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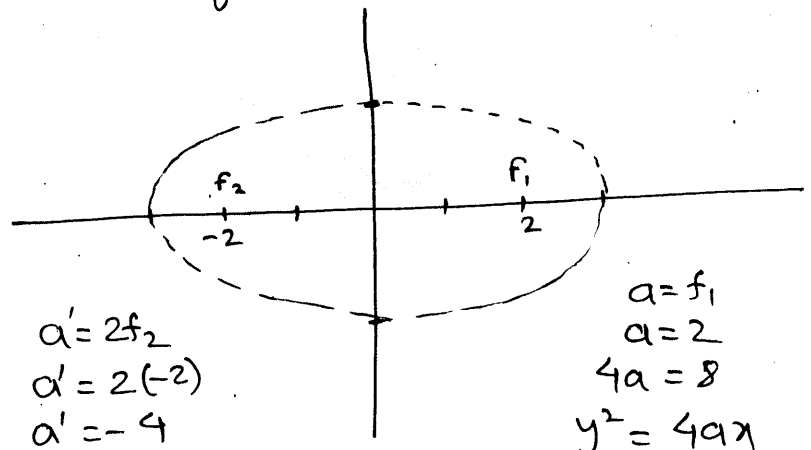
Solution of JEE Advanced 2015 Paper 2, of Maths By Suhag Kariya, Page 1 of 13

Total Que 60, Each Subj. 20 Code 2 Total Marks 240; Each Subj. 80.

IITJEE Advance Paper 2 Solution of Maths By Suhag Sir and also his students Anurag Gupta, Lucky Dubey & Manas Deep Vishwakarma, Akshay Swarnakar
 Single correct type Q. 41 to Q. 48

Q.41. Suppose that the foci of the ellipse -----

Sol.
Ans 4



finding

$$\frac{1}{m_1^2} + m_2^2$$

$$2^2 + 2$$

Ans: 4

$$\begin{aligned} a' &= 2f_2 \\ a' &= 2(-2) \\ a' &= -4 \\ y^2 &= -4 \cdot 4 \cdot x \\ y^2 &= -16x \\ y &= mx + \frac{a'}{m} \\ y &= mx - \frac{4}{m} \\ (2, 0) \\ 0 &= 2m - \frac{4}{m} \\ \frac{4}{m} &= 2m \\ 2 &= m^2 \end{aligned}$$

$$\begin{aligned} a &= f_1 \\ a &= 2 \\ 4a &= 8 \\ y^2 &= 4ax \\ y^2 &= 8x \\ y &= mx + \frac{a}{m} \\ y &= mx + \frac{2}{m} \\ (-4, 0) \\ 0 &= m(-4) + \frac{2}{m} \\ 4m &= \frac{2}{m} \\ m^2 &= \frac{1}{2} \end{aligned}$$

Q.42. let m and n be two positive -----

② $\lim_{x \rightarrow 0} \left(\frac{e^{\cos x^n} - e}{x^m} \right) = -\frac{e}{2}$

S. By L'Hospital

$$\begin{aligned} \frac{e^{\cos x^n} (-\sin x^n) \cdot n x^{n-1}}{m x^{m-1}} &\Rightarrow -\frac{e n}{m} \frac{x^{2n-1}}{x^{m-1}} = -\frac{e}{2} \\ \Rightarrow 2n &= m \Rightarrow \boxed{\frac{m}{n} = 2} \\ &\text{A} \end{aligned}$$

P.T.O

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43.
$$9 \int \alpha = \int_0^1 (e^{9x+3\tan^{-1}x}) \left(\frac{12+9x^2}{1+x^2} \right) dx$$

(9)
$$9x + 3\tan^{-1}x = t$$

$$dx \left(9 + \frac{3}{1+x^2} \right) = dt \Rightarrow dt = \left(\frac{12+9x^2}{1+x^2} \right) dx$$

$$\Rightarrow \int_0^1 e^t dt = e^{(9x+3\tan^{-1}x)} \Rightarrow e^{9+3\pi/4} - 1$$

$$\left(\log_e \left(e^{9+3\pi/4} - 1 \right) - \frac{3\pi}{4} \right)$$

$$\Rightarrow \log_e e^{9+3\pi/4} - \frac{3\pi}{4}$$

$$\Rightarrow 9$$

Q. 44. Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be a continuous, odd func. -----

~~Soln:~~
$$\lim_{x \rightarrow 1} \frac{f(x)}{g(x)} = \frac{1}{14}$$

(7)

