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42
(A) $I = \int_{-\pi/2}^{\pi/2} \frac{x^2 \cos x dx}{1+e^x} \quad \text{--- (1)}$

$$I = \int_{-\pi/2}^{\pi/2} \frac{(-x)^2 \cos(-x) dx}{1+e^{-x}} \rightarrow \int_{-\pi/2}^{\pi/2} \frac{x^2 \cos x e^x}{e^x + 1} \quad \text{--- (2)}$$

adding (1) & (2)

$$2I = \int_{-\pi/2}^{\pi/2} \frac{x^2 \cos x (e^x + 1) dx}{(e^x + 1)}$$

$$2I = \int_{-\pi/2}^{\pi/2} x^2 \cos x \rightarrow 2I = 2 \int_0^{\pi/2} x^2 \cos x dx$$

$$I = \int_0^{\pi/2} x^2 \cos x dx$$

$$I = (\sin x x^2)_0^{\pi/2} - \int_0^{\pi/2} \sin x 2x dx$$

$$= \frac{\pi^2}{4} - \left[(-\cos x (2x)) - \int -\cos x (2) \right]$$

$$= \frac{\pi^2}{4} - 2 \text{ so option (A)}$$

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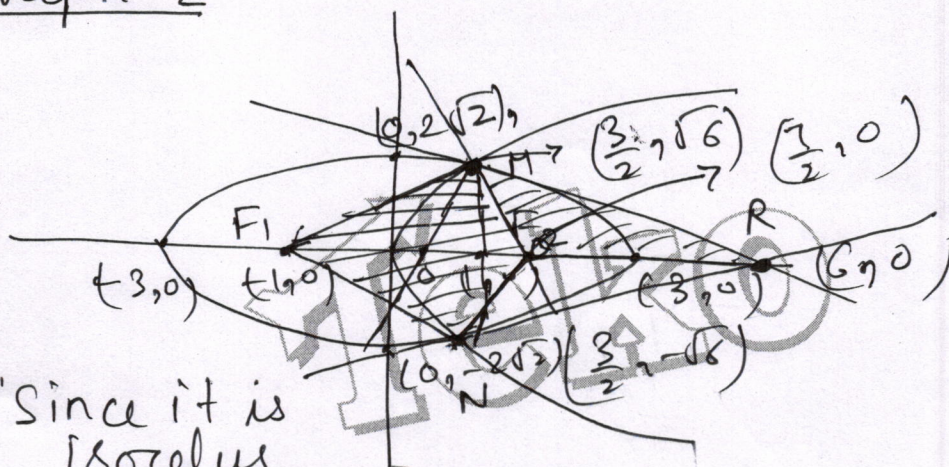
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Paragraph-2

Q.53
-(A)



Since it is isosceles triangle.

→ Orthocentre (O) will lie on x-axis → y = 0
eqn of line \perp F1M & passing through M.

$$m_{F1M} = -\frac{\sqrt{6} \times 2}{3} = -\frac{2\sqrt{6}}{3}$$

$$m_1 m_2 = -1$$

So eqn of OM

$$m_{OM} = \frac{3}{2\sqrt{6}}$$

$$y - \sqrt{6} = \frac{3}{2\sqrt{6}} \left(x - \frac{3}{2}\right)$$

$$\text{as } y = 0$$

$$\text{so } x = \frac{9}{10}, \text{ Ans (A)}$$

Q.54
(C)

$$R \rightarrow (6, 0)$$

$$\begin{aligned} \text{Area of } \triangle MNF_1F_2 &= \text{ar}(\triangle MNF_1) - \text{ar}(\triangle MNF_2) \\ &= \frac{1}{2} \times 2\sqrt{6} \times \left(\frac{3}{2} + 1\right) - \frac{1}{2} \times 2\sqrt{6} \times \left(\frac{3}{2} - 1\right) \\ &= \sqrt{6}(2) = 2\sqrt{6} \end{aligned}$$

Area($\triangle MOR$)

For (C) eqn:
eqn of line $y = m_1x - 2am - am^3$
eqn of line $y = m_2x - 2am - am^3$
eqn of line $y = m_3x - 2am - am^3$
eqn of line $y = m_4x - 2am - am^3$
eqn of line $y = m_5x - 2am - am^3$
eqn of line $y = m_6x - 2am - am^3$
eqn of line $y = m_7x - 2am - am^3$
eqn of line $y = m_8x - 2am - am^3$
eqn of line $y = m_9x - 2am - am^3$
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eqn of line $y = m_{99}x - 2am - am^3$
eqn of line $y = m_{100}x - 2am - am^3$

$$\text{ratio} = \frac{2\sqrt{6} \times 4}{5\sqrt{6}} = \frac{8}{5} = \frac{5\sqrt{6}}{4}$$

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51 Paragraph - I.

