



Exercise 1A

- 1 a x^7 b $6x^5$ c k d $2p^2$
 e x f y^{10} g $5x^2$ h p^2
 i $2a^3$ j $2p$ k $6a^9$ l $3a^2b^3$
 m $27x^8$ n $24x^{11}$ o $63a^{12}$ p $32y^6$
 q $4a^6$ r $6a^{12}$
- 2 a $9x - 18$ b $x^2 + 9x$
 c $-12y + 9y^2$ d $xy + 5x$
 e $-3x^2 - 5x$ f $-20x^2 - 5x$
 g $4x^2 + 5x$ h $-15y + 6y^3$
 i $-10x^2 + 8x$ j $3x^3 - 5x^2$
 k $4x - 1$ l $2x - 4$
 m $9d^2 - 2c$ n $13 - r^2$
 o $3x^3 - 2x^2 + 5x$ p $14y^2 - 35y^3 + 21y^4$
 q $-10y^2 + 14y^3 - 6y^4$ r $4x + 10$
 s $11x - 6$ t $7x^2 - 3x + 7$
 u $-2x^2 + 26x$ v $-9x^3 + 23x^2$
- 3 a $3x^3 + 5x^2$ b $3x^4 - x^6$ c $\frac{x^3}{2} - x$
 d $4x^2 + \frac{5}{2}$ e $\frac{7x^6}{5} + x$ f $3x^4 - \frac{5x^2}{3}$

Exercise 1B

- 1 a $x^2 + 11x + 28$
 b $x^2 - x - 6$
 c $x^2 - 4x + 4$
 d $2x^2 + 3x - 2xy - 3y$
 e $4x^2 + 11xy - 3y^2$
 f $6x^2 - 10xy - 4y^2$
 g $2x^2 - 11x + 12$
 h $9x^2 + 12xy + 4y^2$
 i $4x^2 + 6x + 16xy + 24y$
 j $2x^2 + 3xy + 5x + 15y - 25$
 k $3x^2 - 4xy - 8x + 4y + 5$
 l $2x^2 + 5x - 7xy - 4y^2 - 20y$
 m $x^2 + 2x + 2xy + 6y - 3$
 n $2x^2 + 15x + 2xy + 12y + 18$
 o $13y - 4x + 12 - 4y^2 + xy$
 p $12xy - 4y^2 + 3y + 15x + 10$
 q $5xy - 20y - 2x^2 + 11x - 12$
 r $22y - 4y^2 - 5x + xy - 10$
- 2 a $5x^2 - 15x - 20$
 b $14x^2 + 7x - 70$
 c $3x^2 - 18x + 27$
 d $x^3 - xy^2$
 e $6x^3 + 8x^2 + 3x^2y + 4xy$
 f $x^2y - 4xy - 5y$
 g $12x^2y + 6xy - 8xy^2 - 4y^2$
 h $19xy - 35y - 2x^2y$
 i $10x^3 - 4x^2 + 5x^2y - 2xy$
 j $x^3 + 3x^2y - 2x^2 + 6xy - 8x$
 k $2x^2y + 9xy + xy^2 + 5y^2 - 5y$
 l $6x^2y + 4xy^2 + 2y^2 - 3xy - 3y$
 m $2x^3 + 2x^2y - 7x^2 + 3xy - 15x$
 n $24x^3 - 6x^2y - 26x^2 + 2xy + 6x$
 o $6x^3 + 15x^2 - 3x^2y - 18xy^2 - 30xy$
 p $x^3 + 6x^2 + 11x + 6$
 q $x^3 + x^2 - 14x - 24$
 r $x^3 - 3x^2 - 13x + 15$
 s $x^3 - 12x^2 + 47x - 60$
 t $2x^3 - x^2 - 5x - 2$
 u $6x^3 + 19x^2 + 11x - 6$
 v $18x^3 - 15x^2 - 4x + 4$
 w $x^3 - xy^2 - x^2 + y^2$
 x $8x^3 - 36x^2y + 54xy^2 - 27y^3$
- 3 $2x^2 - xy + 29x - 7y + 24$
 4 $4x^3 + 12x^2 + 5x - 6 \text{ cm}^3$
 5 $a = 12, b = 32, c = 3, d = -5$

