1. a) $2(x+3)=2x+6$ **A1**

   b) $2x(5-9x)=10x-18x^2$ **A1**

   c) $(x+1)(x+2)=x^2+2x+x+2$ **M1**
   $=x^2+3x+2$ **A1**

   d) $(3+y)(4-y)=12-3y+4y-y^2$ **M1**
   $=12+y-y^2$ **A1**

   e) $(x+3)(x^2+5x-2)=x^3+5x^2-2x+3x^2+15x-6$ **M1**
   $=x^3+8x^2+13x-6$ **A1**

   f) $(x+1)(x+2)(x+3)=(x^2+3x+2)(x+3)$ **M1**
   $=x^3+3x^2+3x^2+9x+2x+6$ **M1**
   $=x^3+6x^2+11x+6$ **A1** **[11 Marks]**

Alternative Method: You could also expand the second pair of brackets first and then expand the first bracket afterwards

2. a) $3x+6=3(x+2)$ **A1**

   b) $12x-x^2=x(12-x)$ **A1**

   c) $x^2+7x+10=(x+2)(x+5)$ **A1**

   d) $x^2-4=x^2-2^2$ **M1**
   $=(x+2)(x-2)$ **A1**

   e) $2x^2-x-1=(2x+1)(x-1)$ **A1A1**

   f) $x^3+4x^2+3x=x(x^2+4x+3)$ **M1**
   $=x(x+3)(x+1)$ **A1** **[9 Marks]**

Technique: Use the difference of two squares:
$a^2-b^2=(a+b)(a-b)$

3. a) $x^2\times x^3=x^{2+3}=x^5$ **A1**

   b) $x^0=1$ **A1**

   c) $(x^2)^{\frac{5}{2}}=x^{2\times\frac{5}{2}}=x^5$ **A1**

   d) $3x^7\div x^3=3x^{7-3}=3x^4$ **A1**

   e) $y^5\times y^{-3}=y^{5+(-3)}=y^{5-3}=y^2$ **A1**

   f) $\dfrac{15y^6}{5y^3}=3\times\dfrac{y^6}{y^3}=3\times y^{6-3}=3y^3$ **A1** **[6 Marks]**

Technique: Remember the following rules:
- $x^a\times x^b=x^{a+b}$
- $x^a\div x^b=x^{a-b}$
- $(x^a)^b=x^{a\times b}$
- $x^0=1$

Technique: Find a factor of 75 that is also a square number, i.e. 25. A similar technique can be used for parts c) and d).

4. a) $\sqrt{16}=\sqrt{4^2}=4$ **A1**

   b) $\sqrt{75}=\sqrt{25\times3}=\sqrt{25}\times\sqrt{3}$ **M1**
   $=5\sqrt{3}$ **A1**

   c) $3\sqrt{24}=3\times\sqrt{4\times6}=3\times\sqrt{4}\times\sqrt{6}$ **M1**
   $=3\times2\times\sqrt{6}=6\sqrt{6}$ **A1**

   d) $\sqrt{12}+\sqrt{27}=\sqrt{4\times3}+\sqrt{9\times3}=\sqrt{4}\times\sqrt{3}+\sqrt{9}\times\sqrt{3}$ **M1**
   $=2\sqrt{3}+3\sqrt{3}=5\sqrt{3}$ **A1**

   e) $\dfrac{\sqrt{32}}{\sqrt{2}}=\sqrt{\dfrac{32}{2}}$ **M1**
   $=\sqrt{16}=4$ **A1**

   f) $\sqrt{2}\times\sqrt{32}=\sqrt{2\times32}=\sqrt{64}=8$ **A1** **[10 Marks]**

5. a) $\left(\sqrt{x}\right)^2 = \left(x^{\frac{1}{2}}\right)^2 = x^{\frac{1}{2}\times 2} = x$ **A1**

b) $\sqrt{y^2} \times \sqrt{y^3} = \left(y^2\right)^{\frac{1}{2}} \times \left(y^3\right)^{\frac{1}{2}}$ **M1**

$= y^{2\times\frac{1}{2}} \times y^{3\times\frac{1}{2}} = y^1 \times y^{\frac{3}{2}} = y^{1+\frac{3}{2}} = y^{\frac{5}{2}} \left(\text{or } \sqrt{y^5}\right)$ **A1**

c) $\left(3\sqrt{y}\right)^2 = 3^2 \times \left(\sqrt{y}\right)^2 = 9 \times \left(y^{\frac{1}{2}}\right)^2$ **M1**

