5.9 Drawing Quadratic Graphs: 2-hour Pack

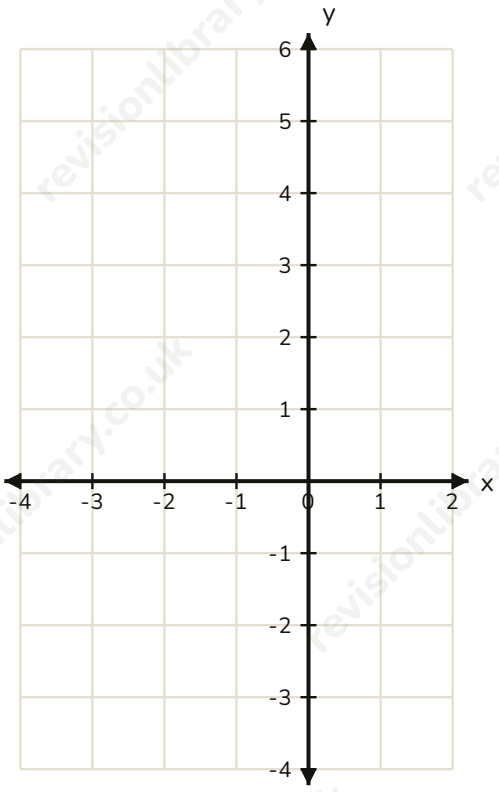
EDEXCEL 1MA1 · Calculator allowed · about 120 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 The graph of $y = x^2 + 2x - 3$ is to be drawn for $-4 \leq x \leq 2$.

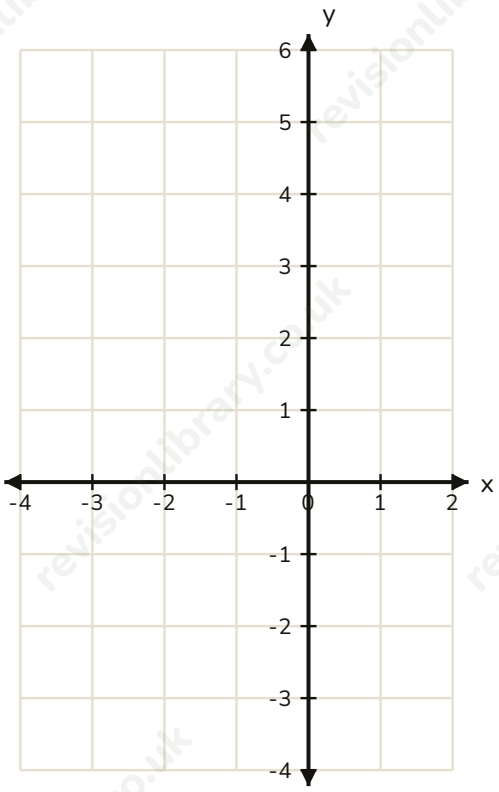


(a) Complete the table of values for $y = x^2 + 2x - 3$. **(2)**

x	-4	-3	-2	-1	0	1	2
y	_	_	_	_	_	_	_

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(b) Draw the graph of $y = x^2 + 2x - 3$ for $-4 \leq x \leq 2$. **(2)**



(c) Use the graph to write down the solutions of $x^2 + 2x - 3 = 0$. **(2)**

.....