(B) For $P(X \geq Y)$

| | | | | | |
|--|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| T_1 | T_2 | T_1 | T_2 | T_1 | T_2 |
| W | L | W | L | D | D |
| W | L | D | L | W | L |
| $\frac{1}{2} \times \frac{1}{2}$ | $\frac{1}{2} \times \frac{1}{2}$ | $\frac{1}{2} \times \frac{1}{6}$ | $\frac{1}{2} \times \frac{1}{6}$ | $\frac{1}{6} \times \frac{1}{2}$ | $\frac{1}{6} \times \frac{1}{2}$ |
| $= \frac{1}{4}$ | $= \frac{1}{4}$ | $= \frac{1}{12}$ | $= \frac{1}{12}$ | $= \frac{1}{12}$ | $= \frac{1}{12}$ |
| $= \frac{1}{4} + \frac{1}{6} \rightarrow \frac{5}{12} \quad (B)$ | | | | | |

52

(C)

For $P(X = Y)$

| | | | | | |
|---|----------------------------------|----------------------------------|----------------------------------|----------------------------------|----------------------------------|
| T_1 | T_2 | T_1 | T_2 | T_1 | T_2 |
| W | L | L | W | D | D |
| L | W | W | L | D | D |
| $\frac{1}{2} \times \frac{1}{3}$ | $\frac{1}{2} \times \frac{1}{3}$ | $\frac{1}{2} \times \frac{1}{3}$ | $\frac{1}{2} \times \frac{1}{3}$ | $\frac{1}{8} \times \frac{1}{8}$ | $\frac{1}{8} \times \frac{1}{8}$ |
| $= \frac{1}{6}$ | $= \frac{1}{6}$ | $= \frac{1}{6}$ | $= \frac{1}{6}$ | $= \frac{1}{64}$ | $= \frac{1}{64}$ |
| $= \frac{1}{6} + \frac{1}{6} + \frac{1}{6} + \frac{1}{6} + \frac{1}{64} + \frac{1}{64} = \frac{13}{36} \quad (C)$ | | | | | |

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Q49. (B, C, D) Let $a, \lambda, \mu \in \mathbb{R}$. Consider

$$\begin{aligned} ax + 2y &= 1 \\ 3x - 2y &= \mu \end{aligned}$$

for infinite solⁿs $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

$$\frac{a}{3} = \frac{2}{-2} = \frac{1}{-\mu} \quad a = -3 \quad \lambda = -\mu$$

so $\lambda + \mu = 0 \quad a = -3$ for infinite solⁿs

for no solⁿ: $\frac{a}{3} = \frac{2}{-2} \neq \frac{1}{-\mu} \quad \lambda + \mu \neq 0 \quad a \neq -3$

for unique solⁿ $\frac{a_1}{a_2} \neq \frac{b_1}{b_2} \quad \frac{a}{3} \neq \frac{2}{-2} \quad a \neq -3$

49 BCD

Q44. (A, C, D) $x + iy = \frac{a - ibt}{a^2 + b^2 t^2}$

(c) option $b=0 \quad a \neq 0$ $y=0$ x axis

$$x + iy = \frac{a}{a^2} = \frac{1}{a} \quad x = \frac{1}{a}$$

(d) option $a=0$ $x + iy = \frac{-ibt}{b^2 t^2} = \frac{-i}{bt} \quad y = \frac{-1}{bt}$ y axis

$$x + iy = \frac{a}{a^2 + b^2 t^2} - \frac{ibt}{a^2 + b^2 t^2}$$

$$x = \frac{a}{a^2 + b^2 t^2} \quad (1) \quad y = \frac{-bt}{a^2 + b^2 t^2} \quad (2) \quad (1) \div (2) \quad t = \frac{-ay}{bx}$$

