

$$\begin{aligned}
 -2S_n &= 1 + 3 + 3^2 + \dots + 3^9 - 10 \cdot 3^{10} \\
 &= \frac{1(3^{10} - 1)}{3 - 1} - 10 \cdot 3^{10} \\
 &= \frac{1}{2} \cdot 3^{10} - \frac{1}{2} \cdot 3^{10} \cdot 10 \\
 -2S_n &= -\frac{1}{2} \cdot \frac{19}{2} \cdot 3^{10} \\
 S_n &= \frac{19}{4} \cdot 3^{10} + \frac{1}{4}
 \end{aligned}$$

2.  $\tan^{-1} \left( \frac{\cos\left(\frac{15\pi}{4}\right) - 1}{\sin\frac{\pi}{4}} \right)$  equal to

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

Ans. (3)

Sol.  $\tan^{-1} \left( \frac{\frac{1}{\sqrt{2}} - 1}{\frac{1}{\sqrt{2}}} \right) = \tan^{-1}(1 - \sqrt{2}) = -\tan^{-1}(\sqrt{2} - 1) = -\frac{\pi}{8}$

3.  $2\sin 12^\circ - \sin 72^\circ$  is equal to

- (1)  $\sqrt{3} \left( \frac{\sqrt{5} - 1}{4} \right)$       (2)  $\frac{\sqrt{3}}{4} (1 - \sqrt{5})$       (3)  $\frac{\sqrt{3}}{4} (1 + \sqrt{5})$       (4) None of these

Ans. (2)

Sol.  $2(\sin(72^\circ - 60^\circ)) - \sin 72^\circ$   
 $2 \left( \sin 72^\circ \cdot \frac{1}{2} - \cos 72^\circ \cdot \frac{\sqrt{3}}{2} \right) - \sin 72^\circ$   
 $-\sqrt{3} \cos(72^\circ)$   
 $-\sqrt{3} \sin(18^\circ) = -\sqrt{3} \left( \frac{\sqrt{5} - 1}{4} \right) = \sqrt{3} \left( \frac{1 - \sqrt{5}}{4} \right)$

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4. How many three digit numbers in which exactly two digits are same are

Ans. (243)

Sol.  $0aa + 00a + aab \text{ or } abb$

$${}^9C_1 \times 2 + {}^9C_1 \times 1 + {}^9C_2 \times 2C_1 \times \frac{3!}{2!}$$

$$18 + 9 + 216$$

$$243$$

5. In the expansion of  $(5 + x)^{500} + x(5 + x)^{499} + x^2(5 + x)^{498} + \dots + x^{500}$  then coefficient of  $x^{101}$  is

- (1)  ${}^{501}C_{101} \cdot 5^{399}$       (2)  ${}^{501}C_{101} \cdot 5^{400}$       (3)  ${}^{501}C_{101} \cdot 5^{401}$       (4) None of these

Ans. (1)

Sol.  $(5 + x)^{500} \left( 1 - \left( \frac{x}{5 + x} \right)^{501} \right)$

$$1 - \frac{x}{5 + x}$$

$$(5 + x)^{501} \frac{1 - \frac{x^{501}}{(5 + x)^{501}}}{5}$$

$$\frac{1}{5} [(5 + x)^{501} - x^{501}]$$

coefficient of  $x^{101}$  is  $\frac{1}{5} \times {}^{501}C_{101} \cdot 5^{400} = {}^{501}C_{101} \cdot 5^{399}$

6. If  $z_1$  and  $z_2$  are two complex number such that  $\bar{z}_1 = i\bar{z}_2$  and  $\arg\left(\frac{z_1}{z_2}\right) = \pi$  then

(1)  $\arg z_1 = \frac{3\pi}{4}$       (2)  $\arg z_2 = \frac{-3\pi}{4}$       (3)  $\arg z_1 = \frac{\pi}{4}$       (4)  $\arg z_2 = \frac{-\pi}{4}$

Ans. (3)

