q.7 If \( \frac{dy}{dx} = y + 3 > 0 \) and \( y(0) = 2 \), then \( y(\ln 2) \) is equal to

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(b) 13  
(c) -2  
(d) 7

Sol: 7 (d) \[ \frac{dy}{dx} = y + 3 \Rightarrow \frac{dy}{y + 3} = dx \]

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Statement 1: \( A = \{(x, y) \in R \times R : y - x \text{ is an integer}\} \) is an equivalence relation on \( R \).

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(1) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for Statement 1.

(2) Statement 1 is true, Statement 2 is false.

(3) Statement 1 is false, Statement 2 is true.

(4) Statement 1 is true, Statement 2 is true; Statement 2 is a correct explanation for Statement 1.

Sol: 8 (b)

Q.9 The value of \( \int_0^{\frac{\pi}{4}} \log(1 + \tan \theta) d\theta \) is

(a) \( \frac{\pi}{8} \log 2 \)  
(b) \( \frac{\pi}{2} \log 2 \)  
(c) \( \log 2 \)  
(d) \( \pi \log 2 \)

Sol: 9 (d) \[ I = \int_0^{\frac{\pi}{4}} \log(1 + \tan \theta) d\theta = \int_0^{\frac{\pi}{4}} \log \left(1 + \tan \left(\frac{\pi}{4} - \theta\right)\right) d\theta \]

Q.10 Let \( \alpha, \beta \) be real and \( z \) be a complex number. If \( z^2 + \alpha z + \beta = 0 \) has two distinct roots on the line \( \text{Re} z = 1 \), then it is necessary that

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(b) \( \beta = 1 \)  
(c) \( \beta \in (1, \infty) \)  
(d) \( \beta \in (0, 1) \)

Sol: 10 (c) Let roots are \( 1 + pi, 1 + qi \)

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### Q.11
Consider 5 independent Bernoulli's trials each with probability of success \( p \). If the probability of at least one failure is greater than or equal to \( \frac{31}{32} \), then \( p \) lies in the interval

(a) \( \left( \frac{11}{12} \right) \)  
(b) \( [0, \frac{1}{2}] \)  
(c) \( \left( \frac{11}{12}, 1 \right) \)  
(d) \( \left( \frac{1}{2}, \frac{3}{4} \right) \)

**Sol:** (b)

\( n = 5 \)

\[ P(\text{at least one failure}) \geq \frac{31}{32} \]

no failure, \( 1 - P \geq \frac{31}{32} \)

\[ 1 - P(x=5) \geq \frac{31}{32} \]

\[ 1 - 5C_5 p^5 \geq \frac{31}{32} \]

\[ p^5 \geq - \frac{1}{32} \]

\[ p^5 \leq \frac{1}{32} \]

\[ p \leq \frac{1}{2} \]

\( p \in \left[ 0, \frac{1}{2} \right] \)

### Q.12
A man saves Rs. 200 in each of the first three months of his service. In each of the subsequent months his saving increases by Rs. 40 more than the saving of immediately previous month. His total saving from the start of service will be Rs. 11040 after

(a) 19 months  
(b) 20 months  
(c) 21 months  
(d) 18 months

**Sol:** (c)

\[
\begin{align*}
&A = 200 + 240 + 280 + \ldots + N \text{ terms} \\
&\Rightarrow n \left( \frac{200 + (n - 1)40}{2} \right) = 11040 - 400 \\
&\Rightarrow 200n + 20n^2 - 20n = 10640 \\
&\Rightarrow n = 19 \\
&\text{Total} = 19 + 2 = 21
\end{align*}
\]

### Q.13
The domain of the function \( f(x) = \frac{1}{\sqrt{|x|-x}} \) is

(a) \((0, \infty)\)  
(b) \((-\infty, 0)\)  
(c) \((-\infty, \infty) - \{0\}\)  
(d) \((-\infty, \infty)\)

**Sol:** (b)

\[ \frac{1}{\sqrt{|x|} - x} \Rightarrow |x| - x > 0 \Rightarrow |x| > x \Rightarrow x < 0 \]

\[ x \in (-\infty, 0) \]

### Q.14
If the angle between the line \( \frac{x - y}{2} = \frac{z - 3}{\lambda} \) and the plane \( x + 2y + 3z = 4 \) is \( \cos^{-1} \left( \frac{5}{\sqrt{19}} \right) \), then \( \lambda \) equals