Put in (1)

$$x = \frac{a}{a^2 + b^2 \left(\frac{-ay}{bx} \right)^2}$$

$$x = \frac{a}{a^2 + \frac{a^2 y^2}{x^2}} \quad x^2 + y^2 = \frac{x}{a} \quad C \left(\frac{1}{2a}, 0 \right)$$

$$x^2 + y^2 = \frac{x}{a}$$

$$x = \frac{1}{2a} \quad \text{for } a > 0 \quad |a| = a$$

$$r = \sqrt{\frac{1}{4a^2}} = \frac{1}{2|a|}$$

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40
(c) $\frac{x-3}{1} = \frac{y-1}{-2} = \frac{z-7}{1} = k$

$$x = k + 3$$

$$y = -k + 1$$

$$z = k + 7$$

it will satisfy plane

$$(k+3) - (-k+1) + k+7 = 3$$

$$3k = -6 \Rightarrow k = -2$$

$$x = 1, y = 3, z = 5$$

So $P(-1, 5, 3)$

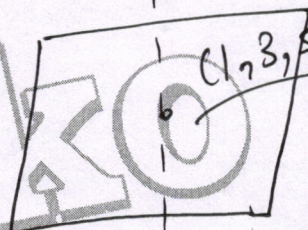
P will lie on plane & also $\frac{x}{1} = \frac{y}{-2} = \frac{z}{1}$ is in plane so dot product of d's should be 0.
checking option c.

$$-1 - 4(5) + 7(3) = 0$$

$$-1 - 4(2) + 7(1) = 0$$

Hence (c) is correct.

$$A(3, 1, 7)$$



$$x - y + 2z = 3$$

$$\hookrightarrow \hookrightarrow \frac{x-3}{1} = \frac{y-1}{-2} = \frac{z-7}{1}$$

$$P(x, y, z)$$

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Q.39 Let $b_i > 1$ for $i = 1, 2, \dots, 101$. Then,

(B) $\log_e b_1, \log_e b_2, \dots, \log_e b_{101} \rightarrow A.P.$
 $\Rightarrow b_1, b_2, b_3, \dots, b_{101} \rightarrow G.P.$ $\mu = 2$ $C.D = \log_e 2$

so $b_{51} = 2^{50} b_1$

$a_1, a_2, \dots, a_{101} \rightarrow A.P.$

$a_1 = b_1$ & $a_{51} = b_{51}$

now $a_{101} = a_1 + 100d$ $d = \frac{2^{50} - 1}{50} b_1$
 $= b_1 + 100 \left(\frac{2^{50} - 1}{50} \right) b_1$

