

Solutionbank C1

Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise A, Question 1

Question:

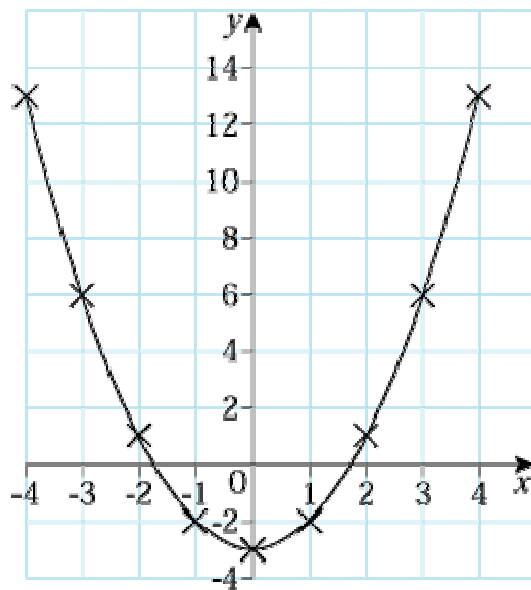
Draw a graph with the following equation, taking values of x from -4 to $+4$. For each graph write down the equation of the line of symmetry.

$$y = x^2 - 3$$

Solution:

$$y = x^2 - 3.$$

x	-4	-3	-2	-1	0	1	2	3	4
$x^2 - 3$	$16 - 3$	$9 - 3$	$4 - 3$	$1 - 3$	$0 - 3$	$1 - 3$	$4 - 3$	$9 - 3$	$16 - 3$
y	13	6	1	-2	-3	-2	1	6	13



Equation of line of symmetry is $x = 0$.

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Exercise A, Question 2

Question:

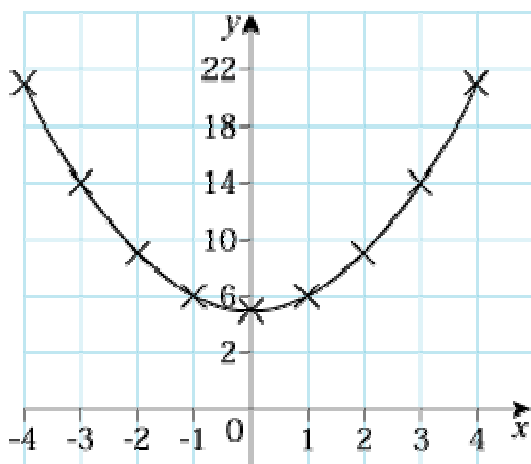
Draw a graph with the following equation, taking values of x from -4 to $+4$. For each graph write down the equation of the line of symmetry.

$$y = x^2 + 5$$

Solution:

$$y = x^2 + 5.$$

x	-4	-3	-2	-1	0	1	2	3	4
$x^2 + 5$	$16 + 5$	$9 + 5$	$4 + 5$	$1 + 5$	$0 + 5$	$1 + 5$	$4 + 5$	$9 + 5$	$16 + 5$
y	21	14	9	6	5	6	9	14	21



Equation of line of symmetry is $x = 0$.

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Exercise A, Question 3

Question:

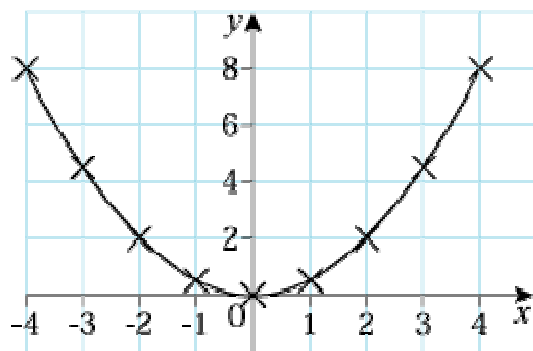
Draw a graph with the following equation, taking values of x from -4 to $+4$. For each graph write down the equation of the line of symmetry.

$$y = \frac{1}{2}x^2$$

Solution:

$$y = \frac{1}{2}x^2$$

x	-4	-3	-2	-1	0	1	2	3	4
$\frac{1}{2}x^2$	8	$4\frac{1}{2}$	2	$\frac{1}{2}$	0	$\frac{1}{2}$	2	$4\frac{1}{2}$	8
y	8	$4\frac{1}{2}$	2	$\frac{1}{2}$	0	$\frac{1}{2}$	2	$4\frac{1}{2}$	8



Equation of line of symmetry is $x = 0$.

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Quadratic Equations

Exercise A, Question 4

Question:

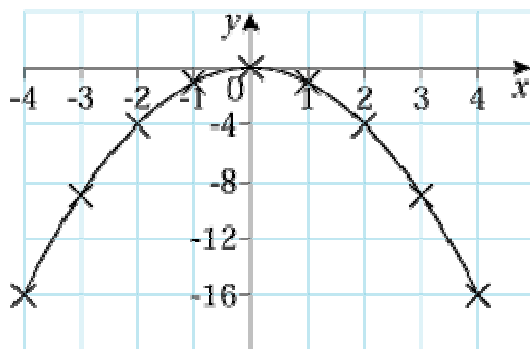
Draw a graph with the following equation, taking values of x from -4 to $+4$. For each graph write down the equation of the line of symmetry.

$$y = -x^2$$

Solution:

$$y = -x^2$$

x	-4	-3	-2	-1	0	1	2	3	4
$-x^2$	-16	-9	-4	-1	0	-1	-4	-9	-16
y	-16	-9	-4	-1	0	-1	-4	-9	-16



Equation of line of symmetry is $x = 0$.

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Quadratic Equations

Exercise A, Question 5

Question:

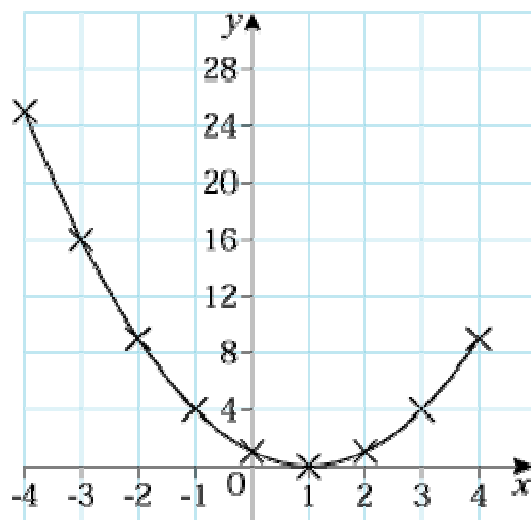
Draw a graph with the following equation, taking values of x from -4 to $+4$. For each graph write down the equation of the line of symmetry.

$$y = (x - 1)^2$$

Solution:

$$y = (x - 1)^2$$

x	-4	-3	-2	-1	0	1	2	3	4
$(x - 1)^2$	25	16	9	4	1	0	1	4	9
y	25	16	9	4	1	0	1	4	9



Equation of line of symmetry is $x = 1$.

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Quadratic Equations

Exercise A, Question 6

Question:

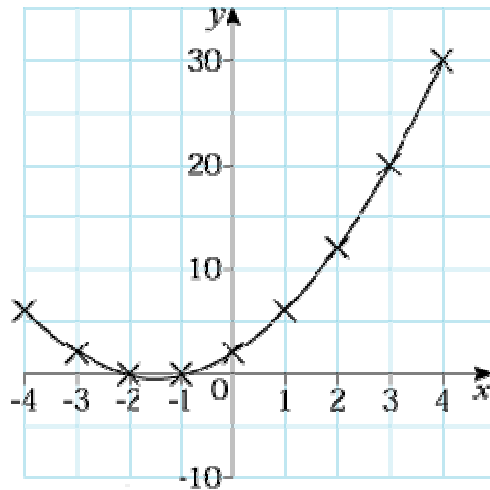
Draw a graph with the following equation, taking values of x from -4 to $+4$. For each graph write down the equation of the line of symmetry.

$$y = x^2 + 3x + 2$$

Solution:

$$y = x^2 + 3x + 2$$

x	-4	-3	-2	-1	0	1	2	3	4
$x^2 + 3x + 2$	$16 - 12 + 2$	$9 - 9 + 2$	$4 - 6 + 2$	$1 - 3 + 2$	$0 + 0 + 2$	$1 + 3 + 2$	$4 + 6 + 2$	$9 + 9 + 2$	$16 + 12 + 2$
y	6	2	0	0	2	6	12	20	30



Equation of line of symmetry is $x = -1\frac{1}{2}$.

