1 **a** $= 3 + 2 = 5$ **b** $= 12 - 5 = 7$ **c** $= -5 + 4 = -1$

2 $(\mathbf{i} + 4\mathbf{j}).(8\mathbf{i} - 2\mathbf{j}) = 8 - 8 = 0$
$\therefore$ perpendicular

3 **a** $\begin{pmatrix} 3 \\ -1 \end{pmatrix} . \begin{pmatrix} c \\ 3 \end{pmatrix} = 0$
$3c - 3 = 0$
$c = 1$

b $\begin{pmatrix} 2 \\ 1 \end{pmatrix} . \begin{pmatrix} 3 \\ c \end{pmatrix} = 0$
$6 + c = 0$
$c = -6$

c $\begin{pmatrix} 2 \\ -5 \end{pmatrix} . \begin{pmatrix} c \\ -4 \end{pmatrix} = 0$
$2c + 20 = 0$
$c = -10$

4 **a** $|4\mathbf{i} - 3\mathbf{j}| = \sqrt{16+9} = 5$, $|8\mathbf{i} + 6\mathbf{j}| = \sqrt{64+36} = 10$
$(4\mathbf{i} - 3\mathbf{j}).(8\mathbf{i} + 6\mathbf{j}) = 32 - 18 = 14$
$\therefore$ angle $= \cos^{-1} \frac{14}{5\times10} = \cos^{-1} \frac{7}{25} = 73.7°$

b $|7\mathbf{i} + \mathbf{j}| = \sqrt{49+1} = 5\sqrt{2}$, $|2\mathbf{i} + 6\mathbf{j}| = \sqrt{4+36} = 2\sqrt{10}$
$(7\mathbf{i} + \mathbf{j}).(2\mathbf{i} + 6\mathbf{j}) = 14 + 6 = 20$
$\therefore$ angle $= \cos^{-1} \frac{20}{5\sqrt{2}\times2\sqrt{10}} = \cos^{-1} \frac{1}{\sqrt{5}} = 63.4°$

c $|4\mathbf{i} + 2\mathbf{j}| = \sqrt{16+4} = 2\sqrt{5}$, $|-5\mathbf{i} + 2\mathbf{j}| = \sqrt{25+4} = \sqrt{29}$
$(4\mathbf{i} + 2\mathbf{j}).(-5\mathbf{i} + 2\mathbf{j}) = -20 + 4 = -16$
$\therefore$ angle $= \cos^{-1} \frac{-16}{2\sqrt{5}\times\sqrt{29}} = \cos^{-1} (-\frac{8}{\sqrt{5}\sqrt{29}}) = 131.6°$

5 $\overrightarrow{BA} = (9\mathbf{i} + \mathbf{j}) - (3\mathbf{i} - \mathbf{j}) = 6\mathbf{i} + 2\mathbf{j}$
$\overrightarrow{BC} = (5\mathbf{i} - 2\mathbf{j}) - (3\mathbf{i} - \mathbf{j}) = 2\mathbf{i} - \mathbf{j}$
$|\overrightarrow{BA}| = \sqrt{36+4} = 2\sqrt{10}$, $|\overrightarrow{BC}| = \sqrt{4+1} = \sqrt{5}$
$\overrightarrow{BA}.\overrightarrow{BC} = (6\mathbf{i} + 2\mathbf{j}).(2\mathbf{i} - \mathbf{j}) = 12 - 2 = 10$
$\therefore \angle ABC = \cos^{-1} \frac{10}{2\sqrt{10}\times\sqrt{5}} = \cos^{-1} \frac{1}{\sqrt{2}} = 45°$

6 **a** $= 3 + 2 + 8 = 13$ **b** $= 6 + 6 - 2 = 10$
c $= -5 + 0 - 6 = -11$ **d** $= -3 + 22 + 32 = 51$
e $= 27 - 28 - 1 = -2$ **f** $= 0 + 9 + 0 = 9$

