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8.	$\cos x = -\frac{1}{2}$	
	We know that	
	$\cos\frac{\pi}{3} = \frac{1}{2}$	
	We know that	
	$\cos(\pi + \theta) = -\cos \theta$ , $\cos(\pi - \theta) = -\cos \theta$ (1)	
	$Put x = \frac{\pi}{3} in (1)$	
	$\cos\left(\pi + \frac{\pi}{3}\right) = \cos\left(\pi - \frac{\pi}{3}\right) = -\cos\frac{\pi}{3}$	[1M]
	$\cos\left(\frac{4\pi}{3}\right) = \cos\left(\frac{2\pi}{3}\right) = -\cos\frac{\pi}{3}$	[1 M]
	$\frac{4\pi}{3}, \frac{2\pi}{3} \in [0, 2\pi)$	
	$\therefore$ $x = \frac{4\pi}{3}$ , $x = \frac{2\pi}{3}$ are principal solution.	[1 M]
9.	In $\triangle$ ABC	
	$\cos A = \frac{b^2 + c^2 - a^2}{2bc} = \frac{1 + 3 - 4}{2 \times 1 \times \sqrt{3}} = 0^{\circ} \Longrightarrow A = \frac{\pi^c}{2}$	[1 M]
	$\cos B = \frac{c^2 + a^2 - b^2}{2ca} = \frac{3 + 4 - 1}{2 \times \sqrt{3} \times 2} = \frac{6}{4\sqrt{3}} = \frac{\sqrt{3}}{2} \implies B = \frac{\pi^c}{6}$	
	$\cos^2 \mathbf{A} + \cos^2 \mathbf{B} + \cos^2 \mathbf{c} = 1$	
	$0 + \frac{3}{4} + \cos^2 c = 1$	
	$\cos^2 c = 1 - \frac{3}{4} = \frac{1}{4}$	
	$\cos = \frac{1}{2} \implies c = \frac{\pi}{3}$	[1 M]
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#### GuruAanklan / HSC Examination / Grand Test / Maths Code / Set-A / Solutions Let a, b, c are direction ratios of a vector prependicular to the two lines having direction ratios are -2, 1, -1 10. and -3, -4, 1. -2a + b - c = 0...(1) -3a - 4b + c = 0...(2) [1 M] By Cramers' rule $\frac{a}{\begin{vmatrix} 1 & -1 \\ -4 & 1 \end{vmatrix}} = \frac{-b}{\begin{vmatrix} -2 & -1 \\ -3 & 1 \end{vmatrix}} = \frac{c}{\begin{vmatrix} -2 & 1 \\ -3 & -4 \end{vmatrix}$

 $\frac{a}{-3} = \frac{b}{5} = \frac{c}{11}$  $\therefore$  a = -3, b = 3, c = 11

 $\frac{a}{1-4} = \frac{-b}{-2-3} = \frac{c}{8+3}$ 

 $\frac{a}{-3} = \frac{-b}{-5} = \frac{c}{11}$ 

11. 
$$y = x^{e^x}$$

taking log on both side

 $\log y = \log x^{e^x}$  $\log y = e^x \log x$ differentiating w.r.t. x

$$\frac{1}{y}\frac{dy}{dx} = e^{x}\frac{d}{dx}\log x + \log x\frac{d}{dx}e^{x}$$
[1 M]  

$$\frac{dy}{dx} = y\left[e^{x}\cdot\frac{1}{x} + \log x \cdot e^{x}\right]$$

$$= y \cdot e^{x}\left[\frac{1}{x} + \log x\right]$$

$$= e^{e^{x}} \cdot e^{x}\left[\frac{1}{x} + \log x\right]$$
[1 M]  
12.  $f(x) = x^{2} + 2x - 5$ 
[1 M]  
diff w.r.t x  
 $f'(x) = 2x + 2$ 
[1 M]  
 $\therefore f'(x) > 0$   
 $2x + 2 > 0$   
 $2x > -2$   
 $x \ge -1$ 
[1 M]

#### [1 M]

[1 M]

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13. $I = \int \frac{e^{x-1} + x^{e-1}}{e^x + x^e} dx$	
Let $\theta = e^{x} + x^{e}$	
$\frac{d\theta}{dx} = e^x + e \cdot x^{e^{-1}}$	
ux ux	
$d\theta = e(e^{x-1} + x^{e-1}) dx$	
$\frac{1}{e}d\theta = (e^{x-1} + x^{e-1})dx$	[1 M]
$\therefore  I = \int \frac{\frac{1}{e} d\theta}{\theta}$	
$=rac{1}{e}\intrac{d\theta}{ heta}$	
$=\frac{1}{e}\log \theta +c$	
$=\frac{1}{e}\log e^{x} + x^{e}  + c$	[1 M]
OR	
$I = \int \frac{\sec \theta}{\sec \theta + \tan \theta} d\theta$	
$= \int \frac{\sec \theta}{\sec \theta + \tan \theta} \times \frac{\sec \theta - \tan \theta}{\sec \theta - \tan \theta} d\theta$	[1 M]
$=\int \frac{\sec^2 \theta - \sec \theta \tan \theta}{\sec^2 \theta - \tan^2 \theta} d\theta$	
$= \int (\sec^2 \theta - \sec \theta  \tan \theta)  d\theta$	
$= \tan \theta - \sec \theta + c$	[1 M]
14. $\int_{0}^{a} (2x + 1)dx = 2$	
$\left[\frac{2x^2}{2} + x\right]_0^a = 2$	[1 M]
$\begin{bmatrix} x^2 + x \end{bmatrix}_0^a = 2$ $a^2 + a = 2$	
$a^2 + a - 2 = 0$	
$a^{2} + 2a - a - 2 = 0$ a(a + 2) - 1(a + 2) = 0	
(a-1)(a+2)=0	
a-1=0  OR  a+2=0 a=1  OR  a=-2	[1 M]
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#### **SECTION-C**

15. Equation of given lines are  $5x^2 - 8xy + 3y^2 = 0$ Comparing with  $ax^2 + 2hxy + by^2 = 0$ a = 5, 2h = -8, b = 3a = 5, h = -4, b = 3Let m<sub>1</sub> and m<sub>2</sub> are slope of lines  $m_1 + m_2 = \frac{-2h}{b}, \quad m_1 m_2 = \frac{a}{b}$  $m_1 + m_2 = \frac{8}{3}, m_1 m_2 = \frac{5}{3}$ [1 M] Since required lines are  $\perp^{ar}$  to given lines  $\therefore$  Slopes of required lines are  $\frac{-1}{m_1}$  and  $\frac{-1}{m_2}$ . Since required lines are passing through origin. Equation of lines are ...  $y = \frac{-1}{m_1}x$  and  $y = \frac{-1}{m_2}x$  $m_1 y = -x$  and  $m_2 y = -x$  $x + m_1 y = 0$  and  $x + m_2 y = 0$ [1 M] : Joint equation of lines is  $(\mathbf{x} + \mathbf{m}_1 \mathbf{y}) \cdot (\mathbf{x} + \mathbf{m}_2 \mathbf{y}) = \mathbf{0}$  $x^2 + m_2 xy + m_1 xy + m_1 m_2 y^2 = 0$  $x^{2} + (m_{1} + m_{2})xy + m_{1}m_{2}y^{2} = 0$  $x^{2} + \frac{8}{3}xy + \frac{5}{3}y^{2} = 0$  $3x^2 + 8xy + 5y^2 = 0$ [1 M] This is required equation of lines. 16. Equation of lines are  $L_1: \frac{x+1}{7} = \frac{y+1}{-6} = \frac{z+1}{1}$  ...(1)  $L_2: \frac{x-3}{1} = \frac{y-5}{-2} = \frac{z-7}{1}$  ...(2) From(1) and(2) $x_1 = -1, y_1 = -1, z_1 = -1$  $a_1 = 7$ ,  $b_1 = -6$ ,  $c_1 = 1$  $x_2 = 3$ ,  $y_2 = 5$   $z_2 = 7$  $a_2 = 1$ ,  $b_2 = -2$ ,  $c_2 = 1$ [1 M] **Guru Aanklan** Website : www.guruaanklan.com

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Shortest distance = 
$$\begin{vmatrix} \frac{x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix}$$

$$= \begin{vmatrix} \frac{4}{\sqrt{(M_{11})^2 + (M_{12})^2 + (M_{13})^2}} \end{vmatrix}$$

$$= \begin{vmatrix} \frac{4}{\sqrt{(-4)^2 + (6)^2 + (-8)^2}} \\ \frac{4(-4) - 6(6) + 8(-8)}{\sqrt{(-4)^2 + (6)^2 + (-8)^2}} \end{vmatrix}$$

$$= \begin{vmatrix} \frac{4(-4) - 6(6) + 8(-8)}{\sqrt{16 + 36 + 64}} \end{vmatrix}$$

$$= \begin{vmatrix} -16 - 36 - 64 \\ \sqrt{116} \end{vmatrix}$$

$$= \begin{vmatrix} -16 - 36 - 64 \\ \sqrt{116} \end{vmatrix}$$

$$= \begin{vmatrix} -\sqrt{166} \\ = \sqrt{166} \ \text{unit}$$
[1 M]