By L Hospital

$$\lim_{x \rightarrow 1} \frac{f(x)}{x|f(f(x))|} = \frac{1}{14}$$

$$\frac{f(1)}{1|f(f(1))|} = \frac{1}{14}$$

$$\left| f\left(\frac{1}{2}\right) \right| = \frac{1}{7}$$

$$\frac{1}{2|f(\frac{1}{2})|} = \frac{1}{14}$$

P.T.O

⊖ odd fn. $f\left(\frac{1}{2}\right) = 7$

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Q.45. Suppose that $\vec{p}, \vec{q}, \vec{r}$ are three non coplanar vectors.

Sol. ^{Suhag} Short Trick let $\vec{p} = \hat{i}, \vec{q} = \hat{j}, \vec{r} = \hat{k}$

Ans 9 $\vec{s} = 4\hat{i} + 3\hat{j} + 5\hat{k}$

also $\vec{s} = x(-i+j+k) + y(i-j+k) + z(-i-j+k)$

$$\vec{s} = i(-x+y-z) + j(x-y-z) + k(x+y+z)$$

$$\left. \begin{array}{l} -x+y-z=4 \\ x-y-z=3 \\ x+y+z=5 \end{array} \right\} \begin{array}{l} \xrightarrow{\text{add}} z = -\frac{7}{2} \\ \xrightarrow{\text{add}} x = \frac{8}{2} \\ \text{add } 1+3 \rightarrow y = \frac{9}{2} \end{array}$$

$$\text{Ans } 2x+y+z = \frac{16}{2} + \left(-\frac{7}{2}\right) + \frac{9}{2} = \frac{16-7+9}{2} = 9$$

Q.46. For any integer k , let $a_k = \cos\left(\frac{k\pi}{7}\right) + i \sin\left(\frac{k\pi}{7}\right)$

Sol. $a_k = e^{k\pi/7}, a_{k+1} = e^{(k+1)\pi/7}, a_{4k-1} = e^{(4k-1)\pi/7}, a_{4k-2} = e^{(4k-2)\pi/7}$

④ finding $\frac{\sum_{k=1}^{12} (a_{k+1} - a_k)}{\sum_{k=1}^3 |a_{4k-1} - a_{4k-2}|} = \frac{\sum_{k=1}^{12} |e^{(k+1)\pi/7} - e^{k\pi/7}|}{\sum_{k=1}^3 |e^{(4k-1)\pi/7} - e^{(4k-2)\pi/7}|}$

$$= \frac{\sum_{k=1}^{12} 2 \sin \frac{76}{14}}{\sum_{k=1}^3 2 \sin \frac{76}{14}}$$

$$= \frac{12}{3} = 4$$

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Q.47. Suppose that all the terms of an arithmetic prog...

Solⁿ :
$$\frac{S_{07}}{S_{11}} = \frac{\frac{7}{2} [2a+6d]}{\frac{11}{2} [2a+10d]} = \frac{6}{11} \Rightarrow \frac{7[a+3d]}{[a+5d]} = \frac{6}{11} \Rightarrow 7a+21d = 6a+30d$$

$$\Rightarrow \boxed{a=9d}$$

$140 > a_7 > 130 \Rightarrow 140 > a+6d > 130 \Rightarrow 140 > 15d > 130$

$8.66 > d > 9.33$ } Now it is given that A.P. is of only natural nos. $\therefore d$ should be only an integer.

\therefore Integer b/w 8.66 and 9.33 is 9.

