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CLASS XII-COMMON PRE-BOARD EXAMINATION

Answer key (Mathematics)

Section A

1. $x = 13$	1 mark
2. $x + y = 6$	1 mark
3. $degree = 3$	1 mark
4. $-\frac{\pi}{3}$	1 mark
5. 0	1 mark
6. 0	1 mark
7. 5	1 mark
8. $x + y + z = 13$	1 mark
9. 110	1 mark
10. 66	1 mark

Section B

11. Proving Reflexive	1 mark
Proving Symmetric	1 mark
Proving Transitive	1 ½ mark
Conclusion	½ mark

12.

$$\tan^{-1}\left(\frac{1}{3}\right) + \tan^{-1}\left(\frac{1}{5}\right) + \tan^{-1}\left(\frac{1}{7}\right) + \tan^{-1}\left(\frac{1}{8}\right)$$

$$\Rightarrow \tan^{-1}\frac{\frac{1}{3}+\frac{1}{5}}{1-\frac{1}{3}X\frac{1}{5}} + \tan^{-1}\frac{\frac{1}{7}+\frac{1}{8}}{1-\frac{1}{7}X\frac{1}{8}}$$ 1 mark

$$\Rightarrow \tan^{-1}\frac{4}{7} + \tan^{-1}\frac{3}{11}$$ 1 mark

$$\Rightarrow \tan^{-1}\frac{\frac{4}{7}+\frac{3}{11}}{1-\frac{4}{7}X\frac{3}{11}}$$ 1 mark

$$\Rightarrow \tan^{-1} 1$$

$$\Rightarrow \frac{\pi}{4}$$ 1 mark

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OR

$\tan^{-1}\left(\frac{x-1}{x-2}\right)+\tan^{-1}\left(\frac{x+1}{x+2}\right)=\left(\frac{\pi}{4}\right)$

$\Rightarrow \tan^{-1}\left(\frac{x-1}{x-2}\right)+\tan^{-1}\left(\frac{x+1}{x+2}\right)=\tan^{-1}1$

$\Rightarrow \tan^{-1}\left(\frac{x-1}{x-2}\right)=\tan^{-1}1-\tan^{-1}\left(\frac{x+1}{x+2}\right)$ 1 mark

By applying formula on the R.H.S.

$\Rightarrow \tan^{-1}\left(\frac{x-1}{x-2}\right)=\tan^{-1}\left(\frac{1}{2x+3}\right)$ 1 mark

Applying tan both sides and solving

$x=\pm\frac{1}{\sqrt{2}}$ 2 mark

13. $x^{13}y^{7}=(x+y)^{20}$

$\Rightarrow \log(x^{13}y^{7})=\log(x+y)^{20}$

$\Rightarrow 13logx+7\log y=20\log(x+y)$ 1 mark

Differentiating with respect to x

$\Rightarrow \frac{13y-7x}{x(x+y)}=\left(\frac{13y-7x}{y(x+y)}\right)\frac{dy}{dx}$ 2 mark

$\Rightarrow \frac{dy}{dx}=\frac{y}{x}$ 1 mark

OR

Let $x^{2}=cos2\theta \Rightarrow \cos^{-1}x^{2}=2\theta$ ½ mark

Let $y=\tan^{-1}\frac{\sqrt{1+x^2}-\sqrt{1-x^2}}{\sqrt{1+x^2}+\sqrt{1-x^2}}$

$\Rightarrow y=\tan^{-1}\frac{\sqrt{1+\cos 2\theta}-\sqrt{1-\cos 2\theta}}{\sqrt{1+\cos 2\theta}+\sqrt{1-\cos 2\theta}}$

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$\Rightarrow y = \tan^{-1}(\frac{1-tan\theta}{1+tan\theta}) \Rightarrow y = (\frac{\pi}{4} - \theta)$ 1 ½ mark