Sol.  $\arg\left(\frac{z_1}{z_2}\right) = \pi \Rightarrow \arg z_1 - \arg z_2 = \pi$

$\Rightarrow \arg z_1 + \arg z_2 = \pi$  .....(1)

$\therefore \bar{z}_1 = i\bar{z}_2 \Rightarrow z_1 = -iz_2$

$\Rightarrow \arg z_1 = \arg(-iz_2)$

$\Rightarrow \arg z_1 = \arg(-i) + \arg z_2$

$\Rightarrow \arg z_1 - \arg z_2 = -\frac{\pi}{2}$  .....(2)

from (1) and (2)  $\arg z_1 = \frac{\pi}{4}$  and  $\arg z_2 = \frac{3\pi}{4}$

7.  $\frac{x^2}{4} + \frac{y^2}{2} = 1$  and line  $y = x + 1$  intersect at P & Q. A circle is described by assuming PQ as a diameter with radius r then the value of  $(3r)^2$  is

- (1) 20      (2) 22      (3) 25      (4) 30

Ans. (1)

Sol.  $\frac{x^2}{4} + \frac{(x+1)^2}{2} = 1$

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$x^2 + 2(x+1)^2 = 4$

$3x^2 + 4x - 2 = 0$

$(x_1 - x_2) = \sqrt{(x_1 + x_2)^2 - 4x_1x_2}$

$= \sqrt{\frac{16}{9} + \frac{8}{3}}$

$= \sqrt{\frac{40}{9}}$

also  $(y_1 - y_2) = |x_1 - x_2| = \sqrt{\frac{40}{9}}$

radius  $= \frac{1}{2} \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$

$= \frac{1}{2} \sqrt{2 \times \frac{40}{9}}$

$= \frac{1}{2} \times \frac{\sqrt{80}}{3}$

$r = \frac{\sqrt{80}}{6}$

$(3r)^2 = 9r^2 = 9 \times \frac{80}{36} = 20$

8. A biased dice whose faces are 2, 4, 8, 16, 32, 32 is rolled thrice. If probability of getting number n on dice in one trial is  $\frac{1}{n}$  then probability of getting sum 48 is

- (1)  $\frac{3}{2^{12}}$       (2)  $\frac{7}{2^{11}}$       (3)  $\frac{13}{2^{12}}$       (4)  $\frac{9}{2^{12}}$

Ans. (2)

Sol. Given  $P(n) = \frac{1}{n}$

Favourable cases (16, 16, 16), (32, 8, 8), (8, 32, 8), (8, 8, 32)

Prob  $= \left(\frac{1}{16} \times \frac{1}{16} \times \frac{1}{16}\right) + 3 \times \left(\frac{1}{8} \times \frac{1}{8} \times \frac{1}{32}\right) = \frac{1}{2^{12}} + \frac{3}{2^{11}} = \frac{7}{2^{12}}$

9. If equation  $ax^2 - 2bx + 15 = 0$  has repeated root  $\alpha$  and equation  $x^2 - 2bx + 21 = 0$  has root  $\alpha$  and  $\beta$ . then the value of  $\alpha^2 + \beta^2$

- (1) 57      (2) 58      (3) 59      (4) 60

Ans. (2)

Sol. Equation

$ax^2 - 2bx + 15 = 0$

Sum of root  $\alpha + \alpha = \frac{2b}{a} \Rightarrow \alpha = b/a$

Sum of root  $\alpha + \beta = \frac{15}{a}$   
 Product of root  $\alpha \cdot \beta = \frac{15}{a} \Rightarrow a = \frac{15}{\alpha^2}$   
 since roots are repeated  $\Rightarrow D = 0$   
 $\Rightarrow 4b^2 - 4a \cdot 15 = 0 \Rightarrow b^2 = 15a = \frac{15^2}{\alpha^2} \Rightarrow b = \pm \frac{15}{\alpha}$