\therefore The common difference of AP is $\boxed{9}$

Q.48. The coeff. of x^9 in the ---

Solⁿ $(1+x)(1+x^2)(1+x^3) \dots (1+x^{100})$

(8) Here we will get the coeff. of x^9 by following ways
 $1 \cdot x^9 + x \cdot x^8 + x^2 \cdot x^7 + x^3 \cdot x^6 + x^4 \cdot x^5 + x^1 \cdot x^2 \cdot x^6$
 $+ x^1 \cdot x^3 \cdot x^5 + x^2 \cdot x^3 \cdot x^5$

Thus the total cases will be 8
 and answer is

(8)

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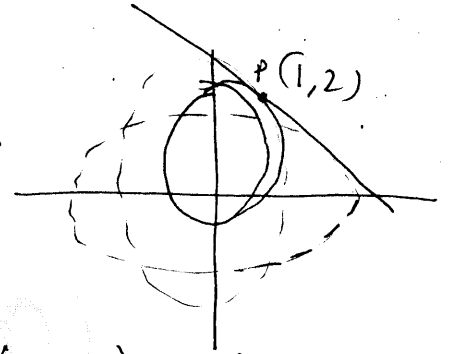
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Q.49 Let E_1 and E_2 be two ellipse whose centres...

Sol. S: $x^2 + (y-1)^2 = 2$

Given. distance b/w two pt. from P is

$\frac{2\sqrt{2}}{3}$



By Polar coordinate line

By $(x_1 + r \cos \theta, y_1 + r \sin \theta)$
 $r = \pm \frac{2\sqrt{2}}{3}, \theta = 135^\circ$

$(1 + \frac{2\sqrt{2}}{3} \times \frac{1}{\sqrt{2}}, 2 - \frac{2\sqrt{2}}{3} \times \frac{1}{\sqrt{2}}) = (\frac{5}{3}, \frac{4}{3})$

$(1 - \frac{2\sqrt{2}}{3} \times \frac{1}{\sqrt{2}}, 2 + \frac{2\sqrt{2}}{3} \times \frac{1}{\sqrt{2}}) = (\frac{1}{3}, \frac{8}{3})$

Let the ellipse by $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

Tangent is $\frac{xx_1}{a^2} + \frac{yy_1}{b^2} = 1 \Rightarrow$ Putting $(\frac{5}{3}, \frac{4}{3})$

$\frac{5x}{3a^2} + \frac{4y}{3b^2} = 1$ & $x+y=3$ [same]

||| by

$a_1 = \sqrt{5}, b_1 = 2$

5. $\frac{1}{3} \frac{x^2}{a^2} + \frac{8}{3} \frac{y^2}{b^2} = 1$ & $x+y=3$ [same]

$a^2 = 1, b^2 = 8$

$a_2 = 1, b_2 = 2\sqrt{2}$

$e_1^2 = 1 - \frac{4}{5}, e_2^2 = 1 - (\frac{1}{2\sqrt{2}})^2$

$e_1 = \frac{1}{\sqrt{5}}, e_2 = \frac{\sqrt{7}}{2\sqrt{2}}$

(A) $e_1^2 + e_2^2 = \frac{1}{5} + \frac{7}{8} = \frac{43}{40}$

(B) $e_1 e_2 = \frac{\sqrt{7}}{2\sqrt{2}} \times \frac{1}{\sqrt{5}} = \frac{\sqrt{7}}{2\sqrt{10}}$ P.T.O

(C) $k_1^2 - e_2^2 = |\frac{1}{5} - \frac{7}{8}| = \frac{27}{40} \times$

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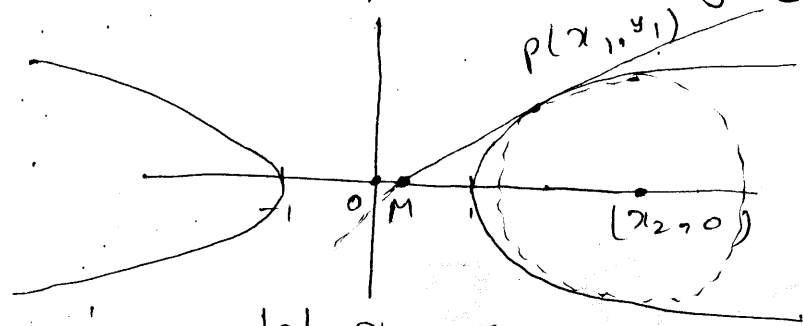
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Q.50. Consider the hyperbola $H: x^2 - y^2 = 1$ and a Circle S

