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OAVS PGT Math Previous Year Question **FREE DEMO**

10 Toughest Subject Content Questions (2021) with Full Solutions



SUBJECT CONTENT – 10 TOUGHEST PYQ

Hand-picked from the OAVS PGT Math paper (30-01-2021) – calculus, algebra, vectors, matrices, probability & more – with the same step-by-step solutions you get in the full pack.

Q-1 $\frac{1^3}{1} + \frac{1^3+2^3}{1+3} + \frac{1^3+2^3+3^3}{1+3+5} + \dots$ to n terms = ?

[OAVS PGT MATH 2021]

(A) $\frac{n(2n^2+9n+13)}{24}$

(B) $\frac{4n^2+1}{5}$

(C) $\frac{n(n+1)(n+2^3)}{24}$

(D) $\frac{n(n+1)^3(n+2)}{24}$

ANS- (A) $\frac{n(2n^2+9n+13)}{24}$

Given:

→ Series $\frac{1^3}{1} + \frac{1^3+2^3}{1+3} + \frac{1^3+2^3+3^3}{1+3+5} + \dots$ to n terms

Concept:

→ $1^3+2^3+\dots+n^3 = \left(\frac{n(n+1)}{2}\right)^2$ and $1+3+\dots+(2n-1) = n^2$

Solution:

► $T_n = \frac{n^2(n+1)^2}{4n^2} = \frac{(n+1)^2}{4}$

► $S_n = \frac{1}{4}(2^2+3^2+\dots+(n+1)^2)$

⇒ $S_n = \frac{1}{4} \left[\frac{(n+1)(n+2)(2n+3)}{6} - 1 \right]$

⇒ $S_n = \frac{2n^3+9n^2+13n}{24}$

⇒ $S_n = \frac{n(2n^2+9n+13)}{24}$

► Ans: (A) $\frac{n(2n^2+9n+13)}{24}$

Hint:

→ Check with $n=1$: $S_1=1$ and $\frac{1 \cdot 24}{24} = 1$ — only option (A) fits.



Q-2 n students are to be seated around a table. Among them, 2 particular students shall be neighbours. The probability for this event is:

[OAVS PGT MATH 2021]

(A) $\frac{1}{(n-1)!}$

(B) $\frac{2}{n!}$

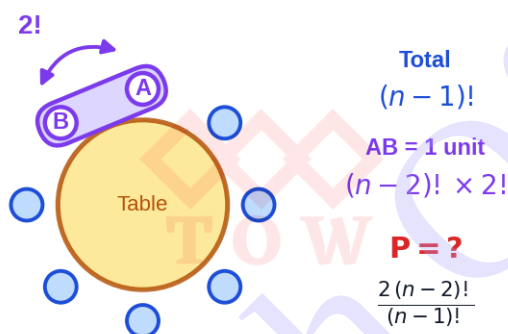
(C) $\frac{1}{n-1}$

(D) $\frac{2}{n-1}$

ANS- (D) $\frac{2}{n-1}$

Given:

→ n students around a table; 2 particular students must sit together



Concept:

→ n persons in a circle: $(n-1)!$ ways; treat the pair as one unit.

Solution:

➤ Total ways = $(n-1)!$

➤ Favourable = $(n-2)! \cdot 2!$ (pair as one unit, the two can swap)

➤ $P = \frac{2(n-2)!}{(n-1)!}$

⇒ $P = \frac{2}{n-1}$

➤ Ans: (D) $\frac{2}{n-1}$

Q-3 Angle between the lines $x-2y+z=0$ and $x+2y-2z=0$ is:

$x+2y+z=0$ and $3x+9y+5z=0$ is:

[OAVS PGT MATH 2021]



(A) $\theta = \cos^{-1} \left(\frac{\sqrt{406}}{7} \right)$

(B) $\theta = \cos^{-1} \left(\frac{7}{\sqrt{406}} \right)$

(C) $\theta = \cos^{-1} \left(\frac{\sqrt{406}}{8} \right)$

(D) $\theta = \cos^{-1} \left(\frac{8}{\sqrt{406}} \right)$

ANS- (D) $\theta = \cos^{-1} \left(\frac{8}{\sqrt{406}} \right)$

Given:

→ Line 1: $x - 2y + z = 0 = x + 2y - 2z$

→ Line 2: $x + 2y + z = 0 = 3x + 9y + 5z$

Concept:

→ Direction of a line of intersection = cross product of the two plane normals.