17. Let  $\overline{a} = \hat{i} + \hat{j} - 2\hat{k}$ ,  $\overline{b} = \hat{i} + 2\hat{j} + \hat{k}$ ,  $\overline{c} = 2\hat{i} - \hat{j} + \hat{k}$  are the three points through which plane passes.  $\therefore$  Equation of plane is

$$(\overline{\mathbf{r}} - \overline{\mathbf{a}}) \cdot (\overline{\mathbf{a}} \times \overline{\mathbf{b}} + \overline{\mathbf{b}} \times \overline{\mathbf{c}} + \overline{\mathbf{c}} \times \overline{\mathbf{a}}) = 0 \qquad \dots(1) \qquad [1 \text{ M}]$$

$$\overline{\mathbf{a}} \times \overline{\mathbf{b}} = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 1 & 1 & -2 \\ 1 & 2 & 1 \end{vmatrix} = \hat{\mathbf{i}}(1 + 4) - \hat{\mathbf{j}}(1 + 2) + \hat{\mathbf{k}}(2 - 1) = 5\hat{\mathbf{i}} - 3\hat{\mathbf{j}} + \hat{\mathbf{k}}$$

$$\overline{\mathbf{b}} \times \overline{\mathbf{c}} = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 1 & 2 & 1 \\ 2 & -1 & 1 \end{vmatrix} = \hat{\mathbf{i}}(3) - \hat{\mathbf{j}}(-1) + \hat{\mathbf{k}}(-5) = 3\hat{\mathbf{i}} + \hat{\mathbf{j}} - 5\hat{\mathbf{k}}$$

$$\overline{\mathbf{c}} \times \overline{\mathbf{a}} = \begin{vmatrix} \hat{\mathbf{i}} & \hat{\mathbf{j}} & \hat{\mathbf{k}} \\ 2 & -1 & 1 \\ 1 & 1 & -2 \end{vmatrix} = \hat{\mathbf{i}}(1) - \hat{\mathbf{j}}(-5) + \hat{\mathbf{k}}(2 + 1) = \hat{\mathbf{i}} + 5\hat{\mathbf{j}} + 3\hat{\mathbf{k}}$$

$$(\overline{\mathbf{a}} \times \overline{\mathbf{b}}) + (\overline{\mathbf{b}} \times \overline{\mathbf{c}}) + (\overline{\mathbf{c}} \times \overline{\mathbf{a}}) = (5\hat{\mathbf{i}} - 3\hat{\mathbf{j}} + \hat{\mathbf{k}}) + (3\hat{\mathbf{i}} + \hat{\mathbf{j}} - 5\hat{\mathbf{k}}) + (\hat{\mathbf{i}} + 5\hat{\mathbf{j}} + 3\hat{\mathbf{k}}) \qquad [1 \text{ M}]$$

$$= 9\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - \hat{\mathbf{k}}$$
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From(1)	
$[\overline{\mathbf{r}} - (\hat{\mathbf{i}} + \hat{\mathbf{j}} - 2\hat{\mathbf{k}})] \cdot (9\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - \hat{\mathbf{k}}) = 0$	
$\overline{r} \cdot (9\hat{i} + 3\hat{j} - \hat{k}) - (9 + 3 + 2) = 0$	
$\overline{\mathbf{r}} \cdot (9\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - \hat{\mathbf{k}}) - 14 = 0$	
$\overline{\mathbf{r}} \cdot (9\hat{\mathbf{i}} + 3\hat{\mathbf{j}} - \hat{\mathbf{k}}) = 14$	[1 M]
OR	
Equation of lines are	
$L_1: \frac{x-2}{1} = \frac{y-4}{4} = \frac{z-6}{7} \qquad \dots(1)$	
L <sub>2</sub> : $\frac{x+1}{3} = \frac{y+3}{5} = \frac{z+5}{7}$ (2)	
From (1) $x_1 = 2$ , $y_1 = 4$ , $z_1 = 6$ , $a_1 = 1$ , $b_1 = 4$ , $c_1 = 7$ $x_2 = -1$ , $y_2 = -3$ , $z_2 = -5$ , $a_2 = 3$ , $b_2 = 5$ , $c_2 = 7$	[1 M]
$\begin{vmatrix} x_2 - x_1 & y_2 - y_1 & z_2 - z_1 \\ a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix}$	
$= \begin{vmatrix} 2 - (-1) & 4 - (-3) & 6 + 5 \\ 1 & 4 & 7 \\ 3 & 5 & 7 \end{vmatrix}$	
$= \begin{vmatrix} 3 & 7 & 11 \\ 1 & 4 & 7 \\ 3 & 5 & 7 \end{vmatrix}$	[1 M]
= 3(28 - 35) - 7(7 - 21) + 11(5 - 12) = 3(-7) - 7(-14) + 11(-7) = -21 + 98 - 77 = -98 + 98	
 = 0 Lines $L_1$ and $L_2$ are coplanar. Equation of plane containing $L_1$ and $L_2$ are	[1 M]
$\begin{vmatrix} \mathbf{x} - \mathbf{x}_1 & \mathbf{y} - \mathbf{y}_1 & \mathbf{z} - \mathbf{z}_1 \end{vmatrix}$	
$\begin{vmatrix} a_1 & b_1 & c_1 \\ a_2 & b_2 & c_2 \end{vmatrix} = 0$	
$\begin{vmatrix} x - 2 & y - 4 & z - 6 \\ 1 & 4 & 7 \\ 3 & 5 & 7 \end{vmatrix} = 0$	
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(x-2)(28-35) - (y-4)(7-21) + (z-6)(5-12) = 0	
(x-2)(-7) - (y-4)(-14) + (z-6)(-7) = 0	
-7x + 14 + 14y - 56 - 7z + 42 = 0	
-7x + 14y - 7z = 0	
$\mathbf{x} - 2\mathbf{y} + \mathbf{z} = 0$	[1 M]
This is required equation of plane.	
18. Given:	
$x^5 \cdot y^7 = (x + y)^{12}$	
taking log on both side, we get	
$\log(x^5 \cdot y^7) = \log(x+y)^{12}$	[1 M]
$\log x^5 + \log y^7 = 12 \log (x + y)$	
$5 \log x + 7\log y = 12 \log(x + y)$	
differentiating w.r.t. x	
$5 \cdot \frac{1}{x} + 7 \times \frac{1}{y} \frac{dy}{dx} = \frac{12}{x+y} \left(1 + \frac{dy}{dx}\right)$	
$\frac{5}{x} + \frac{7}{y}\frac{dy}{dx} = \frac{12}{x+y} + \frac{12}{x+y}\frac{dy}{dx}$	[1 M]
$\frac{7}{y}\frac{dy}{dx} - \frac{12}{x+y}\frac{dy}{dx} = \frac{12}{x+y} - \frac{5}{x}$	
$\left(\frac{7}{y} - \frac{12}{x+y}\right)\frac{dy}{dx} = \left(\frac{12}{x+y} - \frac{5}{x}\right)$	
$\frac{7x + 7y - 12y}{y(x+y)}\frac{dy}{dx} = \frac{12x - 5x - 5y}{x(x+y)}$	
$\frac{7x - 5y}{y} \frac{dy}{dx} = \frac{7x - 5y}{x}$	
$\frac{\mathrm{d}y}{\mathrm{d}x} = \frac{y}{x}$	[1 M]
OR	
Let $u = \cos^{-1}(\sin x)$ $v = \tan^{-1} x$	
$u = \frac{\pi}{2} - x \qquad v = \tan^{-1} x$	[1 M]
$\frac{\mathrm{d}u}{\mathrm{d}x} = -1 \qquad \qquad \frac{\mathrm{d}v}{\mathrm{d}x} = \frac{1}{1+x^2}$	[1 M]
By parametric differentiation	
$\frac{du}{dv} = \frac{du/dx}{dv/dx} = \frac{-1}{1/(1+x^2)} = -(1+x^2)$	[1 M]
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$P_{\cdot}$ x $P(x)$	X	P(x)	x P(x)	$x^2 P(x)$
-2 0.1	-2	0.1	-0.2	0.4
-1 k	-1	0.1	-0.1	0.1
0 0.2	0	0.2	0	0
1 2k	1	0.2	0.2	0.2
2 0.3	2	0.3	0.6	1.2
3 <u>k</u>	3	0.1	0.3	0.9
0.6 + 4k			E(x) = 0.8	$E(x^2) = 2.8$
Since P is p.m.t.	H	E(x) = 0.8		
$\therefore \qquad \sum P_i = 1$	V	$V(\mathbf{x}) = \mathbf{E}(\mathbf{x}^2)$	$-(E(x))^{2}$	
0.6 + 4k = 1		= 2.8 -	$(0.8)^2$	
4k = 1 - 0.6		= 2.8 -	0.64	
4k = 0.4		= 2.16		

20. Experiment : Hitting a target in 10 shots.

X : number of shots hit the target

P: Probability that a short hit the target

p = 0.2, n = 10, q = 1 - P = 0.8

 $\therefore$  X ~ B (10, 0.2)

k = 0.1

p.m.t. of x is

 $P(x=r) = {}^{10}c_r (0.2)^r (0.8)^{10-r} \qquad ..(1)$ 

Probability that target will be hit at least twice

$$= P(x \ge 2)$$
  
= 1 - P(x < 2)  
= 1 - {P(x = 0) + P(x = 1)}  
= 1 - {<sup>10</sup>c<sub>0</sub> (0.2)<sup>0</sup> (0.8)<sup>10</sup> + <sup>10</sup>c<sub>1</sub> (0.2)<sup>1</sup> (0.8)<sup>10-1</sup>}  
= 1 - {(0.8)<sup>10</sup> + (10 × 0.2 × 0.8<sup>9</sup>)}  
= 1 - {(0.8)<sup>10</sup> + 2 × (0.8)<sup>9</sup>}  
= 1 - {(0.8)<sup>9</sup> (0.8 + 2)}  
= 1 - (0.8)<sup>9</sup> (2.8)  
= 1 - 0.3758  
= 0.6242