7 **a** $= (2\mathbf{i} + \mathbf{j} - 3\mathbf{k}).(\mathbf{i} + 5\mathbf{j} - \mathbf{k}) = 2 + 5 + 3 = 10$

b $= (2\mathbf{i} + \mathbf{j} - 3\mathbf{k}).(6\mathbf{i} - 2\mathbf{j} - 3\mathbf{k}) = 12 - 2 + 9 = 19$

c $\mathbf{q} + \mathbf{r} = (\mathbf{i} + 5\mathbf{j} - \mathbf{k}) + (6\mathbf{i} - 2\mathbf{j} - 3\mathbf{k}) = 7\mathbf{i} + 3\mathbf{j} - 4\mathbf{k}$
$\mathbf{p}.(\mathbf{q} + \mathbf{r}) = (2\mathbf{i} + \mathbf{j} - 3\mathbf{k}).(7\mathbf{i} + 3\mathbf{j} - 4\mathbf{k}) = 14 + 3 + 12 = 29$
$\mathbf{p}.\mathbf{q} + \mathbf{p}.\mathbf{r} = 10 + 19 = 29$
$\therefore \mathbf{p}.(\mathbf{q} + \mathbf{r}) = \mathbf{p}.\mathbf{q} + \mathbf{p}.\mathbf{r}$

8 **a** $= \mathbf{p}.\mathbf{q} + \mathbf{p}.\mathbf{r} + \mathbf{p}.\mathbf{q} - \mathbf{p}.\mathbf{r}$
$= 2\mathbf{p}.\mathbf{q}$

b $= \mathbf{p}.\mathbf{q} + \mathbf{p}.\mathbf{r} + \mathbf{q}.\mathbf{r} - \mathbf{q}.\mathbf{p}$
$= \mathbf{p}.\mathbf{q} + \mathbf{p}.\mathbf{r} + \mathbf{q}.\mathbf{r} - \mathbf{p}.\mathbf{q}$
$= \mathbf{p}.\mathbf{r} + \mathbf{q}.\mathbf{r}$
$= (\mathbf{p} + \mathbf{q}).\mathbf{r}$

9 $(5\mathbf{i} - 3\mathbf{j} + 2\mathbf{k}).(3\mathbf{i} + \mathbf{j} - 6\mathbf{k}) = 15 - 3 - 12 = 0$

$\therefore$ perpendicular

10 $\overrightarrow{BA} = (3\mathbf{i} + 4\mathbf{j} - 6\mathbf{k}) - (\mathbf{i} + 5\mathbf{j} - 2\mathbf{k}) = 2\mathbf{i} - \mathbf{j} - 4\mathbf{k}$

$\overrightarrow{BC} = (8\mathbf{i} + 3\mathbf{j} + 2\mathbf{k}) - (\mathbf{i} + 5\mathbf{j} - 2\mathbf{k}) = 7\mathbf{i} - 2\mathbf{j} + 4\mathbf{k}$

$\overrightarrow{BA}.\overrightarrow{BC} = (2\mathbf{i} - \mathbf{j} - 4\mathbf{k}).(7\mathbf{i} - 2\mathbf{j} + 4\mathbf{k}) = 14 + 2 - 16 = 0$

$\therefore$ $\overrightarrow{BA}$ and $\overrightarrow{BC}$ are perpendicular $\therefore$ $\angle ABC = 90°$

11

a $(2\mathbf{i} + 3\mathbf{j} + \mathbf{k}).(c\mathbf{i} - 3\mathbf{j} + \mathbf{k}) = 0$

$2c - 9 + 1 = 0$

$c = 4$

b $(-5\mathbf{i} + 3\mathbf{j} + 2\mathbf{k}).(c\mathbf{i} - \mathbf{j} + 3c\mathbf{k}) = 0$

$-5c - 3 + 6c = 0$

$c = 3$

c $(c\mathbf{i} - 2\mathbf{j} + 8\mathbf{k}).(c\mathbf{i} + c\mathbf{j} - 3\mathbf{k}) = 0$

$c^2 - 2c - 24 = 0$

$(c + 4)(c - 6) = 0$

$c = -4, 6$

d $(3c\mathbf{i} + 2\mathbf{j} + c\mathbf{k}).(5\mathbf{i} - 4\mathbf{j} + 2c\mathbf{k}) = 0$

$15c - 8 + 2c^2 = 0$

$2c^2 + 15c - 8 = 0$

$(2c - 1)(c + 8) = 0$

$c = -8, \frac{1}{2}$

12

a $\left|\begin{pmatrix}1\\2\\-2\end{pmatrix}\right| = \sqrt{1+4+4} = 3$, $\left|\begin{pmatrix}8\\1\\-4\end{pmatrix}\right| = \sqrt{64+1+16} = 9$, $\begin{pmatrix}1\\2\\-2\end{pmatrix}.\begin{pmatrix}8\\1\\-4\end{pmatrix} = 8 + 2 + 8 = 18$