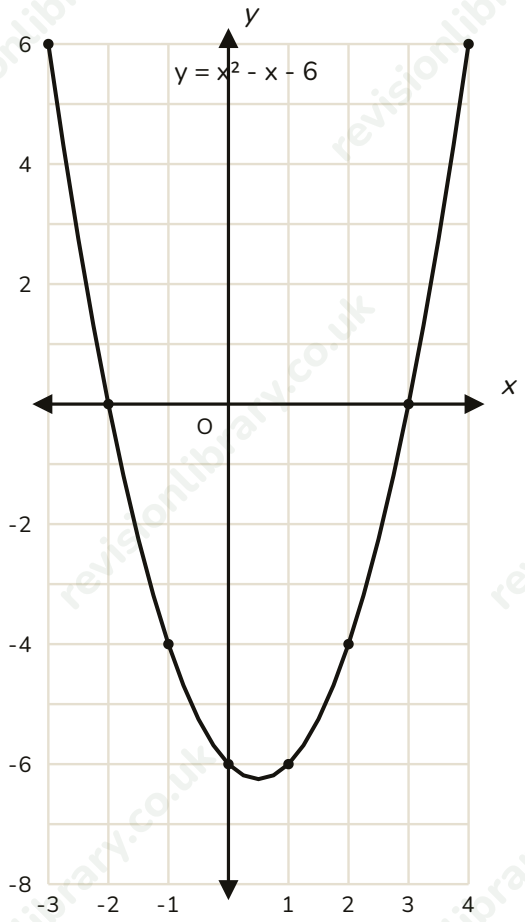
(d) Write down the coordinates of the minimum point of the graph. **(1)**

.....

(Total for Question 1 is 7 marks)

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2 The grid shows an accurately drawn graph of $y = x^2 - x - 6$ for $-3 \leq x \leq 4$.



(a) Use the graph to write down the solutions of $x^2 - x - 6 = 0$. **(2)**

.....

(b) By drawing the line $y = 4$ on the grid, use the graphs to find estimates for the solutions of $x^2 - x - 6 = 4$. **(3)**

(Total for Question 2 is 5 marks)

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3 The equation of a graph is $y = -x^2 + 4$.

(a) State whether the graph is u-shaped or n-shaped, giving a reason. **(2)**

(b) Write down the coordinates of the y-intercept of the graph. **(1)**

.....

(c) Write down the coordinates of the maximum point of the graph. **(1)**

.....

(d) Which of these is the correct set of x-axis intercepts for $y = -x^2 + 4$? **(1)**

- ☐ A) (-4, 0) and (4, 0)
- ☐ B) (-2, 0) and (2, 0)
- ☐ C) (-16, 0) and (16, 0)
- ☐ D) no x-axis intercepts

(Total for Question 3 is 5 marks)

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4 The graph of $y = x^2 - 3x$ is to be drawn for $0 \leq x \leq 4$.

(a) Complete the table of values for $y = x^2 - 3x$. **(2)**

x	0	1	2	3	4
y	_	_	_	_	_

(b) Using your table, write down the equation of the line of symmetry of the graph. **(1)**

.....

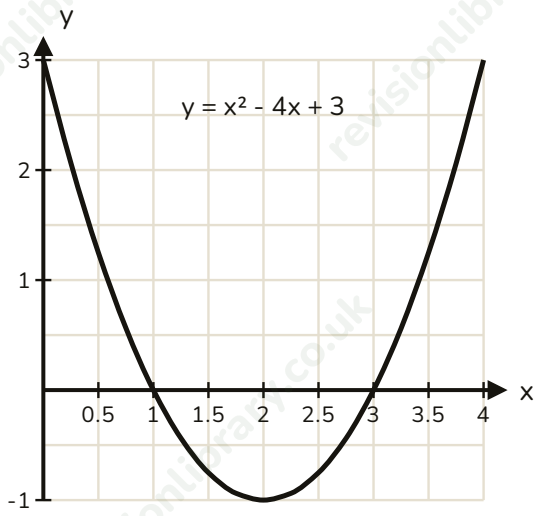
(c) Hence write down the coordinates of the turning point of the graph. **(1)**

.....

(Total for Question 4 is 4 marks)

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5 The grid shows an accurately drawn graph of $y = x^2 - 4x + 3$ for $0 \leq x \leq 4$.



(a) Write down the solutions of $x^2 - 4x + 3 = 0$. **(2)**

.....

(b) Write down the coordinates of the minimum point of the graph. **(1)**

.....