$= b_1 [2^{51} - 1]$ but $b_{101} = 2^{100} b_1$

now $t = b_1 + b_2 + \dots + b_{50}$

$= \frac{b_1 (2^{50} - 1)}{2 - 1} = (2^{50} - 1) b_1$

$S = \frac{51}{2} [a_1 + a_{51}] = \frac{51}{2} [b_1 + b_1 (2^{51} - 1)]$

so $S > t$ $= \frac{51}{2} (2^{51}) b_1$

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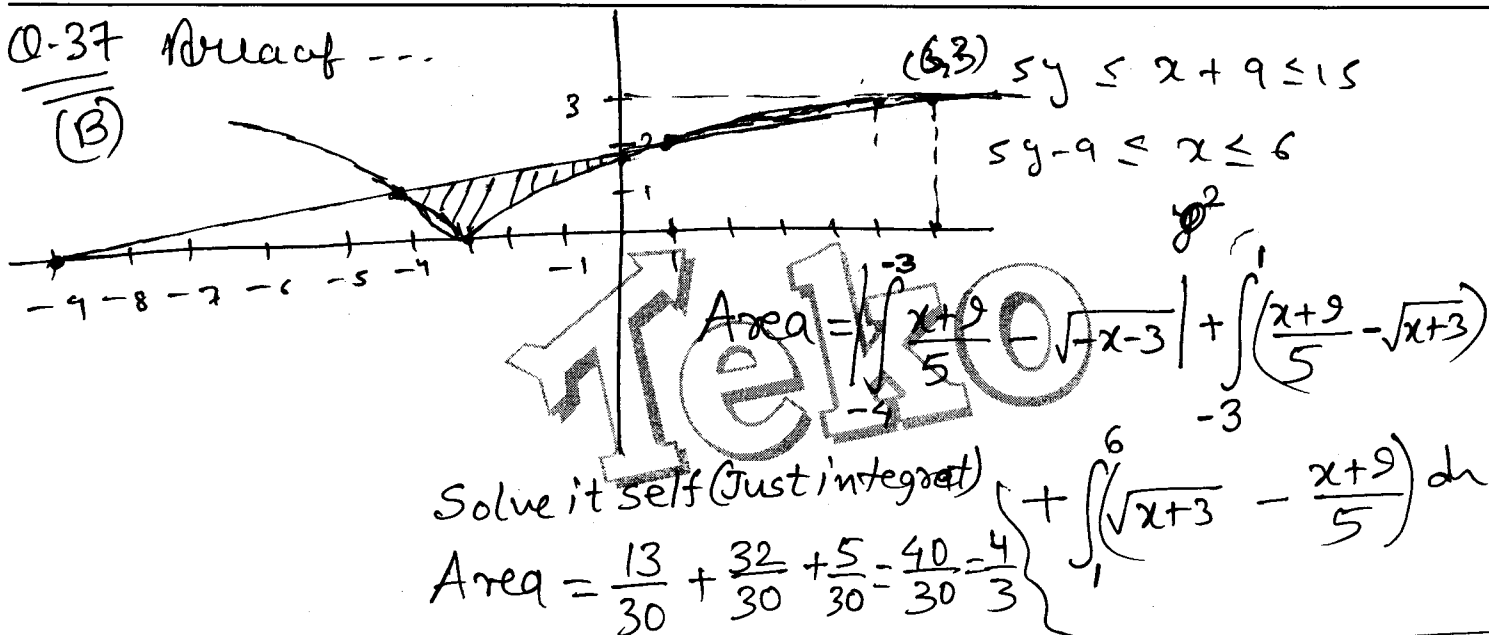
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Q-37 Area of ---

(B)



the value of ---

Q38. Using $\sin(A-B) = \sin A \sin B (\cot B - \cot A)$

$\frac{1}{\sin A \sin B} = \frac{\cot B - \cot A}{\sin(A-B)}$

$A = \frac{\pi}{4} + \frac{k\pi}{6}$ $B = \frac{\pi}{4} + \frac{(k-1)\pi}{6}$

$A-B = \frac{\pi}{6}$

(C)

$k=1$ $-2 \left[\cot\left(\frac{\pi}{4} + \frac{\pi}{6}\right) - \cot\frac{\pi}{4} \right]$

$k=2$ $-2 \left[\cot\left(\frac{\pi}{4} + \frac{2\pi}{6}\right) - \cot\left(\frac{\pi}{4} + \frac{\pi}{6}\right) \right]$

$k=3$ $-2 \left[\cot\left(\frac{\pi}{4} + \frac{3\pi}{6}\right) - \cot\left(\frac{\pi}{4} + \frac{2\pi}{6}\right) \right]$

$= -2 \left[\cot\left(\frac{\pi}{4} + \frac{13\pi}{6}\right) - \cot\frac{\pi}{4} \right]$

$= -2 \left[\cot\left(\frac{\pi}{4} + \frac{\pi}{6}\right) - 1 \right]$

$= -2 \left[\cot 75^\circ - 1 \right] = -2 \left[2 - \sqrt{3} - 1 \right]$

$= -2 \left[\sqrt{3} - 1 \right] (C)$

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Q.47. let $a, b \in \mathbb{R}$ $f: \mathbb{R} \rightarrow \mathbb{R}$ be defined by $f(x) = a \cos \dots$

Sol. for A $f(x) = |x| \sin(|x^3 + x|)$ at $x=0$
 $LHD = RHD = 0$
ABD

for B $f(x) = \cos(|x^3 - x|)$ at $x=1$
 $LHD = RHD = 0$

for C $f(x) = \cos(x^3 - x)$ at $x=0$
 $LHD = RHD = 0$
 is diff.ble.

for D $f(x) = \cos|x^3 - x| + |x| \sin|x^3 + x|$
 $LHD \neq RHD$

Q.48. let $\hat{u} = u_1 \hat{i} + u_2 \hat{j} + u_3 \hat{k}$ be a unit vector, ---