$\Rightarrow y = (\frac{\pi}{4} - \frac{1}{2}\cos^{-1} x^2)$

Let $z = \cos^{-1} x^2$ 1 mark

$\Rightarrow y = \left(\frac{\pi}{4} - \frac{1}{2}z\right)$

$\Rightarrow \frac{dy}{dz} = -\frac{1}{2}$ 1 mark

14. For calculating LHL = 8 1 ½ mark

For calculating RHL = 8 1 ½ mark

For calculating K = 8 1 mark

15. $\int \frac{e^x(sin4x-4)}{1-cos4x} dx$

$= \int \frac{e^x(2sin2xcos2x-4)}{2\cos^2 2x} dx$ 1 ½ mark

$= \int e^x[tan2x - 2\sec^2 2x]\, dx$ 1 ½ mark

$= e^x tan2x + c$ 1 mark

16. $y\sqrt{x^2+1} = \ln\left(\sqrt{x^2+1} - x\right)$

Differentiating with respect to x

$\Rightarrow y\left(\frac{1}{2\sqrt{x^2+1}}\right)2x + \sqrt{x^2+1}\frac{dy}{dx} = \frac{1}{\sqrt{x^2+1}-x}\left(\frac{1}{2\sqrt{x^2+1}}\ 2x - 1\right)$ 1 mark

$\Rightarrow \frac{xy}{\sqrt{x^2+1}} + \sqrt{x^2+1}\frac{dy}{dx} = \frac{x-\sqrt{x^2+1}}{(\sqrt{x^2+1})(\sqrt{x^2+1}-x)}$

$\Rightarrow \frac{xy}{\sqrt{x^2+1}} + \sqrt{x^2+1}\frac{dy}{dx} = -\frac{1}{\sqrt{x^2+1}}$ 1 mark

$\Rightarrow \sqrt{x^2+1}\frac{dy}{dx} = -\frac{(1+xy)}{\sqrt{x^2+1}}$ 1 mark

$\Rightarrow (x^2+1)\frac{dy}{dx} + xy + 1 = 0$ 1 mark

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17. $\int_{-1}^{\frac{3}{2}} |x\ sin\pi x| dx$

$= \int_{-1}^{1} |x\ sin\pi x| dx + \int_{1}^{\frac{3}{2}} |x\ sin\pi x| dx$ 1 mark

$= \int_{-1}^{1} x\ sin\pi x\ dx - \int_{1}^{\frac{3}{2}} x\ sin\pi x\ dx$ 1 mark

On integrating both integrals on right-hand side, we get

$= \left[-\frac{xcos\pi x}{\pi} + \frac{sin\pi x}{\pi^2}\right]_{-1}^{1} - \left[-\frac{xcos\pi x}{\pi} + \frac{sin\pi x}{\pi^2}\right]_{1}^{\frac{3}{2}}$ 1 mark

$= \frac{3}{\pi} + \frac{1}{\pi^2}$ 1 mark

18. $\int \left(\frac{1}{\sqrt{\sin^3 x\ sin(x+\alpha)}}\right) dx$

$= \int \left(\frac{1}{\sqrt{\sin^3 x\ (sinxcos\alpha + cosxsin\alpha)}}\right) dx$

$= \int \left(\frac{1}{\sqrt{\sin^4 x\ (cos\alpha + cotxsin\alpha)}}\right) dx$

$= \int \left(\frac{cosec^2 x}{\sqrt{(cos\alpha + cotxsin\alpha)}}\right) dx$ 2 marks

On substitution of $cos\alpha + cotxsin\alpha = t$

$= \int \left(-\frac{1}{sin\alpha\sqrt{t}}\right) dt$

$= -\frac{2\sqrt{t}}{sin\alpha} + C$ 1 mark

On substitution of t $t = cos\alpha + cotxsin\alpha$

$= -\left(\frac{2}{sin\alpha}\right)\sqrt{\frac{\sin(x+\alpha)}{sinx}} + C$ 1 mark

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19. $\vec{a} = \hat{\imath} + \hat{\jmath} + \hat{k}, \ \vec{b} = 2\hat{\imath} + 4\hat{\jmath} - 5\hat{k}, \ \vec{c} = \lambda\hat{\imath} + 2\hat{\jmath} + 3\hat{k}$

$\left|\frac{\vec{a}\text{X}(\vec{b}+\vec{c})}{|\vec{b}+\vec{c}|}\right| = \sqrt{2}$ ------ (i) 1 mark