(c) By drawing the line $y = 3$ on the grid, find the solutions of $x^2 - 4x + 3 = 3$. **(3)**

.....

(Total for Question 5 is 6 marks)

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6 The graph of a quadratic function crosses the x-axis at $x = -3$ and $x = 5$.
Find the equation of the line of symmetry of the graph.

(Total for Question 6 is 2 marks)

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7 Stretch question for higher foundation: Sketch the graph of $y = -x^2 + 2x + 3$. Give the vertex and the x-intercepts (to the nearest whole number if needed).

(a) Find the vertex (turning point) of $y = -x^2 + 2x + 3$. **(3)**

(b) Find the x-intercepts (solutions) of $-x^2 + 2x + 3 = 0$. Give answers to the nearest whole number. **(3)**

(Total for Question 7 is 6 marks)

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8 A simple real-life context: A small ball is thrown up and its height h metres after t seconds is modelled by $h = -t^2 + 4t + 1$. Find the height after t = 0, t = 1 and t = 4. Then state whether the ball is above the ground at t = 4 seconds.

(a) Find h when t = 0. **(1)**

(b) Find h when t = 1. **(2)**

(c) Find h when t = 4. **(2)**

(d) Is the ball above the ground at t = 4 seconds? Explain briefly. **(1)**

(Total for Question 8 is 6 marks)

9 A quadratic graph has the equation $y = (x - 2)^2 - 3$.

(a) Write down the coordinates of the turning point of the graph. **(1)**

(b) State the equation of the line of symmetry of the graph. **(1)**

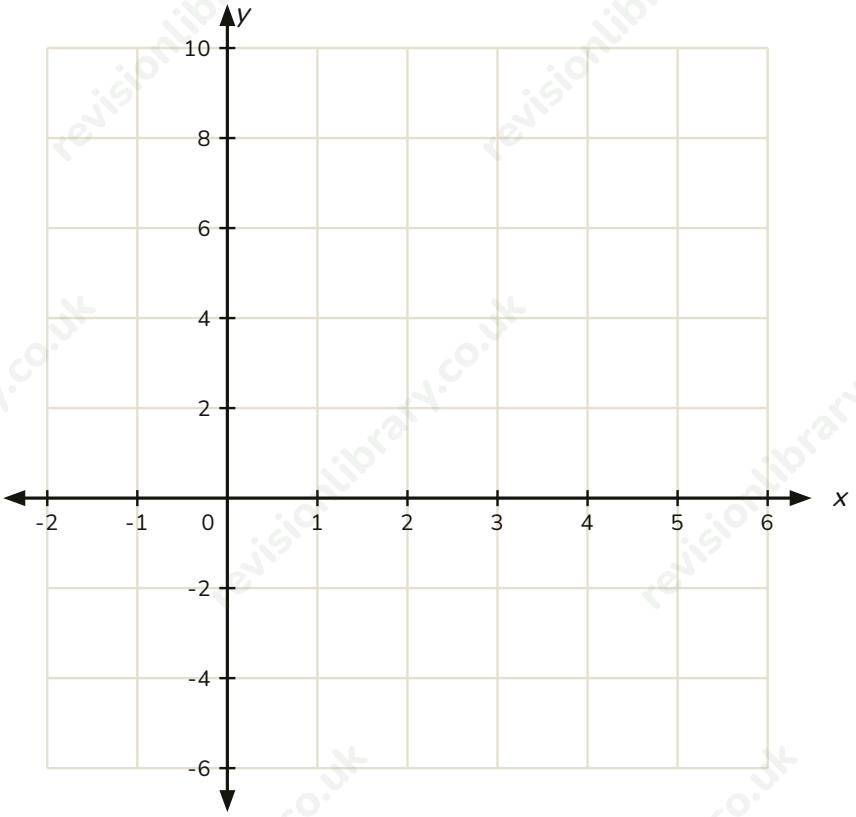
(c) Show that $y = (x - 2)^2 - 3$ can be written in the form $y = x^2 - 4x + 1$. **(2)**

(d) Hence write down the coordinates of the y-intercept of the graph. **(1)**

(Total for Question 9 is 5 marks)

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10 The graph of $y = x^2 - 4x - 2$ is to be drawn for $-2 \leq x \leq 6$.