Challenge

$x^4 + 4x^3y + 6x^2y^2 + 4xy^3 + y^4$

Exercise 1C

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|------------------|------------------|
| 1 a $4(x + 2)$ | b $6(x - 4)$ |
| c $5(4x + 3)$ | d $2(x^2 + 2)$ |
| e $4(x^2 + 5)$ | f $6x(x - 3)$ |
| g $x(x - 7)$ | h $2x(x + 2)$ |
| i $x(3x - 1)$ | j $2x(3x - 1)$ |
| k $5y(2y - 1)$ | l $7x(5x - 4)$ |
| m $x(x + 2)$ | n $y(3y + 2)$ |
| o $4x(x + 3)$ | p $5y(y - 4)$ |
| q $3xy(3y + 4x)$ | r $2ab(3 - b)$ |
| s $5x(x - 5y)$ | t $4xy(3x + 2y)$ |
| u $5y(3 - 4z^2)$ | v $6(2x^2 - 5)$ |
| w $xy(y - x)$ | x $4y(3y - x)$ |
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|-----------------------|-------------------------|
| 2 a $x(x + 4)$ | b $2x(x + 3)$ |
| c $(x + 8)(x + 3)$ | d $(x + 6)(x + 2)$ |
| e $(x + 8)(x - 5)$ | f $(x - 6)(x - 2)$ |
| g $(x + 2)(x + 3)$ | h $(x - 6)(x + 4)$ |
| i $(x - 5)(x + 2)$ | j $(x + 5)(x - 4)$ |
| k $(2x + 1)(x + 2)$ | l $(3x - 2)(x + 4)$ |
| m $(5x - 1)(x - 3)$ | n $2(3x + 2)(x - 2)$ |
| o $(2x - 3)(x + 5)$ | p $2(x^2 + 3)(x^2 + 4)$ |
| q $(x + 2)(x - 2)$ | r $(x + 7)(x - 7)$ |
| s $(2x + 5)(2x - 5)$ | t $(3x + 5y)(3x - 5y)$ |
| u $4(3x + 1)(3x - 1)$ | v $2(x + 5)(x - 5)$ |
| w $2(3x - 2)(x - 1)$ | x $3(5x - 1)(x + 3)$ |
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|----------------------|----------------------|
| 3 a $x(x^2 + 2)$ | b $x(x^2 - x + 1)$ |
| c $x(x^2 - 5)$ | d $x(x + 3)(x - 3)$ |
| e $x(x - 4)(x + 3)$ | f $x(x + 5)(x + 6)$ |
| g $x(x - 1)(x - 6)$ | h $x(x + 8)(x - 8)$ |
| i $x(2x + 1)(x - 3)$ | j $x(2x + 3)(x + 5)$ |
| k $x(x + 2)(x - 2)$ | l $3x(x + 4)(x + 5)$ |
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| 4 $(x^2 + y^2)(x + y)(x - y)$ |
| 5 $x(3x + 5)(2x - 1)$ |