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Equation

$$x^2 - 2bx + 21 = 0 \begin{cases} \alpha \\ \beta \end{cases}$$

Sum of root  $\alpha + \beta = 2b$

Product of root  $\alpha\beta = 21$

$$\alpha + \frac{21}{\alpha} = 2\left(\frac{15}{\alpha}\right) \Rightarrow \alpha^2 = 9 \Rightarrow \alpha = \pm 3$$

$$\Rightarrow \beta = \pm 7$$

The value of

$$\alpha^2 + \beta^2 = 9 + 49 = 58$$

10.  $2x^2 \frac{dy}{dx} - 2xy + 3y^2 = 0$  &  $y(e) = e/3$  then the value  $y(1)$  is  
 (1) 2/3 (2) 3/2 (3) 1/3 (4) None

Ans. (1)

Sol.  $2x^2 \frac{dy}{dx} - 2xy + 3y^2 = 0$

$$\frac{1}{y^2} \frac{dy}{dx} - \frac{1}{xy} + \frac{3}{2x^2} = 0$$

$$\text{Let } \frac{1}{y} = t$$

Difference of

$$-\frac{1}{y^2} \frac{dy}{dx} = \frac{dt}{dx}$$

$$-\frac{dt}{dx} - \frac{1}{x}t + \frac{3}{2x^2} = 0$$

$$\frac{dt}{dx} + \frac{1}{x}t = \frac{3}{2x^2}$$

$$\text{I.F.} = e^{\int \frac{1}{x} dx} = x$$

$$x.t = \int x \cdot \frac{3}{2x^2} dx$$

$$x.t = \frac{3}{2} \ln x + c$$

$$\frac{x}{y} = \frac{3}{2} \ln x + c$$

$$x = e, y = e/3$$

$$\frac{e}{e/3} = \frac{3}{2} \ln e + c$$

$$\Rightarrow c = \frac{3}{2}$$

$$\frac{x}{y} = \frac{3}{2} \ln x + \frac{3}{2}$$

$$\Rightarrow x = 1$$

$$\Rightarrow \frac{1}{y} = \frac{3}{2}$$

$$y = 2/3$$

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11. Locus of centre of a circle which touches the line  $x - y = 0$  and  $y -$  axis, is  
 (1)  $x^2 + 2xy - y^2 = 0$  (2)  $x^2 - 2xy + y^2 = 0$   
 (3)  $2x + y^2 + xy = 0$  (4)  $x^2 + 4xy = 0$

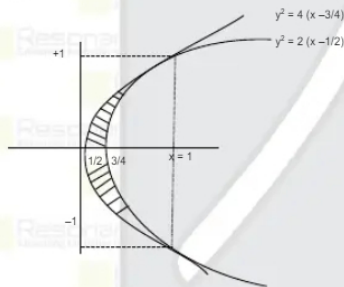
Ans. (1)

Sol. Let centre of circle be  $C(h, k)$   
 $\therefore$  circle touches  $y -$  axis  $\Rightarrow$  radius  $= |h|$   
 $\therefore$  circle touches  $x - y = 0$   
 $\Rightarrow \frac{|h - k|}{\sqrt{2}} = |h|$   
 $\Rightarrow (h - k)^2 = 2h^2$   
 $\Rightarrow h^2 + k^2 - 2hk = 2h^2$   
 $\Rightarrow h^2 + 2hk - k^2 = 0$   
 locus of  $(h, k) \rightarrow x^2 + 2xy - y^2 = 0$

12. The area bounded by  $y^2 = 2x - 1$  and  $y^2 = 4x - 3$  is  
 (1)  $1/3$  (2)  $1/4$  (3)  $1/5$  (4)  $1/6$

Ans. (1)

Sol.



