1 Factorise

a $x^2 + 4x + 3$ **b** $x^2 + 7x + 10$ **c** $y^2 - 3y + 2$ **d** $x^2 - 6x + 9$

e $y^2 - y - 2$ **f** $a^2 + 2a - 8$ **g** $x^2 - 1$ **h** $p^2 + 9p + 14$

i $x^2 - 2x - 15$ **j** $16 - 10m + m^2$ **k** $t^2 + 3t - 18$ **l** $y^2 - 13y + 40$

m $r^2 - 16$ **n** $y^2 - 2y - 63$ **o** $121 + 22a + a^2$ **p** $x^2 + 6x - 72$

q $26 - 15x + x^2$ **r** $s^2 + 23s + 120$ **s** $p^2 + 14p - 51$ **t** $m^2 - m - 90$

2 Factorise

a $2x^2 + 3x + 1$ **b** $2 + 7p + 3p^2$ **c** $2y^2 - 5y + 3$ **d** $2 - m - m^2$

e $3r^2 - 2r - 1$ **f** $5 - 19y - 4y^2$ **g** $4 - 13a + 3a^2$ **h** $5x^2 - 8x - 4$

i $4x^2 + 8x + 3$ **j** $9s^2 - 6s + 1$ **k** $4m^2 - 25$ **l** $2 - y - 6y^2$

m $4u^2 + 17u + 4$ **n** $6p^2 + 5p - 4$ **o** $8x^2 + 19x + 6$ **p** $12r^2 + 8r - 15$

3 Using factorisation, solve each equation.

a $x^2 - 4x + 3 = 0$ **b** $x^2 + 6x + 8 = 0$ **c** $x^2 + 4x - 5 = 0$ **d** $x^2 - 7x = 8$

e $x^2 - 25 = 0$ **f** $x(x - 1) = 42$ **g** $x^2 = 3x$ **h** $27 + 12x + x^2 = 0$

i $60 - 4x - x^2 = 0$ **j** $5x + 14 = x^2$ **k** $2x^2 - 3x + 1 = 0$ **l** $x(x - 1) = 6(x - 2)$

m $3x^2 + 11x = 4$ **n** $x(2x - 3) = 5$ **o** $6 + 23x - 4x^2 = 0$ **p** $6x^2 + 10 = 19x$

q $4x^2 + 4x + 1 = 0$ **r** $3(x^2 + 4) = 13x$ **s** $(2x + 5)^2 = 5 - x$ **t** $3x(2x - 7) = 2(7x + 3)$

4 Factorise fully

a $2y^2 - 10y + 12$ **b** $x^3 + x^2 - 2x$ **c** $p^3 - 4p$ **d** $3m^3 + 21m^2 + 18m$

e $a^4 + 4a^2 + 3$ **f** $t^4 + 3t^2 - 10$ **g** $12 + 20x - 8x^2$ **h** $6r^2 - 9r - 42$

i $6x^3 - 26x^2 + 8x$ **j** $y^4 + 3y^3 - 18y^2$ **k** $m^4 - 1$ **l** $p^5 - 4p^3 + 4p$

5 Sketch each curve showing the coordinates of any points of intersection with the coordinate axes.

a $y = x^2 - 3x + 2$ **b** $y = x^2 + 5x + 6$ **c** $y = x^2 - 9$

d $y = x^2 - 2x$ **e** $y = x^2 - 10x + 25$ **f** $y = 2x^2 - 14x + 20$

g $y = -x^2 + 5x - 4$ **h** $y = 2 + x - x^2$ **i** $y = 2x^2 - 3x + 1$

j $y = 2x^2 + 13x + 6$ **k** $y = 3 - 8x + 4x^2$ **l** $y = 2 + 7x - 4x^2$

m $y = 5x^2 - 17x + 6$ **n** $y = -6x^2 + 7x - 2$ **o** $y = 6x^2 + x - 5$

6 Solve each of the following equations.

a $x - 5 + \frac{4}{x} = 0$ **b** $x - \frac{10}{x} = 3$ **c** $2x^3 - x^2 - 3x = 0$ **d** $x^2(10 - x^2) = 9$

e $\frac{5}{x^2} + \frac{4}{x} - 1 = 0$ **f** $\frac{x-6}{x-4} = x$ **g** $x + 5 = \frac{3}{x+3}$ **h** $x^2 - \frac{4}{x^2} = 3$

i $4x^4 + 7x^2 = 2$ **j** $\frac{2x}{3-x} = \frac{1}{x+2}$ **k** $\frac{2x+1}{x+3} = \frac{2}{x}$ **l** $\frac{7}{x+2} - 3x = 2$