Challenge

$(x - 1)(x + 1)(2x + 3)(2x - 3)$

Exercise 1F

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|--------------------------|--------------------------|------------------------|
| 1 a $\frac{\sqrt{5}}{5}$ | b $\frac{\sqrt{11}}{11}$ | c $\frac{\sqrt{2}}{2}$ |
| d $\frac{\sqrt{5}}{5}$ | e $\frac{1}{2}$ | f $\frac{1}{4}$ |
| g $\frac{\sqrt{13}}{13}$ | h $\frac{1}{3}$ | |
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|-------------------------------|-----------------------------------|---|
| 2 a $\frac{1 - \sqrt{3}}{-2}$ | b $\sqrt{5} - 2$ | c $\frac{3 + \sqrt{7}}{2}$ |
| d $3 + \sqrt{5}$ | e $\frac{\sqrt{5} + \sqrt{3}}{2}$ | f $\frac{(3 - \sqrt{2})(4 + \sqrt{5})}{11}$ |
| g $5(\sqrt{5} - 2)$ | h $5(4 + \sqrt{14})$ | i $\frac{11(3 - \sqrt{11})}{-2}$ |
| j $\frac{5 - \sqrt{21}}{-2}$ | k $\frac{14 - \sqrt{187}}{3}$ | l $\frac{35 + \sqrt{1189}}{6}$ |
| m -1 | | |
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|---------------------------------|--------------------------------|--------------------------------|
| 3 a $\frac{11 + 6\sqrt{2}}{49}$ | b $9 - 4\sqrt{5}$ | c $\frac{44 + 24\sqrt{2}}{49}$ |
| d $\frac{81 - 30\sqrt{2}}{529}$ | e $\frac{13 + 2\sqrt{2}}{161}$ | f $\frac{7 - 3\sqrt{3}}{11}$ |
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| 4 $-\frac{7}{4} + \frac{\sqrt{5}}{4}$ |
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Exercise 1D

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|-------------|---------------------|----------------------|---------------------|
| 1 a x^5 | b x^{-2} | c x^4 | d x^3 |
| e x^5 | f $12x^0 = 12$ | g $3x^{\frac{1}{2}}$ | h $5x$ |
| i $6x^{-1}$ | j $x^{\frac{1}{2}}$ | k $x^{\frac{1}{2}}$ | l $x^{\frac{1}{2}}$ |
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- | | | | |
|--------------------|--------------------|-----------------|-------------------|
| 2 a 5 | b 729 | c 3 | d $\frac{1}{16}$ |
| e $\frac{1}{3}$ | f $\frac{-1}{125}$ | g 1 | h 216 |
| i $\frac{125}{64}$ | j $\frac{9}{4}$ | k $\frac{5}{6}$ | l $\frac{64}{49}$ |
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|------------------------|-----------------------------------|---------------------|
| 3 a $8x^5$ | b $\frac{5}{x^2} - \frac{2}{x^3}$ | c $5x^4$ |
| d $\frac{1}{x^2} + 4$ | e $\frac{2}{x^3} + \frac{1}{x^2}$ | f $\frac{8}{27}x^6$ |
| g $\frac{3}{x} - 5x^2$ | h $\frac{1}{3x^2} + \frac{1}{5x}$ | |
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- | | |
|-------------------|----------------------------|
| 4 a 3 | b $\frac{16}{\sqrt[3]{x}}$ |
| 5 a $\frac{x}{2}$ | b $\frac{32}{x^6}$ |

Exercise 1E

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|-----------------|----------------|----------------|---------------|
| 1 a $2\sqrt{7}$ | b $6\sqrt{2}$ | c $5\sqrt{2}$ | d $4\sqrt{2}$ |
| e $3\sqrt{10}$ | f $\sqrt{3}$ | g $\sqrt{3}$ | h $6\sqrt{5}$ |
| i $7\sqrt{2}$ | j $12\sqrt{7}$ | k $-3\sqrt{7}$ | l $9\sqrt{5}$ |
| m $23\sqrt{5}$ | n 2 | o $19\sqrt{3}$ | |
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|---|---|
| 2 a $2\sqrt{3} + 3$ | b $3\sqrt{5} - \sqrt{15}$ |
| c $4\sqrt{2} - \sqrt{10}$ | d $6 + 2\sqrt{5} - 3\sqrt{2} - \sqrt{10}$ |
| e $6 - 2\sqrt{7} - 3\sqrt{3} + \sqrt{21}$ | f $13 + 6\sqrt{5}$ |
| g $8 - 6\sqrt{3}$ | h $5 - 2\sqrt{3}$ |
| i $3 + 5\sqrt{11}$ | |
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|---------------|
| 3 $3\sqrt{3}$ |
|---------------|

Mixed exercise

- 1 a y^8 b $6x^7$ c $32x$ d $12b^9$
 2 a $x^2 - 2x - 15$ b $6x^2 - 19x - 7$
 c $6x^2 - 2xy + 19x - 5y + 10$

