

MATHEMATICS

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. The coefficient of x^2 in the binomial expansion of

$$\left(2x^2 + \frac{1}{x}\right)^{10} \text{ is}$$

- (1) 3260 (2) 3360
(3) 1760 (4) 1890

Answer (2)

Sol. $\left(2x^2 + \frac{1}{x}\right)^{10}$

$$T_{r+1} = {}^{10}C_r (2x^2)^{10-r} \left(\frac{1}{x}\right)^r$$

$$20 - 2r - r = 2$$

$$r = 6$$

$$\text{coff of } x^2 = {}^{10}C_6 (2)^4 = 3360$$

2. If it is given that probability of A becoming captain of the team is 0.8 and B becomes captain is 0.4. If A becomes captain then chances of winning the match by the team is 0.6 and when B becomes captain then chances of team winning the match is 0.7. Then the probability that team wins the match is

- (1) 0.76 (2) 0.78
(3) 0.74 (4) 0.84

Answer (1)

Sol. $P(W) = P(A)P\left(\frac{W}{A}\right) + P(B)P\left(\frac{W}{B}\right)$

$$= 0.8 \times 0.6 + 0.4 \times 0.7$$

$$= \frac{48 + 28}{100} = 0.76$$

3. Let $A = \{2, 3\}$ and $B = \{5, 6\}$. Then, the number of relations from $A \times B$ to $A \times B$ are

- (1) 2^{12} (2) 2^{16}
(3) 2^{10} (4) 2^{15}

Answer (2)

Sol. $n(A \times B) = 2 \times 2$

$$= 4$$

Number of relations from $A \times B$ to $A \times B$

$$= 2^{4 \times 4}$$

$$= 2^{16}$$

4. Let $A_1, A_2, A_3, \dots, A_{49}$ be 49 AM's between 49 and 149. Then the mean of A_1, A_{25}, A_{47} and A_{49} is

- (1) 110 (2) 120
(3) 130 (4) 140

Answer (1)

Sol. $d = \frac{149 - 49}{49 + 1}$

$$d = 2$$

$$A_1 = 49 + 2$$

$$A_{25} = 49 + 25.2$$

$$A_{47} = 49 + 47.2$$

$$A_{49} = 49 + 49.2$$

$$\text{Mean} = \frac{49.4 + 2[1 + 25 + 47 + 49]}{4} = 110$$

5. The value of $\sum_{r=1}^{10} \frac{r}{4+r^4}$ is equal to

- (1) $\frac{4832}{123565}$ (2) $\frac{4565}{12322}$
(3) $\frac{4565}{12321}$ (4) $\frac{4564}{12321}$

Answer (2)

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Sol. $\sum_{r=1}^{10} \frac{r}{4+r^4} = \sum_{r=1}^{10} \frac{r}{r^4 + 4 - 4r^2 + 4r^2}$

$$= \sum_{r=1}^{10} \frac{r}{(r^2+2)^2 - (2r)^2}$$

$$= \sum_{r=1}^{10} \frac{r}{(r^2+2r+2) - (r^2-2r+2)}$$

$$= \frac{1}{4} \sum_{r=1}^{10} \left(\frac{(r^2+2r+2) - (r^2-2r+2)}{(r^2+2r+2)(r^2-2r+2)} \right)$$

$$= \frac{1}{4} \sum_{r=1}^{10} \left(\frac{1}{r^2-2r+2} - \frac{1}{r^2+2r+2} \right)$$

$$= \frac{1}{4} \left[1 - \frac{1}{5} + \frac{1}{2} - \frac{1}{10} + \frac{1}{5} - \frac{1}{17} + \frac{1}{10} - \frac{1}{26} + \dots + \frac{1}{65} - \frac{1}{101} + \frac{1}{82} - \frac{1}{122} \right]$$

$$= \frac{1}{4} \left[1 + \frac{1}{2} - \frac{1}{101} - \frac{1}{122} \right]$$

$$= \frac{4565}{12322}$$

6. If α, β are the roots of the equation $x^2 - 4x + p = 0$ and γ and δ are the roots of the equation $x^2 - x + q = 0$. If α, β, γ and δ form a GP with positive common ratio, then the value of $p + q$ is

- (1) $\frac{22}{9}$ (2) $\frac{33}{9}$
 (3) $\frac{21}{9}$ (4) $\frac{34}{9}$

Answer (4)