$\therefore \cos\theta = \frac{18}{3\times9} = \frac{2}{3}$

b $\left|\begin{pmatrix}4\\1\\-2\end{pmatrix}\right| = \sqrt{16+1+4} = \sqrt{21}$, $\left|\begin{pmatrix}-2\\3\\-6\end{pmatrix}\right| = \sqrt{4+9+36} = 7$, $\begin{pmatrix}4\\1\\-2\end{pmatrix}.\begin{pmatrix}-2\\3\\-6\end{pmatrix} = -8 + 3 + 12 = 7$

$\therefore \cos\theta = \frac{7}{\sqrt{21}\times7} = \frac{1}{\sqrt{21}}$ or $\frac{1}{21}\sqrt{21}$

c $\left|\begin{pmatrix}1\\2\\-1\end{pmatrix}\right| = \sqrt{1+4+1} = \sqrt{6}$, $\left|\begin{pmatrix}1\\-7\\2\end{pmatrix}\right| = \sqrt{1+49+4} = 3\sqrt{6}$, $\begin{pmatrix}1\\2\\-1\end{pmatrix}.\begin{pmatrix}1\\-7\\2\end{pmatrix} = 1 - 14 - 2 = -15$

$\therefore \cos\theta = \frac{-15}{\sqrt{6}\times3\sqrt{6}} = -\frac{5}{6}$

d $\left|\begin{pmatrix}5\\-3\\4\end{pmatrix}\right| = \sqrt{25+9+16} = 5\sqrt{2}$, $\left|\begin{pmatrix}3\\-4\\-1\end{pmatrix}\right| = \sqrt{9+16+1} = \sqrt{26}$, $\begin{pmatrix}5\\-3\\4\end{pmatrix}.\begin{pmatrix}3\\-4\\-1\end{pmatrix} = 15 + 12 - 4 = 23$

$\therefore \cos\theta = \frac{23}{5\sqrt{2}\times\sqrt{26}} = \frac{23}{10\sqrt{13}}$ or $\frac{23}{130}\sqrt{13}$

13

a $|(3\mathbf{i} - 4\mathbf{k})| = \sqrt{9+16} = 5$

$|(7\mathbf{i} - 4\mathbf{j} + 4\mathbf{k})| = \sqrt{49+16+16} = 9$

$(3\mathbf{i} - 4\mathbf{k}).(7\mathbf{i} - 4\mathbf{j} + 4\mathbf{k}) = 21 + 0 - 16 = 5$

$\therefore$ angle $= \cos^{-1}\frac{5}{5\times9} = \cos^{-1}\frac{1}{9} = 83.6°$

b $|(2\mathbf{i} - 6\mathbf{j} + 3\mathbf{k})| = \sqrt{4+36+9} = 7$

$|(\mathbf{i} - 3\mathbf{j} - \mathbf{k})| = \sqrt{1+9+1} = \sqrt{11}$

$(2\mathbf{i} - 6\mathbf{j} + 3\mathbf{k}).(\mathbf{i} - 3\mathbf{j} - \mathbf{k}) = 2 + 18 - 3 = 17$

$\therefore$ angle $= \cos^{-1}\frac{17}{7\times\sqrt{11}} = 42.9°$

c $|(6\mathbf{i} - 2\mathbf{j} - 9\mathbf{k})| = \sqrt{36+4+81} = 11$

$|(3\mathbf{i} + \mathbf{j} + 4\mathbf{k})| = \sqrt{9+1+16} = \sqrt{26}$

$(6\mathbf{i} - 2\mathbf{j} - 9\mathbf{k}).(3\mathbf{i} + \mathbf{j} + 4\mathbf{k}) = 18 - 2 - 36 = -20$

$\therefore$ angle $= \cos^{-1}\frac{-20}{11\times\sqrt{26}} = 110.9°$

d $|(\mathbf{i} + 5\mathbf{j} - 3\mathbf{k})| = \sqrt{1+25+9} = \sqrt{35}$

$|(-3\mathbf{i} - 4\mathbf{j} + 2\mathbf{k})| = \sqrt{9+16+4} = \sqrt{29}$

$(\mathbf{i} + 5\mathbf{j} - 3\mathbf{k}).(-3\mathbf{i} - 4\mathbf{j} + 2\mathbf{k}) = -3 - 20 - 6 = -29$