(a) \( \frac{3}{2} \)  
(b) \( \frac{7}{5} \)  
(c) \( \frac{5}{3} \)  
(d) \( \frac{2}{3} \)

**Sol:** (d)

\[ \frac{\ell a + mb + nc}{\sqrt{\ell^2 + m^2 + n^2 \sqrt{a^2 + b^2 + c^2}}} \]

\[ \frac{3}{\sqrt{19}} = \frac{1 + 4 + 3\lambda}{\sqrt{1 + 4 + 2\lambda + 1 + 8 + \lambda}} \Rightarrow \lambda = \frac{3}{2} \]

### Q.15
If \( \vec{a} = \frac{1}{\sqrt{19}} (3\vec{i} + \vec{k}) \) and \( \vec{b} = \frac{1}{7} (2\vec{i} + 3\vec{j} - 6\vec{k}) \), then the value of \( (2\vec{a} - \vec{b}) \cdot (\vec{a} \times \vec{b}) \) is

(a) -3  
(b) 5  
(c) 3  
(d) -5

**Sol:** (d)

\[ (2\vec{a} - \vec{b}) \cdot (\vec{a} \times \vec{b}) = (2\vec{a} - \vec{b}) \cdot [(\vec{a} \times \vec{b}) \times (\vec{a} + 2\vec{b})] = (2\vec{a} - \vec{b}) \cdot [(\vec{a} \cdot (\vec{a} + 2\vec{b})] - [\vec{b} \cdot (\vec{a} + 2\vec{b})] \vec{a}] \]

\[ = -5 (\vec{a})^2 (\vec{b})^2 + 5(\vec{a}, \vec{b})^2 = -5 \]
Q.16  Equation of the ellipse whose axes are the axes of coordinates and which passes through
the point (−3, 1) and has  eccentricity $\sqrt{5}/2$ is
(a) $5x^2 + 3y^2 = 48 = 0$  (2) $3x^2 + 5y^2 = 15 = 0$
(3) $5x^2 + 3y^2 = 32 = 0$  (4) $3x^2 + 5y^2 = 32 = 0$

Sol: 16 (d)

$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1 \Rightarrow \frac{a^2}{b^2} = \frac{3x^2}{5} = \frac{3a^2}{5}$

Q.17  Let I be the purchase value of an equipment and $V(t)$ be the value after it has been used
for t years. The value $V(t)$ depreciates at a rate given by differential equation $rac{dv}{dt} = k(T - t)$,
where $k > 0$ is a constant and $T$ is the total life in years of the equipment. Then
the scrap value $V(T)$ of the equipment is
(a) $I - kT^2$  (b) $I - k(T - t)^2$
(c) $e^{-kT}$  (d) $T^2 - I$

Sol: 17 (a)

$\frac{dv}{dt} = k(T - t)$
$\Rightarrow \frac{dV}{dt} = -k(T - t)$
Integrate, $V = k(T - t)^2 + c$
at $t = 0 \Rightarrow V = I, c = I$
$\Rightarrow c = V(T) = I - kT^2$

Q.18  The vector $\vec{a}$ and $\vec{b}$ are not perpendicular and $\vec{c}$ and $\vec{d}$ are two vector satisfying:
$\vec{b} \times \vec{c} = \vec{b} \times \vec{d}$ and $\vec{a} \cdot \vec{d} = 0$. Then the vector $\vec{d}$ is equal to
(a) $\vec{c} + \left(\frac{\vec{a} \cdot \vec{c}}{\vec{a} \cdot \vec{b}}\right) \vec{b}$
(b) $\vec{B} + \left(\frac{\vec{b} \cdot \vec{c}}{\vec{a} \cdot \vec{b}}\right) \vec{c}$
(c) $\vec{c} - \left(\frac{\vec{a} \cdot \vec{c}}{\vec{a} \cdot \vec{b}}\right) \vec{c}$
(d) $\vec{b} - \left(\frac{\vec{c} \cdot \vec{c}}{\vec{a} \cdot \vec{b}}\right) \vec{c}$

Sol: 18 (c)