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	SI	ECTION - I	)				
21.	$p$ : switch $s_1$ is closed						[1 M]
	q : switch $s_2$ is closed						
	Symbolic form :						
	$(p \land {\sim} q) \lor ({\sim} p \land q) \lor ({\sim} p \land {\sim} q)$						[1 M]
	$= (p \land \neg q) \lor [(\neg p) \land (q \lor \neg q)]$	Distributiv	e law				
	$= (p \land \neg q) \lor [\neg p \land T]$	Compleme	ent law				
	$= (p \land \neg q) \lor \neg p$	Identity lav	V				
	$= (p \lor \neg p) \land (\neg q \lor \neg p)$	Distributiv	e law				
	$= T \land (\sim q \lor \sim p)$	Compleme	ent law				
	$= \sim q \lor \sim p$	Identity law	v				[1 M]
	$\therefore$ simplified form : $\sim q \lor \sim p$						
	S'2						
	S'1						
	S'1						[1 M]
22.	Let cost of one dozen pencil, pen and eraser	r are Rs x, y a	nd z.				
	Given that						
	4x + 3y + 2z = 60						
	2x + 4y + 6z = 90						
	6x + 2y + 3z = 70						
	Matrix form						
	$\begin{bmatrix} 4 & 3 & 2 \\ 2 & 4 & 6 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 60 \\ 90 \end{bmatrix}$						
	$\begin{vmatrix} 2 & 4 & 6 \end{vmatrix} \begin{vmatrix} y \end{vmatrix} = \begin{vmatrix} 90 \end{vmatrix}$						[1 M]
	$\begin{bmatrix} 6 & 2 & 3 \end{bmatrix} \begin{bmatrix} z \\ z \end{bmatrix} \begin{bmatrix} 70 \end{bmatrix}$						[]
	(1)						
	$\left(\frac{1}{4}R_{1}\right)$						
		R	2 2	4	6	90	
	$\begin{vmatrix} 1 & \frac{3}{4} & \frac{1}{2} \end{vmatrix} \begin{bmatrix} x \end{bmatrix} \begin{bmatrix} 15 \end{bmatrix}$		-2	3	-1	20	
	$\begin{vmatrix} 4 & 2 \\ 2 & 4 & 6 \end{vmatrix} \begin{vmatrix} x \\ y \end{vmatrix} = \begin{vmatrix} 10 \\ 90 \end{vmatrix}$	2R	-1 -2	$-\frac{3}{2}$	-1	-30	
	$\begin{bmatrix} 1 & \frac{3}{4} & \frac{1}{2} \\ 2 & 4 & 6 \\ 6 & 2 & 3 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 15 \\ 90 \\ 70 \end{bmatrix}$		0	$\frac{5}{2}$	5	60	
			0	2	5	00	[1M]
	$R_2 - 2R_1, R_3 - 6R_1$				1		
	$\begin{vmatrix} 1 & \frac{3}{4} & \frac{1}{2} \end{vmatrix}$	R	6	2	3	70	J
	$\begin{vmatrix} 4 & 2 \\ 5 & \end{vmatrix} x \begin{vmatrix} 15 \\ 15 \end{vmatrix}$	6R	1 -6	$-\frac{9}{2}$	-3	-90	
	$\begin{bmatrix} 1 & \frac{3}{4} & \frac{1}{2} \\ 0 & \frac{5}{2} & 5 \\ 0 & -\frac{5}{2} & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 15 \\ 60 \\ -20 \end{bmatrix}$						
	$\begin{bmatrix} 5 \\ -5 \end{bmatrix} \begin{bmatrix} z \\ -20 \end{bmatrix}$		0	$-\frac{5}{2}$	0	-20	
	$\begin{bmatrix} 0 & -\frac{1}{2} & 0 \end{bmatrix}$		-	2			
	5						
	$\mathbf{R}_3 + \frac{5}{2}\mathbf{R}_2$						
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	Guiu Aalikiali			10030		Juruan	