$\therefore$ angle $= \cos^{-1}\frac{-29}{\sqrt{35}\times\sqrt{29}} = \cos^{-1}(-\sqrt{\frac{29}{35}}) = 155.5°$

14 **a** $\overrightarrow{BA} = (7 + 1)\mathbf{i} + (2 - 6)\mathbf{j} + (-2 + 3)\mathbf{k} = 8\mathbf{i} - 4\mathbf{j} + \mathbf{k}$

$\overrightarrow{BC} = (-3 + 1)\mathbf{i} + (1 - 6)\mathbf{j} + (2 + 3)\mathbf{k} = -2\mathbf{i} - 5\mathbf{j} + 5\mathbf{k}$

b $|\overrightarrow{BA}| = \sqrt{64+16+1} = 9$

$|\overrightarrow{BC}| = \sqrt{4+25+25} = 3\sqrt{6}$

$\overrightarrow{BA}\,.\,\overrightarrow{BC} = (8\mathbf{i} - 4\mathbf{j} + \mathbf{k}).(-2\mathbf{i} - 5\mathbf{j} + 5\mathbf{k}) = -16 + 20 + 5 = 9$

$\therefore\ \angle ABC = \cos^{-1}\frac{9}{9\times3\sqrt{6}} = \cos^{-1}\frac{1}{3\sqrt{6}} = 82.2°$

c $= \frac{1}{2}\times 9\times 3\sqrt{6}\times \sin 82.18° = 32.8$

15 **a** $\overrightarrow{AB} = (4\mathbf{i} + 3\mathbf{j} - 2\mathbf{k}) - (3\mathbf{i} - 2\mathbf{j} - \mathbf{k}) = \mathbf{i} + 5\mathbf{j} - \mathbf{k}$

$\overrightarrow{AC} = (2\mathbf{i} - \mathbf{j}) - (3\mathbf{i} - 2\mathbf{j} - \mathbf{k}) = -\mathbf{i} + \mathbf{j} + \mathbf{k}$

$|\overrightarrow{AB}| = \sqrt{1+25+1} = 3\sqrt{3}$

$|\overrightarrow{AC}| = \sqrt{1+1+1} = \sqrt{3}$

$\overrightarrow{AB}\,.\,\overrightarrow{AC} = (\mathbf{i} + 5\mathbf{j} - \mathbf{k}).(-\mathbf{i} + \mathbf{j} + \mathbf{k}) = -1 + 5 - 1 = 3$

$\cos(\angle BAC) = \frac{3}{3\sqrt{3}\times\sqrt{3}} = \frac{1}{3}$

b $\sin^2(\angle BAC) = 1 - (\frac{1}{3})^2 = \frac{8}{9}$

$\sin(\angle BAC) = \sqrt{\frac{8}{9}} = \frac{2}{3}\sqrt{2}$

$\text{area} = \frac{1}{2}\times 3\sqrt{3}\times\sqrt{3}\times\frac{2}{3}\sqrt{2} = 3\sqrt{2}$

16 **a** $\left|\begin{pmatrix}4\\-4\\2\end{pmatrix}\right| = \sqrt{16+16+4} = 6,\ \left|\begin{pmatrix}8\\0\\-6\end{pmatrix}\right| = \sqrt{64+36} = 10,\ \begin{pmatrix}4\\-4\\2\end{pmatrix}.\begin{pmatrix}8\\0\\-6\end{pmatrix} = 32 + 0 - 12 = 20$

$\therefore$ acute angle $= \cos^{-1}\left|\frac{20}{6\times10}\right| = \cos^{-1}\frac{1}{3} = 70.5°$

b $\left|\begin{pmatrix}6\\-1\\-18\end{pmatrix}\right| = \sqrt{36+1+324} = 19,\ \left|\begin{pmatrix}4\\-12\\3\end{pmatrix}\right| = \sqrt{16+144+9} = 13,\ \begin{pmatrix}6\\-1\\-18\end{pmatrix}.\begin{pmatrix}4\\-12\\3\end{pmatrix} = 24 + 12 - 54 = -18$