$\vec{b} + \vec{c} = (2+\lambda)\hat{\imath} + 6\hat{\jmath} - 2\hat{k}$

$|\vec{b} + \vec{c}| = \sqrt{\lambda^2 + 4\lambda + 44}$ ------ (ii) 1 mark

$\vec{a}\text{X}(\vec{b} + \vec{c}) = \begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 1 & 1 & 1 \\ 2+\lambda & 6 & -2 \end{vmatrix}$

$= -8\hat{\imath} + (4+\lambda)\hat{\jmath} + (4-\lambda)\hat{k}$------ (iii) 1 mark

By equation (i), (ii) & (iii)

$\left|\frac{-8\hat{\imath}+(4+\lambda)\hat{\jmath}+(4-\lambda)\hat{k}}{\sqrt{\lambda^2+4\lambda+44}}\right| = \sqrt{2}$

On solving we will get

$\lambda = 1$ 1 mark

OR

$\vec{a} + \vec{b} + \vec{c} = 0$

$\Rightarrow (\vec{a} + \vec{b})^2 = (-\vec{c})^2$ 1 mark

$(\vec{a} + \vec{b}).(\vec{a} + \vec{b}) = \vec{c}.\vec{c}$ ½ mark

$|\vec{a}|^2 + |\vec{b}|^2 + 2\vec{a}.\vec{b} = |\vec{c}|^2$ ½ mark

By Substitution of values

$9 + 25 + 2\vec{a}.\vec{b} = 49$

$\Rightarrow \vec{a}.\vec{b} = \frac{15}{2}$ 1 mark

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$\Rightarrow |\vec{a}||\vec{b}|cos\theta = \frac{15}{2}$

By Substitution of values

$cos\theta = \frac{1}{2} \Rightarrow \theta = 60°$ 1 mark

20.

$\frac{x+1}{7} = \frac{y+1}{-6} = \frac{z+1}{1}$ and $\frac{x-3}{1} = \frac{y-5}{-2} = \frac{z-7}{1}$

$\overrightarrow{a1} = -\hat{\imath} - \hat{\jmath} - \hat{k}$

$\overrightarrow{a2} = 3\hat{\imath} + 5\hat{\jmath} + 7\hat{k}$

$\overrightarrow{b1} = 7\hat{\imath} - 6\hat{\jmath} + \hat{k}$

$\overrightarrow{b2} = \hat{\imath} - 2\hat{\jmath} + \hat{k}$

$\overrightarrow{a2} - \overrightarrow{a1} = 4\hat{\imath} + 6\hat{\jmath} + 8\hat{k}$ 1 mark

$\overrightarrow{b1} \text{ X } \overrightarrow{b2} = -4\hat{\imath} - 6\hat{\jmath} - 8\hat{k}$

$|\overrightarrow{b1} \text{ X } \overrightarrow{b2}| = \sqrt{116}$ 1 mark

Shortest distance = $\left|\frac{(\overrightarrow{a2} - \overrightarrow{a1}).(\overrightarrow{b1} \text{ X } \overrightarrow{b2})}{|\overrightarrow{b1} \text{ X } \overrightarrow{b2}|}\right|$ 1 mark

$= \left|-\frac{116}{\sqrt{116}}\right|$

$= \sqrt{116}$ 1 mark

OR

Equation of plane passing through $(2,1,-1)$is

$a(x-2) + b(y-1) + c(z+1) = 0$ ----- (i) ½ mark

(i) Passes through $(-1,3,4)$

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$\Rightarrow -3a + 2b + 5c = 0$ ----- (ii) 1 mark

(i) is perpendicular to $x - 2y + 4z = 10$

$\Rightarrow a - 2b + 4c = 0$ ----- (iii) 1 mark

On solving (ii) and (iii)

$a = 18, b = 17\ , c = 4$ 1 mark

From (i) equation of plane

$18x + 17y + 4z - 49 = 0$ ½ mark

21. Let X is the random variable denoting the number of selected scouts, X takes values 0, 1, 2. ½ mark

$P(X = 0) = \frac{^{20}C_2}{^{50}C_2} = \frac{38}{245}$ ½ mark

$P(X = 1) = \frac{(^{20}C_1 \text{X } ^{30}C_1)}{^{50}C_2} = \frac{120}{245}$ ½ mark