Sol. A is wrong

BC B is correct because

C is correct

$$\hat{u} \times \vec{v} = \hat{w}$$

So \hat{u} & \hat{w} are + dot-product zero

$$u_1 \cdot 1 + u_2 \cdot 1 = 0$$

$$u_1 = -u_2$$

$$|u_1| = |u_2|$$

D is wrong

$$u_1 \cdot 1 + 2 \cdot u_3 = 0$$

$$u_1 = -2u_3$$

$$|u_1| = 2|u_3|$$

$$\hat{w} \cdot (\hat{u} \times \vec{v}) = 1$$

$$|\hat{w}| \cdot |\hat{u} \times \vec{v}| \cos \theta = 1$$

$$1 \times 1 \times \cos \theta = 1$$

$$\theta = 0$$

So \hat{w} & $(\hat{u} \times \vec{v})$ are parallel

$$\text{So } \hat{w} = \hat{u} \times \vec{v}$$

Same vector

\vec{v} अपनी length and \hat{u} के $\frac{\pi}{2}$ angle पर रख कर कैं Position gain कर सकते हैं

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Q.45

(A, D)

$$\lim_{x \rightarrow 2} \frac{f(x) \cdot g(x)}{f'(x) \cdot g'(x)} = 1$$

0/0 case

using L. Hospital

$$\lim_{x \rightarrow 2} \frac{f(x) \cdot g(x)}{f'(x) \cdot g'(x)} = \lim_{x \rightarrow 2} \frac{f'(x) \cdot g(x) + f(x) \cdot g'(x)}{f''(x) \cdot g'(x) + f'(x) \cdot g''(x)} = 1$$

$$= \lim_{x \rightarrow 2} \frac{f(x) \cdot g'(x)}{f'(x) \cdot g''(x)} = \lim_{x \rightarrow 2} \frac{f(x)}{f'(x)} = 1$$

Since $f(x) = +ve$

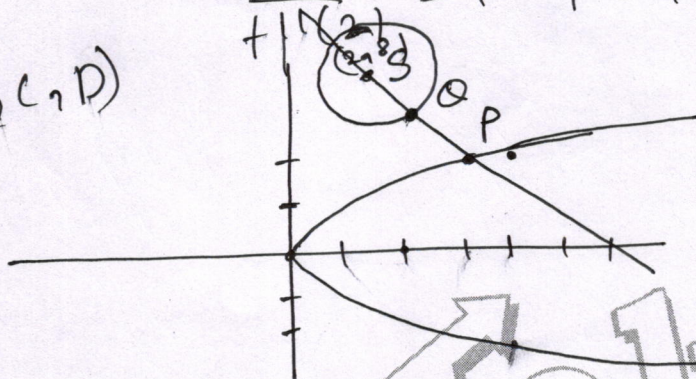
so $f''(2) = +ve$ Hence

it has minimum at $x=2$. (A)

$$2 \quad f(2) = 1 \quad f(2) - f'(2) = 0 \quad (D)$$

Q.46

(A, C, D)



→ Shortest distance is along common normal.

normal of Parabola

so normal

$$y = mx - mx^3 - 2m.$$

it passes (2, 8)

which gives $m = -2$

$$y = -2x + 12$$

$$\frac{SQ}{SP} = \frac{2}{2\sqrt{5}-2} = \frac{\sqrt{5}+1}{4}$$

$$\rightarrow SP = \frac{P(4, 4)}{\sqrt{(4-2)^2 + (8-4)^2}} = 2\sqrt{5}$$

→ x intercept

$$y = 0 \rightarrow x = \underline{\underline{6}}$$

slope of circle at Q.

$$\rightarrow x^2 + y^2 - 4x - 16y + 64 = 0$$

$$\text{diff } 2x + 2y \cdot y' - 4 - 16y' + 0 = 0$$

$$y' = \frac{2-x}{y-8}$$

$$2-x = \frac{-4}{2\sqrt{5}} \quad [y' = \frac{1}{2}]$$

$$y-8 = -\frac{2\sqrt{5}}{1}$$

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Q.41. let $P = \begin{bmatrix} 1 & 0 & 0 \\ 4 & 1 & 0 \\ 16 & 4 & 1 \end{bmatrix}$ and $I = \dots$
(B)

Sol. $P^2 = \begin{bmatrix} 1 & 0 & 0 \\ 8 & 1 & 0 \\ 16 \times 3 & 8 & 1 \end{bmatrix}$; $P^3 = \begin{bmatrix} 1 & 0 & 0 \\ 12 & 1 & 0 \\ 16 \times 6 & 12 & 1 \end{bmatrix}$
 4×2 $(1+2)$ 4×3 $(1+2+3)$

$$P^{50} = \begin{bmatrix} 1 & 0 & 0 \\ 4 \times 50 & 1 & 0 \\ 16(1+2+\dots+50) & 4 \times 50 & 1 \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 200 & 1 & 0 \\ 20400 & 200 & 1 \end{bmatrix}$$