$= 9 \times y^{\frac{1}{2}\times 2} = 9y$ **A1** **[5 Marks]**

6. a) $22^{-1} = \frac{1}{22^1} = \frac{1}{22}$ **A1**

Technique: Remember that $x^{-a} = \frac{1}{x^a}$

b) $27^{\frac{1}{3}} = \sqrt[3]{27} = \sqrt[3]{3\times 3\times 3} = 3$ **A1**

c) $9^{\frac{3}{2}} = \left(\sqrt{9}\right)^3$ **M1**

$= 3^3 = 27$ **A1** **[4 Marks]**

7. a) $\frac{1}{\sqrt{5}} = \frac{1}{\sqrt{5}} \times \frac{\sqrt{5}}{\sqrt{5}} = \frac{\sqrt{5}}{\left(\sqrt{5}\right)^2} = \frac{\sqrt{5}}{5}$ **A1**

b) $\frac{3}{\sqrt{2}} = \frac{3}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = \frac{3\sqrt{2}}{\left(\sqrt{2}\right)^2} = \frac{3\sqrt{2}}{2}$ **A1**

c) $\frac{1}{2+\sqrt{3}} = \frac{1}{2+\sqrt{3}} \times \frac{2-\sqrt{3}}{2-\sqrt{3}}$ **M1**

Technique: Use the difference of two squares to eliminate surds from the denominator by multiplying by a fraction equivalent to 1

$= \frac{2-\sqrt{3}}{\left(2+\sqrt{3}\right)\left(2-\sqrt{3}\right)} = \frac{2-\sqrt{3}}{2^2 - \left(\sqrt{3}\right)^2}$ **M1**

$= \frac{2-\sqrt{3}}{4-3} = \frac{2-\sqrt{3}}{1} = 2-\sqrt{3}$ **A1** **[5 Marks]**

TOTAL 50 MARKS

1. $3x+y=5$ **(1)**
   $2x+y=4$ **(2)**
   (1) – (2): $3x+y-(2x+y)=5-4$ **M1**
   $\therefore 3x-2x+y-y=1 \therefore x=1$ **A1**
   Substitute $x=1$ into **(2)**:
   $2\times1+y=4 \therefore y=4-2=2$ **A1** **[3 Marks]**

2. $x-y=4$ **(1)**
   $3x+y=16$ **(2)**
   $\therefore y=x-4$ (by **(1)**)
   Substitute $y=x-4$ into **(2)**:
   $3x+(x-4)=16 \therefore 4x-4=16 \therefore 4x=20$ **M1**
   $\therefore x=5$ **A1**
   Substitute $x=5$ into **(1)**:
   $5-y=4 \therefore y=5-4=1$ **A1** **[3 Marks]**

3. $2x+3y=7$ **(1)**
   $3x+y=7$ **(2)**
   $3\times$**(2)**: $3(3x+y)=3\times7$
   $\therefore 9x+3y=21$ **(3)** **M1**
   (3) – (1): $9x+3y-(2x+3y)=21-7$ **M1**
   $\therefore 7x=14 \therefore x=2$ **A1**
   Substitute $x=2$ into **(2)**:
   $3\times2+y=7 \therefore y=7-6=1$ **A1** **[4 Marks]**

Technique: Multiply the second equation by 3, and then subtract the first equation to eliminate *y*. Then solve for *x* and substitute this value in to find *y*. Alternatively, use the substitution method.