$P(X = 2) = \frac{^{30}C_2}{^{50}C_2} = \frac{87}{245}$ ½ mark

Now mean $= \sum(P_i X_i) = \frac{294}{245}$ 1 mark

Relevant Value 1 mark

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22. $\begin{vmatrix} x & x+y & x+2y \\ x+2y & x & x+y \\ x+y & x+2y & x \end{vmatrix}$

Applying $R1 \Rightarrow R1 + R2 + R3$

$= \begin{vmatrix} 3(x+y) & 3(x+y) & 3(x+y) \\ x+2y & x & x+y \\ x+y & x+2y & x \end{vmatrix}$ 1 mark

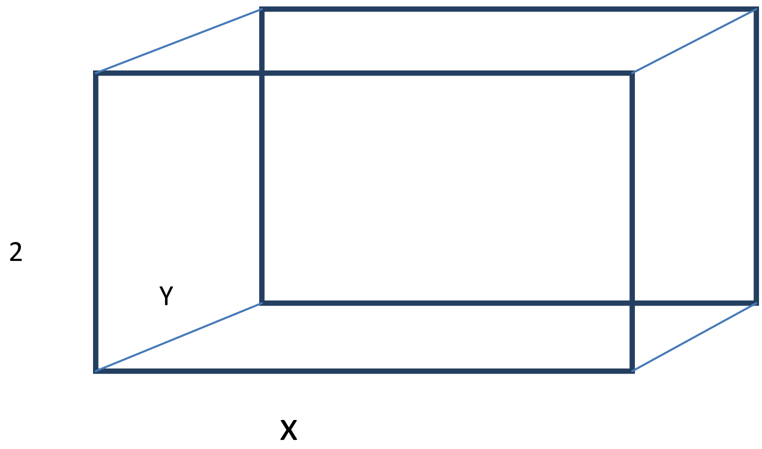
$= 3(x+y) \begin{vmatrix} 1 & 1 & 1 \\ x+2y & x & x+y \\ x+y & x+2y & x \end{vmatrix}$ 1 mark

Applying $C1 \Rightarrow C1 - C3,\ C2 \Rightarrow C2 - C3$

$= 3(x+y) \begin{vmatrix} 0 & 0 & 1 \\ y & -y & x+y \\ y & 2y & x \end{vmatrix}$ 1 mark

Expanding along R1 we get

$= 9y^2\ (x+y)$ 1 mark



23. Diagram ½ mark

Volume of the tank $= 8m^3 = 2xy$----- (i) ½ mark

Let C be the cost of making the tank

$C = 70xy + 45 \text{ X } 2(2x + 2y)$

$C = 70xy + 180(x + y)$ 1 mark

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From equation (i)

$C = 70x.\frac{4}{x} + 180(x + \frac{4}{x})$

$C = 280 + 180\left(x + \frac{4}{x}\right)$ ----- (ii) 1 mark

$\frac{dC}{dx} = 180\left(1 - \frac{4}{x^2}\right)$ 1 mark

For maxima and minima, $\frac{dC}{dx} = 0$

$\Rightarrow 180\left(1 - \frac{4}{x^2}\right) = 0$

$\Rightarrow x = \pm 2$ as x≠-2, x=2

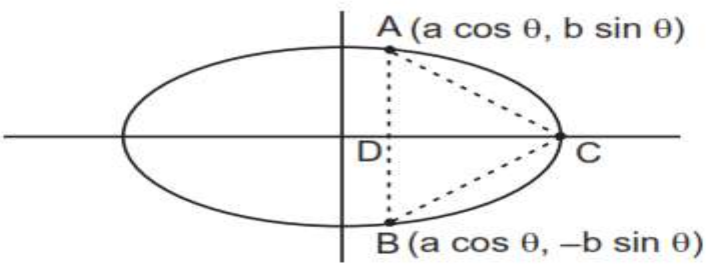
Now $\frac{d^2C}{Dx^2} = 180$ X $\frac{8}{x^3}$

$\left(\frac{d^2C}{Dx^2}\right)_{x=2} = 180 > 0 \Rightarrow C\ is\ minimum\ at\ x = 2$

By equation (ii)

$C_{x=2} = Rs. 1000$

OR



1 mark

Area of $\Delta ABC = \frac{1}{2}$ X AB X $DC = \frac{1}{2}$ X $2bsin\theta(a - acos\theta)$