When  $y^2 = 2x - 1$   
 $y^2 = 4x - 3$

$4x - 3 = 2x - 1$   
 $x = 1, y = \pm 1$

Point of intersection are  $(1, 1), (1, -1)$

Required area  $= \int_{-1}^1 (x_1 - x_2) dy = \int_{-1}^1 \left( \frac{y^2 + 3}{4} - \frac{y^2 + 1}{2} \right) dy = \int_{-1}^1 \left( \frac{-y^2 + 1}{4} \right) dy$   
 $= \frac{1}{4} \left( -\frac{y^3}{3} + y \right)_{-1}^1 = \frac{1}{4} \left( \left(1 - \frac{1}{3}\right) - \left(-1 - \frac{1}{3}\right) \right) = \frac{1}{3}$

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13. If solution set of  $|x + 1| < 2$  is A and  $|x - 1| \geq 2$  is B then which of following is incorrect  
 (1)  $A \cap B = (-3, -1)$  (2)  $A \cup B = (-\infty, 1) \cup [3, \infty)$   
 (3)  $A - B = A \cap B' = (-1, 1)$  (4)  $B - A = A' \cap B = (-\infty, -2] \cup [2, \infty)$

Ans. (4)

Sol.  $|x + 1| < 2 \Rightarrow -2 < x + 1 < 2 \Rightarrow x \in (-3, 1) = A$   
 $|x - 1| \geq 2 \Rightarrow x - 1 \leq -2 \cup x - 1 \geq 2$   
 $\Rightarrow x \leq -1 \cup x \geq 3 \Rightarrow x \in (-\infty, -1] \cup [3, \infty)$   
 $A = (-3, 1)$   $B = (-\infty, -1] \cup [3, \infty)$   
 $A' = (-\infty, -3] \cup [1, \infty)$   $B' = (-1, 3)$   
 $A - B = A \cap B' = (-1, 1)$



$$B - A = A' \cap B = (-\infty, -3] \cup [3, \infty)$$

$$A \cup B = (-\infty, 1) \cup [3, \infty)$$

$$A \cap B = (-3, -1]$$

14. If line  $y = kx + 4$  is tangent to parabola  $y = x - x^2$  at point 'P' then find slope of 'OP' where 'O' is vertex of parabola
- (1)  $-\frac{3}{2}$                       (2)  $-\frac{5}{4}$                       (3)  $-\frac{5}{2}$                       (4)  $\frac{3}{2}$

**Ans. (1)**  
**Sol.**  $y = kx + 4$   
 $y = x - x^2$   
 $kx + 4 = x - x^2$  .....(1)  
 $x^2 + (k-1)x + 4 = 0$   
 $(k-1)^2 - 4 \cdot 4 = 0$   
 $k-1 = \pm 4$   
 if  $k = 5$   
 now put the value of  $k = 5$   
 $5x + 4 = x - x^2$   
 $x^2 + 4x + 4 = 0$   
 $(x+2)^2 = 0$   
 $x = -2$   
 $y = -6$   
 if  $k = -3$   
 now put the value of  $k = -3$  in equation (1)  
 $-3x + 4 = x - x^2$   
 $x^2 - 4x + 4 = 0$   
 $x = 2, y = -2$   
 then the point of P is (2, -2) and (-2, -6)  
 and vertex of parabola 'O' =  $y - \frac{1}{4} = -\frac{1}{4} + x - x^2$   
 $y - \frac{1}{4} = -\left(x - \frac{1}{2}\right)^2$   
 point P is (2, -2)  
 slope of OP =  $\frac{-2 - \frac{1}{4}}{2 - \frac{1}{2}} = -\frac{9}{3 \times 2} = -\frac{3}{2}$   
 point P is (-2, -6) slope of OP =  $\frac{-6 - \frac{1}{4}}{-2 - \frac{1}{2}} = \frac{5}{2}$

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15. If  $b_n = \int_0^{\frac{\pi}{2}} \frac{\cos^2(nx)}{\sin x} dx$  then.
- (1)  $\frac{1}{b_3 - b_2}, \frac{1}{b_4 - b_3}, \frac{1}{b_5 - b_4}$  are in A.P with common difference 2
- (2)  $\frac{1}{b_3 - b_2}, \frac{1}{b_4 - b_3}, \frac{1}{b_5 - b_4}$  are in A.P with common difference -2
- (3)  $b_3 - b_2, b_4 - b_3, b_5 - b_4$  are in A.P with common difference 2
- (4)  $b_3 - b_2, b_4 - b_3, b_5 - b_4$  are in A.P with common difference -2