- 3 a $x^3 + 3x^2 - 4x$ b $x^3 + 6x^2 - 13x - 42$
 c $6x^3 - 5x^2 - 17x + 6$

- 4 a $15y + 12$ b $15x^2 - 25x^3 + 10x^4$
 c $16x^2 + 13x$ d $9x^3 - 3x^2 + 4x$

- 5 a $x(3x + 4)$ b $2y(2y + 5)$
 c $x(x + y + y^2)$ d $2xy(4y + 5x)$

- 6 a $(x + 1)(x + 2)$ b $3x(x + 2)$
 c $(x - 7)(x + 5)$ d $(2x - 3)(x + 1)$

- 7 a $2x(x^2 + 3)$ b $x(x + 6)(x - 6)$
 c $x(2x - 3)(x + 5)$

- 8 a $3x^6$ b 2 c $6x^2$ d $\frac{1}{2}x^{-4}$

- 9 a $\frac{4}{9}$ b $\pm \frac{3375}{4913}$

- 10 a $\frac{\sqrt{7}}{7}$ b $4\sqrt{5}$

- 11 a 21 877
 b $(5x + 6)(7x - 8)$
 When $x = 25$, $5x + 6 = 131$ and $7x - 8 = 167$; both 131 and 167 are prime numbers.

- 12 a $3\sqrt{2} + \sqrt{10}$ b $10 + 2\sqrt{3} - 5\sqrt{5} - \sqrt{15}$
 c $24 - 6\sqrt{7} - 4\sqrt{2} + \sqrt{14}$

- 13 a $\frac{\sqrt{3}}{3}$ b $\sqrt{2} + 1$ c $-3\sqrt{3} - 6$

- d $\frac{30 - \sqrt{851}}{-7}$ e $7 - 4\sqrt{3}$ f $\frac{23 + 8\sqrt{7}}{81}$

- 14 a $b = -4$ and $c = -5$ b $(x + 3)(x - 5)(x + 1)$

- 15 a $\frac{1}{4}x$ b $256x^{-3}$

- 16 $\frac{5}{\sqrt{75} - \sqrt{50}} = \frac{1}{\sqrt{3} - \sqrt{2}} = \sqrt{3} + \sqrt{2}$

- 17 $-36 + 10\sqrt{11}$

- 18 $x(1 + 8x)(1 - 8x)$

- 19 $y = 6x + 3$

- 20 $4\sqrt{3}$

- 21 $3 - \sqrt{3}$ cm

- 22 $\frac{4 - 4x^{\frac{1}{2}} + x^{\frac{1}{4}}}{x^{\frac{1}{4}}} = 4x^{-\frac{1}{4}} - 4 + x^{\frac{1}{4}}$

- 23 $\frac{11}{2}$

- 24 $4x^{\frac{5}{2}} + x^2$, $a = \frac{5}{2}$ $b = 2$

Challenge

- a $a - b$

- b $\frac{(\sqrt{1} - \sqrt{2}) + (\sqrt{2} - \sqrt{3}) + \dots + (\sqrt{24} - \sqrt{25})}{-1} = \sqrt{25} - \sqrt{1} = 4$

Exercise 2A

- 1 a $x = -1$ or $x = -2$ b $x = -1$ or $x = -4$
 c $x = -5$ or $x = -2$ d $x = 3$ or $x = -2$

- e $x = 3$ or $x = 5$ f $x = 4$ or $x = 5$
 g $x = 6$ or $x = -1$ h $x = 6$ or $x = -2$

- 2 a $x = 0$ or $x = 4$ b $x = 0$ or $x = 25$
 c $x = 0$ or $x = 2$ d $x = 0$ or $x = 6$

- e $x = -\frac{1}{2}$ or $x = -3$ f $x = -\frac{1}{3}$ or $x = \frac{3}{2}$
 g $x = -\frac{2}{3}$ or $x = \frac{3}{2}$ h $x = \frac{3}{2}$ or $x = \frac{5}{2}$