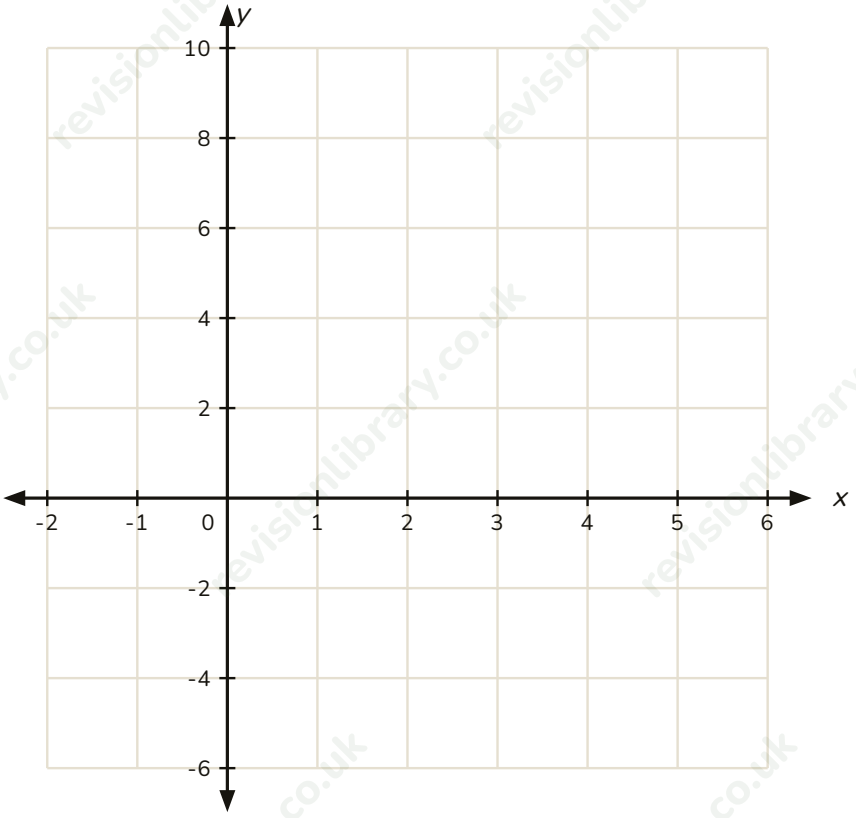


(a) Complete the table of values for $y = x^2 - 4x - 2$. **(2)**

x	-2	-1	0	1	2	3	4	5	6
y	10	_	-2	_	-6	_	-2	_	10

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(b) Draw the graph of $y = x^2 - 4x - 2$ for $-2 \leq x \leq 6$. **(2)**



(c) By drawing a suitable straight line on the grid, use your graph to find estimates for the solutions of $x^2 - 4x - 2 = 2x - 5$. **(3)**

(Total for Question 10 is 7 marks)

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11 The graph of $y = x^2 - 10x + 21$ crosses the x-axis at two points. Find the coordinates of the two points where the graph crosses the x-axis.

(Total for Question 11 is 2 marks)

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12 A ball is thrown in the air. Its height, h metres, above the ground after t seconds is given by $h = 24t - 6t^2$.

(a) Complete the table of values for $h = 24t - 6t^2$. **(2)**

t	0	1	2	3	4
h	_	_	_	_	_

(b) Using the symmetry of your table, write down the maximum height reached by the ball and the time at which it occurs. **(1)**

.....

(Total for Question 12 is 3 marks)

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13 Find the equation of the parabola with vertex at (2, -3) that passes through the point (0, 1). Give your answer in the form $y = a(x - h)^2 + k$ and then expand it to $y = ax^2 + bx + c$.

