39 $\begin{pmatrix} 5t - \frac{1}{3} \\ -t + \frac{2}{3} \\ 3t \end{pmatrix}$ **40** Not possible

Exercise 14.4

1 a) $\mathbf{r} = \begin{pmatrix} -1 \\ 0 \\ 2 \end{pmatrix} + t\begin{pmatrix} 1 \\ 5 \\ -4 \end{pmatrix}$ $\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} -1 + t \\ 5t \\ 2 - 4t \end{pmatrix}$

b) $\mathbf{r} = \begin{pmatrix} 3 \\ -1 \\ 2 \end{pmatrix} + t\begin{pmatrix} 2 \\ 5 \\ -1 \end{pmatrix}$ $\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 3 + 2t \\ -1 + 5t \\ 2 - t \end{pmatrix}$

c) $\mathbf{r} = \begin{pmatrix} 1 \\ -2 \\ 6 \end{pmatrix} + t\begin{pmatrix} 3 \\ 5 \\ -11 \end{pmatrix}$ $\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} 1 + 3t \\ -2 + 5t \\ 6 - 11t \end{pmatrix}$

2 a) $\mathbf{r} = \begin{pmatrix} -1 \\ 4 \\ 2 \end{pmatrix} + t\begin{pmatrix} 8 \\ 1 \\ -2 \end{pmatrix}$ b) $\mathbf{r} = \begin{pmatrix} 4 \\ 2 \\ -3 \end{pmatrix} + t\begin{pmatrix} -4 \\ -4 \\ 4 \end{pmatrix}$

c) $\mathbf{r} = \begin{pmatrix} 1 \\ 3 \\ -3 \end{pmatrix} + t\begin{pmatrix} 4 \\ -2 \\ 5 \end{pmatrix}$

3 a) $\mathbf{r} = \begin{pmatrix} 3 \\ -2 \end{pmatrix} + t\begin{pmatrix} 2 \\ 3 \end{pmatrix}$ b) $\mathbf{r} = \begin{pmatrix} 0 \\ -2 \end{pmatrix} + t\begin{pmatrix} 5 \\ 2 \end{pmatrix}$

4 $2x + 3y = 7$

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

6 $\mathbf{r} = (-2, 1, 4) + t(3, -4, 7)$

7 a) $(1, -1, 2)$ b) $(-17, -1, 1)$
c) No d) No

8 a) $\mathbf{r} = (2, -1) + t(1, 3)$ $\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 2 + t \\ -1 + 3t \end{pmatrix}$

b) $\mathbf{r} = (2, -1) + t(-3, 7)$ $\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 2 - 3t \\ -1 + 7t \end{pmatrix}$

c) $\mathbf{r} = (2, -1) + t(7, 3)$ $\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 2 + 7t \\ -1 + 3t \end{pmatrix}$

d) $\mathbf{r} = (0, 2) + t(2, -4)$ $\begin{pmatrix} x \\ y \end{pmatrix} = \begin{pmatrix} 2t \\ 2 - 4t \end{pmatrix}$

9 a) $t = \frac{3}{2}$ b) no c) $m = \frac{7}{2}$

10 a) (i) $(3, -4)$ (ii) $(7, 24)$ (iii) 25
b) (i) $(-3, 1)$ (ii) $(5, -12)$ (iii) 13
c) (i) $(5, -2)$ (ii) $(24, -7)$ (iii) 25

11 a) $(-96, 128)$ b) $\left(\frac{2040}{13}, -\frac{850}{13}\right)$

12 a) $(24, 18)$
b) $\mathbf{r} = (3, 2) + t(24, 18)$
c) In 10 minutes

13 a) $a = -3, b = -5$

b) $-\frac{\sqrt{21}}{6}$

c) $\frac{\sqrt{15}}{6}, \frac{\sqrt{35}}{2}$

14 a) 146.8° b) 3.87
c) (i) L_1: $\mathbf{r} = (2, -1, 0) + t(0, 1, 2)$; L_2: $\mathbf{r} = (-1, 1, 1) + t(1, -3, -2)$

15 a) $(x, y, z) = (1 + t, 3 - 2t, -17 + 5t)$
b) $(4, -3, -2)$

16 a) $\mathbf{r} = \left(\frac{p}{m}, 0\right) + t(n, -m)$
b) (i) $bx - ay = bx_0 - ay_0$ (ii) slope $= \frac{b}{a}$

17 (i) $\mathbf{r} = (t, t, 3t), 0 \leqslant t \leqslant 1$
(ii) $\mathbf{r} = (2t - 1, t, 1 - 3t), 0 \leqslant t \leqslant 1$
(iii) $\mathbf{r} = (1 - t, 3t, t - 1), 0 \leqslant t \leqslant 1$

18 $\mathbf{r} = (2\mathbf{j} + 3\mathbf{k}) + 2t\mathbf{k}$
$\begin{cases} x = 0 \\ y = 2 \\ z = 3 + 2t \end{cases}$

19 $\mathbf{r} = (\mathbf{i} + 2\mathbf{j} - \mathbf{k}) + t(2\mathbf{i} - 3\mathbf{j} + \mathbf{k})$
$\begin{cases} 1 + 2t \\ 2 - 3t \\ -1 + t \end{cases}$

20 $\mathbf{r} = t(x_0\mathbf{i} + y_0\mathbf{j} + z_0\mathbf{k})$
$\begin{cases} tx_0 \\ ty_0 \\ tz_0 \end{cases}$

21 a) $\mathbf{r} = (3\mathbf{i} + 2\mathbf{j} - 3\mathbf{k}) + t\mathbf{j}$
$\begin{cases} 3 \\ 2 + t \\ -3 \end{cases}$
b) $\mathbf{r} = (3\mathbf{i} + 2\mathbf{j} - 3\mathbf{k}) + t\mathbf{i}$
$\begin{cases} 3 + t \\ 2 \\ -3 \end{cases}$

22 $\frac{x - x_0}{x_0} = \frac{y - y_0}{y_0} = \frac{z - z_0}{z_0}$

23 Intersect at $(1, 3, 1)$

24 Parallel **25** Skew lines
26 Skew lines **27** Parallel
28 Skew lines **29** $(4, -4, 8)$

30 $\left(\frac{16}{11}, \frac{35}{11}, \frac{13}{11}\right)$ **31** $\left(\frac{17}{11}, -\frac{7}{11}, \frac{72}{11}\right)$ **32** $\left(\frac{43}{11}, \frac{58}{11}, -\frac{1}{11}\right)$

Exercise 14.5

1 B and C

2 A

3 $\begin{pmatrix} 2 \\ -4 \\ 3 \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} = 26; 2x - 4y + 3z - 26 = 0$

4 $\begin{pmatrix} 2 \\ 0 \\ 3 \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} = -3; 2x + 3z + 3 = 0$

5 $\begin{pmatrix} 0 \\ 0 \\ 3 \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} = 3; 3z - 3 = 0; \mathbf{r} = \begin{pmatrix} 0 \\ 3 \\ 1 \end{pmatrix} + t\begin{pmatrix} 2 \\ -1 \\ 0 \end{pmatrix} + s\begin{pmatrix} 1 \\ 1 \\ 0 \end{pmatrix}$

6 $\begin{pmatrix} 5 \\ 1 \\ -2 \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} = 5; 5x + y - 2z - 5 = 0$

7 $\begin{pmatrix} 0 \\ 1 \\ -2 \end{pmatrix}\begin{pmatrix} x \\ y \\ z \end{pmatrix} = -2; y - 2z + 2 = 0$