**Ans. (2)**

**Sol.**  $b_n - b_{n-1} = \int_0^{\frac{\pi}{2}} \frac{\cos^2 nx - \cos^2 (n-1)x}{\sin x} dx$   
 $= \int_0^{\frac{\pi}{2}} \frac{\sin(2n-1)x \sin(-x)}{\sin x} dx$   
 $= - \int_0^{\frac{\pi}{2}} \sin(2n-1)x dx$   
 $= \frac{1}{2n-1} [\cos(2n-1)x]_0^{\frac{\pi}{2}} = -\frac{1}{2n-1}$   
 $b_n - b_{n-1} = -\frac{1}{2n-1}$

$$\frac{1}{b_3 - b_2} = -5, \quad \frac{1}{b_4 - b_3} = -7, \quad \frac{1}{b_5 - b_4} = -9$$

common difference = -2

16. Negation of  $(p \wedge \sim q) \rightarrow (\sim p \vee q)$  is  
 (1)  $\sim(p \rightarrow q)$       (2)  $(\sim p \rightarrow q)$       (3)  $(p \rightarrow q)$       (4)  $p \rightarrow \sim q$   
**Ans. (1)**  
**Sol.**  $(p \wedge \sim q) \wedge (p \vee \sim q)$   
 $= (p \wedge \sim q)$   
 $= \sim(p \rightarrow q)$

17. For the first n natural numbers, where n is odd, the mean deviation from mean is  $5 \frac{(n+1)}{n}$  then the value of n is  
**Ans. 21.00**  
**Sol.**  $\bar{x} = \frac{1+2+3+\dots+n}{n} = \frac{n(n+1)}{2} = \frac{n+1}{2}$  (which is middle term)  
 M.D. =  $\frac{\sum |x_i - \bar{x}|}{n} = \frac{5(n+1)}{n}$

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$$\Rightarrow \frac{2 \left( 1+2+3+\dots+\frac{(n-1)}{2} \right)}{n} = \frac{5(n+1)}{n}$$

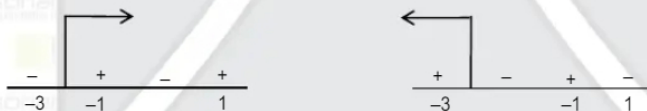
$$\Rightarrow \frac{2 \cdot \frac{(n-1) \left( \frac{(n-1)}{2} + 1 \right)}{2}}{n} = \frac{5(n+1)}{n}$$

$$\Rightarrow \frac{(n-1)(n+1)}{4n} = \frac{5(n+1)}{n}$$

n = 21

18. If m and n are respectively the local maxima & local minima of  $f(x) = |(x-1)(x^2+2x-3)|(x+3)$  then the value of m + n is

**Ans. (00.00)**  
**Sol.**  $f(x) = |(x-1)^2(x+3)|(x+3)$   
 $f(x) = \begin{cases} (x-1)^2(x+3)^2, & x \geq -3 \\ -(x-1)^2(x+3)^2, & x < -3 \end{cases}$   
 $f(x) = \begin{cases} (x^2+2x-3)^2, & x \geq -3 \\ -(x^2+2x-3)^2, & x < -3 \end{cases}$   
 $f(x) = \begin{cases} 2(x^2+2x-3)(2x+2), & x \geq -3 \\ -2(x^2+2x-3)(2x+2), & x < -3 \end{cases}$   
 $f'(x) = \begin{cases} 4(x+3)(x-1)(x+1), & x \geq -3 \\ -4(x+3)(x-1)(x+1), & x < -3 \end{cases}$   
 Local maxima  $\rightarrow m = -1$   
 Local Minima  $\rightarrow n = 1$   
 m + n = 0



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