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Quadratic Equations

Exercise A, Question 7

Question:

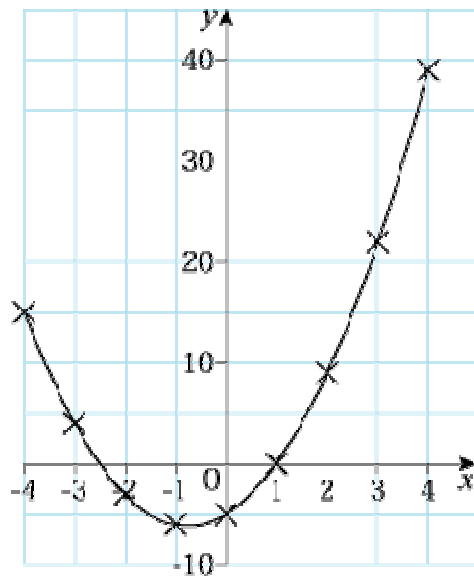
Draw a graph with the following equation, taking values of x from -4 to $+4$. For each graph write down the equation of the line of symmetry.

$$y = 2x^2 + 3x - 5$$

Solution:

$$y = 2x^2 + 3x - 5$$

x	-4	-3	-2	-1	0	1	2	3	4
$2x^2 + 3x - 5$	$32 - 12 - 5$	$18 - 9 - 5$	$8 - 6 - 5$	$2 - 3 - 5$	$0 + 0 - 5$	$2 + 3 - 5$	$8 + 6 - 5$	$18 + 9 - 5$	$32 + 12 - 5$
y	15	4	-3	-6	-5	0	9	22	39



Equation of line of symmetry is $x = -\frac{3}{4}$.

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Quadratic Equations

Exercise A, Question 8

Question:

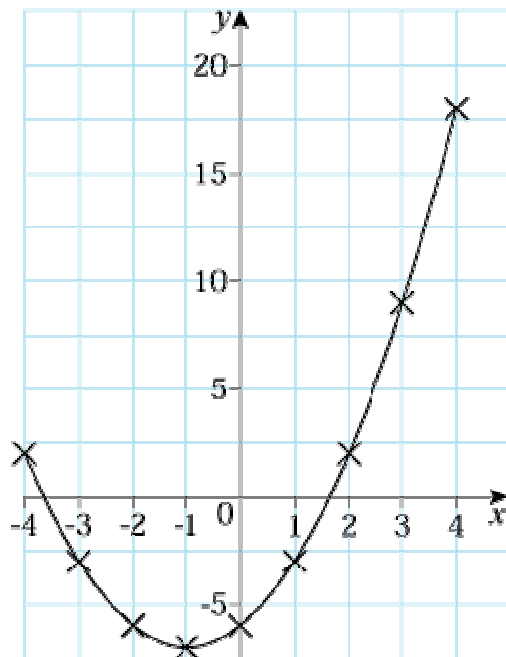
Draw a graph with the following equation, taking values of x from -4 to $+4$. For each graph write down the equation of the line of symmetry.

$$y = x^2 + 2x - 6$$

Solution:

$$y = x^2 + 2x - 6$$

x	-4	-3	-2	-1	0	1	2	3	4
$x^2 + 2x - 6$	$16 - 8 - 6$	$9 - 6 - 6$	$4 - 4 - 6$	$1 - 2 - 6$	$0 + 0 - 6$	$1 + 2 - 6$	$4 + 4 - 6$	$9 + 6 - 6$	$16 + 8 - 6$
y	2	-3	-6	-7	-6	-3	2	9	18



Equation of line of symmetry is $x = -1$.

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Quadratic Equations

Exercise A, Question 9

Question:

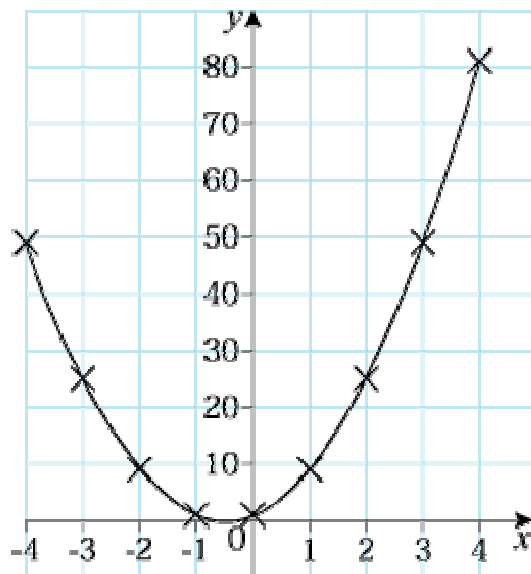
Draw a graph with the following equation, taking values of x from -4 to $+4$. For each graph write down the equation of the line of symmetry.

$$y = (2x + 1)^2$$

Solution:

$$y = (2x + 1)^2$$

x	-4	-3	-2	-1	0	1	2	3	4
$2x + 1$	$-8 + 1$	$-6 + 1$	$-4 + 1$	$-2 + 1$	$0 + 1$	$2 + 1$	$4 + 1$	$6 + 1$	$8 + 1$
$(2x + 1)^2$	49	25	9	1	1	9	25	49	81
$y = (2x + 1)^2$	49	25	9	1	1	9	25	49	81



Equation of line of symmetry is $x = -\frac{1}{2}$.

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Quadratic Equations

Exercise B, Question 1

Question:

Solve the following equation:

$$x^2 = 4x$$

Solution:

$$x^2 - 4x = 0$$

$$x (x - 4) = 0$$

$$x = 0 \text{ or } x - 4 = 0$$

$$\text{So } x = 0 \text{ or } x = 4$$

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Quadratic Equations

Exercise B, Question 2

Question:

Solve the following equation:

$$x^2 = 25x$$

Solution:

$$x^2 - 25x = 0$$

$$x (x - 25) = 0$$

$$x = 0 \text{ or } x - 25 = 0$$

$$\text{So } x = 0 \text{ or } x = 25$$

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Quadratic Equations

Exercise B, Question 3

Question:

Solve the following equation:

$$3x^2 = 6x$$

Solution:

$$3x^2 - 6x = 0$$

$$3x(x - 2) = 0$$

$$x = 0 \text{ or } x - 2 = 0$$

$$\text{So } x = 0 \text{ or } x = 2$$

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Quadratic Equations

Exercise B, Question 4

Question:

Solve the following equation:

$$5x^2 = 30x$$

Solution:

$$5x^2 - 30x = 0$$

$$5x(x - 6) = 0$$

$$x = 0 \text{ or } x - 6 = 0$$

$$\text{So } x = 0 \text{ or } x = 6$$

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Quadratic Equations

Exercise B, Question 5

Question:

Solve the following equation:

$$x^2 + 3x + 2 = 0$$

Solution:

$$(x + 1)(x + 2) = 0$$
$$x + 1 = 0 \text{ or } x + 2 = 0$$
$$\text{So } x = -1 \text{ or } x = -2$$

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Quadratic Equations

Exercise B, Question 6

Question:

Solve the following equation:

$$x^2 + 5x + 4 = 0$$

Solution:

$$(x + 1)(x + 4) = 0$$
$$x + 1 = 0 \text{ or } x + 4 = 0$$
$$\text{So } x = -1 \text{ or } x = -4$$