$\therefore$ acute angle $= \cos^{-1}\left|\frac{-18}{19\times13}\right| = \cos^{-1}\frac{18}{247} = 85.8°$

c $\left|\begin{pmatrix}1\\-1\\3\end{pmatrix}\right| = \sqrt{1+1+9} = \sqrt{11},\ \left|\begin{pmatrix}2\\-5\\3\end{pmatrix}\right| = \sqrt{4+25+9} = \sqrt{38},\ \begin{pmatrix}1\\-1\\3\end{pmatrix}.\begin{pmatrix}2\\-5\\3\end{pmatrix} = 2 + 5 + 9 = 16$

$\therefore$ acute angle $= \cos^{-1}\left|\frac{16}{\sqrt{11}\times\sqrt{38}}\right| = \cos^{-1}\frac{16}{\sqrt{11}\sqrt{38}} = 38.5°$

d $\left|\begin{pmatrix}-4\\-6\\7\end{pmatrix}\right| = \sqrt{16+36+49} = \sqrt{101},\ \left|\begin{pmatrix}5\\-1\\-8\end{pmatrix}\right| = \sqrt{25+1+64} = \sqrt{90},\ \begin{pmatrix}-4\\-6\\7\end{pmatrix}.\begin{pmatrix}5\\-1\\-8\end{pmatrix} = -20 + 6 - 56 = -70$

$\therefore$ acute angle $= \cos^{-1}\left|\frac{-70}{\sqrt{101}\times\sqrt{90}}\right| = \cos^{-1}\frac{70}{\sqrt{101}\sqrt{90}} = 42.8°$

17 **a** $\overrightarrow{AB} = (6\mathbf{i} + 5\mathbf{j} + \mathbf{k}) - (5\mathbf{i} + 8\mathbf{j} - \mathbf{k}) = \mathbf{i} - 3\mathbf{j} + 2\mathbf{k}$

$\therefore\ \mathbf{r} = 5\mathbf{i} + 8\mathbf{k} - \mathbf{k} + \lambda(\mathbf{i} - 3\mathbf{j} + 2\mathbf{k})$

b $5 + \lambda = 4 - 5\mu$ (1)

$8 - 3\lambda = -3 + \mu$ (2)

$-1 + 2\lambda = 5 - 2\mu$ (3)

$3\times(1) + (2) \Rightarrow 23 = 9 - 14\mu$

$\mu = -1,\ \lambda = 4$

check (3) $-1 + 2(4) = 5 - 2(-1)$

true $\therefore$ intersect

pos. vector of int. $= 9\mathbf{i} - 4\mathbf{j} + 7\mathbf{k}$

c $|(\mathbf{i} - 3\mathbf{j} + 2\mathbf{k})| = \sqrt{1+9+4} = \sqrt{14}$

$|(-5\mathbf{i} + \mathbf{j} - 2\mathbf{k})| = \sqrt{25+1+4} = \sqrt{30}$

$(\mathbf{i} - 3\mathbf{j} + 2\mathbf{k}).(-5\mathbf{i} + \mathbf{j} - 2\mathbf{k}) = -5 - 3 - 4 = -12$

acute angle $= \cos^{-1}\left|\frac{-12}{\sqrt{14}\times\sqrt{30}}\right| = \cos^{-1}\frac{6}{\sqrt{105}} = 54.2°$ (1dp)

18 $\lambda = \frac{x-2}{3} = \frac{y}{2} = \frac{z+5}{-6}$ $\mu = \frac{x-4}{-4} = \frac{y+1}{7} = \frac{z-3}{-4}$

$x = 2 + 3\lambda,\ y = 2\lambda,\ z = -5 - 6\lambda$ $x = 4 - 4\mu,\ y = -1 + 7\mu,\ z = 3 - 4\mu$

$\mathbf{r} = 2\mathbf{i} - 5\mathbf{k} + \lambda(3\mathbf{i} + 2\mathbf{j} - 6\mathbf{k})$ $\mathbf{r} = 4\mathbf{i} - \mathbf{j} + 3\mathbf{k} + \mu(-4\mathbf{i} + 7\mathbf{j} - 4\mathbf{k})$

$|(3\mathbf{i} + 2\mathbf{j} - 6\mathbf{k})| = \sqrt{9+4+36} = 7$ $|(-4\mathbf{i} + 7\mathbf{j} - 4\mathbf{k})| = \sqrt{16+49+16} = 9$