(Total for Question 13 is 4 marks)

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14 Solve algebraically the points of intersection between the parabola $y = x^2 - x - 6$ and the line $y = 2x + 3$. Give exact answers.

(Total for Question 14 is 4 marks)

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15 The graphs of $y = x^2 - 3x + 1$ and $y = 2x - 4$ intersect at two points.

(a) Show that the x-coordinates of the points of intersection satisfy $x^2 - 5x + 5 = 0$. **(2)**

(b) Solve $x^2 - 5x + 5 = 0$, giving your answers to 2 decimal places. **(3)**

(c) Hence find the coordinates of the two points of intersection, giving your answers to 2 decimal places. **(2)**

(Total for Question 15 is 7 marks)

16 $y = x^2 - 8x + 10$

(a) Express y in the form $(x - a)^2 + b$, where a and b are integers. **(2)**

(b) Hence write down the coordinates of the minimum point of the graph of $y = x^2 - 8x + 10$. **(1)**

(Total for Question 16 is 3 marks)

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17 $y = 3 - 2x - x^2$

(a) Write down the coordinates of the y-intercept of the graph. **(1)**

.....

(b) State, giving a reason, whether the graph is u-shaped or n-shaped. **(1)**

(c) By writing y in the form $-(x + p)^2 + q$, find the coordinates of the turning point of the graph. **(2)**

.....

(Total for Question 17 is 4 marks)

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18 Show that for any quadratic $y = ax^2 + bx + c$ (a not equal to 0), the axis of symmetry of its graph is $x = -b/(2a)$, and that the y-intercept is c. You must show the algebraic steps (show that question).

(Total for Question 18 is 4 marks)

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19 For which value(s) of k does the quadratic $y = x^2 + 2kx + k + 1$ have exactly one x-intercept? Show your working and give exact values.

(Total for Question 19 is 3 marks)

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20 Without solving the equation, determine how many times the graph of $y = 2x^2 - 5x + 4$ crosses the x-axis.

(Total for Question 20 is 3 marks)

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Mark scheme · 5.9 Drawing Quadratic Graphs: 2-hour Pack

A correct answer earns full marks unless the question asks for working, a method, proof or explanation.

Question 1

(a) at least 5 of the 7 y-values correct **B1**

(a) all 7 y-values correct **B1**

(a) Answer: 5, 0, -3, -4, -3, 0, 5

(b) all points plotted correctly ft from table **B1**

(b) smooth u-shaped curve drawn through all points **B1**

(b) Answer: Smooth u-shaped parabola, minimum point at (-1,-4)

(c) x = -3 **B1**

(c) x = 1 **B1**

(c) Answer: x = -3 and x = 1

(d) (-1, -4) **B1**

(d) Answer: (-1, -4)

Question 2

(a) x = -2 **B1**

(a) x = 3 **B1**

(a) Answer: x = -2 and x = 3

(b) line y = 4 drawn on the grid **M1**

(b) x = awrt 3.7 (range 3.6 to 3.8), ft **A1**

(b) x = awrt -2.7 (range -2.8 to -2.6), ft **A1**

(b) Answer: x = awrt 3.7 and x = awrt -2.7

Question 3

(a) n-shaped **B1**

(a) reason: coefficient of x^2 is negative oe **B1**

(a) Answer: n-shaped, because the coefficient of x^2 is negative

(b) (0, 4) **B1**

(b) Answer: (0, 4)

(c) (0, 4) **B1**

(c) Answer: (0, 4)

(d) B **B1**

(d) Answer: B

Question 4

(a) at least 3 of the 5 y-values correct **B1**

(a) all 5 y-values correct **B1**

(a) Answer: 0, -2, -2, 0, 4

(b) x = 1.5 oe, ft from candidate's table **B1**

(b) Answer: x = 1.5

(c) (1.5, -2.25) ft from part (b) **B1**

(c) Answer: (1.5, -2.25)