- 3 a $x = \frac{1}{3}$ or $x = -2$ b $x = 3$ or $x = 0$
 c $x = 13$ or $x = 1$ d $x = 2$ or $x = -2$

- e $x = \pm\sqrt{\frac{5}{3}}$ f $x = 3 \pm \sqrt{13}$
 g $x = \frac{1 \pm \sqrt{11}}{3}$ h $x = 1$ or $x = -\frac{7}{6}$

- i $x = -\frac{1}{2}$ or $x = \frac{7}{3}$ j $x = 0$ or $x = -\frac{11}{6}$

- 4 $x = 4$

- 5 $x = -1$ or $x = -\frac{2}{25}$

Exercise 2B

- 1 a $x = \frac{1}{2}(-3 \pm \sqrt{5})$ b $x = \frac{1}{2}(3 \pm \sqrt{17})$
 c $x = -3 \pm \sqrt{3}$ d $x = \frac{1}{2}(5 \pm \sqrt{33})$

- e $x = \frac{1}{3}(-5 \pm \sqrt{31})$ f $x = \frac{1}{2}(1 \pm \sqrt{2})$
 g $x = 2$ or $x = -\frac{1}{4}$ h $x = \frac{1}{11}(-1 \pm \sqrt{78})$

- 2 a $x = -0.586$ or $x = -3.41$ b $x = 7.87$ or $x = 0.127$
 c $x = 0.765$ or $x = -11.8$ d $x = 8.91$ or $x = -1.91$

- e $x = 0.105$ or $x = -1.90$ f $x = 3.84$ or $x = -2.34$
 g $x = 4.77$ or $x = 0.558$ h $x = 4.89$ or $x = -1.23$

- 3 a $x = -6$ or $x = -2$ b $x = 1.09$ or $x = -10.1$
 c $x = 9.11$ or $x = -0.110$ d $x = -\frac{1}{2}$ or $x = -2$

- e $x = 1$ or $x = -9$ f $x = 1$
 g $x = 4.68$ or $x = -1.18$ h $x = 3$ or $x = 5$

- 4 Area = $\frac{1}{2}(2x)(x + (x+10)) = 50 \text{ m}^2$

So $x^2 + 5x - 25 = 0$

Using the quadratic formula:

$$x = \frac{1}{2}(-5 \pm 5\sqrt{5})$$

Height = $2x = 5(\sqrt{5} - 1)$ m

Challenge

$x = 13$

Exercise 2C

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|--|---|
| 1 a $(x + 2)^2 - 4$ | b $(x - 3)^2 - 9$ |
| c $(x - 8)^2 - 64$ | d $(x + \frac{1}{2})^2 - \frac{1}{4}$ |
| e $(x - 7)^2 - 49$ | |
| 2 a $2(x + 4)^2 - 32$ | b $3(x - 4)^2 - 48$ |
| c $5(x + 2)^2 - 20$ | d $2(x - \frac{5}{4})^2 - \frac{25}{8}$ |
| e $-2(x - 2)^2 + 8$ | |
| 3 a $2(x + 2)^2 - 7$ | b $5(x - \frac{3}{2})^2 - \frac{33}{4}$ |
| c $3(x + \frac{1}{3})^2 - \frac{4}{3}$ | d $-4(x + 2)^2 + 26$ |
| e $-8(x - \frac{1}{8})^2 + \frac{81}{8}$ | |

- 4 $a = \frac{3}{2}, b = \frac{15}{4}$
 5 $A = 6, B = 0.04, C = -10$

Exercise 2D

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|---|---------------------------------------|
| 1 a $x = -3 \pm 2\sqrt{2}$ | b $x = -6 \pm \sqrt{33}$ |
| c $x = -2 \pm \sqrt{6}$ | d $x = 5 \pm \sqrt{30}$ |
| 2 a $x = \frac{1}{2}(-3 \pm \sqrt{15})$ | b $x = \frac{1}{5}(-4 \pm \sqrt{26})$ |
| c $x = \frac{1}{8}(1 \pm \sqrt{129})$ | d $x = \frac{1}{2}(-3 \pm \sqrt{39})$ |
| 3 a $p = -7, q = -48$ | |
| b $(x - 7)^2 = 48$
$x = 7 \pm \sqrt{48} = 7 \pm 4\sqrt{3}$
$r = 7, s = 4$ | |
| 4 $x^2 + 2bx + c = (x + b)^2 - b^2 + c$
$(x + b)^2 = b^2 - c$
$x = -b \pm \sqrt{b^2 - c}$ | |