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Exercise B, Question 7

Question:

Solve the following equation:

$$x^2 + 7x + 10 = 0$$

Solution:

$$\begin{aligned}(x + 2)(x + 5) &= 0 \\ x + 2 = 0 \text{ or } x + 5 &= 0 \\ x = -2 \text{ or } x &= -5\end{aligned}$$

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Quadratic Equations

Exercise B, Question 8

Question:

Solve the following equation:

$$x^2 - x - 6 = 0$$

Solution:

$$(x - 3)(x + 2) = 0$$
$$x - 3 = 0 \text{ or } x + 2 = 0$$
$$\text{So } x = 3 \text{ or } x = -2$$

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Quadratic Equations

Exercise B, Question 9

Question:

Solve the following equation:

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

Solution:

$$(x - 3)(x - 5) = 0$$
$$x - 3 = 0 \text{ or } x - 5 = 0$$
$$\text{So } x = 3 \text{ or } x = 5$$

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Exercise B, Question 10

Question:

Solve the following equation:

$$x^2 - 9x + 20 = 0$$

Solution:

$$(x - 4)(x - 5) = 0$$
$$x - 4 = 0 \text{ or } x - 5 = 0$$
$$\text{So } x = 4 \text{ or } x = 5$$

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Quadratic Equations

Exercise B, Question 11

Question:

Solve the following equation:

$$x^2 - 5x - 6 = 0$$

Solution:

$$(x - 6)(x + 1) = 0$$
$$x - 6 = 0 \text{ or } x + 1 = 0$$
$$\text{So } x = 6 \text{ or } x = -1$$

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Quadratic Equations

Exercise B, Question 12

Question:

Solve the following equation:

$$x^2 - 4x - 12 = 0$$

Solution:

$$(x - 6)(x + 2) = 0$$
$$x - 6 = 0 \text{ or } x + 2 = 0$$
$$\text{So } x = 6 \text{ or } x = -2$$

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Quadratic Equations

Exercise B, Question 13

Question:

Solve the following equation:

$$2x^2 + 7x + 3 = 0$$

Solution:

$$(2x + 1)(x + 3) = 0$$

$$2x + 1 = 0 \text{ or } x + 3 = 0$$

$$2x = -1 \text{ or } x = -3$$

$$\text{So } x = -\frac{1}{2} \text{ or } x = -3$$

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Quadratic Equations

Exercise B, Question 14

Question:

Solve the following equation:

$$6x^2 - 7x - 3 = 0$$

Solution:

$$(3x + 1)(2x - 3) = 0$$
$$3x + 1 = 0 \text{ or } 2x - 3 = 0$$

$$\text{So } x = -\frac{1}{3} \text{ or } x = \frac{3}{2}$$

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Quadratic Equations

Exercise B, Question 15

Question:

Solve the following equation:

$$6x^2 - 5x - 6 = 0$$

Solution:

$$(3x + 2)(2x - 3) = 0$$
$$3x + 2 = 0 \text{ or } 2x - 3 = 0$$

$$\text{So } x = -\frac{2}{3} \text{ or } x = \frac{3}{2}$$

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Quadratic Equations

Exercise B, Question 16

Question:

Solve the following equation:

$$4x^2 - 16x + 15 = 0$$

Solution:

$$(2x - 3)(2x - 5) = 0$$
$$2x - 3 = 0 \text{ or } 2x - 5 = 0$$

$$\text{So } x = \frac{3}{2} \text{ or } x = \frac{5}{2}$$

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Quadratic Equations

Exercise B, Question 17

Question:

Solve the following equation:

$$3x^2 + 5x = 2$$

Solution:

$$\begin{aligned} 3x^2 + 5x - 2 &= 0 \\ (3x - 1)(x + 2) &= 0 \\ 3x - 1 = 0 \text{ or } x + 2 &= 0 \end{aligned}$$

$$\text{So } x = \frac{1}{3} \text{ or } x = -2$$

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Quadratic Equations

Exercise B, Question 18

Question:

Solve the following equation:

$$(2x - 3)^2 = 9$$

Solution:

$$2x - 3 = \pm 3$$

$$2x = \pm 3 + 3$$

$$x = \frac{\pm 3 + 3}{2}$$

$$\text{So } x = 3 \text{ or } x = 0$$

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Quadratic Equations

Exercise B, Question 19

Question:

Solve the following equation:

$$(x - 7)^2 = 36$$

Solution:

$$x - 7 = \pm 6$$

$$x = \pm 6 + 7$$

$$\text{So } x = 1 \text{ or } x = 13$$

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Exercise B, Question 20

Question:

Solve the following equation:

$$2x^2 = 8$$

Solution:

$$x^2 = 4$$

$$x = \pm 2$$

$$\text{So } x = 2 \text{ or } x = -2$$

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Exercise B, Question 21

Question:

Solve the following equation:

$$3x^2 = 5$$

Solution:

$$x^2 = \frac{5}{3}$$

$$x = \pm \sqrt{\frac{5}{3}}$$

$$\text{So } x = \sqrt{\frac{5}{3}} \text{ or } x = -\sqrt{\frac{5}{3}}$$

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Exercise B, Question 22

Question:

Solve the following equation:

$$(x - 3)^2 = 13$$

Solution:

$$x - 3 = \pm \sqrt{13}$$

$$x = 3 \pm \sqrt{13}$$

$$\text{So } x = 3 + \sqrt{13} \text{ or } x = 3 - \sqrt{13}$$

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Quadratic Equations

Exercise B, Question 23

Question:

Solve the following equation:

$$(3x - 1)^2 = 11$$

Solution:

$$\begin{aligned}3x - 1 &= \pm \sqrt{11} \\3x &= 1 \pm \sqrt{11} \\x &= \frac{1 \pm \sqrt{11}}{3}\end{aligned}$$

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Quadratic Equations

Exercise B, Question 24

Question:

Solve the following equation:

$$5x^2 - 10x^2 = -7 + x + x^2$$

Solution:

$$\begin{aligned} -6x^2 - x + 7 &= 0 \\ (1 - x)(7 + 6x) &= 0 \\ x = 1 \text{ or } 6x &= -7 \end{aligned}$$

$$\text{So } x = 1 \text{ or } x = -\frac{7}{6}$$

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Quadratic Equations

Exercise B, Question 25

Question:

Solve the following equation:

$$6x^2 - 7 = 11x$$

Solution:

$$\begin{aligned}6x^2 - 11x - 7 &= 0 \\(3x - 7)(2x + 1) &= 0 \\3x - 7 = 0 \text{ or } 2x + 1 &= 0 \\ \text{So } x &= \frac{7}{3} \text{ or } x = -\frac{1}{2}\end{aligned}$$

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Quadratic Equations

Exercise B, Question 26

Question:

Solve the following equation:

$$4x^2 + 17x = 6x - 2x^2$$

Solution:

$$6x^2 + 11x = 0$$

$$x(6x + 11) = 0$$

$$x = 0 \text{ or } 6x + 11 = 0$$

$$\text{So } x = 0 \text{ or } x = -\frac{11}{6}$$

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Quadratic Equations

Exercise C, Question 1

Question:

Complete the square for the expression:

$$x^2 + 4x$$

Solution:

$$= (x + 2)^2 - 4$$

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Quadratic Equations

Exercise C, Question 2

Question:

Complete the square for the expression:

$$x^2 - 6x$$

Solution:

$$= (x - 3)^2 - 9$$

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Quadratic Equations

Exercise C, Question 3

Question:

Complete the square for the expression:

$$x^2 - 16x$$

Solution:

$$= (x - 8)^2 - 64$$

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Quadratic Equations

Exercise C, Question 4

Question:

Complete the square for the expression:

$$x^2 + x$$

Solution:

$$= \left(x + \frac{1}{2} \right)^2 - \frac{1}{4}$$

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Exercise C, Question 5

Question:

Complete the square for the expression:

$$x^2 - 14x$$

Solution:

$$= (x - 7)^2 - 49$$

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Quadratic Equations

Exercise C, Question 6

Question:

Complete the square for the expression:

$$2x^2 + 16x$$

Solution:

$$\begin{aligned} &= 2 (x^2 + 8x) \\ &= 2 [(x + 4)^2 - 16] \\ &= 2 (x + 4)^2 - 32 \end{aligned}$$

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Quadratic Equations

Exercise C, Question 7

Question:

Complete the square for the expression:

$$3x^2 - 24x$$

Solution:

$$\begin{aligned} &= 3 (x^2 - 8x) \\ &= 3 [(x - 4)^2 - 16] \\ &= 3 (x - 4)^2 - 48 \end{aligned}$$

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Exercise C, Question 8

Question:

Complete the square for the expression:

$$2x^2 - 4x$$

Solution:

$$\begin{aligned} &= 2 (x^2 - 2x) \\ &= 2 [(x - 1)^2 - 1] \\ &= 2 (x - 1)^2 - 2 \end{aligned}$$

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Quadratic Equations

Exercise C, Question 9

Question:

Complete the square for the expression:

$$5x^2 + 20x$$

Solution:

$$\begin{aligned} &= 5 (x^2 + 4x) \\ &= 5 [(x + 2)^2 - 4] \\ &= 5 (x + 2)^2 - 20 \end{aligned}$$

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Quadratic Equations

Exercise C, Question 10

Question:

Complete the square for the expression:

$$2x^2 - 5x$$

Solution:

$$\begin{aligned} &= 2 \left(x^2 - \frac{5}{2}x \right) \\ &= 2 \left[\left(x - \frac{5}{4} \right)^2 - \frac{25}{16} \right] \\ &= 2 \left(x - \frac{5}{4} \right)^2 - \frac{25}{8} \end{aligned}$$

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Quadratic Equations

Exercise C, Question 11

Question:

Complete the square for the expression:

$$3x^2 + 9x$$

Solution:

$$\begin{aligned} &= 3 (x^2 + 3x) \\ &= 3 \left[\left(x + \frac{3}{2} \right)^2 - \frac{9}{4} \right] \\ &= 3 \left(x + \frac{3}{2} \right)^2 - \frac{27}{4} \end{aligned}$$

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Quadratic Equations

Exercise C, Question 12

Question:

Complete the square for the expression:

$$3x^2 - x$$

Solution:

$$\begin{aligned} &= 3 \left(x^2 - \frac{1}{3}x \right) \\ &= 3 \left[\left(x - \frac{1}{6} \right)^2 - \frac{1}{36} \right] \\ &= 3 \left(x - \frac{1}{6} \right)^2 - \frac{3}{36} \\ &= 3 \left(x - \frac{1}{6} \right)^2 - \frac{1}{12} \end{aligned}$$

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Quadratic Equations

Exercise D, Question 1

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$x^2 + 6x + 1 = 0$$

Solution:

$$x^2 + 6x = -1$$

$$(x + 3)^2 - 9 = -1$$

$$(x + 3)^2 = -1 + 9$$

$$(x + 3)^2 = 8$$

$$x + 3 = \pm \sqrt{8}$$

$$x = -3 \pm \sqrt{8}$$

$$x = -3 \pm \sqrt{2} \sqrt{4}$$

$$x = -3 \pm 2\sqrt{2}$$

$$\text{So } x = -3 + 2\sqrt{2} \text{ or } x = -3 - 2\sqrt{2}$$

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Quadratic Equations

Exercise D, Question 2

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$x^2 + 12x + 3 = 0$$

Solution:

$$\begin{aligned}x^2 + 12x &= -3 \\(x + 6)^2 - 36 &= -3 \\(x + 6)^2 &= 33 \\x + 6 &= \pm \sqrt{33} \\x &= -6 \pm \sqrt{33} \\\text{So } x &= -6 + \sqrt{33} \text{ or } x = -6 - \sqrt{33}\end{aligned}$$

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Quadratic Equations

Exercise D, Question 3

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$x^2 - 10x = 5$$

Solution:

$$(x - 5)^2 - 25 = 5$$

$$(x - 5)^2 = 5 + 25$$

$$(x - 5)^2 = 30$$

$$x - 5 = \pm \sqrt{30}$$

$$x = 5 \pm \sqrt{30}$$

$$\text{So } x = 5 + \sqrt{30} \text{ or } x = 5 - \sqrt{30}$$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise D, Question 4

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$x^2 + 4x - 2 = 0$$

Solution:

$$x^2 + 4x = 2$$

$$(x + 2)^2 - 4 = 2$$

$$(x + 2)^2 = 6$$

$$x + 2 = \pm \sqrt{6}$$

$$\text{So } x = -2 + \sqrt{6} \text{ or } x = -2 - \sqrt{6}$$

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Quadratic Equations

Exercise D, Question 5

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$x^2 - 3x - 5 = 0$$

Solution:

$$x^2 - 3x = 5$$

$$\left(x - \frac{3}{2}\right)^2 - \frac{9}{4} = 5$$

$$\left(x - \frac{3}{2}\right)^2 = 5 + \frac{9}{4}$$

$$\left(x - \frac{3}{2}\right)^2 = \frac{29}{4}$$

$$x - \frac{3}{2} = \pm \frac{\sqrt{29}}{2}$$

$$x = \frac{3}{2} \pm \frac{\sqrt{29}}{2}$$

$$\text{So } x = \frac{3 + \sqrt{29}}{2} \text{ or } x = \frac{3 - \sqrt{29}}{2}$$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise D, Question 6

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$2x^2 - 7 = 4x$$

Solution:

$$2x^2 - 4x = 7$$

$$x^2 - 2x = \frac{7}{2}$$

$$(x - 1)^2 - 1 = \frac{7}{2}$$

$$(x - 1)^2 = \frac{9}{2}$$

$$x - 1 = \pm \frac{3}{\sqrt{2}}$$

$$x = 1 \pm \frac{3}{\sqrt{2}}$$

$$x = 1 \pm \frac{3\sqrt{2}}{2}$$

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Quadratic Equations

Exercise D, Question 7

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$4x^2 - x = 8$$

Solution:

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

$$\left(x - \frac{1}{8}\right)^2 - \frac{1}{64} = 2$$

$$\left(x - \frac{1}{8}\right)^2 = 2 + \frac{1}{64}$$

$$\left(x - \frac{1}{8}\right)^2 = \frac{129}{64}$$

$$x - \frac{1}{8} = \pm \frac{\sqrt{129}}{8}$$

$$x = \frac{1}{8} \pm \frac{\sqrt{129}}{8}$$

$$\text{So } x = \frac{1 + \sqrt{129}}{8} \text{ or } x = \frac{1 - \sqrt{129}}{8}$$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise D, Question 8

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$10 = 3x - x^2$$

Solution:

$$x^2 - 3x = -10$$

$$\left(x - \frac{3}{2}\right)^2 - \frac{9}{4} = -10$$

$$\left(x - \frac{3}{2}\right)^2 = -\frac{31}{4}$$

No real roots as RHS is negative.