$\vec{b} \times \vec{c} = \vec{b} \times \vec{d}$
$\Rightarrow \vec{a} \times (\vec{b} \times \vec{c}) = \vec{a} (\vec{b} \times \vec{d})$
$\Rightarrow (\vec{a} \cdot \vec{c}) \vec{b} - (\vec{a} \cdot \vec{b}) \vec{c} = (\vec{a} \cdot \vec{d}) \vec{b} - (\vec{a} \cdot \vec{b}) \vec{d}$
$\Rightarrow (\vec{a} \cdot \vec{c}) \vec{b} - (\vec{a} \cdot \vec{b}) \vec{c} = - (\vec{a} \cdot \vec{d}) \vec{d}$
$\Rightarrow \vec{d} = \vec{c} - \left(\frac{\vec{a} \cdot \vec{c}}{\vec{a} \cdot \vec{b}}\right) \vec{b}$

Q.19  The two circles $x^2 + y^2 = ax$ and $x^2 + y^2 = c^2$ (c > 0) touch each other if
(a) $|a| = c$  (b) $a = 2c$
(c) $|a| = 2c$  (d) $2 |a| = c$

Sol: 19 (a)

$\frac{a}{2}$
$c$
(0,0)
$C_1, C_2 = r_1 - r_2 \Rightarrow \frac{a}{2} = c \Rightarrow a = 2c \Rightarrow a = c$

Q.20  If C and D are two events such that $C \subset D$ and $P(D) \neq 0$, then the correct statement
among the following is
(a) $P(C | D) \geq P(C)$  (b) $P(C | D) < P(C)$
(c) $P(C | D) = P(D)$  (d) $P(C | D) = P(C)$

Sol: 20 (a)

$\frac{P(C \cap D)}{P(D)} = \frac{P(C)}{P(D)} \Rightarrow \frac{P(C)}{P(D)} \geq P(C)$

$P(C) \geq P(C | D)$
Q.21 The number of values of k for which the linear equations $4x + ky + 2z = 0$; $kx + 4y + z = 0$; $2x + 2y + z = 0$ possess a non-zero solution is
(a) 2 (b) 1 (c) zero (d) 3

Solution: 21

$\begin{vmatrix} 4 & k & 2 \\ k & 4 & 1 \\ 2 & 2 & 1 \end{vmatrix} = 0 \Rightarrow k^2 - 6k + 8 = 0 \Rightarrow k(k - 4) - 2(k - 2) = 0 \Rightarrow (k - 4)(k - 2) = 0 \Rightarrow k = 4, 2$

Q.22 Consider the following statements
P: Suman is brilliant
Q: Suman is rich
R: Suman is honest
The negation of the statement “Suman is brilliant and dishonest if and only if Suman is rich” can be expressed as
(a) $\sim (Q \Leftrightarrow (P \land \neg R))$ (b) $\sim (Q \Leftrightarrow P \land R)$ (c) $\sim (P \land \neg R) \Leftrightarrow Q$ (d) $\sim P \land (Q \Leftrightarrow \neg R)$

Solution: 22

$\sim (Q \leftrightarrow (P \land \neg R)) = \sim (Q \leftrightarrow (P \land \neg R))$

Q.23 The shortest distance between line $y - x = 1$ and curve $x = y^2$ is
(a) $\frac{3\sqrt{2}}{8}$ (b) $\frac{8}{3\sqrt{2}}$ (c) $\frac{4}{\sqrt{3}}$ (d) $\frac{\sqrt{7}}{4}$

Solution: 23

The shortest distance between the line $y - x = 1$ and the curve $x = y^2$ is $\frac{3\sqrt{2}}{8}$.

Q.24 If the mean deviation about the median of the numbers $a, 2a, \ldots, 50a$ is 50, then $a$ equals
(a) 3 (b) 4 (c) 5 (d) 2

Solution: 24

$\frac{1}{n} \sum |x_i - A| = 50$

$A = \text{Median} = \frac{25a + 26a}{2} = 25.5a$

$\text{Mean deviation} = \frac{1}{50} \{|a - 25.5a| + |2a - 25.5a|\}$

$= \frac{2}{50} \{(24.5a + 23.5a) + \ldots + (0.5a)\} = \frac{2}{50} (312.5a) = 50$ (Given)

$\Rightarrow 625a = 2500 \Rightarrow a = 4$

Q.25 Statement – 1: The point A(1, 0, 7) is the mirror image of the point B(1, 6, 3) in the line $\frac{x - 1}{2} = \frac{y - 1}{2} = \frac{z - 3}{3}$.

Statement – 2: The line joining A(1, 0, 7) and B(1, 6, 3) bisects the line segment joining A(1, 0, 7) and B(1, 6, 3).