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$\begin{bmatrix} 1 & \frac{3}{4} & \frac{1}{2} \\ 0 & \frac{5}{2} & 5 \\ 0 & 0 & 5 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 15 \\ 60 \\ 40 \end{bmatrix}$	[1 M]
$\therefore x + \frac{3}{4}y + \frac{z}{2} = 15$ (1)	
$\frac{5}{2}y + 5z = 60 \qquad(2)$ $5z = 40 \qquad(3)$	
From (3) $\Rightarrow z = 8$ From (2)	
$\frac{5}{2}y + 40 = 60$	
$\frac{5}{2}y = 60 - 40$ $\frac{5}{2}y = 20$	
$\frac{1}{2}y = 20$ $y = \frac{40}{5} = 8$	
From (1)	
$x + \frac{3}{4} \times 8 + \frac{8}{2} = 15$ x + 6 + 4 = 15	
x + 10 = 15 x = 15 - 10 x = 5	
Thus cost of one dozen pencil, pen and eraser are Rs 5, 8 and 8 OR	3. [1 M]
Step 1: Standard form x + y + z = -1 x - y + z = 2 x + y - z = 3	
Step 2: Matrix form $ \begin{bmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix} $ A X = B(1)	[1 M]
$A = \begin{bmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{bmatrix}  X = \begin{bmatrix} x \\ y \\ z \end{bmatrix}  B = \begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix}$	[1 M]
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Step 3 : Calculation of A <sup>-1</sup>	
$ \mathbf{A}  = \begin{vmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{vmatrix}$	
= 1(1-1) - 1(-1-1) + 1(1+1)	
= 0 + 2 + 2	
= 4	
$\neq 0$	
(2) $\mathbf{A} \cdot \mathbf{A}^{-1} = \mathbf{I}$	
$\begin{bmatrix} 1 & 1 & 1 \\ 1 & -1 & 1 \\ 1 & 1 & -1 \end{bmatrix} \mathbf{A}^{-1} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$	
$\begin{bmatrix} 1 & -1 & 1 \\ 1 & 1 & 1 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}$	
$\begin{bmatrix} I & I & -I \end{bmatrix} \begin{bmatrix} 0 & 0 & I \end{bmatrix} \\ R_2 - R_1, R_3 - R_1$	
$\begin{vmatrix} 1 & 1 & 1 \\ 0 & -2 & 0 \end{vmatrix} A^{-1} = \begin{vmatrix} 1 & 0 & 0 \\ -1 & 1 & 0 \end{vmatrix}$	
$\begin{bmatrix} 1 & 1 & 1 \\ 0 & -2 & 0 \\ 0 & 0 & -2 \end{bmatrix} \mathbf{A}^{-1} = \begin{bmatrix} 1 & 0 & 0 \\ -1 & 1 & 0 \\ -1 & 0 & 1 \end{bmatrix}$	
$-\frac{1}{2}R_2, -\frac{1}{2}R_3$	
=	
$\begin{bmatrix} 1 & 1 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \mathbf{A}^{-1} = \begin{bmatrix} 1 & 0 & 0 \\ +\frac{1}{2} & -\frac{1}{2} & 0 \\ \frac{1}{2} & 0 & -\frac{1}{2} \end{bmatrix}$	
$\begin{vmatrix} 0 & 1 & 0 \end{vmatrix} A^{-1} = \begin{vmatrix} +\frac{1}{2} & -\frac{1}{2} & 0 \end{vmatrix}$	
$\begin{bmatrix} 0 & 0 & 1 \end{bmatrix}$ $\begin{bmatrix} 2 & 2 & 2 \\ 1 & 0 & 1 \end{bmatrix}$	
$\begin{bmatrix} \frac{1}{2} & 0 & -\frac{1}{2} \end{bmatrix}$	
$R_1 - R_2$ ,	
$\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \mathbf{A}^{-1} = \begin{bmatrix} \frac{1}{2} & +\frac{1}{2} & 0 \\ +\frac{1}{2} & -\frac{1}{2} & 0 \\ \frac{1}{2} & 0 & -\frac{1}{2} \end{bmatrix}$	
$\begin{bmatrix} 1 & 0 & 1 \end{bmatrix}$ $\begin{bmatrix} 2 & 2 \\ 1 & 1 \end{bmatrix}$	
$\begin{vmatrix} 0 & 1 & 0 \end{vmatrix} A^{-1} = \begin{vmatrix} +\frac{1}{2} & -\frac{1}{2} & 0 \end{vmatrix}$	
$\begin{bmatrix} -\frac{1}{2} & 0 & -\frac{1}{2} \end{bmatrix}$	
$R_{1} - R_{3}$	
$\begin{bmatrix} 0 & 1 & 1 \end{bmatrix}$	
$\begin{bmatrix} 1 & 0 & 0 \end{bmatrix}$ $\begin{bmatrix} 0 & \pm \frac{1}{2} & \pm \frac{1}{2} \end{bmatrix}$	
$\begin{vmatrix} 0 & 1 & 0 \end{vmatrix} A^{-1} = \begin{vmatrix} +\frac{1}{2} & -\frac{1}{2} & 0 \end{vmatrix}$	
	[1 M]
$\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \mathbf{A}^{-1} = \begin{bmatrix} 0 & +\frac{1}{2} & +\frac{1}{2} \\ +\frac{1}{2} & -\frac{1}{2} & 0 \\ \frac{1}{2} & 0 & -\frac{1}{2} \end{bmatrix}$	
$\begin{vmatrix} 0 & +\frac{1}{2} & \frac{1}{2} \end{vmatrix}$	
$A^{-1} = \begin{bmatrix} 1 & 1 & 0 \end{bmatrix}$	
$A = \begin{vmatrix} +\frac{1}{2} & -\frac{1}{2} & 0 \end{vmatrix}$	[1 M]
$\mathbf{A}^{-1} = \begin{bmatrix} 0 & +\frac{1}{2} & \frac{1}{2} \\ +\frac{1}{2} & -\frac{1}{2} & 0 \\ \frac{1}{2} & 0 & -\frac{1}{2} \end{bmatrix}$	- J
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$\begin{array}{c} \text{(3)}  \text{From}(1) \\  \text{A X} = \text{B} \end{array}$	
$A^{-1}AX = A^{-1}B$	
$X = A^{-1} B$	
$\begin{vmatrix} 0 & +\frac{1}{2} & \frac{1}{2} \end{vmatrix}$	
$\begin{vmatrix} 2 & 2 \\ 1 & 1 \end{vmatrix} \begin{bmatrix} -1 \end{bmatrix}$	
$= \begin{bmatrix} 0 & +\frac{1}{2} & \frac{1}{2} \\ +\frac{1}{2} & -\frac{1}{2} & 0 \\ \frac{1}{2} & 0 & -\frac{1}{2} \end{bmatrix} \begin{bmatrix} -1 \\ 2 \\ 3 \end{bmatrix}$	
$\begin{vmatrix} 1 \\ -1 \end{vmatrix} = 0 = -\frac{1}{2} \begin{vmatrix} 3 \\ -1 \end{vmatrix}$	
$\begin{bmatrix} 0 & \pm 1 & \frac{3}{2} \end{bmatrix}$	
$\begin{vmatrix} -\frac{1}{2} & -1 & +0 \end{vmatrix}$	
$= \begin{bmatrix} 0 & +1 & \frac{3}{2} \\ -\frac{1}{2} & -1 & +0 \\ -\frac{1}{2} & +0 & -\frac{3}{2} \end{bmatrix}$	
$\begin{bmatrix} 5\\ -5 \end{bmatrix}$	
$= \begin{bmatrix} \frac{5}{2} \\ -\frac{3}{2} \\ -2 \end{bmatrix}$	
$= \left  -\frac{3}{2} \right $	
$=\frac{5}{2}, y = -\frac{3}{2}, z = -2$	[1 M]
2 2 23. In $\triangle$ ABC, all angles are not obtuse.	
Let $\angle B$ be acute. There are three cases on $\angle C$ .	
(i) $\angle C$ can be acute (ii) $\angle C$ can be obtuse (iii) $\angle C = 90^{\circ}$ A A	
$B \xrightarrow{\square} C \qquad B \xrightarrow{\square} C \qquad B \xrightarrow{\square} D \qquad B \xrightarrow{\square} C = C$	D
(1) (2) (3) From $(1), (2)$ and $(3)$	
$\sin B = \frac{AD}{AB} \implies \sin B = \frac{AD}{c} \implies AD = c \sin B \qquad(1)$	[1 M]
From (1)	
$\sin C = \frac{AD}{AC} \implies \sin C = \frac{AD}{b} \implies AD = b \sin C \qquad(2)$	
AC b From (2)	
	·[1M]
From (3)	
$\sin C = \sin 90^{\circ} = \frac{AD}{AD} = \frac{AD}{AC} \implies \sin C = \frac{AD}{b} \implies AD = b \sin C  \dots (4)$	
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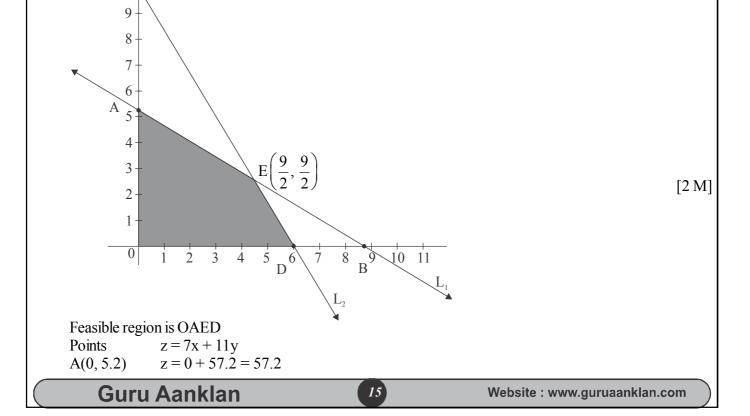
If we can show that $\frac{a}{\sin A} = \frac{b}{\sin B} \qquad(6)$ From (5) and (6) $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \qquad [1 M]$ 24. Given A( $\overline{a}$ ), B( $\overline{b}$ ), C( $\overline{c}$ ) and D( $\overline{d}$ ) are coplanar. $\Rightarrow \overline{AB} \overline{AC}$ and $\overline{AD}$ are coplanar. $\therefore [\overline{AB} \overline{AC} \overline{AD}] = 0 \qquad [1 M]$ $[\overline{b} - \overline{a} - \overline{c} - \overline{a} - \overline{d} - \overline{a}] = 0$ $[\overline{b} \ \overline{c} - \overline{a} \ \overline{d} - \overline{a}] - [\overline{b} \ \overline{a} \ \overline{d} - \overline{a}] - [\overline{a} \ \overline{c} - \overline{a}] + [\overline{a} \ \overline{a} \ \overline{d} - \overline{a}] = 0$ $[\overline{b} \ \overline{c} - \overline{a} \ \overline{d} - \overline{a}] - [\overline{b} \ \overline{c} \ \overline{a}] - [\overline{b} \ \overline{a} \ \overline{d}] + [\overline{b} \ \overline{a} \ \overline{a}]$ $- [\overline{a} \ \overline{c} \ \overline{d}] + [\overline{a} \ \overline{c} \ \overline{a}] + [\overline{a} \ \overline{a} \ \overline{d} - \overline{a}] = 0$ $[\overline{b} \ \overline{c} \ \overline{d}] - [\overline{b} \ \overline{c} \ \overline{a}] - [\overline{b} \ \overline{a} \ \overline{d}] - 0 - [\overline{a} \ \overline{c} \ \overline{d}] + 0 + 0 = 0 \qquad [1 M]$ $[\overline{b} \ \overline{c} \ \overline{d}] + [\overline{a} \ \overline{b} \ \overline{d}] + [\overline{c} \ \overline{a} \ \overline{d}] = [\overline{b} \ \overline{c} \ \overline{a}]$ $[\overline{b} \ \overline{c} \ \overline{d}] + [\overline{a} \ \overline{b} \ \overline{d}] + [\overline{c} \ \overline{a} \ \overline{d}] = [\overline{b} \ \overline{c} \ \overline{a}]$ $[\overline{b} \ \overline{c} \ \overline{d}] + [\overline{a} \ \overline{b} \ \overline{d}] + [\overline{c} \ \overline{a} \ \overline{d}] = [\overline{b} \ \overline{c} \ \overline{a}]$ $[\overline{b} \ \overline{c} \ \overline{d}] + [\overline{a} \ \overline{b} \ \overline{d}] + [\overline{c} \ \overline{a} \ \overline{d}] = [\overline{b} \ \overline{c} \ \overline{a}]$ $[\overline{b} \ \overline{c} \ \overline{d}] + [\overline{a} \ \overline{b} \ \overline{d}] + [\overline{c} \ \overline{a} \ \overline{d}] = [\overline{a} \ \overline{b} \ \overline{c}]$ [1 M] $Let A, B and C be the vertices of a triangle. Let AD, BE and CF be the calitudes of the triangle ABC, therefore AD L BC, BF \perp AC, CF \perp AB.[1 M]Let \overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{c}, \overline{BF} \perp AC(1)To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passesthrough the point P We will have to prove that \overline{CF} and \overline{CP} are collinear vectors. This can be achieved byshowing \overline{CP} and \overline{AP}.Now from (1) we have\overline{AP} \perp BC and \overline{BP} \perp \overline{AC}\overline{AP} \cdot BC = 0 and \overline{BP} + \overline{AC}$	GuruAanklan / HSC Examination / Grand Test / Maths Code / Set-A / Soluti	ons
$\ _{\mathbf{y}} \text{ we can show that} \qquad \frac{\mathbf{a}}{\sin \mathbf{A}} = \frac{\mathbf{b}}{\sin \mathbf{B}} \qquad \dots (6)$ From (S) and (6) $\frac{\mathbf{a}}{\sin \mathbf{A}} = \frac{\mathbf{b}}{\sin \mathbf{B}} = \frac{\mathbf{c}}{\sin \mathbf{C}} \qquad $	From (1), (2), (3) and (4)	