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Quadratic Equations

Exercise D, Question 9

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$15 - 6x - 2x^2 = 0$$

Solution:

$$2x^2 + 6x = 15$$

$$x^2 + 3x = \frac{15}{2}$$

$$\left(x + \frac{3}{2}\right)^2 - \frac{9}{4} = \frac{15}{2}$$

$$\left(x + \frac{3}{2}\right)^2 = \frac{39}{4}$$

$$x + \frac{3}{2} = \pm \frac{\sqrt{39}}{2}$$

$$x = -\frac{3}{2} \pm \frac{\sqrt{39}}{2}$$

$$\text{So } x = -\frac{3}{2} + \frac{\sqrt{39}}{2} \text{ or } x = -\frac{3}{2} - \frac{\sqrt{39}}{2}$$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise D, Question 10

Question:

Solve the quadratic equation by completing the square (remember to leave your answer in surd form):

$$5x^2 + 8x - 2 = 0$$

Solution:

$$x^2 + \frac{8}{5}x = \frac{2}{5}$$

$$\left(x + \frac{4}{5}\right)^2 - \frac{16}{25} = \frac{2}{5}$$

$$\left(x + \frac{4}{5}\right)^2 = \frac{26}{25}$$

$$x + \frac{4}{5} = \pm \frac{\sqrt{26}}{5}$$

$$x = -\frac{4}{5} \pm \frac{\sqrt{26}}{5}$$

$$\text{So } x = \frac{-4 + \sqrt{26}}{5} \text{ or } x = \frac{-4 - \sqrt{26}}{5}$$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise E, Question 1

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$x^2 + 3x + 1 = 0$$

Solution:

$$x = \frac{-3 \pm \sqrt{3^2 - 4(1)(1)}}{2 \times 1}$$

$$x = \frac{-3 \pm \sqrt{9 - 4}}{2}$$

$$x = \frac{-3 \pm \sqrt{5}}{2}$$

$$\text{Then } x = \frac{-3 + \sqrt{5}}{2} \text{ or } x = \frac{-3 - \sqrt{5}}{2}$$

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Quadratic Equations

Exercise E, Question 2

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$x^2 - 3x - 2 = 0$$

Solution:

$$x = \frac{-(-3) \pm \sqrt{(-3)^2 - 4(1)(-2)}}{2 \times 1}$$

$$x = \frac{+3 \pm \sqrt{9+8}}{2}$$

$$x = \frac{3 \pm \sqrt{17}}{2}$$

$$\text{Then } x = \frac{3 + \sqrt{17}}{2} \text{ or } x = \frac{3 - \sqrt{17}}{2}$$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise E, Question 3

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$x^2 + 6x + 6 = 0$$

Solution:

$$x = \frac{-6 \pm \sqrt{(6)^2 - 4(1)(6)}}{2 \times 1}$$

$$x = \frac{-6 \pm \sqrt{36 - 24}}{2}$$

$$x = \frac{-6 \pm \sqrt{12}}{2}$$

$$x = \frac{-6 \pm 2\sqrt{3}}{2}$$

$$x = -3 \pm \sqrt{3}$$

$$\text{Then } x = -3 + \sqrt{3} \text{ or } x = -3 - \sqrt{3}$$

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Quadratic Equations

Exercise E, Question 4

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$x^2 - 5x - 2 = 0$$

Solution:

$$x = \frac{-(-5) \pm \sqrt{(-5)^2 - 4(1)(-2)}}{2 \times 1}$$

$$x = \frac{+5 \pm \sqrt{25 + 8}}{2}$$

$$x = \frac{5 \pm \sqrt{33}}{2}$$

$$\text{Then } x = \frac{5 + \sqrt{33}}{2} \text{ or } x = \frac{5 - \sqrt{33}}{2}$$

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Quadratic Equations

Exercise E, Question 5

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$3x^2 + 10x - 2 = 0$$

Solution:

$$x = \frac{-10 \pm \sqrt{10^2 - 4(3)(-2)}}{2 \times 3}$$

$$x = \frac{-10 \pm \sqrt{100 + 24}}{6}$$

$$x = \frac{-10 \pm \sqrt{124}}{6}$$

$$x = \frac{-10 \pm 2\sqrt{31}}{6}$$

$$\text{Then } x = \frac{-5 + \sqrt{31}}{3} \text{ or } x = \frac{-5 - \sqrt{31}}{3}$$

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Quadratic Equations

Exercise E, Question 6

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$4x^2 - 4x - 1 = 0$$

Solution:

$$x = \frac{-(-4) \pm \sqrt{(-4)^2 - 4(4)(-1)}}{2 \times 4}$$

$$x = \frac{+4 \pm \sqrt{16 + 16}}{8}$$

$$x = \frac{4 \pm \sqrt{32}}{8}$$

$$x = \frac{4 \pm 4\sqrt{2}}{8}$$

$$\text{Then } x = \frac{1 + \sqrt{2}}{2} \text{ or } x = \frac{1 - \sqrt{2}}{2}$$

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Quadratic Equations

Exercise E, Question 7

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$7x^2 + 9x + 1 = 0$$

Solution:

$$x = \frac{-9 \pm \sqrt{9^2 - 4(7)(1)}}{2 \times 7}$$

$$x = \frac{-9 \pm \sqrt{81 - 28}}{14}$$

$$x = \frac{-9 \pm \sqrt{53}}{14}$$

$$\text{Then } x = \frac{-9 + \sqrt{53}}{14} \text{ or } x = \frac{-9 - \sqrt{53}}{14}$$

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Quadratic Equations

Exercise E, Question 8

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$5x^2 + 4x - 3 = 0$$

Solution:

$$x = \frac{-4 \pm \sqrt{4^2 - 4(5)(-3)}}{2 \times 5}$$

$$x = \frac{-4 \pm \sqrt{16 + 60}}{10}$$

$$x = \frac{-4 \pm \sqrt{76}}{10}$$

$$x = \frac{-4 \pm 2\sqrt{19}}{10}$$

$$\text{Then } x = \frac{-2 + \sqrt{19}}{5} \text{ or } x = \frac{-2 - \sqrt{19}}{5}$$

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Quadratic Equations

Exercise E, Question 9

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$4x^2 - 7x = 2$$

Solution:

$$4x^2 - 7x - 2 = 0$$

$$x = \frac{-(-7) \pm \sqrt{(-7)^2 - 4(4)(-2)}}{2 \times 4}$$

$$x = \frac{+7 \pm \sqrt{49 + 32}}{8}$$

$$x = \frac{7 \pm \sqrt{81}}{8}$$

$$x = \frac{7 \pm 9}{8}$$

$$\text{Then } x = 2 \text{ or } x = -\frac{1}{4}$$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise E, Question 10

Question:

Solve the following quadratic equation by using the formula, giving the solution in surd form. Simplify your answer:

$$11x^2 + 2x - 7 = 0$$

Solution:

$$x = \frac{-2 \pm \sqrt{2^2 - 4(11)(-7)}}{2 \times 11}$$

$$x = \frac{-2 \pm \sqrt{4 + 308}}{22}$$

$$x = \frac{-2 \pm \sqrt{312}}{22}$$

$$x = \frac{-2 \pm 2\sqrt{78}}{22}$$

$$x = \frac{-1 \pm \sqrt{78}}{11}$$

$$\text{Then } x = \frac{-1 + \sqrt{78}}{11} \text{ or } x = \frac{-1 - \sqrt{78}}{11}$$

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Quadratic Equations

Exercise F, Question 1

Question:

Sketch the graphs of the following equations:

(a) $y = x^2 + 3x + 2$

(b) $y = x^2 - 3x + 10$

(c) $y = x^2 + 2x - 15$

(d) $y = 2x^2 + 7x + 3$

(e) $y = 2x^2 + x - 3$

(f) $y = 6x^2 - 19x + 10$

(g) $y = 3x^2 - 2x - 5$

(h) $y = 3x^2 - 13x$

(i) $y = -x^2 + 6x + 7$

(j) $y = 4 - 7x - 2x^2$

Solution:

(a) $a > 0$ so graph is a \cup shape.

$$b^2 = 9, 4ac = 8$$

$b^2 > 4ac$, so there are two different roots of the equation $y = 0$.

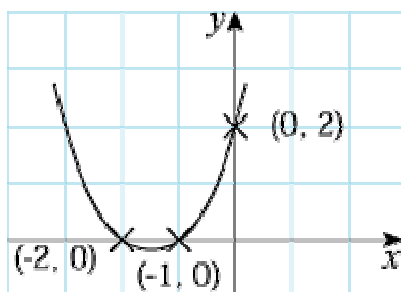
When $y = 0$,

$$(x + 2)(x + 1) = 0$$

$$x = -2 \text{ or } x = -1$$

So crossing points are $(-2, 0)$ and $(-1, 0)$.