1 Express in the form $(x + a)^2 + b$

a $x^2 + 2x + 4$ **b** $x^2 - 2x + 4$ **c** $x^2 - 4x + 1$ **d** $x^2 + 6x$

e $x^2 + 4x + 8$ **f** $x^2 - 8x - 5$ **g** $x^2 + 12x + 30$ **h** $x^2 - 10x + 25$

i $x^2 + 6x - 9$ **j** $18 - 4x + x^2$ **k** $x^2 + 3x + 3$ **l** $x^2 + x - 1$

m $x^2 - 18x + 100$ **n** $x^2 - x - \frac{1}{2}$ **o** $20 + 9x + x^2$ **p** $x^2 - 7x - 2$

q $5 - 3x + x^2$ **r** $x^2 - 11x + 37$ **s** $x^2 + \frac{2}{3}x + 1$ **t** $x^2 - \frac{1}{2}x - \frac{1}{4}$

2 Express in the form $a(x + b)^2 + c$

a $2x^2 + 4x + 3$ **b** $2x^2 - 8x - 7$ **c** $3 - 6x + 3x^2$ **d** $4x^2 + 24x + 11$

e $-x^2 - 2x - 5$ **f** $1 + 10x - x^2$ **g** $2x^2 + 2x - 1$ **h** $3x^2 - 9x + 5$

i $3x^2 - 24x + 48$ **j** $3x^2 - 15x$ **k** $70 + 40x + 5x^2$ **l** $2x^2 + 5x + 2$

m $4x^2 + 6x - 7$ **n** $-2x^2 + 4x - 1$ **o** $4 - 2x - 3x^2$ **p** $\frac{1}{3}x^2 + \frac{1}{2}x - \frac{1}{4}$

3 Solve each equation by completing the square, giving your answers as simply as possible in terms of surds where appropriate.

a $y^2 - 4y + 2 = 0$ **b** $p^2 + 2p - 2 = 0$ **c** $x^2 - 6x + 4 = 0$ **d** $7 + 10r + r^2 = 0$

e $x^2 - 2x = 11$ **f** $a^2 - 12a - 18 = 0$ **g** $m^2 - 3m + 1 = 0$ **h** $9 - 7t + t^2 = 0$

i $u^2 + 7u = 44$ **j** $2y^2 - 4y + 1 = 0$ **k** $3p^2 + 18p = -23$ **l** $2x^2 + 12x = 9$

m $-m^2 + m + 1 = 0$ **n** $4x^2 + 49 = 28x$ **o** $1 - t - 3t^2 = 0$ **p** $2a^2 - 7a + 4 = 0$

4 By completing the square, find the maximum or minimum value of y and the value of x for which this occurs. State whether your value of y is a maximum or a minimum in each case.

a $y = x^2 - 2x + 7$ **b** $y = x^2 + 2x - 3$ **c** $y = 1 - 6x + x^2$

d $y = x^2 + 10x + 35$ **e** $y = -x^2 + 4x + 4$ **f** $y = x^2 + 3x - 2$

g $y = 2x^2 + 8x + 5$ **h** $y = -3x^2 + 6x$ **i** $y = 7 - 5x - x^2$

j $y = 4x^2 - 12x + 9$ **k** $y = 4x^2 + 20x - 8$ **l** $y = 17 - 2x - 2x^2$

5 Sketch each curve showing the exact coordinates of its turning point and the point where it crosses the y-axis.

a $y = x^2 - 4x + 3$ **b** $y = x^2 + 2x - 24$ **c** $y = x^2 - 2x + 5$

d $y = 30 + 8x + x^2$ **e** $y = x^2 + 2x + 1$ **f** $y = 8 + 2x - x^2$

g $y = -x^2 + 8x - 7$ **h** $y = -x^2 - 4x - 7$ **i** $y = x^2 - 5x + 4$

j $y = x^2 + 3x + 3$ **k** $y = 3 + 8x + 4x^2$ **l** $y = -2x^2 + 8x - 15$

m $y = 1 - x - 2x^2$ **n** $y = 25 - 20x + 4x^2$ **o** $y = 3x^2 - 4x + 2$

6 **a** Express $x^2 - 4\sqrt{2}\,x + 5$ in the form $a(x + b)^2 + c$.

b Write down an equation of the line of symmetry of the curve $y = x^2 + 4\sqrt{2}\,x + 5$.