→ $\cos \theta = \frac{|\vec{d}_1 \cdot \vec{d}_2|}{|\vec{d}_1| |\vec{d}_2|}$

Solution:

→ $\vec{d}_1 = (1, -2, 1) \times (1, 2, -2) = (2, 3, 4)$

→ $\vec{d}_2 = (1, 2, 1) \times (3, 9, 5) = (1, -2, 3)$

→ $\vec{d}_1 \cdot \vec{d}_2 = 2 - 6 + 12 = 8$

→ $|\vec{d}_1| = \sqrt{29}, |\vec{d}_2| = \sqrt{14}$

⇒ $\cos \theta = \frac{8}{\sqrt{29} \sqrt{14}} = \frac{8}{\sqrt{406}}$

→ Ans: (D) $\theta = \cos^{-1} \left(\frac{8}{\sqrt{406}} \right)$

Q-4 The algebraic multiplicity of the eigen value 3 of matrix

$A = \begin{bmatrix} 3 & 10 & 5 \\ -2 & -3 & -4 \\ 3 & 5 & 7 \end{bmatrix}$ is:

[OAVS PGT MATH 2021]

(A) 3

(B) 1

(C) 2

(D) 0

ANS- (B) 1

Given:



$$\rightarrow A = \begin{bmatrix} 3 & 10 & 5 \\ -2 & -3 & -4 \\ 3 & 5 & 7 \end{bmatrix}$$

Concept:

$$\rightarrow \lambda^3 - (\text{tr } A)\lambda^2 + \left(\sum \text{ of principal } 2 \times 2 \text{ minors}\right)\lambda - \det A = 0$$

Solution:

$$\rightarrow \text{tr } A = 3 - 3 + 7 = 7$$

$$\rightarrow \text{Minors: } (-21 + 20) + (21 - 15) + (-9 + 20) = -1 + 6 + 11 = 16$$

$$\rightarrow \det A = 3(-1) - 10(-2) + 5(-1) = 12$$

$$\Rightarrow \lambda^3 - 7\lambda^2 + 16\lambda - 12 = 0$$

$$\Rightarrow (\lambda - 3)(\lambda - 2)^2 = 0$$

$$\Rightarrow \lambda = 3, 2, 2$$

► Eigenvalue 3 appears once, so its algebraic multiplicity is 1

► Ans: (B) 1

Q-5 The argument of the complex number $\frac{1+2i}{1-3i}$ is:

[OAVS PGT MATH 2021]

(A) $\frac{\pi}{3}$

(B) $\frac{\pi}{2}$

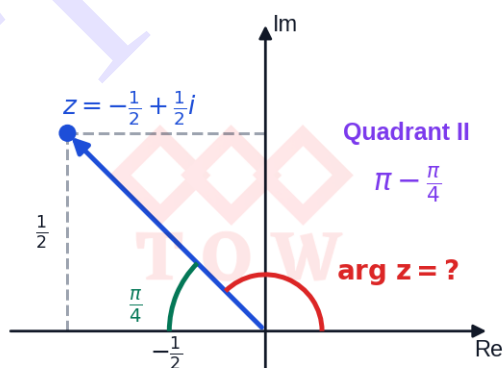
(C) $\frac{\pi}{4}$

(D) $\frac{3\pi}{4}$

ANS- (D) $\frac{3\pi}{4}$

Given:

$$\rightarrow z = \frac{1+2i}{1-3i}$$



Concept:

→ Rationalise, then find the quadrant of z .



Solution:

$$\rightarrow z = \frac{(1+2i)(1+3i)}{1+9}$$

$$\Rightarrow z = \frac{1+5i-6}{10}$$

$$\Rightarrow z = -\frac{1}{2} + \frac{1}{2}i \text{ (second quadrant)}$$

$$\rightarrow \arg z = \pi - \tan^{-1} 1 = \pi - \frac{\pi}{4}$$

$$\Rightarrow \arg z = \frac{3\pi}{4}$$

$$\rightarrow \text{Ans: (D) } \frac{3\pi}{4}$$

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Q-6 Solve the following: $(1+y^2)dx = (\tan^{-1} y - x)dy$.