Question 5

(a) x = 1 **B1**

(a) x = 3 **B1**

(a) Answer: x = 1 and x = 3

(b) (2, -1) **B1**

(b) Answer: (2, -1)

(c) line y = 3 drawn on the grid **M1**

(c) x = 0 **A1**

(c) x = 4 **A1**

(c) Answer: x = 0 and x = 4

Question 6

uses the midpoint of the two roots, (-3 + 5) / 2 **M1**

x = 1 cao **A1**

Answer: x = 1

Question 7

(a) find the turning point from a table of values or from the symmetry of the curve; accept completing the square or x = -b/(2a) **M1**

(a) x-coordinate 1 cao **A1**

(a) y-coordinate 4 cao **A1**

(a) Answer: (1, 4)

(b) factorise correctly, or read the crossings from a table of values; accept the quadratic formula **M1**

(b) x = -1 and x = 3 shown to 1 d.p or whole numbers given **A1**

(b) both intercepts stated (-1, 0) and (3, 0) cao **A1**

(b) Answer: x-intercepts at (-1, 0) and (3, 0)

Question 8

(a) h = 1 cao **B1**

(a) Answer: 1 [h = 0 + 0 + 1 = 1]

(b) substitute t = 1 into $-t^2 + 4t + 1$ **M1**

(b) h = 4 cao **A1**

(b) Answer: 4 [$-(1)^2 + 4(1) + 1 = -1 + 4 + 1 = 4$]

(c) substitute t = 4 into $-t^2 + 4t + 1$ **M1**

(c) h = 1 cao **A1**

(c) Answer: 1 [$-(4)^2 + 4(4) + 1 = -16 + 16 + 1 = 1$]

(d) yes, because h = 1 > 0 oe **B1**

(d) Answer: Yes. At t = 4, h = 1 metre, so the ball is 1 m above the ground.

Question 9

(a) (2, -3) **B1**

(a) Answer: (2, -3)

(b) x = 2 **B1**

(b) Answer: x = 2

(c) expands $(x-2)^2$ to $x^2 - 4x + 4$ **M1**

(c) correct simplification to $x^2 - 4x + 1$ cso **A1**

(c) Answer: $x^2 - 4x + 1$ (shown)

(d) (0, 1) ft from part (c) **B1**

(d) Answer: (0, 1)

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Question 10

(a) at least 2 of the 4 missing y-values correct **B1**

(a) all 4 missing y-values correct **B1**

(a) Answer: x=-1: 3, x=1: -5, x=3: -5, x=5: 3

(b) all 9 points plotted correctly ft from table **B1**

(b) smooth u-shaped curve drawn through all points **B1**

(b) Answer: Smooth u-shaped curve, minimum point at (2,-6)

(c) line $y = 2x - 5$ identified and drawn on the grid **M1**

(c) x = awrt 0.6 (range 0.5 to 0.7), ft **A1**

(c) x = awrt 5.4 (range 5.3 to 5.5), ft **A1**

(c) Answer: x = awrt 0.6 and x = awrt 5.4

Question 11

correct factorisation $(x - 3)(x - 7) = 0$ oe **M1**

(3, 0) and (7, 0) both cao **A1**

Answer: (3, 0) and (7, 0)

Question 12

(a) at least 3 of the 5 h-values correct **B1**

(a) all 5 h-values correct **B1**

(a) Answer: 0, 18, 24, 18, 0

(b) maximum height = 24 m at t = 2 seconds, ft from candidate's table **B1**

(b) Answer: 24 metres at t = 2 seconds

Question 13

use vertex form $y = a(x - 2)^2 - 3$ and substitute (0,1) to form an equation in a **M1**

a = 1 cao **A1**

write vertex form with found a: $y = 1(x - 2)^2 - 3$ (oe) **M1**

expanded form $y = x^2 - 4x + 1$ cao **A1**

Answer: $y = (x - 2)^2 - 3$; expanded $y = x^2 - 4x + 1$.