$= absin\theta(1 - cos\theta)$-----(i) 1 mark

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$\frac{dA}{d\theta} = ab(\sin^2\theta + \cos\theta - \cos^2\theta)$ 1 mark

For maxima and minima $\frac{dA}{d\theta} = 0$

$ab(\sin^2\theta + \cos\theta - \cos^2\theta) = 0$

$cos\theta - cos2\theta = 0$

$cos\theta = cos2\theta$

$2\theta = 2n\pi \pm \theta$

$\theta = n\pi \pm \frac{\theta}{2}$ ----(ii)

As $\theta \in (0, \pi)$ by equation (ii)

$$\theta = \pi - \frac{\theta}{2}$$

$\theta = \frac{2\pi}{3}$ 1 mark

$$\frac{d^2A}{d\theta^2} = ab(2sin2\theta - sin\theta)$$

$\left[\frac{d^2A}{d\theta^2}\right]_{\theta=\frac{2\pi}{3}} < 0 \Rightarrow A$ is maximum. 1 mark

By equation (i)

$A_{\max} = \frac{3\sqrt{3}}{4}ab$ sq.unit 1 mark

24. Let x, y, z be the amount of prize to be awarded in the field of agriculture, education & social science respectively. The given situation Can be written in the matrix form as:

$AX = B$

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Where $A = \begin{bmatrix} 10 & 5 & 15 \\ 15 & 10 & 5 \\ 1 & 1 & 1 \end{bmatrix}, X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}, \ B = \begin{bmatrix} 70000 \\ 55000 \\ 6000 \end{bmatrix}$

$AX = B \Rightarrow X = A^{-1}B$ 1 mark

$|A| = 75$ 1 mark

$$adj\ A = \begin{bmatrix} 5 & 10 & -125 \\ -10 & -5 & 175 \\ 5 & -5 & 25 \end{bmatrix}$$

$A^{-1} = \frac{adj\ \ A}{|A|} = \frac{1}{75}\begin{bmatrix} 5 & 10 & -125 \\ -10 & -5 & 175 \\ 5 & -5 & 25 \end{bmatrix}$ 2 marks

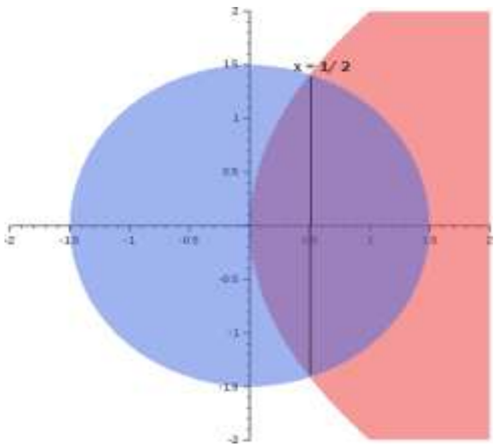
$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \frac{1}{75}\begin{bmatrix} 5 & 10 & -125 \\ -10 & -5 & 175 \\ 5 & -5 & 25 \end{bmatrix}\begin{bmatrix} 70000 \\ 55000 \\ 6000 \end{bmatrix}$$

$$\begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 2000 \\ 1000 \\ 3000 \end{bmatrix}$$

$\Rightarrow x = 2000, y = 1000, z = 3000$ 1 mark

Value based relevant answer 1 mark

25.



1 mark

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Point of intersection of given curves is $x = \frac{1}{2}$ 1 mark

Required Area = $2\left[\int_0^{\frac{1}{2}} \sqrt{4x}dx + \int_{\frac{1}{2}}^{\frac{3}{2}} \sqrt{\frac{9-4x^2}{4}}\,dx\right]$ 1 ½ mark

$= 2.2\left[x^{\frac{3}{2}}\right]_0^{\frac{1}{2}} + 2\left[\frac{x}{2}\sqrt{\frac{9-4x^2}{4}} + \frac{9}{8}\sin^{-1}\left(\frac{2x}{3}\right)\right]_{\frac{1}{2}}^{\frac{3}{2}}$ 1 ½ mark

$= \frac{9\pi}{8} + \frac{\sqrt{2}}{6} - \frac{9}{4}\sin^{-1}\left(\frac{1}{3}\right)$ 1 mark

OR

$I = \int_0^4 (|x-1| + |x-2| + |x-3|)dx$ ---- (i)