[OAVS PGT MATH 2021]

(A) $x = \tan^{-1} y - 1 + c e^{\tan^{-1} y}$

(B) $x = \tan^{-1} y + 1 + c e^{-\tan^{-1} y}$

(C) $x = \tan^{-1} y + 1 + c e^{\tan^{-1} y}$

(D) $x = \tan^{-1} y - 1 + c e^{-\tan^{-1} y}$

ANS- (D) $x = \tan^{-1} y - 1 + c e^{-\tan^{-1} y}$

Given:

$$\rightarrow (1+y^2)dx = (\tan^{-1} y - x)dy$$

Concept:

$$\rightarrow \text{Linear equation in } x: \frac{dx}{dy} + Px = Q, \text{ I.F. } = e^{\int P dy}$$

Solution:

$$\rightarrow \frac{dx}{dy} + \frac{x}{1+y^2} = \frac{\tan^{-1} y}{1+y^2}$$

$$\Rightarrow \text{I.F.} = e^{\tan^{-1} y}$$

$$\rightarrow x e^{\tan^{-1} y} = \int \frac{\tan^{-1} y}{1+y^2} e^{\tan^{-1} y} dy$$

$$\Rightarrow \text{Put } t = \tan^{-1} y: \int t e^t dt = e^t (t-1) + c$$

$$\Rightarrow x e^{\tan^{-1} y} = e^{\tan^{-1} y} (\tan^{-1} y - 1) + c$$

$$\Rightarrow x = \tan^{-1} y - 1 + c e^{-\tan^{-1} y}$$

$$\rightarrow \text{Ans: (D) } x = \tan^{-1} y - 1 + c e^{-\tan^{-1} y}$$



Q-7 Evaluate the following: $\int_0^a \int_{\sqrt{ax}}^a \frac{y^2 dy dx}{\sqrt{y^4 - a^2 x^2}}$

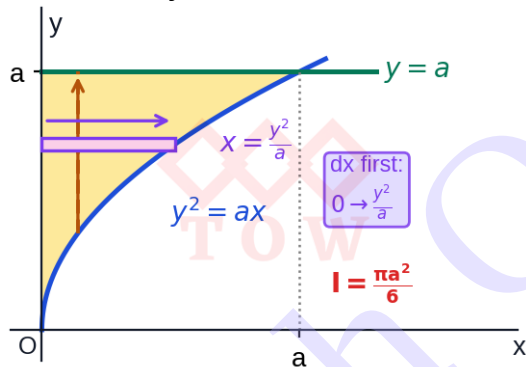
[OAVS PGT MATH 2021]

- (A) $\frac{a}{6}$
(B) $\frac{\pi}{6}$
(C) $\frac{\pi a}{6}$
(D) $\frac{\pi a^2}{6}$

ANS- (D) $\frac{\pi a^2}{6}$

Given:

$$\rightarrow I = \int_0^a \int_{\sqrt{ax}}^a \frac{y^2 dy dx}{\sqrt{y^4 - a^2 x^2}}$$



Concept:

→ Change the order of integration.

Solution:

► Region: $0 \leq x \leq a, \sqrt{ax} \leq y \leq a$

$$\Rightarrow 0 \leq y \leq a, 0 \leq x \leq \frac{y^2}{a}$$

$$\rightarrow I = \int_0^a y^2 \int_0^{\frac{y^2}{a}} \frac{dx}{\sqrt{y^4 - a^2 x^2}} dy$$

$$\Rightarrow \text{Inner} = \frac{1}{a} \left[\sin^{-1} \frac{ax}{y^2} \right]_0^{\frac{y^2}{a}} = \frac{1}{a} \cdot \frac{\pi}{2}$$

$$\Rightarrow I = \frac{\pi}{2a} \int_0^a y^2 dy$$

$$\Rightarrow I = \frac{\pi}{2a} \cdot \frac{a^3}{3} = \frac{\pi a^2}{6}$$

► Ans: (D) $\frac{\pi a^2}{6}$



Q-8 The value of c by using Lagrange's mean value theorem on $[-2, 2]$, if $f(x) = x^3$ is:

[OAVS PGT MATH 2021]

(A) $\pm\sqrt{\frac{2}{3}}$

(B) $\pm\frac{\sqrt{3}}{2}$

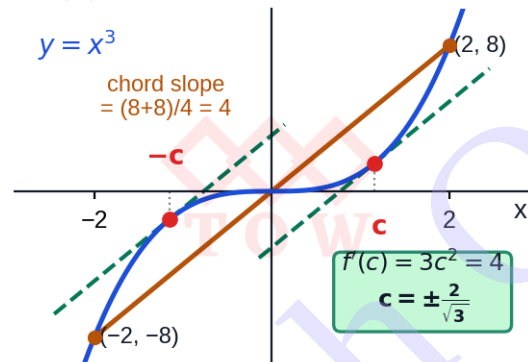
(C) $\pm\sqrt{\frac{3}{2}}$

(D) $\pm\frac{2}{\sqrt{3}}$

ANS- (D) $\pm\frac{2}{\sqrt{3}}$

Given:

$\rightarrow f(x) = x^3$ on $[-2, 2]$



Concept:

$\rightarrow$ Lagrange's MVT: $f'(c) = \frac{f(b) - f(a)}{b - a}$

Solution:

$\rightarrow f'(c) = \frac{8 - (-8)}{2 - (-2)} = \frac{16}{4} = 4$

$\Rightarrow 3c^2 = 4$

$\Rightarrow c = \pm\frac{2}{\sqrt{3}}$ (both lie in $(-2, 2)$)

$\rightarrow$ Ans: (D) $\pm\frac{2}{\sqrt{3}}$

Q-9 The domain of $\sqrt{\frac{(x-1)(x-2)}{x-3}}$ is:

[OAVS PGT MATH 2021]

(A) $[1, 2] \cup (3, \infty)$

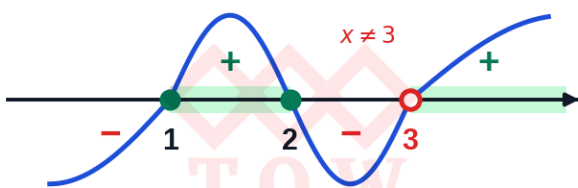


- (B) $[1, 2] \cup (3, \infty)$
(C) $(1, 2) \cup (3, \infty)$
(D) $[1, 2) \cup (3, \infty)$

ANS- (B) $[1, 2] \cup (3, \infty)$

Given:

$$\rightarrow f(x) = \sqrt{\frac{(x-1)(x-2)}{x-3}}$$



Domain: $[1, 2] \cup (3, \infty)$

Concept:

$\rightarrow$ Need $\frac{(x-1)(x-2)}{x-3} \geq 0$ with $x \neq 3$; use the wavy-curve method.

Solution:

- Critical points: 1, 2, 3
- Sign for $x > 3$: +; $2 < x < 3$: -; $1 < x < 2$: +; $x < 1$: -
- $\Rightarrow$ Expression ≥ 0 on $[1, 2] \cup (3, \infty)$
- Ans: (B) $[1, 2] \cup (3, \infty)$

Hint:

$\rightarrow$ Zeros of the numerator are included (square brackets); a zero of the denominator is always excluded.

Q-10 If the number of common tangents of the circles

$x^2 + y^2 - 6x - 8y + a = 0, x^2 + y^2 - 9 = 0$ is 3, then $a = ?$

[OAVS PGT MATH 2021]

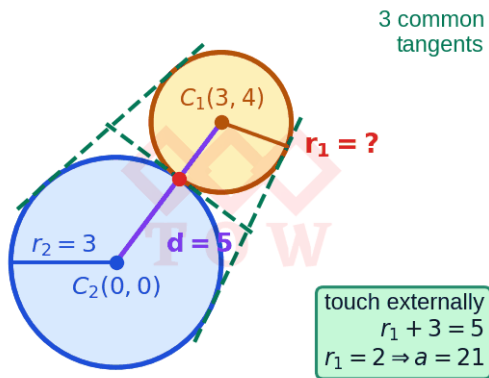
- (A) 21
(B) 20
(C) 19
(D) 18

ANS- (A) 21

Given:

$\rightarrow C_1: x^2 + y^2 - 6x - 8y + a = 0; C_2: x^2 + y^2 - 9 = 0; 3$ common tangents





Concept:

→ 3 common tangents $\Leftrightarrow$ circles touch externally: $C_1C_2 = r_1 + r_2$

Solution:

► $C_1(3, 4)$, $r_1 = \sqrt{25 - a}$; $C_2(0, 0)$, $r_2 = 3$

► $C_1C_2 = 5$

$\Rightarrow \sqrt{25 - a} + 3 = 5$

$\Rightarrow 25 - a = 4$

$\Rightarrow a = 21$

► Ans: (A) 21





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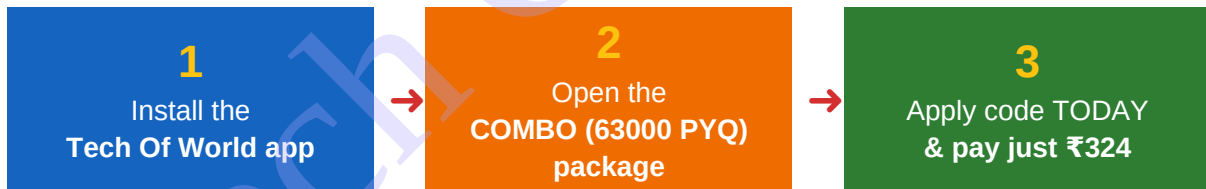
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