A, B, D



Let $x_1 = \sec \theta$

$y_1 = \tan \theta$

eqn of Tangent

$x \sec \theta - y \tan \theta = 1$

at x axis $y = 0$

$x = \frac{1}{\sec \theta} = \frac{1}{x_1}$

So $M(x_1, \frac{1}{x_1}, 0)$

& $N(x_2, 0)$

$$l = \frac{x_1 + \frac{1}{x_1} + x_2}{3}$$

diff. $\frac{dl}{dx_1}$ new eqn of circle

$(x - x_2)^2 + y^2 = r^2$

$x - x_2 + y dy/dx = 0$

slope of Tangent $(x_1, y_1) = \frac{x_2 - x_1}{y_1} = \frac{x_1}{y_1}$

$x_2 = 2x_1$

$$l = \frac{x_1 + \frac{1}{x_1} + 2x_1}{3}$$

$$l = \frac{3x_1 + \frac{1}{x_1}}{3}$$

$$l = x_1 + \frac{1}{3x_1}$$

$$\frac{dl}{dx_1} = 1 - \frac{1}{3x_1^2}$$

$$M = \frac{y_1}{3} = \frac{1}{3} \sqrt{x^2 - 1}$$

$$\frac{dM}{dx_1} = \frac{1}{3\sqrt{x^2 - 1}}, \quad \frac{dM}{dy_1} = \frac{1}{3}$$

(A)
 P.T.O.

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Q.51. The Option(s) with the values of a and L ----

Q.51
$$\int_0^{4\pi} e^t (\sin^6 at + \cos^7 at) dt$$

(A) & (C)

$$= \int_0^{\pi} (\sin^6 at + \cos^7 at) dt + \int_{\pi}^{2\pi} \dots dt + \int_{2\pi}^{3\pi} \dots dt + \int_{3\pi}^{4\pi} \dots dt$$

$$= \int_0^{\pi} e^t (\sin^6 at + \cos^7 at) dt + \int_{\pi}^{2\pi} e^{t+\pi} (\dots) dt + \int_{2\pi}^{3\pi} e^{t+2\pi} (\dots) dt + \int_{3\pi}^{4\pi} e^{t+3\pi} (\dots) dt$$

$$= (1 + e^{\pi} + e^{2\pi} + e^{3\pi}) \int_0^{\pi} e^t (\sin^6 at + \cos^7 at) dt$$

now
$$L = \frac{(1 + e^{\pi} + e^{2\pi} + e^{3\pi}) \int_0^{\pi} e^t (\sin^6 at + \cos^7 at) dt}{\int_0^{\pi} e^t (\sin^6 at + \cos^7 at) dt}$$

$$= 1 + e^{\pi} + e^{2\pi} + e^{3\pi}$$

$$= \frac{e^{4\pi} - 1}{e^{\pi} - 1}$$

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Q.52 Let $f, g: [-1, 2] \rightarrow \mathbb{R}$ be continuous function which...

(B) and (C)

$$h(x) = f(x) - 3g(x)$$

$$h(-1) = f(-1) - 3g(-1) = 3 - 0 = 3$$

$$h(0) = f(0) - 3g(0) = 3$$

$$h(2) = f(2) - 3g(2) = 3$$

$$h(-1) = h(0) = h(2) = 3$$

hence $h'(x) = 0$ for at least one value of $x \in (-1, 0)$

$h'(x) = 0$ for at least one value of $x \in (0, 2)$

Let t_1, t_2 be the points where $h'(x) = 0$
hence $h''(x)$ will be zero for at least one value of $x \in (t_1, t_2)$

So correct options are (B, C)

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Q53 Let $f(x) = 7 \tan^8 x + 7 \tan^6 x - 3 \tan^4 x - 3 \tan^2 x$
 $f(x) = 7 \tan^6 x [\sec^2 x] - 3 \tan^2 x \sec^2 x$
 $= (7 \tan^6 x - 3 \tan^2 x) \sec^2 x$

now $\int_0^{\pi/4} f(x) dx = \int_0^{\pi/4} (7 \tan^6 x - 3 \tan^2 x) \sec^2 x dx$
 Let $\tan x = t$
 $\sec^2 x dx = dt$

