

**JEE MATHS JULY 29 2025**

If the function  $f$  given by  $f(x) = x^3 - 3(a-2)x^2 + 3ax + 7$ , for some  $a \in \mathbb{R}$  is increasing in  $(0, 1]$  and decreasing in  $[1, 5)$ , then a root of the equation,  $\frac{f(x)-14}{(x-1)^2} = 0 (x \neq 1)$  is

- (a)  $-7$  (b)  $6$   
(c)  $7$  (d)  $5$

Ans. (c) : Given,

$$f(x) = x^3 - 3(a-2)x^2 + 3ax + 7$$

On differentiating w.r.t.  $x$ , we get –

$$f'(x) = 3x^2 - 6(a-2)x + 3a$$

$$f'(x) \geq 0 \quad \forall x \in (0, 1]$$

$$f'(x) \leq 0 \quad \forall x \in [1, 5)$$

$$f'(x) = 0 \text{ at } x = 1$$

$$3(1)^2 - 6(a-2) + 3a = 0$$

$$3 - 6a + 12 + 3a = 0$$

$$-3a = -15$$

$$a = 5$$

$$\therefore f(x) - 14 = (x-1)^2 (x-7)$$

$$\frac{f(x)-14}{(x-1)^2} = (x-7)$$

Hence,  $x-7=0$

$$x = 7$$

**An edge of a variable cube is increasing at the rate of 10cm/s. How fast the volume of the cube will increase when the edge is 5 cm long**

- (a)  $750 \text{ cm}^3/\text{s}$  (b)  $75 \text{ cm}^3/\text{s}$   
(c)  $300 \text{ cm}^3/\text{s}$  (d)  $150 \text{ cm}^3/\text{s}$   
(e)  $25 \text{ cm}^3/\text{s}$

Ans. (a) : Volume of cube ( $v$ ) =  $x^3$  [ $x$  is edge of cube  
 $x = 5 \text{ cm}$ ]

$$v = x^3$$

$$\frac{dv}{dt} = 3x^2 \frac{dx}{dt}$$

$$\frac{dv}{dt} = 3 \times 5^2 \times 10$$

$$= 75 \times 10$$

$$\frac{dv}{dx} = 750 \text{ cm}^3/\text{sec}$$

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A cube is expanding in such a way that its edge is increasing at a rate of 2 inches per second. If its edge is 5 inches long, then the rate of change of its volume is

- (a)  $150 \text{ in}^3/\text{sec}$                       (b)  $75 \text{ in}^3/\text{sec}$   
 (c)  $50 \text{ in}^3/\text{sec}$                       (d)  $30 \text{ in}^3/\text{sec}$   
 (e)  $45 \text{ in}^3/\text{sec}$

**Ans. (a) :** Given,

$V = x^3$  [x = length, V = volume]

$$\frac{dV}{dt} = 3x^2 \cdot \frac{dx}{dt} \quad \left[ \text{Given, } \frac{dx}{dt} = 2 \right]$$

$$\frac{dV}{dt} = 3x^2 \times 2$$

$$\frac{dV}{dt} = 6x^2 \quad [\because x = 5 \text{ inch}]$$

$$\frac{dV}{dt} = 6 \times 5^2$$

$$= 6 \times 5^2$$

$$\frac{dV}{dt} = 150 \text{ in}^3 / \text{sec}$$

The function  $f(x) = x^2 + 2x - 5$  is strictly increasing in the interval

- (a)  $[-1, \infty)$                       (b)  $(-\infty, -1)$   
 (c)  $(-\infty, -1)$                       (d)  $(-1, \infty)$

**Ans. (d) :** Given,

$$f(x) = x^2 + 2x - 5$$

$$\therefore f'(x) = 2x + 2$$

$f(x)$  is an increasing function, if  $f'(x) > 0$

$$2x + 2 > 0$$

$$2x > -2$$

$$\therefore x > -1$$

Thus,  $f(x)$  is an increasing function for  $x > -1$

i.e.  $(-1, \infty)$

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The derivative of  $\tan^{-1}\left(\frac{\sqrt{1+x^2}-1}{x}\right)$  with

respect to the  $\tan^{-1}\left(\frac{2x\sqrt{1-x^2}}{1-2x^2}\right)$  at  $x = 0$ , is

(a)  $\frac{1}{8}$

(b)  $\frac{1}{4}$

(c)  $\frac{1}{2}$

(d) 1

**Ans. (b) :** Let,

$$y = \tan^{-1}\left(\frac{\sqrt{1+x^2}-1}{x}\right) \text{ and}$$

$$z = \tan^{-1}\left(\frac{2 \times \sqrt{1-x^2}}{1-2x^2}\right)$$

Putting  $x = \tan \theta$ , we get

$$y = \tan^{-1}\left(\frac{\sec \theta - 1}{\tan \theta}\right) = \tan^{-1}\left(\frac{\tan \theta}{2}\right) = \frac{1}{2} \tan^{-1}(x)$$

$$\frac{dy}{dx} = \frac{1}{2(1+x^2)}$$

Putting  $x = \sin \theta$  in  $z$ , we get

$$z = \tan^{-1}\left(\frac{2 \sin \theta \cos \theta}{\cos 2\theta}\right) = \tan^{-1}(\tan 2\theta) = 2\theta = 2 \sin^{-1} x$$

$$\Rightarrow \frac{dz}{dx} = \frac{2}{\sqrt{1-x^2}}$$

$$\text{Thus, } \frac{dy}{dz} = \frac{dy}{dx} \cdot \frac{dx}{dz} = \frac{1}{4(1+x^2)} \sqrt{1-x^2}$$

at  $x = 0$

$$\left(\frac{dy}{dz}\right) = \frac{1}{4}$$

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**The number of terms in the expansion of  $(x + y + z)^{10}$  is**

- (a) 142 (b) 11  
(c) 110 (d) 66

**Ans. (d) :** The given expansion  $(x + y + z)^{10}$

We know that,

The number of term in the expansion of  $(x_1 + x_2 + x_3 + \dots + x_r)^n = {}^{n+r-1}C_n$

Where,  $n$  = exponent of the term

$r$  = number of terms

Then, total number of terms –

$${}^{n+r-1}C_n = {}^{10+3-1}C_{10} = {}^{12}C_{10}$$

$$= \frac{12!}{(12-10)!10!}$$

$$= \frac{12 \times 11 \times 10!}{2! \times 10!}$$

$$\text{So, total number of term} = \frac{132}{2} = 66$$

**The number of terms in the expansion of**

**$(x^2 + y^2)^{25} - (x^2 - y^2)^{25}$  after simplification is**

- (a) 0 (b) 26  
(c) 13 (d) 50

**Ans. (c) :** Given, expansion is,

$$(x^2 + y^2)^{25} - (x^2 - y^2)^{25}$$

We know that,

$$(a + b)^n - (a - b)^n = \frac{n+1}{2}$$

Where  $n$  is odd number.

So, the number of terms in the given expansior

$$\frac{n+1}{2} = \frac{25+1}{2} = 13$$

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