Question 14

equate and rearrange to form quadratic $x^2 - 3x - 9 = 0$ **M1**

use quadratic formula correctly: $x = (3 \pm \sqrt{45})/2$ **M1**

simplify $\sqrt{45}$ to $3\sqrt{5}$ or leave as $\sqrt{45}$ and give $x = (3 \pm 3\sqrt{5})/2$ cao **A1**

give corresponding y values: $y = 2x + 3$, so $y = 2((3 \pm 3\sqrt{5})/2) + 3 = 3 \pm 3\sqrt{5} + 3 = 6 \pm 3\sqrt{5}$ cao **A1**

Answer: Intersection points: $((3 + 3\sqrt{5})/2, 6 + 3\sqrt{5})$ and $((3 - 3\sqrt{5})/2, 6 - 3\sqrt{5})$.

Question 15

(a) sets $x^2-3x+1 = 2x-4$ and begins to rearrange **M1**

(a) correct simplification to $x^2 - 5x + 5 = 0$ cso **A1**

(a) Answer: $x^2 - 5x + 5 = 0$ (shown)

(b) correct substitution into the quadratic formula, e.g. $x= (5\pm\sqrt{25-20})/2$ **M1**

(b) x = 3.62 (awrt) **A1**

(b) x = 1.38 (awrt) **A1**

(b) Answer: x = 3.62 or x = 1.38 (2 d.p.)

(c) substitutes both x-values into $y = 2x - 4$ (or the other equation) **M1**

(c) (3.62, 3.24) and (1.38, -1.24), ft **A1**

(c) Answer: (3.62, 3.24) and (1.38, -1.24)

Question 16

(a) $(x - 4)^2$ seen (correct value of a) **M1**

(a) $(x - 4)^2 - 6$ oe cao (correct value of b) **A1**

(a) Answer: $(x - 4)^2 - 6$

(b) (4, -6) ft from part (a) **B1**

(b) Answer: (4, -6)

Question 17

(a) (0, 3) **B1**

(a) Answer: (0, 3)

(b) n-shaped, because the coefficient of x^2 is negative (-1) oe **B1**

(b) Answer: n-shaped, because the coefficient of x^2 is -1, which is negative

(c) correctly completes the square, e.g. $y = -((x + 1)^2 - 4)$ oe, or $-(x+1)^2+4$ **M1**

(c) (-1, 4) cao **A1**

(c) Answer: (-1, 4)

Question 18

complete the square: $ax^2 + bx + c = a(x^2 + (b/a)x) + c = a[(x + b/(2a))^2 - (b/(2a))^2] + c$ (dep) **dM1**

rearrange to vertex form $y = a(x + b/(2a))^2 + (c - b^2/(4a))$ **M1**

axis of symmetry $x = -b/(2a)$ cao **A1**

y-intercept is c since at x = 0, y = c cao **A1**

Answer: Completing the square gives $y = a(x + b/(2a))^2 + (c - b^2/(4a))$, so axis $x = -b/(2a)$. Also y(0)=c, so y-intercept is (0, c).

Question 19

use discriminant $b^2 - 4ac = 0$ condition for one x-intercept: $(2k)^2 - 4(1)(k + 1) = 0$ **M1**

simplify to $4(k^2 - k - 1) = 0$ and solve quadratic $k^2 - k - 1 = 0$ **M1**

$k = (1 \pm \sqrt{5})/2$ cao **A1**

Answer: $k = (1 + \sqrt{5})/2$ or $k = (1 - \sqrt{5})/2$.

Question 20

attempts $b^2 - 4ac$ with a = 2, b = -5, c = 4 **M1**

discriminant = -7 cao **A1**

ft conclusion: since the discriminant is negative, the graph does not cross the x-axis (0 times) **B1**

Answer: The graph does not cross the x-axis (0 times), since the discriminant is negative

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