When $x = 0$, $y = 2$, so $(0, 2)$ is a crossing point.



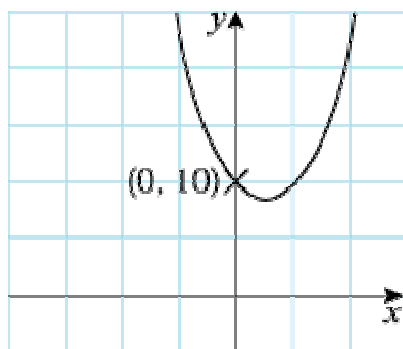
(b) $a > 0$ so graph is a \cup shape.

$$b^2 = 9, 4ac = 40$$

$b^2 < 4ac$, so there are no real roots of the equation $y = 0$.

So there are no crossing points at $y = 0$.

When $x = 0$, $y = 10$, so crossing point is $(0, 10)$.



(c) $a > 0$ so graph is a \cup shape.

$$b^2 = 4, 4ac = -60$$

$b^2 > 4ac$, so two different roots of $y = 0$.

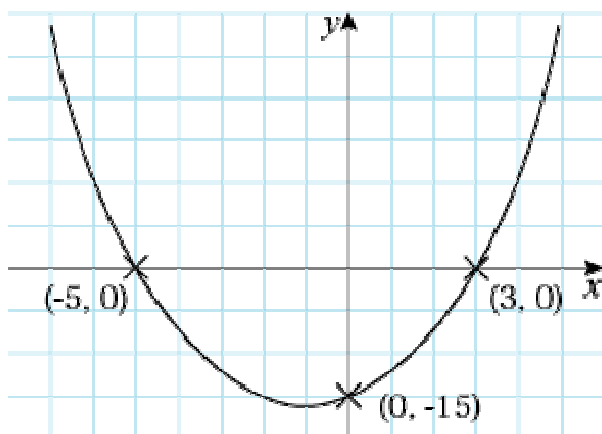
When $y = 0$,

$$0 = (x + 5)(x - 3)$$

$$x = -5 \text{ or } x = 3$$

So crossing points are $(-5, 0)$ and $(3, 0)$.

When $x = 0$, $y = -15$, so crossing point is $(0, -15)$.



(d) $a > 0$ so graph is a \cup shape.

$$b^2 = 49, 4ac = 24$$

$b^2 > 4ac$, so two different roots of $y = 0$.

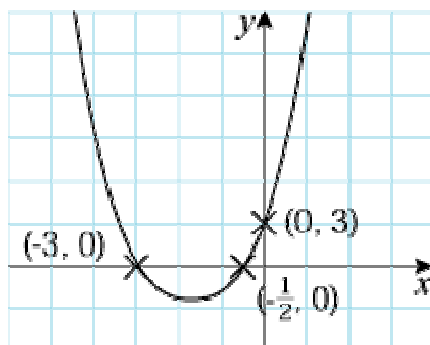
When $y = 0$,

$$0 = (2x + 1)(x + 3)$$

$$x = -\frac{1}{2} \text{ or } x = -3$$

So crossing points are $\left(-\frac{1}{2}, 0\right)$ and $(-3, 0)$.

When $x = 0$, $y = 3$, so crossing point is $(0, 3)$.



(e) $a > 0$ so graph is a \cup shape.

$$b^2 = 1, 4ac = -24$$

$b^2 > 4ac$, so two different roots of $y = 0$.

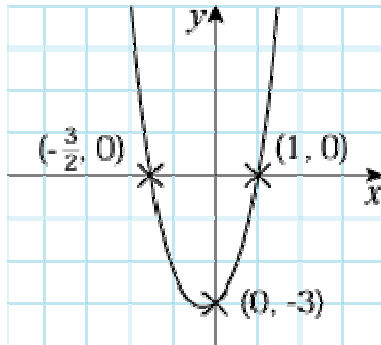
When $y = 0$,

$$0 = (2x + 3)(x - 1)$$

$$x = -\frac{3}{2} \text{ or } x = 1$$

So crossing points are $\left(-\frac{3}{2}, 0\right)$ and $(1, 0)$.

When $x = 0$, $y = -3$, so crossing point is $(0, -3)$.



(f) $a > 0$ so graph is a \cup shape.

$$b^2 = 361, 4ac = 240$$

$b^2 > 4ac$, so two different roots of $y = 0$.

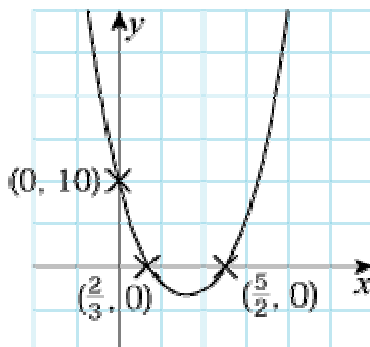
When $y = 0$,

$$0 = (3x - 2)(2x - 5)$$

$$x = \frac{2}{3} \text{ or } x = \frac{5}{2}$$

So crossing points are $\left(\frac{2}{3}, 0\right)$ and $\left(\frac{5}{2}, 0\right)$.

When $x = 0$, $y = 10$, so crossing point is $(0, 10)$.



(g) $a >$ so graph is a \cup shape.

$$b^2 = 4, 4ac = -60$$

$b^2 > 4ac$, so two different roots of $y = 0$.

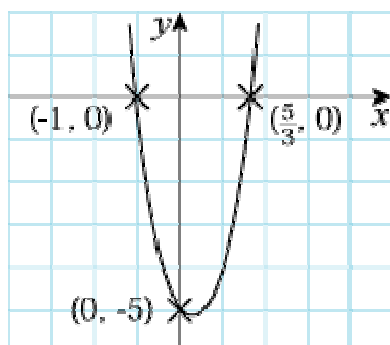
When $y = 0$,

$$0 = (3x - 5)(x + 1)$$

$$x = \frac{5}{3} \text{ or } x = -1$$

So crossing points are $\left(\frac{5}{3}, 0 \right)$ and $(-1, 0)$.

When $x = 0$, $y = -5$, so crossing point is $(0, -5)$.



(h) $a > 0$ so graph is a \cup shape.

$$b^2 = 169, 4ac = 0$$

$b^2 > 4ac$, so two different roots of $y = 0$.

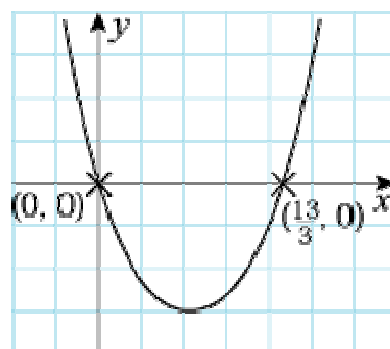
When $y = 0$,

$$0 = x(3x - 13)$$

$$x = 0 \text{ or } x = \frac{13}{3}$$

So crossing points are $(0, 0)$ and $\left(\frac{13}{3}, 0 \right)$.

When $x = 0$, $y = 0$, so crossing point is $(0, 0)$.



(i) $a < 0$ so graph is a \cap shape.

$$b^2 = 36, 4ac = -28$$

$b^2 > 4ac$, so two different roots of $y = 0$.

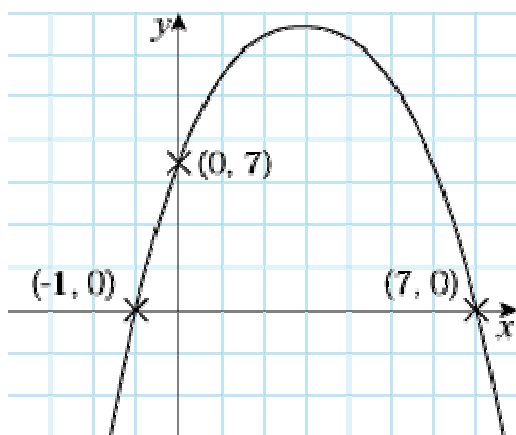
When $y = 0$,

$$0 = (7 - x)(1 + x)$$

$$x = 7 \text{ or } x = -1$$

So crossing points are $(7, 0)$ and $(-1, 0)$.