Given $P^{50} - Q = I \rightarrow Q = \begin{bmatrix} 0 & 0 & 0 \\ 200 & 0 & 0 \\ 20400 & 200 & 0 \end{bmatrix}$
finding

$$\frac{q_{31} + q_{32}}{q_{21}} = \frac{20400 + 200}{200} = 103 \text{ (B)}$$

50) Let $f: [-\frac{1}{2}, 2] \rightarrow \mathbb{R}$. \dots $\forall x \in \mathbb{R}$ Then.

(B, 0) $f(x) = [x^2 - 3]$

Since f is continuous at integers

$$3 - \dots \leq x^2 - 3 \leq 1$$

may be

so $-3, -1, 0, 1$ are points of discontinuity But cent at $x=0$

& $g(x) = |x| + |x| + |4x-7| + |x|$

$$= f(x) [|x| + |4x-7|]$$

discontinuous

$1, \sqrt{2}, \sqrt{3}, 2$

end points are not consider in discontinuity.

$0, \frac{7}{4}$

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Q.43.

(BC)

$$\text{Let } f(x) = \lim_{n \rightarrow \infty} \left(\frac{n^n (x+n)(x+\frac{n}{2}) \cdots (x+\frac{n}{n})}{\ln(x^2+n^2)(x^2+\frac{n^2}{4}) \cdots (x^2+\frac{n^2}{n^2})} \right)^{\frac{x}{n}}$$

Sol.

$$f(x) = \lim_{n \rightarrow \infty} \left\{ \frac{n^n \cdot n^n \left(\frac{x}{n} + 1\right) \left(\frac{x}{n} + \frac{1}{2}\right) \cdots \left(\frac{x}{n} + \frac{1}{n}\right)}{\ln(n^n)^2 \left(\frac{x^2}{n^2} + 1\right) \left(\frac{x^2}{n^2} + \frac{1}{2^2}\right) \cdots \left(\frac{x^2}{n^2} + \frac{1}{n^2}\right)} \right\}^{\frac{x}{n}}$$

$$\ln f(x) = \lim_{n \rightarrow \infty} \frac{x}{n} \left\{ \sum_{r=1}^n \ln\left(\frac{x}{n} + \frac{1}{r}\right) - \sum_{r=1}^n \ln\left(\frac{x^2}{n^2} + \frac{1}{r^2}\right) \right\}$$

taking $\frac{1}{r}$ common out from both & cancelled out

$$\ln f(x) = \lim_{n \rightarrow \infty} \frac{x}{n} \left\{ \sum_{r=1}^n \ln\left(1 + \frac{rx}{n}\right) - \sum_{r=1}^n \ln\left(1 + \frac{r^2 x^2}{n^2}\right) \right\}$$

lim convert to integral

$$\ln f(x) = x \int_0^1 \ln(1+xy) dy - x \int_0^1 \ln(1+x^2 y^2) dy$$

let $xy = t$

$$\ln f(x) = x \int_0^x \ln(1+t) dt - x \int_0^x \ln(1+t^2) dt$$

$$\frac{f'(x)}{f(x)} = \ln\left(\frac{1+x}{1+x^2}\right) \rightarrow \begin{aligned} \frac{f'(2)}{f(2)} &= \ln\left(\frac{3}{5}\right) < 0; f'(2) < 0 \\ \frac{f'(3)}{f(3)} &= \ln\left(\frac{4}{10}\right) < 0 \end{aligned} \quad \text{(B) } \checkmark$$

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Part one 43 from page 11 ; $f(x) = +ve$

$$\frac{f'(x)}{f(x)} > 0 \text{ in } 0 < x < 1 \text{ \& \> } \frac{f'(x)}{f(x)} < 0 \text{ in } 1 < x$$

$$f(x) \uparrow \text{ \& \> } f(x) \downarrow$$

$$f(1) \geq f\left(\frac{1}{2}\right) \text{ \& \> } f\left(\frac{1}{3}\right) \leq f\left(\frac{2}{3}\right).$$

$$\text{becoz } 1 \geq \frac{1}{2}$$

$$\text{becoz } \frac{1}{3} < \frac{2}{3}$$

↑ sign change
fun.

↓ func²
Sign chage etc etc