$(3\mathbf{i} + 2\mathbf{j} - 6\mathbf{k}).(-4\mathbf{i} + 7\mathbf{j} - 4\mathbf{k}) = -12 + 14 + 24 = 26$

$\therefore$ acute angle $= \cos^{-1}\left|\frac{26}{7\times9}\right| = \cos^{-1}\frac{26}{63} = 65.6°$

19 **a** $7 + 2\lambda = -4 + 5\mu$ (1)

$-\lambda = 7 - 4\mu$ (2)

$-2 + 2\lambda = -6 - 2\mu$ (3)

$(1) - (3) \Rightarrow 9 = 2 + 7\mu$

$\mu = 1$

$\therefore\ A\ (1, 3, -8)$

b $|(2\mathbf{i} - \mathbf{j} + 2\mathbf{k})| = \sqrt{4+1+4} = 3$

$|(5\mathbf{i} - 4\mathbf{j} - 2\mathbf{k})| = \sqrt{25+16+4} = 3\sqrt{5}$

$(2\mathbf{i} - \mathbf{j} + 2\mathbf{k}).(5\mathbf{i} - 4\mathbf{j} - 2\mathbf{k}) = 10 + 4 - 4 = 10$

acute angle $= \cos^{-1}\left|\frac{10}{3\times3\sqrt{5}}\right| = \cos^{-1}(\frac{2}{9}\sqrt{5}) = 60.2°$ (1dp)

c $7 + 2\lambda = 5 \Rightarrow \lambda = -1$

sub. $\lambda = -1$ in eqn for l

$\mathbf{r} = 7\mathbf{i} - 2\mathbf{k} - (2\mathbf{i} - \mathbf{j} + 2\mathbf{k}) = 5\mathbf{i} + \mathbf{j} - 4\mathbf{k}$

$\therefore\ B$ lies on l

d $\overrightarrow{AB} = (5\mathbf{i} + \mathbf{j} - 4\mathbf{k}) - (\mathbf{i} + 3\mathbf{j} - 8\mathbf{k}) = 4\mathbf{i} - 2\mathbf{j} + 4\mathbf{k}$

$|\overrightarrow{AB}| = \sqrt{16+4+16} = 6$

$\therefore$ dist. of B from $m = 6\sin 60.20° = 5.21$ (3sf)

20 **a** $\overrightarrow{AB} = (11\mathbf{i} + 5\mathbf{j} + \mathbf{k}) - (9\mathbf{i} + 6\mathbf{j}) = 2\mathbf{i} - \mathbf{j} + \mathbf{k}$

$\overrightarrow{OC} = 9\mathbf{i} + 6\mathbf{j} + \lambda(2\mathbf{i} - \mathbf{j} + \mathbf{k})$

$= \overrightarrow{OA} + \lambda\overrightarrow{AB}$

$\therefore$ C lies on l

b $[(9 + 2\lambda)\mathbf{i} + (6 - \lambda)\mathbf{j} + \lambda\mathbf{k}].[2\mathbf{i} - \mathbf{j} + \mathbf{k}] = 0$

$2(9 + 2\lambda) - (6 - \lambda) + \lambda = 0$

$\lambda = -2$

c sub. $\lambda = -2$ in $\overrightarrow{OC}$

$\therefore$ $5\mathbf{i} + 8\mathbf{j} - 2\mathbf{k}$

21 **a** $[(-4 + \lambda)\mathbf{i} + (2 + 3\lambda)\mathbf{j} + (7 - 4\lambda)\mathbf{k}].[\mathbf{i} + 3\mathbf{j} - 4\mathbf{k}] = 0$

$(-4 + \lambda) + 3(2 + 3\lambda) - 4(7 - 4\lambda) = 0$

$\lambda = 1$

$\therefore$ $(-3, 5, 3)$

b $[(7 + 6\lambda)\mathbf{i} + (11 - 9\lambda)\mathbf{j} + (-9 + 3\lambda)\mathbf{k}].[6\mathbf{i} - 9\mathbf{j} + 3\mathbf{k}] = 0$

$6(7 + 6\lambda) - 9(11 - 9\lambda) + 3(-9 + 3\lambda) = 0$

$\lambda = \frac{2}{3}$

$\therefore$ $(11, 5, -7)$