$= \int_0^1 (7t^6 - 3t^2) dt$
 $= \left(\frac{7}{7} t^7 - \frac{3}{3} t^3 \right)_0^1 = 0$ option B is correct

now $\int_0^{\pi/4} x f(x) dx = x \int_0^{\pi/4} f(x) dx - \int_0^{\pi/4} 1 \cdot \int_0^{\pi/4} f(x) dx$
 $= 0 - \int_0^{\pi/4} \int_0^{\pi/4} (7 \tan^6 x - 3 \tan^2 x) \sec^2 x dx$
 $= - \int_0^{\pi/4} (\tan^7 x - \tan^3 x) dx$
 $= - \int_0^{\pi/4} \tan^3 x [\tan^2 x - 1] [\tan^2 x + 1] dx$
 $= - \int_0^{\pi/4} \tan^3 x [\tan^2 x - 1] \sec^2 x dx$
 Let $\tan x = t$
 $\sec^2 x dx = dt$
 $= - \int_0^1 t^3 (t^2 - 1) dt$
 $= - \int_0^1 (t^5 - t^3) dt$
 $= - \left(\frac{t^6}{6} - \frac{t^4}{4} \right)_0^1$
 $= \frac{1}{12}$ (A is correct) P.T.O

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Q.54. let $f'(x) = \frac{192x^3}{2 + \sin^4 \pi x}$ for all $x \in \mathbb{R}$, ----

$0 = f(\frac{1}{2})$

Sol.

$f(x) = \int_x^{\frac{1}{2}} f'(t) dt$ → because add both side
 $f(x) = \int_{1/2}^x f'(t) dt$ ← f(x)

(D)

now $0 \leq \sin^4 \pi x \leq 1$
 $\Rightarrow \int_1^x 64x^3 dx \leq \int_{1/2}^x f'(t) dt \leq \int_{1/2}^x 96x^3 dx$

$\Rightarrow (16x^4)_{1/2}^x \leq f(x) \leq (24x^4)_{1/2}^x$

$\Rightarrow 16x^4 - 1 \leq f(x) \leq 24x^4 - \frac{3}{2}$

$\int_1^2 (16x^4 - 1) dx \leq \int_{1/2}^2 f(x) dx \leq \int_{1/2}^2 (24x^4 - \frac{3}{2}) dx$

$2.6 \leq \int_{1/2}^2 f(x) dx \leq 3.9$

only D is true

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Q.55 Let S be the set of all non-zero x such that $x^2 - x + 2 = 0$

A, D
Ans.

$$D > 0$$

$$1 - 4a^2 > 0$$

$$4a^2 < 1$$

now $a \in (-\frac{1}{2}, \frac{1}{2}) - \{0\}$

$$|x_1 - x_2| < 1$$

$$(x_1 - x_2)^2 < 1$$

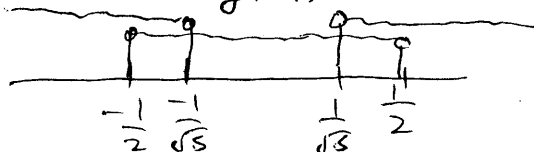
$$(x_1 + x_2)^2 - 4x_1x_2 < 1$$

$$\frac{1}{a^2} - 4 < 1$$

$$a^2 > \frac{1}{5}$$

$$a \in (-\infty, -\frac{1}{\sqrt{5}}) \cup (\frac{1}{\sqrt{5}}, \infty)$$

so common region.



$$so \ a \in (-\frac{1}{2}, -\frac{1}{\sqrt{5}}) \cup (\frac{1}{\sqrt{5}}, \frac{1}{2})$$

Q.56. If $\alpha = 3\sin^{-1}(\frac{6}{11})$ & $\beta = 3\cos^{-1}(\frac{4}{9})$ ---