$I = \int_0^4 (|x-1|)dx + \int_0^4 (|x-2|)dx + \int_0^4 (|x-3|)dx$ 1 mark

Let $I_1 = \int_0^4 (|x-1|)dx = \int_0^1 (1-x)dx + \int_1^4 (x-1)dx$

$= -\frac{1}{2}[(1-x)^2]_0^1 + \frac{1}{2}[(x-1)^2]_1^4$

$= 5$ 1 ½ mark

$I_2 = \int_0^4 (|x-2|)dx = \int_0^2 (2-x)dx + \int_2^4 (x-2)dx$

$= -\frac{1}{2}[(2-x)^2]_0^2 + \frac{1}{2}[(x-2)^2]_2^4$

$= 4$ 1 ½ mark

$I_3 = \int_0^4 (|x-3|)dx = \int_0^3 (3-x)dx + \int_3^4 (x-3)dx$

$= -\frac{1}{2}[(3-x)^2]_0^3 + \frac{1}{2}[(x-3)^2]_3^4$

$= 5$ 1 ½ mark

By equation (i)

$I = I_1 + I_2 + I_3 = 5 + 4 + 5 = 14$ ½ mark

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26. Let x and y be the number of pieces of type A and B manufactured per week respectively. If z is the profit then,

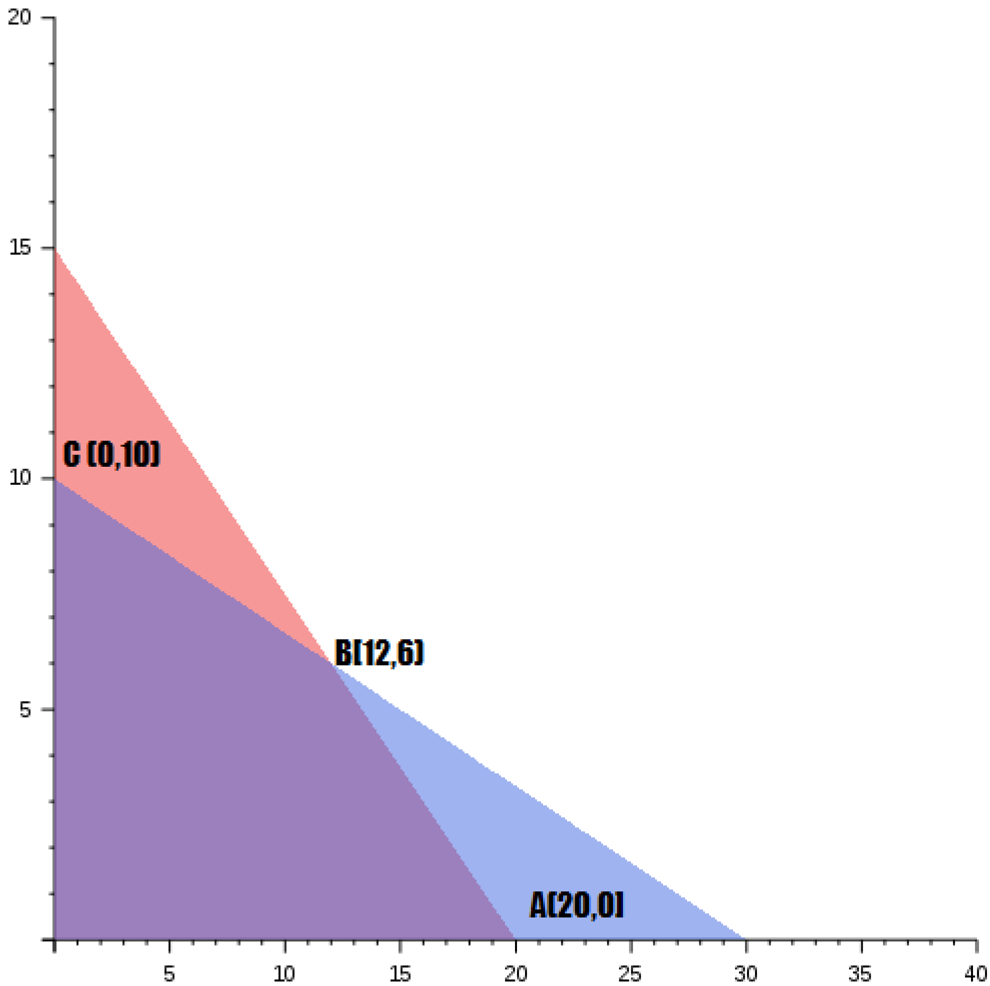
$z = 80x + 120y$

Maximize z subject to the constraint

$9x + 12y \leq 180 \Rightarrow 3x + 4y \leq 60$----(i)