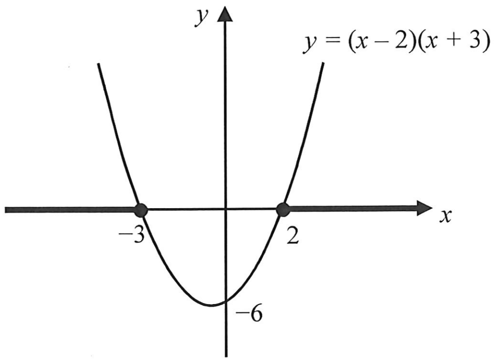
4. $x-y=5$ **(1)**
   $x^2+x+y=-2$ **(2)**
   $\therefore y=x-5$ (by **(1)**)
   Substitute $y=x-5$ into **(2)**:
   $x^2+x+(x-5)=-2$
   $x^2+2x-3=0$ **M1**
   $(x+3)(x-1)=0$
   $\therefore x=-3$ or $x=1$ **A1**
   Substitute $x=-3$ into **(1)**: $-3-y=5 \therefore y=-8$
   Substitute $x=1$ into **(1)**: $1-y=5 \therefore y=-4$ **M1**
   $\therefore$ solutions are $x=-3, y=-8$ or $x=1, y=-4$ **A1A1** **[5 Marks]**

Technique: Substitute the linear equation into the quadratic one to eliminate *y*, and then solve for *x*. Then substitute these values in to find corresponding values of *y*.

5. a) $2x-3>0 \therefore 2x>3 \therefore x>\frac{3}{2}$ $\left(\text{for OCR also accept } x\in\left(\frac{3}{2},\infty\right)\right)$ **A1**

b) $(x-2)(x+3)\geq 0$

Technique: Factorise the equation, then sketch the graph and see for which values of x the function lies above the x-axis. A similar technique can be used for parts c) and d).



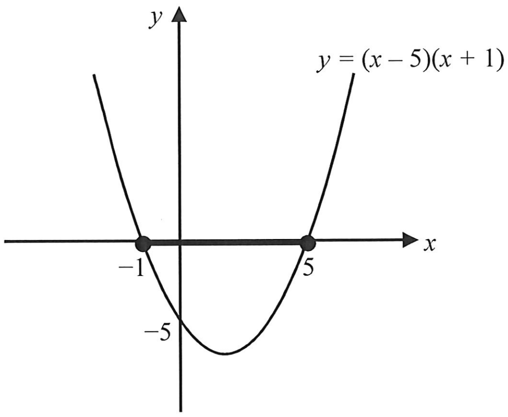
M1

The inequality is satisfied where the graph is on or above the x-axis. **M1**

(Also accept any other method, e.g. solving the quadratic equation $(x-2)(x+3)=0$ (**M1**) and then testing values above and below the solutions (**M1**).)

$\therefore x\leq -3$ or $x\geq 2$ $\left(\text{for OCR also accept } x\in(-\infty,-3]\cup[2,\infty)\right)$ **A1**

c) $x^2-4x-5\leq 0 \therefore (x-5)(x+1)\leq 0$ **M1**



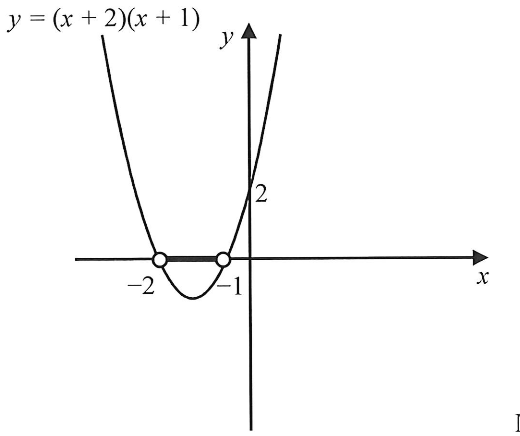
M1

The inequality is satisfied where the graph is on or below the x-axis. **M1**

(Also accept any other method, e.g. solving the quadratic equation $x^2-4x-5=0$ (**M1**) and then testing values above and below the solutions (**M1**).)

$\therefore -1\leq x\leq 5$ $\left(\text{for OCR also accept } x\in[-1,5]\right)$ **A1**

d) $x^2+5x-1<2x-3 \therefore x^2+3x+2<0 \therefore (x+2)(x+1)<0$ **M1**



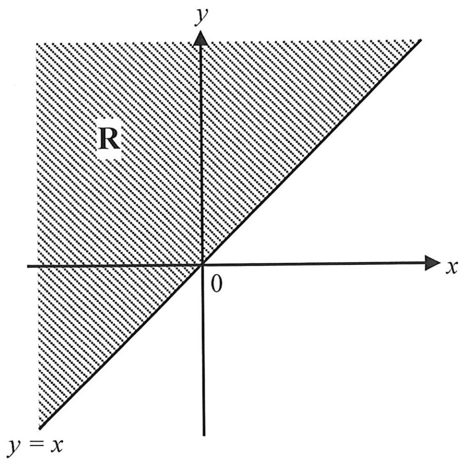
M1

The inequality is satisfied where the graph is strictly below the x-axis. **M1**

(Also accept any other method, e.g. solving the quadratic equation $x^2+5x-1=2x-3$ (**M1**) and then testing values above and below the solutions (**M1**).)