Challenge

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|--|---|
| a $ax^2 + 2bx + c = 0$
$x^2 + \frac{2b}{a}x + \frac{c}{a} = 0$
$(x + \frac{b}{a})^2 - \frac{b^2}{a^2} + \frac{c}{a} = 0$
$(x + \frac{b}{a})^2 = \frac{b^2 - ac}{a^2}$
$x = -\frac{b}{a} \pm \sqrt{\frac{b^2 - ac}{a^2}}$ | b $ax^2 + bx + c = 0$
$x^2 + \frac{b}{a}x + \frac{c}{a} = 0$
$(x + \frac{b}{2a})^2 - \frac{b^2}{4a^2} + \frac{c}{a} = 0$
$(x + \frac{b}{2a})^2 = \frac{b^2 - 4ac}{4a^2}$
$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ |
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Exercise 3A

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|---|---------------------------------------|
| 1 a $x = 4, y = 2$ | b $x = 1, y = 3$ |
| c $x = 2, y = -2$ | d $x = 4\frac{1}{2}, y = -3$ |
| e $x = -\frac{2}{3}, y = 2$ | f $x = 3, y = 3$ |
| 2 a $x = 5, y = 2$ | b $x = 5\frac{1}{2}, y = -6$ |
| c $x = 1, y = -4$ | d $x = 1\frac{3}{4}, y = \frac{1}{4}$ |
| 3 a $x = -1, y = 1$ | b $x = 4, y = -4$ |
| c $x = 0.5, y = -2.5$ | |
| 4 a $3x + ky = 8$ (1); $x - 2ky = 5$ (2)
$(1) \times 2: 6x + 2ky = 16$ (3)
$(2) + (3) 7x = 21$ so $x = 3$ | |
| b -2 | |
| 5 $p = 3, q = 1$ | |

Exercise 3B

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|--|--|
| 1 a $x = 5, y = 6$ or $x = 6, y = 5$ | b $x = 0, y = 1$ or $x = \frac{4}{5}, y = -\frac{3}{5}$ |
| c $x = -1, y = -3$ or $x = 1, y = 3$ | |
| d $a = 1, b = 5$ or $a = 3, b = -1$ | e $u = 1\frac{1}{2}, v = 4$ or $u = 2, v = 3$ |
| f $x = -1\frac{1}{2}, y = 5\frac{3}{4}$ or $x = 3, y = -1$ | |
| 2 a $x = 3, y = \frac{1}{2}$ or $x = 6\frac{1}{3}, y = -2\frac{5}{6}$ | b $x = 4\frac{1}{2}, y = 4\frac{1}{2}$ or $x = 6, y = 3$ |
| c $x = -19, y = -15$ or $x = 6, y = 5$ | |
| 3 a $x = 3 + \sqrt{13}, y = -3 + \sqrt{13}$ or $x = 3 - \sqrt{13}, y = -3 - \sqrt{13}$ | b $x = 2 - 3\sqrt{5}, y = 3 + 2\sqrt{5}$ or $x = 2 + 3\sqrt{5}, y = 3 - 2\sqrt{5}$ |
| 4 $x = -5, y = 8$ or $x = 2, y = 1$ | |
| 5 a $3x^2 + x(2 - 4x) + 11 = 0$
$3x^2 + 2x - 4x^2 + 11 = 0$
$x^2 - 2x - 11 = 0$ | b $x = 1 + 2\sqrt{3}, y = -2 - 8\sqrt{3}$
$x = 1 - 2\sqrt{3}, y = -2 + 8\sqrt{3}$ |
| 6 a $k = 3, p = -2$ | b $x = -6, y = -23$ or $x = 1, y = -2$ |