Sol. $\therefore \alpha, \beta, \gamma, \delta \rightarrow GP$

$$\Rightarrow \alpha = a \quad \beta = ar, \gamma = ar^2, \delta = ar^3$$

$$\therefore x^2 - 4x + p = 0 <_{\beta}^{\alpha}$$

$$\Rightarrow a + ar = 4 \quad \dots(1)$$

$$a^2 r = p$$

$$\text{Also } x^2 - x + q = 0 <_{\delta}^{\gamma}$$

$$ar^2 + ar^3 = 1 \quad \dots(2)$$

$$a^2 r^5 = q$$

from (1) and (2)

$$\frac{a(1+r)}{ar^2(1+r)} = 4$$

$$r = \pm \frac{1}{2}$$

$$\text{If } r = \frac{1}{2}$$

$$a\left(\frac{3}{2}\right) = 4$$

$$\Rightarrow a = \frac{8}{3}$$

$$\text{Now } p = \left(\frac{8}{3}\right)^2 \times \frac{1}{2}$$

$$q = \left(\frac{8}{3}\right)^2 \left(\frac{1}{2}\right)^5$$

$$p + q = \frac{34}{9}$$

7. If Z_1 and Z_2 are the solutions of the equation $6Z^2 - 11Z + 59 - 3i = 0$ then $|Z_1|^2 + |Z_2|^2$ is equal to

- (1) $\frac{709}{36}$ (2) $\frac{703}{18}$
 (3) $\frac{705}{36}$ (4) $\frac{701}{36}$

Answer (1)

Sol. $6z^2 - 11z + 59 - 3i = 0$

$$D = (-11)^2 - 4(6)(59 - 3i)$$

$$= -1295 + 72i$$

$$\sqrt{-1295 + 72i} = x + iy$$

$$\Rightarrow x^2 - y^2 = -1295$$

$$xy = 36$$

$$\Rightarrow x = \pm 1 \text{ then } y = \pm 36$$

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$$z = \frac{11 \pm (1 \pm 36i)}{12}$$

$$= 1 + 3i, \frac{5}{6} - 3i$$

$$\Rightarrow |z_1|^2 = 10$$

$$|z_2|^2 = \left(\frac{25}{36} + 9\right)$$

$$|z_1|^2 + |z_2|^2 = \frac{709}{36}$$

8. If $f(x) = \lim_{y \rightarrow 0} \frac{(1 - \cos xy) \tan(xy)}{y^3}$ then number of roots of the equation $f(x) = \sin x$ is

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

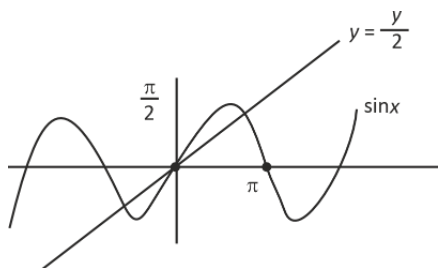
Answer (3)

Sol. $f(x) = \lim_{y \rightarrow 0} \frac{(1 - \cos xy) \tan(xy)}{y^3}$

$$= \lim_{y \rightarrow 0} \frac{2\sin^2\left(\frac{xy}{2}\right)}{\left(\frac{xy}{2}\right)^2 \times \left(\frac{y}{x^2}\right)} \times \frac{\tan(xy)}{(xy) \times \frac{1}{x}}$$

$$= \lim_{y \rightarrow 0} \frac{x^2}{2} \times \frac{1}{x} = \frac{x}{2}$$

$$f(x) = \frac{x}{2}$$



9. Let $\vec{OP} = \vec{a}$, $\vec{OQ} = \vec{b}$. Let a point R be such that $\vec{OP} = 5\vec{OR}$. Let a point M be such that $\vec{OQ} = 5\vec{RM}$ then $\vec{PM}$ is equal to

- (1) $\frac{1}{5}(\vec{b} - 4\vec{a})$ (2) $\frac{1}{5}(4\vec{b} - \vec{a})$
(3) $\frac{1}{5}(\vec{b} + 4\vec{a})$ (4) $\frac{1}{5}(4\vec{b} + \vec{a})$

Answer (1)

