HIGHER

8.4 Completing the Square: 30-minute Pack

EDEXCEL 1MA1 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

Completing the Square: Method Reminder

Revision Library original resource, written for Edexcel 1MA1 topic 8.4.

To complete the square for x^2 + bx + c, halve the coefficient of x to get b/2, then write (x + b/2)^2 - (b/2)^2 + c. For ax^2 + bx + c with a not equal to 1, first factorise a out of the x^2 and x terms before completing the square inside the bracket, then multiply back through. Once in the form a(x+p)^2 + q, you can read off the turning point of the graph directly: minimum (or maximum) at (-p, q). To solve ax^2 + bx + c = 0, isolate the squared bracket and take a square root of both sides, remembering the +/- sign.

1 Write $x^2 - 20x + 3$ in the form $(x + p)^2 + q$.

(Total for Question 1 is 2 marks)

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2 Answer the following multiple choice questions on completing the square.

(a) $x^2 - 12x + 40$ can be written in the form $(x - 6)^2 + k$. What is the value of k? **(1)**

- ☐ A) 4
- ☐ B) -4
- ☐ C) 40
- ☐ D) -32

(b) $x^2 - 14x + 51$ can be written in the form $(x - 7)^2 + k$. What is the value of k? **(1)**

- ☐ A) 2
- ☐ B) -2
- ☐ C) 51
- ☐ D) -49

(Total for Question 2 is 2 marks)

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3 The expression $x^2 - 10x + 30$ is to be written in completed square form.

(a) Write $x^2 - 10x + 30$ in the form $(x - a)^2 + b$. **(2)**

(b) Hence state the minimum value of $x^2 - 10x + 30$, and the value of x for which this minimum occurs. **(2)**

(Total for Question 3 is 4 marks)

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4 Consider the expression $x^2 + 8x + 20$.

(a) Show that $x^2 + 8x + 20$ can be written as $(x + 4)^2 + 4$. **(2)**

(b) Hence explain why $x^2 + 8x + 20$ is positive for all values of x. **(1)**

(Total for Question 4 is 3 marks)

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5 Solve $x^2 - 6x - 3 = 0$ by completing the square. Give your answers in surd form, simplified where possible.

(Total for Question 5 is 4 marks)

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6 Express $3x^2 - 12x + 7$ in the form $a(x + p)^2 + q$, stating the values of a, p and q.

(Total for Question 6 is 4 marks)

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7 Given that $x^2 + 24x + k = (x + 12)^2$ for all values of x, find the value of k. Hence state the minimum value of $y = x^2 + 24x + k$.

(Total for Question 7 is 3 marks)

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8 Solve $3x^2 - 6x - 2 = 0$ by completing the square. Give your answer in the form $1 \pm (\sqrt{15} / 3)$, fully simplified.

(Total for Question 8 is 4 marks)

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Mark scheme · 8.4 Completing the Square: 30-minute Pack

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

Question 1

$(x - 10)^2$ seen	**M1**
$(x - 10)^2 - 97$ cao	**A1**

Answer: $(x - 10)^2 - 97$

Question 2

(a) A	**B1**

(a) Answer: A

(b) A	**B1**

(b) Answer: A

Question 3

(a) $(x - 5)^2$ seen	**M1**
(a) $(x - 5)^2 + 5$ cao	**A1**

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

(b) ft minimum value = 5	**B1**
(b) ft occurs when x = 5	**B1**

(b) Answer: Minimum value 5, at x = 5

Question 4

(a) $(x + 4)^2 = x^2 + 8x + 16$ obtained	**M1**
(a) cso: 16 + 4 = 20, so $x^2 + 8x + 20 = (x + 4)^2 + 4$, answer printed	**A1**

(a) Answer: $(x + 4)^2 + 4$, as shown

(b) $(x + 4)^2 \geq 0$ for all real x, so $(x + 4)^2 + 4 \geq 4$, which is always greater than 0 oe	**B1**

(b) Answer: $(x+4)^2 \geq 0$, so the expression is always at least 4, hence always positive

Question 5

$(x - 3)^2 - 9 - 3 = 0$ oe, correct completed square set to zero	**M1**
$(x - 3)^2 = 12$ (dep. on previous M1)	**M1**
$x - 3 = \pm \sqrt{12}$, condone unsimplified surd	**M1**
$x = 3 + 2\sqrt{3}$ or $x = 3 - 2\sqrt{3}$ oe, both fully simplified, cao	**A1**

Answer: $x = 3 + 2\sqrt{3}$ or $x = 3 - 2\sqrt{3}$

Question 6

$3(x^2 - 4x) + 7$ seen, factor of 3 taken out correctly	**M1**
$(x - 2)^2$ seen within the bracket	**M1**
$3(x - 2)^2 - 12 + 7$ correctly simplified (dep. on both M marks)	**A1**
a = 3, p = -2, q = -5 all correct, fully simplified $3(x - 2)^2 - 5$ cao	**A1**

Answer: $3(x - 2)^2 - 5$ (a = 3, p = -2, q = -5)

Question 7

expand $(x + 12)^2 = x^2 + 24x + 144$, or compare coefficients directly	**M1**
k = 144 cao	**A1**
ft minimum value = 0, occurring at x = -12	**B1**

Answer: k = 144; minimum value of y = 0

Question 8

$3(x^2 - 2x) - 2 = 0$ oe, factor of 3 taken out correctly	**M1**
$3[(x - 1)^2 - 1] - 2 = 0$ oe leading to $3(x-1)^2 = 5$	**M1**
$(x - 1)^2 = 5/3$ leading to $x - 1 = +-\sqrt{15}/3$ (rationalising $\sqrt{5/3}$)	**M1**
$x = 1 + \sqrt{15}/3$ and $x = 1 - \sqrt{15}/3$ oe, both exact and simplified	**A1**

Answer: $x = 1 + \sqrt{15}/3$ or $x = 1 - \sqrt{15}/3$

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