$\frac{a}{\sin A} = \frac{b}{\sin B} \qquad(6)$ From (5) and (6) $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \qquad [1 M]$ 24. Given A( $\overline{a}$ ), B( $\overline{b}$ ), C( $\overline{c}$ ) and D( $\overline{d}$ ) are coplanar. $\Rightarrow \overline{AB} \overline{AC} \text{ and } \overline{AD} \text{ are coplanar.}$ $\therefore [\overline{AB} \overline{AC} \overline{AD}] = 0 \qquad [1 M]$ [ $\overline{b} - \overline{a}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] = 0$ [ $\overline{b}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] - [\overline{a}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] = 0$ [ $\overline{b}  \overline{c}  \overline{a} - \overline{a}] - [\overline{b}  \overline{a}  \overline{d} - \overline{a}] - [\overline{a}  \overline{c}  \overline{d} - \overline{a}] + [\overline{a}  \overline{a}  \overline{d} - \overline{a}] = 0$ [ $\overline{b}  \overline{c}  \overline{d} - \overline{a}] - [\overline{b}  \overline{c}  \overline{d}] - [\overline{b}  \overline{c}  \overline{d}] + [\overline{b}  \overline{a}  \overline{a}]$ $- [\overline{a}  \overline{c}  \overline{d}] + [\overline{a}  \overline{c}  \overline{a}] + [\overline{a}  \overline{a}  \overline{d} - \overline{a}] = 0$ [ $\overline{b}  \overline{c}  \overline{d}] - [\overline{b}  \overline{c}  \overline{a}] - [\overline{b}  \overline{a}  \overline{d}] - 0 - [\overline{a}  \overline{c}  \overline{d}] + 0 + 0 = 0$ [ $\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{b}  \overline{c}  \overline{a}]$ [ $\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{b}  \overline{c}  \overline{a}]$ [ $\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{b}  \overline{c}  \overline{a}]$ [ $\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{b}  \overline{c}  \overline{a}]$ [Let A, B and C be the vertices of a triangle. Let AD, BE and CF be the altitudes of the triangle ABC, therefore AD \perp BC, BF \perp AC, CF \perp AB. [I M] Therefore $\overline{AD} \perp BC, \overline{BF} \perp A\overline{C}$ (1) To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude F passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ . Now from (1) we have $\overline{AP} \perp BC and \overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0 \text{ and } \overline{BP} \cdot \overline{AC} = 0$ ([1 M])	$c \sin B = b \sin C \implies \frac{b}{\sin B} = \frac{c}{\sin C} \qquad(5)$	[1 M]
From (5) and (6) $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ [1 M] 24. Given A( $\bar{a}$ ), B( $\bar{b}$ ), C( $\bar{c}$ ) and D( $\bar{d}$ ) are coplanar. $\Rightarrow \overline{AB} \overline{AC} \text{ and } \overline{AD} \text{ are coplanar.}$ $\therefore [AB \overline{AC} \overline{AD}] = 0$ [ $\bar{b} - \bar{a} - \bar{a} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{a} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{c} - \bar{c}$ [ $\bar{b} - \bar{c} - \bar{c} - \bar{c} - \bar{c}$ ] [ $\bar{b} - \bar{c} - \bar{c} - \bar{c} - \bar{c} - \bar{c} - \bar{c}$ [ $\bar{b} - \bar{c} - $	$  _{y}$ we can show that	
From (5) and (6) $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ [1 M] 24. Given A( $\bar{a}$ ), B( $\bar{b}$ ), C( $\bar{c}$ ) and D( $\bar{d}$ ) are coplanar. $\Rightarrow \overline{AB} \overline{AC} \text{ and } \overline{AD} \text{ are coplanar.}$ $\therefore [AB \overline{AC} \overline{AD}] = 0$ [ $\bar{b} - \bar{a} - \bar{a} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{a} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{a} - \bar{a} = 0$ [ $\bar{b} - \bar{c} - \bar{c} - \bar{c}$ [ $\bar{b} - \bar{c} - \bar{c} - \bar{c} - \bar{c}$ ] [ $\bar{b} - \bar{c} - \bar{c} - \bar{c} - \bar{c} - \bar{c} - \bar{c}$ [ $\bar{b} - \bar{c} - $	$\frac{a}{a} = \frac{b}{a}$	
$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$ [1 M] 24. Given A( $\overline{a}$ ), B( $\overline{b}$ ), C( $\overline{c}$ ) and D( $\overline{d}$ ) are coplanar. $\Rightarrow \overline{AB} \overline{AC} \text{ and } \overline{AD} \text{ are coplanar.}$ $\therefore [AB \overline{AC} \overline{AD}] = 0$ [1 M] $[\overline{b} - \overline{a}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] = 0$ [ $\overline{b}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] = 0$ [ $\overline{b}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] - [\overline{a}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] = 0$ [ $\overline{b}  \overline{c}  \overline{d} - \overline{a}] - [\overline{b}  \overline{a}  \overline{d} - \overline{a}] - [\overline{a}  \overline{c}  \overline{d} - \overline{a}] + [\overline{a}  \overline{a}  \overline{d} - \overline{a}] = 0$ [ $\overline{b}  \overline{c}  \overline{d}] - [\overline{b}  \overline{c}  \overline{a}] - [\overline{b}  \overline{a}  \overline{d}] + [\overline{b}  \overline{a}  \overline{a}]$ $- [\overline{a}  \overline{c}  \overline{d}] + [\overline{a}  \overline{c}  \overline{a}] + [\overline{a}  \overline{a}  \overline{d} - \overline{a}] = 0$ [ $\overline{b}  \overline{c}  \overline{d}] - [\overline{b}  \overline{c}  \overline{a}] - [\overline{b}  \overline{a}  \overline{d}] - 0 - [\overline{a}  \overline{c}  \overline{d}] + 0 + 0 = 0$ [ $1M$ ] [ $\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{b}  \overline{c}  \overline{a}]$ [ $\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{a}  \overline{b}  \overline{c}]$ [1 M] [ $\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{a}  \overline{b}  \overline{c}]$ [1 M] [ $\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{a}  \overline{b}  \overline{c}]$ [1 M] [Let A, B and C be the vertices of a triangle. Let AD, BF and CF be the abitudes of the triangle ABC, therefore AD \perp BC, BF \perp AC, CF \perp AB. [1 M] Let $\overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{c}, \overline{f}$ be the position vectors of A, B, C, D, F, F respectively. Let P be the point of intersection of the altitudes AD BE with $\overline{P} \ abt = abtitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that \overline{CF} \ and \overline{CP} \ ac collinear vectors. This can be achieved by showing \overline{CP} \ ad \overline{AP}.Now from (1) we have\overline{AP} \perp BC \ ad \overline{BP} \perp \overline{AC} \overline{AP} \cdot \overline{BC} = 0 (\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0 [1 M]$		
24. Given A(a), B(b), C(c) and D(d) are coplanar. $\Rightarrow \overline{AB} \overline{AC} \text{ and } \overline{AD} \text{ are coplanar.}$ $\therefore [\overline{AB} \overline{AC} \overline{AD}] = 0 \qquad [1 M]$ $[\overline{b} - \overline{a} - \overline{c} - \overline{a} - \overline{d} - \overline{a}] = 0$ $[\overline{b} - \overline{c} - \overline{a} - \overline{d} - \overline{a}] - [\overline{b} - \overline{a} - \overline{c} - \overline{a} - \overline{d} - \overline{a}] = 0$ $[\overline{b} - \overline{c} - \overline{a} - \overline{a}] - [\overline{b} - \overline{a} - \overline{a}] - [\overline{a} - \overline{c} - \overline{a} - \overline{d} - \overline{a}] = 0$ $[\overline{b} - \overline{c} - \overline{a}] - [\overline{b} - \overline{c} - \overline{a}] - [\overline{b} - \overline{a} - \overline{a}] - [\overline{a} - \overline{c} - \overline{a}] + [\overline{a} - \overline{a} - \overline{a}] = 0$ $[\overline{b} - \overline{c} - \overline{a}] - [\overline{b} - \overline{c} - \overline{a}] - [\overline{b} - \overline{a} - \overline{a}] + [\overline{a} - \overline{a}] + [\overline{a} - \overline{a} - \overline{a}] = 0$ $[\overline{b} - \overline{c} - \overline{a}] - [\overline{b} - \overline{c} - \overline{a}] - [\overline{b} - \overline{a} - \overline{a}] - 0 - [\overline{a} - \overline{c} - \overline{a}] + [\overline{a} - \overline{a} - \overline{a}] = 0$ $[\overline{b} - \overline{c} - \overline{a}] - [\overline{b} - \overline{c} - \overline{a}] - [\overline{b} - \overline{a} - \overline{a}] - 0 - [\overline{a} - \overline{c} - \overline{a}] + 0 + 0 = 0$ $[1 M]$ $[\overline{b} - \overline{c} - \overline{d}] + [\overline{a} - \overline{b} - \overline{d}] + [\overline{c} - \overline{a} - \overline{d}] = [\overline{b} - \overline{c} - \overline{a}]$ $[\overline{b} - \overline{c} - \overline{d}] + [\overline{a} - \overline{b} - \overline{d}] + [\overline{c} - \overline{a} - \overline{d}] = [\overline{a} - \overline{b} - \overline{c}]$ $[1 M]$ $CR$ Let A, B and C be the vertices of a triangle. Let A, B and C be the vertices of a triangle. Let A, B and C be the vertices of A B, C, D, E, F respectively. Let P be the position vectors of A, B, C, D, E, F respectively. Let P be the position vectors of A, B, C, D, E, F respectively. Let P be the position vectors of A, B, C, D, E, F respectively. Let P be the position vectors of A, B, C, D, E, F respectively. Let P be the position vectors of A, B, C, D, E, F respectively. Let P be the position vectors of A, B, C, D, E, F respectively. Let P be the position vectors of A, B, C, D, E, F respectively. Let P be the position vectors of A, B, C, D, E, F respectively. Let P be the point of intersection of the altitudes AD BE with $\overline{P}$ as the position vectors. [1 M] To show that the altitude AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing		
$\Rightarrow \overline{AB} \overline{AC} \text{ and } \overline{AD} \text{ are coplanar.}$ $\therefore [\overline{AB} \overline{AC} \overline{AD}] = 0 \qquad [1 M]$ $[\overline{b} - \overline{a}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] = 0 \qquad [1 M]$ $[\overline{b} - \overline{a}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] - [\overline{b}  \overline{a}  \overline{c} - \overline{a}  \overline{d} - \overline{a}] = 0 \qquad [1 M]$ $[\overline{b}  \overline{c}  \overline{d} - \overline{a}] - [\overline{b}  \overline{c}  \overline{a}] - [\overline{b}  \overline{a}  \overline{d} - \overline{a}] - [\overline{a}  \overline{c}  \overline{d} - \overline{a}] + [\overline{a}  \overline{a}  \overline{d} - \overline{a}] = 0 \qquad [1 M]$ $[\overline{b}  \overline{c}  \overline{d}] - [\overline{b}  \overline{c}  \overline{a}] - [\overline{b}  \overline{a}  \overline{d}] + [\overline{b}  \overline{a}  \overline{a}] \qquad - [\overline{a}  \overline{c}  \overline{d}] + [\overline{a}  \overline{c}  \overline{a}] + [\overline{a}  \overline{a}  \overline{d} - \overline{a}] = 0 \qquad [1 M]$ $[\overline{b}  \overline{c}  \overline{d}] - [\overline{b}  \overline{c}  \overline{a}] - [\overline{b}  \overline{a}  \overline{d}] - 0 - [\overline{a}  \overline{c}  \overline{d}] + 0 + 0 = 0 \qquad [1 M]$ $[\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{b}  \overline{c}  \overline{a}] \qquad [1 M]$ $[\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{a}  \overline{b}  \overline{c}] \qquad [1 M]$ $[\overline{b}  \overline{c}  \overline{d}] + [\overline{a}  \overline{b}  \overline{d}] + [\overline{c}  \overline{a}  \overline{d}] = [\overline{a}  \overline{b}  \overline{c}] \qquad [1 M]$ $Let A, B and C be the vertices of a triangle.$ $Let AD, BE and CF be the abitive so the triangle ABC, therefore AD \perp BC, BF \perp AC, CF \perp AB. \qquad [1 M]$ $Let \overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{e}, \overline{f}$ be the position vectors of A, B, C, D, E, F respectively. Let P be the point of intersection of the altitudes AD BE with \overline{P} as the position vectors. \qquad [1 M] $Therefore \overline{AP} \perp \overline{BC}, \overline{BP} \perp \overline{AC} \qquad(1)$ To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ . Now from (1) we have $\overline{AP} \perp \overline{BC} \text{ and } \overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0 \text{ and } \overline{BP} \cdot \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ $[1 M]$	$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$	[1 M]