Sol. $\vec{OP} = \vec{a}$, $\vec{OQ} = \vec{b}$

$$\vec{OP} = 5\vec{OR} \Rightarrow \vec{OR} = \frac{1}{5}\vec{a}$$

$$\vec{OQ} = 5\vec{RM} \Rightarrow \vec{RM} = \frac{1}{5}\vec{b}$$

$$\vec{OM} = \vec{OR} + \vec{RM} = \frac{1}{5}(\vec{a} + \vec{b})$$

$$\vec{PM} = \vec{OM} - \vec{OP}$$

$$= \frac{1}{5}\vec{a} + \frac{1}{5}\vec{b} - \vec{a}$$

$$= \frac{1}{5}\vec{b} - \frac{4}{5}\vec{a}$$

$$= \frac{1}{5}(\vec{b} - 4\vec{a})$$

10. If $f(x) = \int_1^x f(t)dt + (1-x)(\ln x - 1) + e$. Then, the value of $f(f(1))$ is

- (1) $e^e + 1$ (2) $e^e - 1$
(3) $e^e + 2$ (4) $e^e - 2$

Answer (1)

Sol. $f(x) = \left(\int_1^x f(t)dt\right) + (1-x)(\ln x - 1) + e$

$$f'(x) = f(x) + \frac{(1-x)}{x} + (\ln x - 1)(-1)$$

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$$\frac{dy}{dx} = y + \frac{1}{x} - 1 - \ln x + 1$$

$$\frac{dy}{dx} + (-1)y = \frac{1}{x} - \ln x$$

$$I.F = e^{-x}$$

$$y(e^{-x}) = \int \left(\frac{e^{-x}}{x} - e^{-x} \ln x \right) dx$$

$$= \int \frac{e^{-x}}{x} dx - \left(-\ln x e^{-x} + \int \frac{e^{-x}}{x} dx \right) + c$$

$$y(e^{-x}) = e^{-x} \ln x + c$$

$$y = \ln x + ce^x$$

$$y(1) = e$$

$$\Rightarrow \boxed{c=1}$$

$$y = e^x + \ln x$$

$$f(x) = e^x + \ln x$$

$$f(1) = e$$

$$f(f(1)) = e^e + \ln(e^e)$$

$$= e^e + 1$$

11.

12.

13.

14.

15.

16.

17.

18.

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. A bag contains 4 red balls, 6 yellow balls and 5 blue balls. In how many ways we can select 8 balls such that we get at least two balls of each colour, is

Answer (4100)

Sol.

R	Y	B	ways
4	2	2	${}^4C_4 \cdot {}^6C_2 \cdot {}^5C_2 = 150$
2	4	2	${}^4C_2 \cdot {}^6C_4 \cdot {}^5C_2 = 900$
2	2	4	${}^4C_2 \cdot {}^6C_2 \cdot {}^5C_4 = 450$
3	3	2	${}^4C_3 \cdot {}^6C_3 \cdot {}^5C_2 = 800$
3	2	3	${}^4C_3 \cdot {}^6C_2 \cdot {}^5C_3 = 600$
2	3	3	${}^4C_2 \cdot {}^6C_3 \cdot {}^5C_3 = 1200$

Total ways = 4100

22. The number of solution of equation $\cos \theta \cos \frac{5\theta}{2} = \cos 7\theta \cos \frac{7\theta}{2}$, $\theta \in [-\pi, \pi]$ is equal to

Answer (19)

Sol. $\cos \theta \cos \frac{5\theta}{2} = \cos 7\theta \cos \frac{7\theta}{2}$

$$\cos \left(\theta + \frac{5\theta}{2} \right) + \cos \left(\theta - \frac{5\theta}{2} \right) = \cos \left(7\theta + \frac{7\theta}{2} \right) + \cos \left(7\theta - \frac{7\theta}{2} \right)$$

$$\cos \frac{7\theta}{2} + \cos \frac{3\theta}{2} = \cos \frac{21\theta}{2} + \cos \frac{7\theta}{2}$$

$$\cos \frac{3\theta}{2} = \cos \frac{21\theta}{2}$$

$$\frac{21\theta}{2} = 2k\pi \pm \frac{3\theta}{2}$$

$$\frac{21\theta}{2} = 2k\pi + \frac{3\theta}{2} \Rightarrow \theta = \frac{2k\pi}{9}, k \in I$$