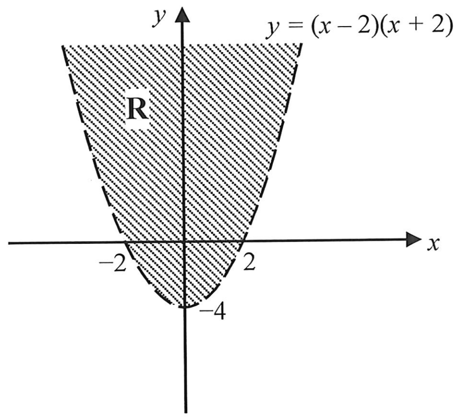
$\therefore -2<x<-1$ $\left(\text{for OCR also accept } x\in(-2,-1)\right)$ **A1** **[12 Marks]**

6. i)a)b) $y \geq x$



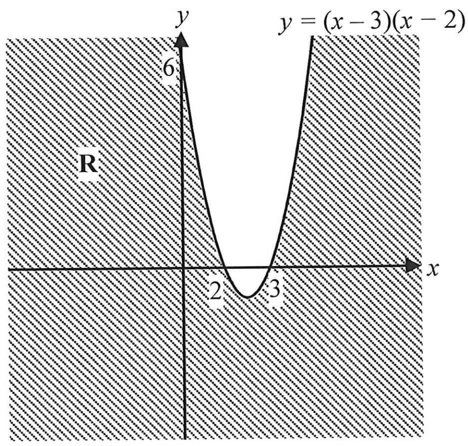
A3A1

ii)a)b) $y > (x-2)(x+2)$



A3A1

iii)a)b) $y \leq x^2 - 5x + 6 \therefore y \leq (x-3)(x-2)$ **M1**



A3A1 **[13 Marks]**

TOTAL 40 MARKS

1. a) $y = -4x + 11$
Gradient: -4 **A1**
y-intercept: 11 **A1**

b) Rearrange $y+2x+3=0$ as $y=-2x-3$
Gradient: -2 **A1**
y-intercept: -3 **A1**

Technique: If a line is given by the equation $y = mx + c$ then its **gradient** is m and its **y-intercept** is c

c) Rearrange $6x-2y+4=0$ as $2y=6x+4$ to $y=3x+2$
Gradient: 3 **A1**
y-intercept: 2 **A1** **[6 Marks]**

2. The gradient can be calculated using the formula $m = \dfrac{y_2 - y_1}{x_2 - x_1}$

a) $m = \dfrac{1-(-1)}{1-(-1)} = \dfrac{2}{2} = 1$ **M1A1**

b) $m = \dfrac{4-2}{5-(-1)} = \dfrac{2}{6} = \dfrac{1}{3}$ **M1A1**

Tip: You will get the same answer whichever order you use the points in, as long as you are consistent between x and y.
So for b) you could use $\dfrac{2-4}{(-1)-5} = \dfrac{-2}{-6} = \dfrac{1}{3}$.

c) $m = \dfrac{1-(-1)}{3-(-1)} = \dfrac{2}{4} = \dfrac{1}{2}$ **M1A1**

d) $m = \dfrac{3-4}{6-8} = \dfrac{-1}{-2} = \dfrac{1}{2}$ **M1A1**

e) $m = \dfrac{0-3c}{6c-0} = \dfrac{-3c}{6c} = -\dfrac{1}{2}$ **M1A1**

f) $m = \dfrac{1-\frac{1}{2}}{\frac{1}{4}-\frac{1}{3}} = \dfrac{2-\frac{1}{2}}{3-\frac{4}{12}} = \dfrac{\frac{1}{2}}{-\frac{1}{12}} = -\dfrac{12}{2} = -6$ **M1A1** **[12 Marks]**