$ \therefore \left[\overline{AB} \ \overline{AC} \ \overline{AD}\right] = 0 $ $ \left[1 \ M\right] $ $ \left[\overline{b} - \overline{a}  \overline{c} - \overline{a}  \overline{d} - \overline{a}\right] = 0 $ $ \left[\overline{b}  \overline{c} - \overline{a}  \overline{d} - \overline{a}\right] - \left[\overline{a}  \overline{c} - \overline{a}  \overline{d} - \overline{a}\right] = 0 $ $ \left[\overline{b}  \overline{c} - \overline{a}  \overline{d} - \overline{a}\right] - \left[\overline{b}  \overline{a}  \overline{d} - \overline{a}\right] - \left[\overline{a}  \overline{c}  \overline{d} - \overline{a}\right] + \left[\overline{a}  \overline{a}  \overline{d} - \overline{a}\right] = 0 $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] - \left[\overline{b}  \overline{c}  \overline{a}\right] - \left[\overline{b}  \overline{a}  \overline{d}\right] + \left[\overline{a}  \overline{c}  \overline{a}\right] + \left[\overline{a}  \overline{a}  \overline{d} - \overline{a}\right] = 0 $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] - \left[\overline{b}  \overline{c}  \overline{a}\right] - \left[\overline{b}  \overline{a}  \overline{d}\right] + \left[\overline{a}  \overline{c}  \overline{a}\right] + \left[\overline{a}  \overline{a}  \overline{d} - \overline{a}\right] = 0 $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] - \left[\overline{b}  \overline{c}  \overline{a}\right] - \left[\overline{b}  \overline{a}  \overline{d}\right] - 0 - \left[\overline{a}  \overline{c}  \overline{d}\right] + 0 + 0 = 0 $ $ \left[1 \ M\right] $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] + \left[\overline{a}  \overline{b}  \overline{d}\right] + \left[\overline{c}  \overline{a}  \overline{d}\right] = \left[\overline{b}  \overline{c}  \overline{a}\right] $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] + \left[\overline{a}  \overline{b}  \overline{d}\right] + \left[\overline{c}  \overline{a}  \overline{d}\right] = \left[\overline{a}  \overline{b}  \overline{c}\right] $ $ \left[1 \ M\right] $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] + \left[\overline{a}  \overline{b}  \overline{d}\right] + \left[\overline{c}  \overline{a}  \overline{d}\right] = \left[\overline{a}  \overline{b}  \overline{c}\right] $ $ \left[1 \ M\right] $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] + \left[\overline{a}  \overline{b}  \overline{d}\right] + \left[\overline{c}  \overline{a}  \overline{d}\right] = \left[\overline{a}  \overline{b}  \overline{c}\right] $ $ \left[1 \ M\right] $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] + \left[\overline{a}  \overline{b}  \overline{d}\right] + \left[\overline{c}  \overline{a}  \overline{d}\right] = \left[\overline{a}  \overline{b}  \overline{c}\right] $ $ \left[1 \ M\right] $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] + \left[\overline{a}  \overline{b}  \overline{d}\right] + \left[\overline{c}  \overline{a}  \overline{d}\right] = \left[\overline{a}  \overline{b}  \overline{c}\right] $ $ \left[1 \ M\right] $ $ \left[\overline{b}  \overline{c}  \overline{d}\right] + \left[\overline{b}  \overline{c}  \overline{B}\right] + \overline{AC} $ $ \dots (1) $ $ To show that the altitudes of the triangle ABC, therefore \overline{AP} \perp BC, BP \perp \overline{AC}   AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that \overline{CF} \text{ and } \overline{CP} are collinear vectors. This can be achieved by showing \overline{CP} and \overline{AP}. Now from (1) we have  \overline{AP} \perp \overline{BC} = 0 \text{ and } \overline{BP} \perp \overline{AC} = 0   \left(\overline{p} - \overline{a} \cdot (\overline{c} - \overline{b}) = 0   \left[1 \ M\right]$	24. Given $A(\overline{a})$ , $B(\overline{b})$ , $C(\overline{c})$ and $D(\overline{d})$ are coplanar.	
$\begin{bmatrix} \overline{b} - \overline{a} & \overline{c} - \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} - \overline{a} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{a} & \overline{c} - \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{a} & \overline{c} & \overline{d} - \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} &$	$\Rightarrow \overline{AB} \overline{AC}$ and $\overline{AD}$ are coplanar.	
$\begin{bmatrix} \overline{b} - \overline{a} & \overline{c} - \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} - \overline{a} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{a} & \overline{c} - \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{a} & \overline{c} & \overline{d} - \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} 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$\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} 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\overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{c} &$	$\therefore  \left\lceil \overline{AB} \ \overline{AC} \ \overline{AD} \right\rceil = 0$	[1 M]
$\begin{bmatrix} \overline{b} & \overline{c} - \overline{a} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{a} & \overline{c} - \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{a} & \overline{c} & \overline{d} - \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0  [1 M]$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{a} & \overline{b} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} 1 M \end{bmatrix}$ $\begin{bmatrix} Et A, B and C b the vertices of a triangle.$ Let AD, BE and CF be the altitudes of the triangle ABC, therefore AD $\perp BC$ , BF $\perp AC$ , CF $\perp AB$ . [1 M] Let $\overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{c}, \overline{f}$ be the position vectors of A, B, C, D, E, F respectively. Let P be the point of intersection of the altitudes AD BE with $\overline{P}$ as the position vectors. [1 M] Therefore $\overline{AP} \perp \overline{BC}$ , $\overline{BP} \perp \overline{AC}$ (1) To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ . Now from (1) we have $\overline{AP} \perp \overline{BC}$ and $\overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0$ and $\overline{BP} \cdot \overline{AC} = 0$ [1 M]		
$\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{a} & \overline{c} & \overline{d} - \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0  [1 \text{ M}]$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{b} & \overline{a} & \overline{a} \end{bmatrix}$ $-\begin{bmatrix} \overline{a} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} - 0 - \begin{bmatrix} \overline{a} & \overline{c} & \overline{d} \end{bmatrix} + 0 + 0 = 0  [1 \text{ M}]$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{a} & \overline{b} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{a} & \overline{b} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} 1 \text{ M} \end{bmatrix}$ $\begin{bmatrix} Let A, B and C be the vertices of a triangle.$ $Let A, B and C be the vertices of a triangle.$ $Let A, B and C be the vertices of a triangle.$ $Let A, B and C be the vertices of a triangle.$ $Let A, B and C be the vertices of a triangle.$ $Let A, B and C be the vertices of a triangle.$ $Let A, B and C be the vertices of a triangle.$ $Let A, B and C be the vertices of a triangle.$ $Let A, B and C be the vertices of a triangle.$ $Let A, B and C be the vertices of a triangle.$ $I M \end{bmatrix}$ $Let \overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{e}, \overline{f}$ be the position vectors of A, B, C, D, E, F respectively. Let P be the point of intersection of the altitudes AD BE with \overline{P} as the position vectors. $[1 M]$ $Therefore \overline{AP} \perp \overline{BC}, \overline{BP} \perp \overline{AC} \qquad(1)$ To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ . Now from (1) we have $\overline{AP} \perp \overline{BC} = 0 \text{ and } \overline{BP} \perp \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ $[1 M]$		
$\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{b} & \overline{a} & \overline{a} \end{bmatrix} \\ -\begin{bmatrix} \overline{a} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} = 0 \\ \begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} \\ \begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{a} & \overline{b} & \overline{c} \end{bmatrix} $ $\begin{bmatrix} 1 M \end{bmatrix} \\ \begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{a} & \overline{b} & \overline{c} \end{bmatrix} $ $\begin{bmatrix} 1 M \end{bmatrix} \\ \begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} 1 M \end{bmatrix} \\ \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} 1 M \end{bmatrix} \\ \end{bmatrix} $ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} 1 M \end{bmatrix} \\ \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} $ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} $ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} $ $\begin{bmatrix} \overline{c} & \overline{c} & \overline{c} \end{bmatrix} = \begin{bmatrix} \overline{c} & \overline{c} & $		_] _ [] ]