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$$\frac{21\theta}{2} = 2k\pi - \frac{3\theta}{2} \Rightarrow \theta = \frac{k\pi}{6}, k \in I$$

when $\theta = \frac{2k\pi}{9}$

$$-\pi \leq \frac{2k\pi}{9} \leq \pi \Rightarrow -\frac{9}{2} \leq k \leq \frac{9}{2}$$

$$k \in \{-4, -3, -2, -1, 0, 1, 2, 3, 4\} \rightarrow 9 \text{ sol}^n$$

for $\theta = \frac{k\pi}{6}$

$$-\pi \leq \frac{k\pi}{6} \leq \pi \Rightarrow -6 \leq k \leq 6$$

$$k \in \{-6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6\} \rightarrow 13 \text{ sol}^n$$

$$\theta = \left\{ -\frac{2\pi}{3}, 0, \frac{2\pi}{3} \right\} \text{ is common}$$

$$\therefore \text{Total Sol}^n = 19$$

23. If $y = y(x)$ be the solution of the differential equation

$$(\sqrt{\tan x}) dy = \left(\sec^3 x - (\tan x)^{\frac{3}{2}} y \right) dx \text{ and } y\left(\frac{\pi}{4}\right) = \frac{6\sqrt{2}}{5}$$

and $y\left(\frac{\pi}{3}\right) = \frac{4\alpha}{5}$ then α^4 is equal to

Answer (48.00)

Sol. $\frac{dy}{dx} = \frac{\sec^3 x - (\sqrt{\tan x})^3}{\sqrt{\tan x}}$

$$\frac{dy}{dx} + (\tan x)y = (\sec^2 x) \frac{\sec x}{\sqrt{\tan x}}$$

$$\text{I.F.} = e^{\int \frac{\sin x}{\cos x} dx} = e^{-\ln|\cos x|} = \sec x$$

$$\Rightarrow y \sec x = \int \frac{(\sec x)^2 (\sec x)^2}{\sqrt{\tan x}} dx$$

Let $\tan x = t^2$

$$(\sec^2 x) dx = 2t dt$$

$$y \sec x = \int \frac{(1+t^4)(2t dt)}{t}$$

$$= 2t + \frac{2t^5}{5} + C$$

$$y \sec x = 2\sqrt{\tan x} + \frac{2}{5}(\sqrt{\tan x})^5 + C$$

$$y\left(\frac{\pi}{4}\right) \times \sqrt{2} = 2 + \frac{2}{5} + C \Rightarrow \frac{6\sqrt{2} \times \sqrt{2}}{5} = \frac{12}{5} + C$$

$$\Rightarrow C = 0$$

$$y\left(\frac{\pi}{3}\right)(2) = 2 \times \sqrt{(\sqrt{3})} \left[1 + \frac{1}{5}(\sqrt{3})^4 \right]$$

$$= 2\sqrt{3} \times \left(1 + \frac{3}{5} \right)$$

$$\Rightarrow y\left(\frac{\pi}{3}\right) = 3^{\frac{1}{4}} \times \frac{8}{5} = \frac{4\alpha}{5} \Rightarrow \alpha = 2 \cdot 3^{\frac{1}{4}}$$

$$\Rightarrow \alpha^4 = 16 \times 3 = 48$$

24. If the mean of the frequency distribution, table

x_i	0	2	6	12	..	.	$n(n+1)$
f_i	nC_0	nC_2	nC_3	.	.	.	nC_n

is 45. Then, the mean will be

Answer (42)

Sol. Mean = 45

$$\frac{\sum f_i x_i}{\sum f_i} = 45$$

$$\sum_{r=0}^n \frac{r(r+1)}{2^n} {}^nC_r = 45$$

$$\sum_{r=0}^n r^2 {}^nC_r + \sum_{r=0}^n r {}^nC_r = 45 \times 2^n$$

$$\Rightarrow n(n+1)2^{n-2} + n(2^{n-1}) = 45 \times 2^n$$

$$\Rightarrow n^{n-2}(n^2 + n + 2n) = 45 \times 2^n$$

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$$\Rightarrow n^2 + 3n = 180$$

$$\Rightarrow n^2 + 3n - 180 = 0$$

$$\Rightarrow \boxed{n=12}$$

$$\text{Total frequency} = 2^{12}$$

$$\sum_{i=0}^5 {}^{12}C_i = \sum_{i=7}^{12} {}^{12}C_i$$

$$\Rightarrow \text{Median will be at } f_i = {}^{12}C_6$$

$$\Rightarrow \text{Median} = 6 \times 7 = 42$$

25.




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