3. a) $y = 2x+1 \therefore 2x - y + 1 = 0$ **A1**

b) $y = \dfrac{4}{5}x \therefore 5y = 4x \therefore 4x - 5y = 0$ (accept $4x - 5y + 0 = 0$) **A1**

c) $y = -3x + \dfrac{5}{8} \therefore 8y = -24x + 5 \therefore 24x + 8y - 5 = 0$ **A1** **[3 Marks]**

4. An equation of a line can be written in the form $y = mx + c$ where m is the gradient of the line $\therefore m = 3$ **A1**
Substitute $x=2$ and $y=1$ into $y=3x+c$
$1 = 3(2)+c$
$\therefore c = 1-6 = -5$
$\therefore y = 3x-5$ **A1** **[2 Marks]**

5. Gradient $= \dfrac{6-2}{5-3} = \dfrac{4}{2} = 2$ **A1**
substitute $x=3$, $y=2$ into $y=2x+c$

Alternative Technique: After finding the gradient you could use $y - y_1 = m(x - x_1)$

$2 = 2(3)+c$ **M1**
$\therefore c = 2-6 = -4$ **M1**
$y = 2x-4$
$\therefore 2x - y - 4 = 0$ **A1** **[4 Marks]**

6. a) Gradient of $y = 2x - 1$ is 2 **M1**

Rearranging $y + 2x + 4 = 0$ to $y = -2x - 4$ we see its gradient is -2 **M1**

The gradients are not equal $\therefore$ the lines are not parallel. **A1**

b) Gradient of $y = 4x + 2$ is 4 **M1**

Rearranging $8x - 2y + 5 = 0$ to $2y = 8x + 5 \therefore y = 4x + \frac{5}{2}$ we see its gradient is 4 **M1**

The gradients are equal $\therefore$ the lines are parallel. **A1**

c) Rearranging $2x - 3y + 8 = 0$ to $3y = 2x + 8 \therefore y = \frac{2}{3}x + \frac{8}{3}$ we see its gradient is $\frac{2}{3}$ **M1**

Rearranging $3x - 2y + 8 = 0$ to $2y = 3x + 8 \therefore y = \frac{3}{2}x + 4$ we see its gradient is $\frac{3}{2}$ **M1**

The gradients are not equal $\therefore$ the lines are not parallel. **A1** **[9 Marks]**

7. a) Gradient of $y = 3x + 2$ is 3 **M1**

Gradient of $y = -\frac{1}{3}x + 2$ is $-\frac{1}{3}$ **M1**

Product of gradients is $3 \times -\frac{1}{3} = -1$ $\therefore$ the lines are perpendicular. **A1**

Technique: Lines with gradients m_1 and m_2 are perpendicular if $m_1 \times m_2 = -1$

b) Gradient of $y = 2x + 4$ is 2 **M1**

Rearranging $y + 2x = 4$ to $y = -2x + 4$ we see its gradient is -2 **M1**

$2 \times -2 = -4 \neq -1$ $\therefore$ the lines are not perpendicular. **A1**

c) Rearranging $4x - 2y - 2 = 0$ to $2y = 4x - 2 \therefore y = 2x - 1$ we see its gradient is 2 **M1**

Rearranging $2x + 4y - 6 = 0$ to $4y = -2x + 6 \therefore y = -\frac{1}{2}x + \frac{3}{2}$ we see its gradient is $-\frac{1}{2}$ **M1**

Product of gradients is $2 \times -\frac{1}{2} = -1 \therefore$ the lines are perpendicular. **A1** **[9 Marks]**

8. The distance between (x_1, y_1) and (x_2, y_2) can be found using the formula $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

a) $d = \sqrt{(2-0)^2 + (6-4)^2}$ **M1**

$= \sqrt{2^2 + 2^2} = \sqrt{4+4} = \sqrt{8} = 2\sqrt{2}$ **A1**

b) $d = \sqrt{(2-(-1))^2 + (9-3)^2}$ **M1**

$= \sqrt{3^2 + 6^2} = \sqrt{9+36} = \sqrt{45} = 3\sqrt{5}$ **A1**

c) $d = \sqrt{(4-(-2))^2 + (1-(-5))^2}$ **M1**

$= \sqrt{6^2 + 6^2} = \sqrt{36+36} = \sqrt{72} = 6\sqrt{2}$ **A1** **[6 Marks]**

TOTAL 51 MARKS