When $x = 0$, $y = 7$, so crossing point is $(0, 7)$.



(j) $a < 0$ so graph is a \cap shape.

$$b^2 = 49, 4ac = -32$$

$b^2 > 4ac$, so two different roots of $y = 0$.

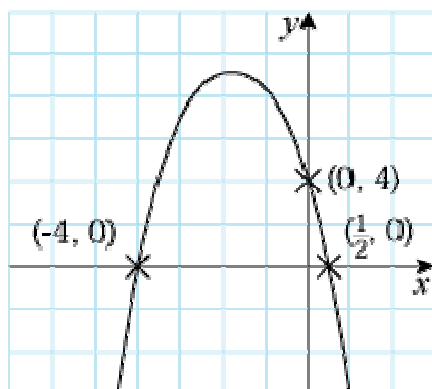
When $y = 0$,

$$0 = (1 - 2x)(4 + x)$$

$$x = \frac{1}{2} \text{ or } x = -4$$

So crossing points are $\left(\frac{1}{2}, 0\right)$ and $(-4, 0)$.

When $x = 0$, $y = 4$, so crossing point is $(0, 4)$.



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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise F, Question 2

Question:

Find the values of k for which $x^2 + kx + 4 = 0$ has equal roots.

Solution:

$x^2 + kx + 4 = 0$ has equal roots if

$$b^2 = 4ac$$

i.e.

$$k^2 = 4 \times 1 \times 4 = 16 \quad \Rightarrow \quad k = \pm 4$$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise F, Question 3

Question:

Find the values of k for which $kx^2 + 8x + k = 0$ has equal roots.

Solution:

$kx^2 + 8x + k = 0$ has equal roots if

$$b^2 = 4ac$$

i.e.

$$8^2 = 4 \times k \times k = 4k^2$$

$$\text{So } k^2 = \frac{64}{4} = 16 \quad \Rightarrow \quad k = \pm 4$$

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Quadratic Equations

Exercise G, Question 1

Question:

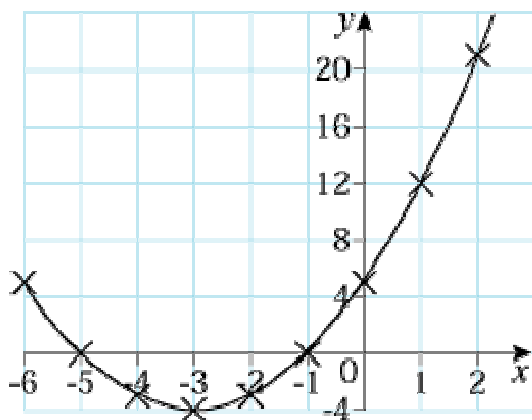
Draw the graphs with the following equations, choosing appropriate values for x . For each graph write down the equation of the line of symmetry.

(a) $y = x^2 + 6x + 5$

(b) $y = 2x^2 - 3x - 4$

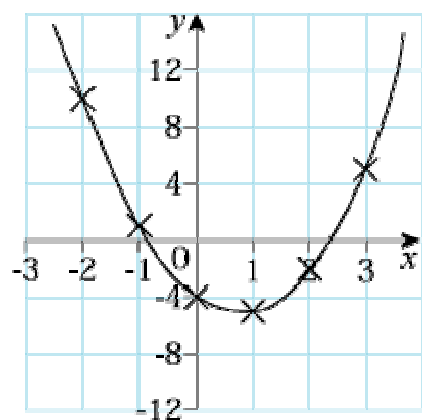
Solution:

x	-6	-5	-4	-3	-2	-1	0	1	2
x^2	36	25	16	9	4	1	0	1	4
(a) $+ 6x$	-36	-30	-24	-18	-12	-6	0	+6	+12
$+ 5$	+5	+5	+5	+5	+5	+5	+5	+5	+5
y	5	0	-3	-4	-3	0	5	12	21



$x = -3$ is line of symmetry.

x	-2	-1	0	1	2	3
$2x^2$	8	2	0	2	8	18
(b) $- 3x$	+6	+3	0	-3	-6	-9
$- 4$	-4	-4	-4	-4	-4	-4
y	10	1	-4	-5	-2	5



$x = \frac{3}{4}$ is line of symmetry.

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Quadratic Equations

Exercise G, Question 2

Question:

Solve the following equations:

(a) $y^2 + 3y + 2 = 0$

(b) $3x^2 + 13x - 10 = 0$

(c) $5x^2 - 10x = 4x + 3$

(d) $(2x - 5)^2 = 7$

Solution:

(a) $(y + 1)(y + 2) = 0$
 $y = -1$ or $y = -2$

(b) $(3x - 2)(x + 5) = 0$
 $x = \frac{2}{3}$ or $x = -5$

(c) $5x^2 - 14x - 3 = 0$
 $(5x + 1)(x - 3) = 0$
 $x = -\frac{1}{5}$ or $x = 3$

(d) $2x - 5 = \pm \sqrt{7}$
 $2x = \pm \sqrt{7} + 5$
 $x = \frac{5 \pm \sqrt{7}}{2}$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise G, Question 3

Question:

Solve the following equations by:

(i) Completing the square.

(ii) Using the formula.

(a) $x^2 + 5x + 2 = 0$

(b) $x^2 - 4x - 3 = 0$

(c) $5x^2 + 3x - 1 = 0$

(d) $3x^2 - 5x = 4$

Solution:

(a) (i) $x^2 + 5x = -2$

$$\left(x + \frac{5}{2}\right)^2 - \frac{25}{4} = -2$$

$$\left(x + \frac{5}{2}\right)^2 = \frac{17}{4}$$

$$x + \frac{5}{2} = \pm \frac{\sqrt{17}}{2}$$

$$x = \frac{-5 \pm \sqrt{17}}{2}$$

(ii) $x = \frac{-5 \pm \sqrt{5^2 - 4(1)(2)}}{2}$

$$x = \frac{-5 \pm \sqrt{25 - 8}}{2}$$

$$x = \frac{-5 \pm \sqrt{17}}{2}$$

(b)(i) $x^2 - 4x = 3$

$$(x - 2)^2 - 4 = 3$$

$$(x - 2)^2 = 7$$

$$x - 2 = \pm \sqrt{7}$$

$$x = 2 \pm \sqrt{7}$$

(ii) $x = \frac{-(-4) \pm \sqrt{16 - 4(1)(-3)}}{2}$

$$x = \frac{+4 \pm \sqrt{16 + 12}}{2}$$

$$x = \frac{4 \pm \sqrt{4 \times 7}}{2}$$

$$x = \frac{4 \pm 2\sqrt{7}}{2}$$

$$x = 2 \pm \sqrt{7}$$

$$(c) (i) 5x^2 + 3x = 1$$

$$5 \left(x^2 + \frac{3}{5}x \right) = 1$$

$$5 \left[\left(x + \frac{3}{10} \right)^2 - \frac{9}{100} \right] = 1$$

$$\left(x + \frac{3}{10} \right)^2 - \frac{9}{100} = \frac{1}{5}$$

$$\left(x + \frac{3}{10} \right)^2 = \frac{29}{100}$$

$$x + \frac{3}{10} = \pm \frac{\sqrt{29}}{10}$$

$$x = \frac{-3 \pm \sqrt{29}}{10}$$

$$(ii) x = \frac{-3 \pm \sqrt{9 - 4(5)(-1)}}{10}$$

$$x = \frac{-3 \pm \sqrt{29}}{10}$$

$$(d)(i) 3 \left(x^2 - \frac{5}{3}x \right) = 4$$

$$3 \left[\left(x - \frac{5}{6} \right)^2 - \frac{25}{36} \right] = 4$$

$$\left(x - \frac{5}{6} \right)^2 - \frac{25}{36} = \frac{4}{3}$$

$$\left(x - \frac{5}{6} \right)^2 = \frac{73}{36}$$

$$x - \frac{5}{6} = \pm \frac{\sqrt{73}}{6}$$

$$x = \frac{5 \pm \sqrt{73}}{6}$$

$$(ii) x = \frac{-(-5) \pm \sqrt{25 - 4(3)(-4)}}{6}$$

$$x = \frac{+5 \pm \sqrt{25 + 48}}{6}$$

$$x = \frac{5 \pm \sqrt{73}}{6}$$

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Edexcel Modular Mathematics for AS and A-Level