7 $\mathrm{f}(x) \equiv x^2 + 2kx - 3$.

By completing the square, find the roots of the equation $\mathrm{f}(x) = 0$ in terms of the constant k.

1 By completing the square, show that the roots of the equation $ax^2 + bx + c = 0$ are given by

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

2 Use the quadratic formula to solve each equation, giving your answers as simply as possible in terms of surds where appropriate.

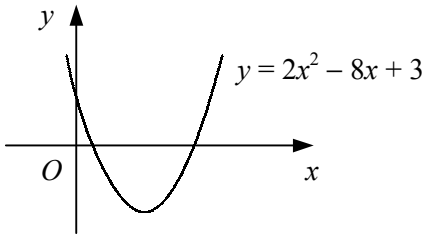
a $x^2 + 4x + 1 = 0$ **b** $4 + 8t - t^2 = 0$ **c** $y^2 - 20y + 91 = 0$ **d** $r^2 + 2r - 7 = 0$

e $6 + 18a + a^2 = 0$ **f** $m(m - 5) = 5$ **g** $x^2 + 11x + 27 = 0$ **h** $2u^2 + 6u + 3 = 0$

i $5 - y - y^2 = 0$ **j** $2x^2 - 3x = 2$ **k** $3p^2 + 7p + 1 = 0$ **l** $t^2 - 14t = 14$

m $0.1r^2 + 1.4r = 0.9$ **n** $6u^2 + 4u = 1$ **o** $\frac{1}{2}y^2 - 3y = \frac{2}{3}$ **p** $4x(x - 3) = 11 - 4x$

3



The diagram shows the curve with equation $y = 2x^2 - 8x + 3$.

Find and simplify the exact coordinates of the points where the curve crosses the x-axis.

4 State the condition for which the roots of the equation $ax^2 + bx + c = 0$ are

a real and distinct **b** real and equal **c** not real

5 Sketch the curve $y = ax^2 + bx + c$ and the x-axis in the cases where

a $a > 0$ and $b^2 - 4ac > 0$ **b** $a < 0$ and $b^2 - 4ac < 0$

c $a > 0$ and $b^2 - 4ac = 0$ **d** $a < 0$ and $b^2 - 4ac > 0$

6 By evaluating the discriminant, determine whether the roots of each equation are real and distinct, real and equal or not real.

a $x^2 + 2x - 7 = 0$ **b** $x^2 + x + 3 = 0$ **c** $x^2 - 4x + 5 = 0$ **d** $x^2 - 6x + 3 = 0$

e $x^2 + 14x + 49 = 0$ **f** $x^2 - 9x + 17 = 0$ **g** $x^2 + 3x = 11$ **h** $2 + 3x + 2x^2 = 0$

i $5x^2 + 8x + 3 = 0$ **j** $3x^2 - 7x + 5 = 0$ **k** $9x^2 - 12x + 4 = 0$ **l** $13x^2 + 19x + 7 = 0$

m $4 - 11x + 8x^2 = 0$ **n** $x^2 + \frac{2}{3}x = \frac{1}{4}$ **o** $x^2 - \frac{3}{4}x + \frac{1}{8} = 0$ **p** $\frac{2}{5}x^2 + \frac{3}{5}x + \frac{1}{3} = 0$

7 Find the value of the constant p such that the equation $x^2 + x + p = 0$ has equal roots.

8 Given that $q \neq 0$, find the value of the constant q such that the equation $x^2 + 2qx - q = 0$ has a repeated root.

9 Given that the x-axis is a tangent to the curve with the equation

$$y = x^2 + rx - 2x + 4,$$

find the two possible values of the constant r.