(a) Statement – 1 is true, Statement – 2 is false; Statement – 2 is not a correct explanation for Statement – 1
(b) Statement – 1 is true, Statement – 2 is false.
(c) Statement – 1 is false, Statement – 2 is true.
(d) Statement – 1 is true, Statement – 2 is true; Statement – 2 is a correct explanation for Statement – 1

Solution: 25 (a)

d. r’s of AB = 0, 6, -4
d. r’s of given line = 1, 2, 3
As AB is $\perp$ to line $: 0.1 + 6.2 - 4.3 = 0$
AB is perpendicular to given line and mid point of AB lies on line it may, may not be bisector.
Q.26 Let A and B be two symmetric matrices of order 3.
Statement – 1: A(BA) and (AB)A are symmetric matrices.
Statement – 2: AB is symmetric matrix if matrix multiplication of A and B is commutative.

(a) Statement – 1 is true, Statement – 2 is true; Statement – 2 is not a correct explanation for Statement – 1
(b) Statement – 1 is true, Statement – 2 is false.
(c) Statement – 1 is false, Statement – 2 is true.
(d) Statement – 1 is true, Statement – 2 is true; Statement – 2 is a correct explanation for Statement – 1

Sol: 26

\(A^T = A, B^T = B\)
\((A(BA))^T = (BA)^T A^T = (A^T B^T) A = (AB) A = A(AB)\)
\(((AB)A)^T = A^T (AB) = A (B^T A^T) = A(BA) = (AB) A\)

∴ State. - 1 is correct

\((AB)^T = B^T A^T = BA = AB \quad (\because AB \text{ is commutative})\)

State. -2 is also correct but it is not correct explanation of Statement -1

Q.27 If \(\omega (\neq 1)\) is a cube root of unity, and \((1+ \omega)^7 = A + B \omega\). Then (A, B) equals

(a) (1, 1)  
(b) (1, 0)  
(c) (-1, 1)  
(d) (0, 1)

Sol: 27

\(1+\omega = -\omega^2\)
\((1+\omega)^7 = -(\omega^2)^7 = -\omega^{14} = -\omega^2 = 1 + \omega = A + B \omega \Rightarrow (A, B) = (1,1)\)

Q.28 The value of p and q for which the function \(f(x) = \begin{cases} \sin(p+1)x + \sin x, & x < 0 \\ \frac{Q}{x^3 + x^2}, & x > 0 \end{cases}\), is continuous for all \(x\) in \(R\), is

(a) \(p = \frac{5}{2}, q = \frac{1}{2}\)  
(b) \(p = -\frac{3}{2}, q = \frac{1}{2}\)  
(c) \(p = -\frac{1}{2}, q = -\frac{3}{2}\)  
(d) \(p = \frac{1}{2}, q = \frac{3}{2}\)

Sol: 28

\[
\lim_{x \to 0} \frac{\sin(p+1)x + \sin x}{x} = q = \lim_{x \to 0} \frac{\sqrt{x + x^2} - \sqrt{x}}{x^{3/2}}
\]

\[
\lim_{x \to 0} \frac{(p+1)\cos(p+1)x + \cos x = q = 1}{x} = \frac{1}{2}
\]

\[
\Rightarrow p+1+1 = \frac{1}{2} \Rightarrow p = -\frac{3}{2}, q = \frac{1}{2}
\]

Q.29 The area of the region enclosed by the curves \(y = x, x = e, y = \frac{1}{x}\) and the positive x-axis is

(a) 1 square units  
(b) \(\frac{3}{2}\) square units  
(c) \(\frac{5}{2}\) square units  
(d) \(\frac{1}{2}\) square units

Sol: 29

area = \(\Delta r ABC + \text{area } BCEDB\)
Area = \(\frac{1}{2} \times |x| + \int_1^e \frac{1}{x} \, dx\)
= \(\frac{3}{2}\) square units

Q.30 For \(x \in \left(0, \frac{2\pi}{2}\right)\), define \(f(x) = \int_0^x \sqrt{1 - \sin^2 t} \, dt\). Then \(f\) has

(a) local minimum at \(\pi\) and \(2\pi\)  
(b) local minimum at \(\pi\) and local maximum at \(2\pi\)  
(c) local maximum at \(\pi\) and local minimum at \(2\pi\)  
(d) local maximum at \(\pi\) and \(2\pi\)  

Sol: 30

\[f'(x) = \sqrt{x} \sin x\]

\(f\) has local max at \(\pi\), local min at \(2\pi\)