Quadratic Equations

Exercise G, Question 4

Question:

Sketch graphs of the following equations:

(a) $y = x^2 + 5x + 4$

(b) $y = 2x^2 + x - 3$

(c) $y = 6 - 10x - 4x^2$

(d) $y = 15x - 2x^2$

Solution:

(a) $a > 0$ so \cup shape

$$b^2 = 25, 4ac = 16$$

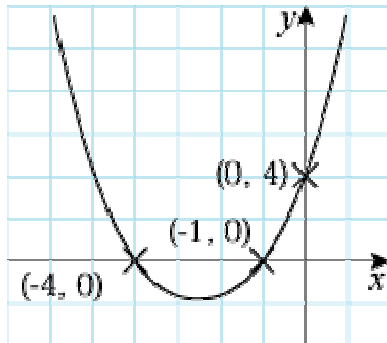
$b^2 > 4ac$, so two different roots of $y = 0$.

$$y = 0 \Rightarrow 0 = (x + 1)(x + 4)$$

$$x = -1 \text{ or } x = -4$$

So x -axis crossing points are $(-1, 0)$ and $(-4, 0)$.

$$x = 0 \Rightarrow y = 4 \text{ So } y\text{-axis crossing point is } (0, 4).$$



(b) $a > 0$ So \cup shape

$$b^2 = 1, 4ac = -24$$

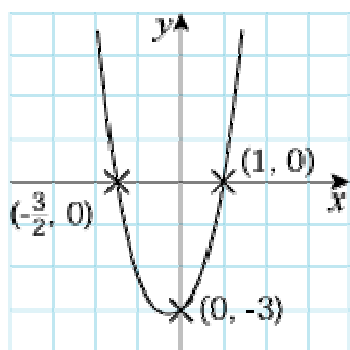
$b^2 > 4ac$, so two different roots of $y = 0$.

$$y = 0 \Rightarrow 0 = (2x + 3)(x - 1)$$

$$x = -\frac{3}{2} \text{ or } x = 1$$

So x -axis crossing points are $\left(-\frac{3}{2}, 0\right)$ and $(1, 0)$.

$$x = 0 \Rightarrow y = -3 \text{ so } y\text{-axis crossing point in } (0, -3).$$



(c) $a < 0$ So \cap shape

$$b^2 = 100, 4ac = -96$$

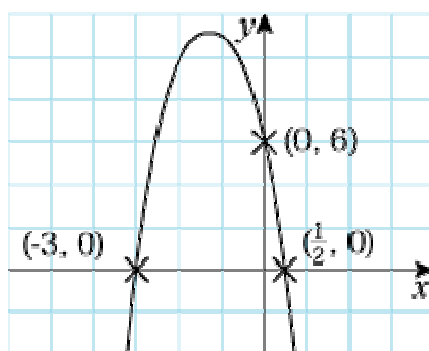
$b^2 > 4ac$, so two different roots of $y = 0$.

$$y = 0 \Rightarrow 0 = (1 - 2x)(6 + 2x)$$

$$x = \frac{1}{2} \text{ or } x = -3$$

So x -axis crossing points are $\left(\frac{1}{2}, 0\right)$ and $(-3, 0)$.

$x = 0 \Rightarrow y = 6$ so y -axis crossing point is $(0, 6)$.



(d) $a < 0$ so \cap shape

$$b^2 = 225, 4ac = 0$$

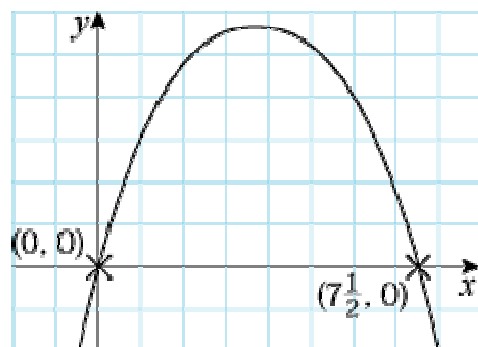
$b^2 > 4ac$, so two different roots of $y = 0$.

$$y = 0 \Rightarrow 0 = x(15 - 2x)$$

$$x = 0 \text{ or } x = 7\frac{1}{2}$$

So x -axis crossing points are $(0, 0)$ and $\left(7\frac{1}{2}, 0\right)$.

$x = 0 \Rightarrow y = 0$ So y -axis crossing point is $(0, 0)$.



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Quadratic Equations

Exercise G, Question 5

Question:

Given that for all values of x :

$$3x^2 + 12x + 5 = p(x + q)^2 + r$$

(a) Find the values of p , q and r .

(b) Solve the equation $3x^2 + 12x + 5 = 0$. **[E]**

Solution:

$$(a) 3x^2 + 12x + 5 = p(x^2 + 2qx + q^2) + r$$

$$3x^2 + 12x + 5 = px^2 + 2pqx + pq^2 + r$$

$$\text{Comparing } x^2 : p = 3 \text{ ①}$$

$$\text{Comparing } x : 2pq = 12 \text{ ②}$$

$$\text{Comparing constants : } pq^2 + r = 5 \text{ ③}$$

Substitute ① into ②:

$$2 \times 3q = 12$$

$$q = 2$$

Substitute $p = 3$ and $q = 2$ into ③:

$$3 \times 2^2 + r = 5$$

$$12 + r = 5$$

$$r = -7$$

$$\text{So } p = 3, q = 2, r = -7$$

$$(b) 3x^2 + 12x + 5 = 0$$

$$\Rightarrow 3(x + 2)^2 - 7 = 0$$

$$\Rightarrow 3(x + 2)^2 = 7$$

$$\Rightarrow (x + 2)^2 = \frac{7}{3}$$

$$\Rightarrow x + 2 = \pm \sqrt{\frac{7}{3}}$$

$$\text{So } x = -2 \pm \sqrt{\frac{7}{3}}$$

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Quadratic Equations

Exercise G, Question 6

Question:

Find, as surds, the roots of the equation

$$2(x + 1)(x - 4) - (x - 2)^2 = 0$$

Solution:

$$2(x^2 - 3x - 4) - (x^2 - 4x + 4) = 0$$

$$2x^2 - 6x - 8 - x^2 + 4x - 4 = 0$$

$$x^2 - 2x - 12 = 0$$

$$x = \frac{-(-2) \pm \sqrt{4 - 4(1)(-12)}}{2}$$

$$x = \frac{+2 \pm \sqrt{52}}{2}$$

$$x = \frac{2 \pm \sqrt{4 \times 13}}{2}$$

$$x = \frac{2 \pm 2\sqrt{13}}{2}$$

$$x = 1 \pm \sqrt{13}$$

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Exercise G, Question 7

Question:

Use algebra to solve $(x - 1)(x + 2) = 18$. [E]

Solution:

$$\begin{aligned}x^2 + x - 2 &= 18 \\x^2 + x - 20 &= 0 \\(x + 5)(x - 4) &= 0 \\x &= -5 \text{ or } x = 4\end{aligned}$$

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