$x + 3y \leq 30$----(ii)

$x \geq 0, y \geq 0$ ----(iii) 2 Mark



2 mark

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Corner Points	$z = 80x + 120y$
0(0,0)	0
A(20,0)	1600
B(12,6)	1680 ← maximum
C(0,10)	1200

1 mark

Relevant answer 1 mark

27.Let the event b defined as

E_1 = The examinee guesses the answer
E_2 = The examinee copies the answer
E_3 = The examinee knows the answer
A = The examinee answers correctly ½ marks

$P(E_1) = \frac{1}{6}, P(E_2) = \frac{1}{9}, P(E_3) = 1 - \left(\frac{1}{6} + \frac{1}{9}\right) = \frac{13}{18}$ 1 mark

$P\left(\frac{A}{E_1}\right) = \frac{1}{4}$ (Out of 4 choices 1 is correct) ½ marks

$P\left(\frac{A}{E_2}\right) = \frac{1}{8}$ ½ marks

$P\left(\frac{A}{E_3}\right) = 1$ (If the answer is known it is always correct) ½ marks

$P\left(\frac{E_3}{A}\right) =$ Required

$P\left(\frac{E_3}{A}\right) = \frac{P(E_3).P\left(\frac{A}{E_3}\right)}{P(E_1).P\left(\frac{A}{E_1}\right)+P(E_2).P\left(\frac{A}{E_2}\right)+P(E_3).P\left(\frac{A}{E_3}\right)}$ 1 mark

On substitution

$P\left(\frac{E_3}{A}\right) = \frac{13}{14}$ 1 mark

Yes the probability of copying is less than other probability. 1 mark

28. The given planes are

$2x + y - 6z - 3 = 0$ ---- (i)
$5x - 3y + 4z + 9 = 0$ ---- (ii)
Equation of the plane passing through the intersection of (i) and (ii)
$2x + y - 6z - 3 + \lambda(5x - 3y + 4z + 9) = 0$ ---- (iii) 2 mark
Given that plane (iii) is parallel to $\frac{x-1}{2} = \frac{y-3}{4} = \frac{z-5}{4}$
$\Rightarrow (2 + 5\lambda).2 + (1 - 3\lambda).4 + (4\lambda - 6).4 = 0$ 1 mark
On solving $\lambda = \frac{8}{7}$ 1 ½ mark
On substitution of λ in (iii) equation of plane
$54x - 17y - 10z + 51 = 0$ 1 ½ mark

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29. $x^2dy + y(x+y)dx = 0$

$\Rightarrow \frac{dy}{dx} = -\frac{xy+y^2}{x^2}$ ----- (i) ½ mark

Let $y = vx \Rightarrow \frac{dy}{dx} = v + x\frac{dv}{dx}$ ½ mark

By equation (i)

$v + x\frac{dv}{dx} = -\frac{vx^2+v^2x^2}{x^2}$

$\Rightarrow \frac{dv}{v^2+2v} = -\frac{dx}{x}$ 1 mark

$\int \left(\frac{dv}{v^2+2v}\right) = \int \left(-\frac{dx}{x}\right)$

$\Rightarrow \frac{1}{2}\int \left(\frac{1}{v} - \frac{1}{v+2}\right) dv = \int \left(-\frac{dx}{x}\right)$

$\Rightarrow \log|v| - \log|v+2| = -2\log|x| + C$ 1 mark

$\Rightarrow \log\left|\frac{vx^2}{v+2}\right| = log\ k$

$\frac{vx^2}{v+2} = k$ 1 mark

Putting $v = \frac{y}{x}$ we get

$x^2y = k(y+2x)$ 1 mark

For Particular solution $k = \frac{1}{3}$

Therefore Particular Solution is

$3x^2y = y + 2x$ 1 mark

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