$-\begin{bmatrix} \overline{a} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} & \overline{d} - \overline{a} \end{bmatrix} = 0$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} - 0 - \begin{bmatrix} \overline{a} & \overline{c} & \overline{d} \end{bmatrix} + 0 + 0 = 0 \qquad [1 M]$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{a} & \overline{b} & \overline{c} \end{bmatrix} \qquad [1 M]$ $\begin{bmatrix} Let A, B and C be the vertices of a triangle. \\ \text{Let AD, BE and CF be the altitudes of the triangle ABC, \\ \text{therefore AD \perp BC, BF \perp AC, CF \perp AB. [1 M]Let \overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{e}, \overline{f} be the position vectors of A, B, C, D, E, Frespectively. Let P be the point of intersection of the altitudes AD BEwith \overline{P} as the position vectors. [1 M]Therefore \overline{AP} \perp \overline{BC}, \overline{BP} \perp \overline{AC}(1)To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passesthrough the point P. We will have to prove that \overline{CF} and \overline{CP} are collinear vectors. This can be achieved byshowing \overline{CP} and \overline{AP}.Now from (1) we have\overline{AP} \perp \overline{BC} and \overline{BP} \perp \overline{AC} = 0(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0 [1 M]$		$-\overline{a} = 0 [IM]$
$\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} - 0 - \begin{bmatrix} \overline{a} & \overline{c} & \overline{d} \end{bmatrix} + 0 + 0 = 0 $ [1 M] $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{a} & \overline{b} & \overline{c} \end{bmatrix}$ [1 M] $\begin{bmatrix} \text{Let A, B and C be the vertices of a triangle.}$ Let AD, BE and CF be the altitudes of the triangle ABC, therefore AD $\perp$ BC, BF $\perp$ AC, CF $\perp$ AB. (1 M] Let $\overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{e}, \overline{f}$ be the position vectors of A, B, C, D, E, F respectively. Let P be the point of intersection of the altitudes AD BE with $\overline{P}$ as the position vectors. [1 M] Therefore $\overline{AP} \perp \overline{BC}, \overline{BP} \perp \overline{AC}$ (1) To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ . Now from (1) we have $\overline{AP} \perp \overline{BC}$ and $\overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0$ and $\overline{BP} \cdot \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ [1 M]		
$\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$ $\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{a} & \overline{b} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} 1 M \end{bmatrix}$ $\begin{bmatrix} \text{Let } A, B \text{ and } C \text{ be the vertices of a triangle.}$ $\begin{bmatrix} \text{Let } AD, BE \text{ and } CF \text{ be the altitudes of the triangle ABC, therefore AD \perp BC, BF \perp AC, CF \perp AB. [1 M] \begin{bmatrix} \text{Let } \overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{e}, \overline{f} \text{ be the position vectors of A, B, C, D, E, F \\ \text{respectively. Let P be the point of intersection of the altitudes AD BE \\ \text{with } \overline{P} \text{ as the position vectors.} [1 M] Therefore \overline{AP} \perp \overline{BC}, \overline{BP} \perp \overline{AC} \qquad(1) To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that \overline{CF} and \overline{CP} are collinear vectors. This can be achieved by showing \overline{CP} and \overline{AP}. Now from (1) we have \overline{AP} \perp \overline{BC} \text{ and } \overline{BP} \perp \overline{AC} = 0 (\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0 \begin{bmatrix} 1 M \end{bmatrix}$	$-\begin{bmatrix} \overline{a} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{c} & \overline{a} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{a} \end{bmatrix}$	$\overline{\mathbf{d}} - \overline{\mathbf{a}} \right] = 0$
$\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{a} & \overline{b} & \overline{c} \end{bmatrix}$ $\begin{bmatrix} 1 \text{ M} \end{bmatrix}$ $\begin{bmatrix} \text{Let A, B and C be the vertices of a triangle.} \\ \text{Let AD, BE and CF be the altitudes of the triangle ABC, therefore AD \perp BC, BF \perp AC, CF \perp AB. \begin{bmatrix} 1 \text{ M} \end{bmatrix} \begin{bmatrix} \text{Let } \overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{e}, \overline{f} \text{ be the position vectors of A, B, C, D, E, F } \\ \text{respectively. Let P be the point of intersection of the altitudes AD BE with \overline{P} as the position vectors. \begin{bmatrix} 1 \text{ M} \end{bmatrix} \begin{bmatrix} \text{Therefore } \overline{AP} \perp \overline{BC}, \overline{BP} \perp \overline{AC} \\ \text{Therefore } \overline{AP} \perp \overline{BC}, \overline{BP} \perp \overline{AC} \\ \text{Though the point P. We will have to prove that } \overline{CF} \text{ and } \overline{CP} \text{ are collinear vectors. This can be achieved by showing } \overline{CP} \text{ and } \overline{AP}. Now from (1) we have \overline{AP} \perp \overline{BC} = 0 \text{ and } \overline{BP} \perp \overline{AC} = 0 (\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0 \begin{bmatrix} 1 \text{ M} \end{bmatrix}$	$\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix} - \begin{bmatrix} \overline{b} & \overline{a} & \overline{d} \end{bmatrix} - 0 - \begin{bmatrix} \overline{a} & \overline{c} & \overline{d} \end{bmatrix} + 0 + 0$	0 = 0 [1 M]
ORLet A, B and C be the vertices of a triangle.Let AD, BE and CF be the altitudes of the triangle ABC, therefore AD $\perp$ BC, BF $\perp$ AC, CF $\perp$ AB.[1 M]Let $\overline{a}, \overline{b}, \overline{c}, \overline{d}, \overline{e}, \overline{f}$ be the position vectors of A, B, C, D, E, F respectively. Let P be the point of intersection of the altitudes AD BE with $\overline{P}$ as the position vectors.[1 M]Therefore $\overline{AP} \perp \overline{BC}, \overline{BP} \perp \overline{AC}$ (1)To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ .Now from (1) we have $\overline{AP} \perp \overline{BC}$ and $\overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0$ and $\overline{BP} \cdot \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$	$\begin{bmatrix} \overline{b} & \overline{c} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{a} & \overline{b} & \overline{d} \end{bmatrix} + \begin{bmatrix} \overline{c} & \overline{a} & \overline{d} \end{bmatrix} = \begin{bmatrix} \overline{b} & \overline{c} & \overline{a} \end{bmatrix}$	
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therefore $AD \perp BC$ , $BF \perp AC$ , $CF \perp AB$ . [1 M] Let $\overline{a}$ , $\overline{b}$ , $\overline{c}$ , $\overline{d}$ , $\overline{e}$ , $\overline{f}$ be the position vectors of A, B, C, D, E, F respectively. Let P be the point of intersection of the altitudes AD BE with $\overline{P}$ as the position vectors. [1 M] Therefore $\overline{AP} \perp \overline{BC}$ , $\overline{BP} \perp \overline{AC}$ (1) To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ . Now from (1) we have $\overline{AP} \perp \overline{BC}$ and $\overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0$ and $\overline{BP} \cdot \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ [1 M]		
Let $\overline{a}$ , $\overline{b}$ , $\overline{c}$ , $\overline{d}$ , $\overline{e}$ , $\overline{f}$ be the position vectors of A, B, C, D, E, F respectively. Let P be the point of intersection of the altitudes AD BE with $\overline{P}$ as the position vectors. [1 M] Therefore $\overline{AP} \perp \overline{BC}$ , $\overline{BP} \perp \overline{AC}$ (1) To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ . Now from (1) we have $\overline{AP} \perp \overline{BC}$ and $\overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0$ and $\overline{BP} \perp \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ [1 M]	therefore $AD \mid BC \mid BE \mid AC \mid CE \mid AB$ [1 M]	
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Therefore $\overline{AP} \perp \overline{BC}$ , $\overline{BP} \perp \overline{AC}$ (1) To show that the altitudes AD, BE and CF are concurrent, It is sufficient to show that the altitude CF passes through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ . Now from (1) we have $\overline{AP} \perp \overline{BC}$ and $\overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0$ and $\overline{BP} \cdot \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ [1 M]	with $\overline{P}$ as the position vectors. [1 M]	F B
through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can be achieved by showing $\overline{CP}$ and $\overline{AP}$ . Now from (1) we have $\overline{AP} \perp \overline{BC}$ and $\overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0$ and $\overline{BP} \cdot \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ [1 M]		_ D
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Now from (1) we have $\overline{AP} \perp \overline{BC} \text{ and } \overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0 \text{ and } \overline{BP} \cdot \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ [1 M]	through the point P. We will have to prove that $\overline{CF}$ and $\overline{CP}$ are collinear vectors. This can	an be achieved by
$\overline{AP} \perp \overline{BC} \text{ and } \overline{BP} \perp \overline{AC}$ $\overline{AP} \cdot \overline{BC} = 0 \text{ and } \overline{BP} \cdot \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ [1 M]		
$\overline{AP} \cdot \overline{BC} = 0 \text{ and } \overline{BP} \cdot \overline{AC} = 0$ $(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ [1 M]		
$(\overline{p} - \overline{a}) \cdot (\overline{c} - \overline{b}) = 0$ [1 M]		
Guru Aanklan 14 Website : www.guruaanklan.com	$(\mathbf{p}-\overline{\mathbf{a}})\cdot(\overline{\mathbf{c}}-\overline{\mathbf{b}})=0$	[1 M]
	Guru Aanklan 14 Website : www.guru	aanklan.com