Challenge

- $y = x + k$
 $x^2 + (x + k)^2 = 4$
 $x^2 + x^2 + 2kx + k^2 - 4 = 0$
 $2x^2 + 2kx + k^2 - 4 = 0$ for one solution $b^2 - 4ac = 0$
 $4k^2 - 4 \times 2(k^2 - 4) = 0$
 $4k^2 - 8k^2 + 32 = 0$ $4k^2 = 32$ $k^2 = 8$ $k = \pm 2\sqrt{2}$

Exercise 3D

- 1 a $x < 4$ b $x \geq 7$ c $x > 2\frac{1}{2}$ d $x \leq -3$
 e $x < 11$ f $x < 2\frac{3}{5}$ g $x > -12$ h $x < 1$
 i $x \leq 8$ j $x > 1\frac{1}{7}$
- 2 a $x \geq 3$ b $x < 1$ c $x \leq -3\frac{1}{4}$ d $x < 18$
 e $x > 3$ f $x \geq 4\frac{2}{5}$ g $x < 4$ h $x > -7$
 i $x \leq -\frac{1}{2}$ j $x \geq \frac{3}{4}$ k $x \geq -\frac{10}{3}$ l $x \geq \frac{9}{11}$
- 3 a $\{x: x > 2\frac{1}{2}\}$ b $\{x: 2 < x < 4\}$
 c $\{x: 2\frac{1}{2} < x < 3\}$ d No values
 e $x = 4$ f $\{x: x < 1.2\} \cup \{x: x > 2.2\}$
 g $\{x: x \leq -\frac{2}{3}\} \cup \{x: x \geq \frac{3}{2}\}$

Challenge

$p = -1, q = 4, r = 6$

Exercise 3E

- 1 a $3 < x < 8$ b $-4 < x < 3$
 c $x < -2, x > 5$ d $x \leq -4, x \geq -3$
 e $-\frac{1}{2} < x < 7$ f $x < -2, x > 2\frac{1}{2}$
 g $\frac{1}{2} \leq x \leq 1\frac{1}{2}$ h $x < \frac{1}{3}, x > 2$
 i $-3 < x < 3$ j $x < -2\frac{1}{2}, x > \frac{2}{3}$
 k $x < 0, x > 5$ l $-1\frac{1}{2} \leq x \leq 0$
- 2 a $-5 < x < 2$ b $x < -1, x > 1$
 c $\frac{1}{2} < x < 1$ d $-3 < x < \frac{1}{4}$
- 3 a $\{x: 2 < x < 4\}$ b $\{x: x > 3\}$
 c $\{x: -\frac{1}{4} < x < 0\}$ d No values
 e $\{x: -5 < x < -3\} \cup \{x: x > 4\}$
 f $\{x: -1 < x < 1\} \cup \{x: 2 < x < 3\}$
- 4 a $x < 0$ or $x > 2$ b $x < 0$ or $x > 0.8$
 c $x < -1$ or $x > 0$ d $x < 0$ or $x > 0.5$
 e $x < -\frac{1}{5}$ or $x > \frac{1}{5}$ f $x \leq -\frac{2}{3}$ or $x \geq 3$
- 5 a $-2 < k < 6$ b $p \leq -8$ or $p \geq 0$
- 6 $\{x: x < -2\} \cup \{x: x > 7\}$
- 7 a $\{x: x < \frac{2}{3}\}$ b $\{x: -\frac{1}{2} < x < 3\}$
 c $\{x: -\frac{1}{2} < x < \frac{2}{3}\}$
- 8 $x < 3$ or $x > 5.5$
- 9 No real roots $b^2 - 4ac < 0$ $(-2k)^2 - 4 \times k \times 3 < 0$
 $4k^2 - 12k = 0$ when $k = 0$ and $k = 3$
 solution $0 \leq k < 3$
 note when $k = 0$ equation gives $3 = 0$