Ans
BCD

$$\frac{6}{11} > \frac{1}{2}$$

$$\sin^{-1} \frac{6}{11} > \sin^{-1} \frac{1}{2}$$

$$3\sin^{-1} \frac{6}{11} > 3 \cdot (30^\circ)$$

$$3\sin^{-1} \frac{6}{11} > 90^\circ$$

$$\alpha > 90^\circ$$

$$\cos \alpha = -ve \quad \text{D} \checkmark$$

$$\frac{4}{9} < \frac{1}{2}$$

$$\cos^{-1} \frac{4}{9} > \cos^{-1} \frac{1}{2}$$

$$\cos^{-1} \frac{4}{9} > 60^\circ$$

$$3\cos^{-1} \frac{4}{9} > 3 \times 60^\circ$$

$$\beta > 180^\circ$$

$$\cos \beta = -ve \quad \text{A} \times$$

$$\sin \beta = -ve \quad \text{B} \checkmark$$

$$\alpha + \beta > 270^\circ$$

$$\cos(\alpha + \beta) = +ve \quad \text{C} \checkmark$$

PT:0.

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Paragraph-2 (cont)

Let $f: \mathbb{R} \rightarrow \mathbb{R}$ be a twice differentiable

Q-57 The correct statement(s) is (are)

A B C

$$f(x) = x f(x)$$

$$f'(x) = f(x) + x f'(x)$$

$$\text{for } x=1$$

$$f'(1) = f(1) + 1 f'(1)$$

$$f'(1) = 0 + 1 f'(1)$$

$$\text{Given } f'(x) < 0 \text{ for } x \in (\frac{1}{2}, 3)$$

$$\text{So } f'(1) < 0 \text{ A is correct}$$

$$f(x) = x f(x)$$

$$f(2) = 2 f(2)$$

Now $f(1) = 0$ & function is decreasing

$$\text{So } f(2) < 0$$

$f(2) < 0$ B is correct.

$$f'(x) = f(x) + x f'(x)$$

$$\text{Now } f'(x) < 0 \text{ for } x \in (1, 3) \&$$

$$f'(x) < 0$$

$$\text{So } f'(x) < 0 \text{ for } x \in (1, 3)$$

$$\text{So } f'(x) \neq 0 \text{ for } x \in (1, 3)$$

So C is correct

$$f(x) = x f(x)$$

$$f'(x) = f(x) + x f'(x) \Rightarrow x^2 f'(x) - x^2 f(x)$$

$$\int_1^3 x^3 f''(x) dx = 40 \quad [x^3 f'(x)]_1^3 - 3 \int_1^3 x^2 f'(x) dx = 40$$

$$27 f'(3) - f'(1) - 3(-12) = 40$$

$$27 f'(3) - f'(1) = 4$$

$$9 f(3) - 9 f(3) - [f(1) - f(1)] = 4$$

$$9 f(3) - f(1) + 32 = 0$$

$$f(x) = f(x) + x f'(x)$$

$$x f'(x) = x f(x) + x^2 f''(x)$$

$$3 \int_1^3 f'(x) dx = \int_1^3 x f'(x) dx - \int_1^3 x^2 f''(x) dx$$

$$\int_1^3 f(x) dx = \int_1^3 x f'(x) dx - \int_1^3 x^2 f''(x) dx = (x f(x))_1^3 - \int_1^3 f(x) dx + 12$$

P.T. 0

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Q. 59 (A) & (B) Let n_1, n_2 be the number of red balls in box I & II respectively. ^{code} Paragraph-2. (two)
 Total probability of selecting a red ball from one of the two boxes

$$= \frac{1}{2} \left(\frac{n_1}{n_1+n_2} \right) + \frac{1}{2} \left(\frac{n_3}{n_3+n_4} \right)$$

 Probability of selecting a red ball from II

$$= \frac{1}{2} \left(\frac{n_3}{n_3+n_4} \right)$$

For conditional probability

$$= \frac{\frac{1}{2} \left(\frac{n_3}{n_3+n_4} \right)}{\frac{1}{2} \left(\frac{n_1}{n_1+n_2} \right) + \frac{1}{2} \left(\frac{n_3}{n_3+n_4} \right)}$$

putting n_1, n_2, n_3, n_4 from options

A & B are correct.

Q. 60 (C) & (D) A ball is drawn from option A.

$$n_1 = 4, n_2 = 6$$

~~The red ball is transferred from~~

$$P(R) = \frac{4}{4+6} = \frac{4}{10} = \frac{2}{5} \times \text{from (C)} \frac{10}{30} = \frac{1}{3}$$

only (C) & (D) satisfy. none of the other options satisfy this

P.T.O