# GuruAanklan / HSC Examination / Grand Test / Maths Code / Set-A / Solutions $(\overline{p} - \overline{b}) \cdot (\overline{c} - \overline{a}) = 0$ $\overline{p} \cdot \overline{c} - \overline{p} \cdot \overline{b} - \overline{a} \cdot \overline{c} + \overline{a} \cdot \overline{b} = 0 \qquad ...(2)$ $\overline{p} \cdot \overline{c} - \overline{p} \cdot \overline{a} - \overline{b} \cdot \overline{c} + \overline{b} \cdot \overline{a} = 0 \qquad ...(3)$ Therefore, subtracting equation (2) from equation (3), we get, $-\overline{p} \cdot \overline{a} + \overline{p} \cdot \overline{b} - \overline{b} \cdot \overline{c} + \overline{a} \cdot \overline{c} = 0$ $\overline{p}(\overline{b} - \overline{a}) - \overline{c}(\overline{b} - \overline{a}) = 0$ $(\overline{p} - \overline{c}) \cdot (\overline{b} - \overline{a}) = 0$ $\overline{CP} \cdot \overline{AB} = 0$ $\overline{CP} \perp \overline{AB}$ Hence the proof. Step 1 :

25. Ste

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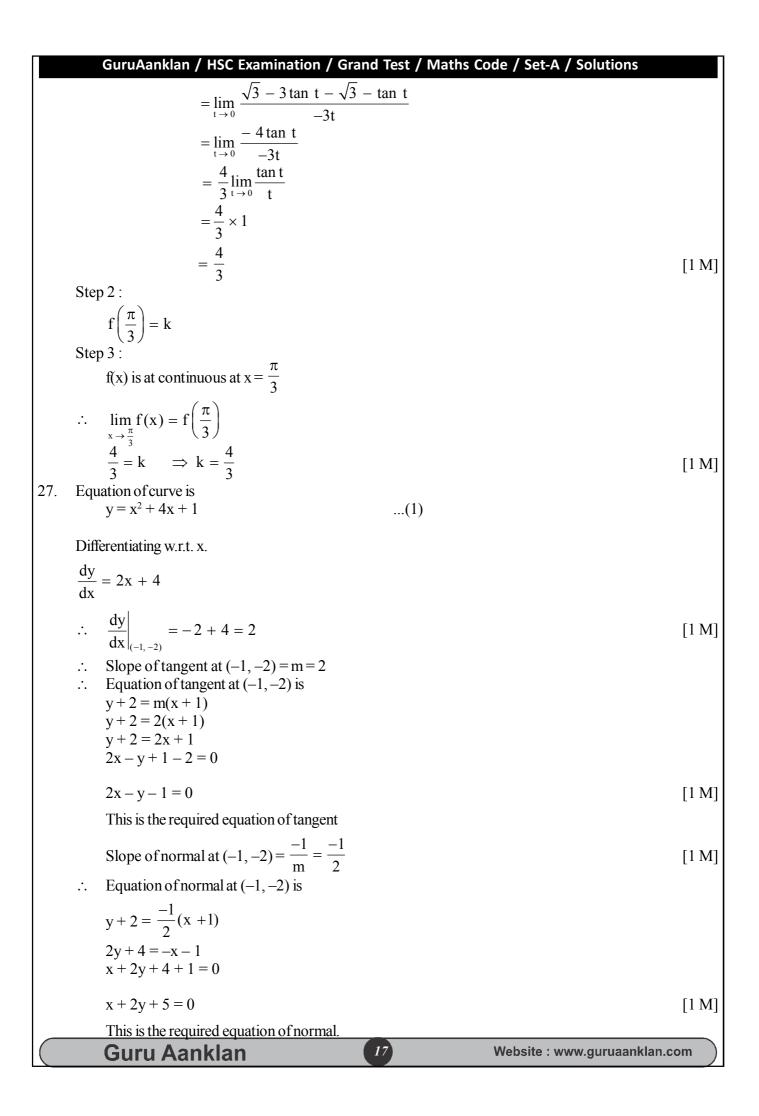
Inequation	Equation	Points	Region
$3x + 5y \le 26$	$3x + 5y = 26$ $L_1$	$ \begin{array}{ c c c c c c c c } \hline x & 0 & 8.6 \\ \hline y & 5.2 & 0 \\ \hline (x, y) & (0, 5.2) & (8.6, 0) \\ \hline A & B \\ \hline \end{array} $	Towards origin.
$5x + 3y \le 30$	$5x + 3y = 30$ $L_2$	$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Towards origin
$x \ge 0$	$\mathbf{x} = 0$	y-axis	+ve x-axis
$y \ge 0$	y = 0	x-axis	+ve y-axis



[1 M]

[1 M]

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28. $\int \frac{3x+1}{(x-2)^2(x+2)} dx$	
$\frac{3x+1}{(x-2)^2(x+2)} = \frac{A}{(x-2)^2} + \frac{B}{(x-2)} + \frac{C}{(x+2)} \qquad \dots (1)$	
$= \frac{A(x+2) + B(x-2)(x+2) + C(x-2)^2}{(x-2)^2(x+2)}$	[1 M]
Comparing we get $3x + 1 = A(x + 2) + B(x - 2) (x + 2) + C(x - 2)^2$ Let $x = 2$	
$6+1 = 4A \implies 7=4A \implies A=\frac{7}{4}$	
Let $x = -2$	
$-6+1 = C(-4)^2 \implies -5 = 16C \implies C = \frac{-5}{16}$	
Let $x = 0$ 1 = 2A - 4B + 4C 4B = 2A + 4C - 1	
$= 2 \times \frac{7}{4} + 4\left(\frac{-5}{16}\right) - 1$	
$= \frac{7}{2} - \frac{5}{4} - 1$	[2 M]
$\mathbf{B} = \frac{7}{8} - \frac{5}{16} - \frac{1}{4}$	
$=\frac{14-5-4}{16}$	
$=\frac{14-9}{16}$	
$=\frac{5}{16}$	
$ \begin{array}{c} 16 \\ \therefore  \text{From}(1) \end{array} $	
$\frac{7}{4}$ $\frac{5}{16}$ $\frac{-5}{16}$	
$\frac{3x+1}{(x-2)^2(x+2)} = \frac{\frac{7}{4}}{(x-2)^2} + \frac{\frac{5}{16}}{(x-2)} + \frac{\frac{-5}{16}}{(x+2)}$	
Integrating on both side	
$\int \frac{3x+1}{(x-2)^2(x+2)} dx = \frac{7}{4} \int \frac{1}{(x-2)^2} dx + \frac{5}{16} \int \frac{1}{(x-2)} dx - \frac{5}{16} \int \frac{1}{(x+2)} dx$	
$= \frac{7}{4} \left( \frac{-1}{x-2} \right) + \frac{5}{16} \log x-2  - \frac{5}{16} \log x+2  + c$	[1 M]
$= \frac{-7}{4(x-2)} + \frac{5}{16}\log x-2  - \frac{5}{16}\log x+2  + c$	
Guru Aanklan 18 Website : www.	guruaanklan.com

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	$\log  \theta - 25  = -kt + c$	(1)	[1 M]
	Initially $t = 0, \theta = 80^{\circ} C$		
	$\log   80 - 25   = -0 + c$ $c = \log 55^{\circ}$		
	From (1)		
	$\log  \theta - 25  = -kt + \log 55^{\circ}$		
	$\log \mid \theta - 25 \mid -\log 55^{\circ} = -kt$		
	$\log\left \frac{\theta-25}{55}\right  = -kt$	(2)	[1 M]
Put	$t = 30 \text{ mm}, \theta = 50^{\circ}\text{C}$		
	$\log\left \frac{50-25}{55}\right  = -k \times 30$		
	$-k = \frac{1}{30} \log \left  \frac{25}{55} \right  = \frac{1}{30} \log \left  \frac{5}{11} \right $		
	From (2)		
	$\log\left \frac{\theta-25}{55}\right  = \frac{t}{30}\log\left \frac{5}{11}\right $	(3)	
Put	t = 1 hrs = 60 min		
	$\log\left \frac{\theta - 25}{55}\right  = \frac{60}{30}\log\left \frac{5}{11}\right $		
	$\log\left \frac{\theta - 25}{55}\right  = 2\log\left \frac{5}{11}\right $		
	$\log\left \frac{\theta-25}{55}\right  = \log\left \frac{5^2}{11^2}\right $		
	$\frac{\theta - 25}{55} = \frac{5 \times 5}{11 \times 11}$		
	$\theta - 25 = \frac{5 \times 5 \times 55}{11 \times 11}$		
	$\theta - 25 = \frac{125}{11}$		
	$\theta = \frac{125}{11} + 25$		
	$\Theta = \frac{125 + 275}{11}$		
	$\Theta = \frac{400}{11}$		
	$\theta = 36.36^{\circ}\mathrm{C}$		[1 M]
		20	
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OR  

$$(1 + e^{x/y})dx + e^{x/y}\left(1 - \frac{x}{y}\right)dy = 0$$

$$Let \frac{x}{y} = v$$

$$(1 M)$$

$$x = vy$$

$$dx = vdy + ydv$$

$$(1 M)$$

$$\therefore (1 + e^{v})(v dy + y dv) + e^{v}(1 - v) dy = 0$$

$$(1 + e^{v}) v dy + y(1 + e^{v}) dv + e^{v}(1 - v) dy = 0$$

$$(v + ve^{v} + e^{v} - ve^{v}) dy + y(1 + e^{v}) dv = 0$$

$$(v + e^{v}) dy = -y(1 + e^{v}) dv$$
Integrating on both side  

$$\int \frac{dy}{y} = -\int \frac{1 + e^{v}}{v + e^{v}} dv$$

$$[1 M]$$

$$\log |y| = -\log |v + e^{v}| + \log |c|$$

$$\log |y| + \log |v + e^{v}| = \log |c|$$

$$\log |y| + \log |v + e^{v}| = \log |c|$$

$$y(v + e^{v}) = c$$

$$y\left[\frac{x}{y} + e^{x/y}\right] = c$$

$$x + ye^{x/y} = c$$

$$[1 M]$$

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