Completing the Square 3

GCSE P P P A Level P P P

Essential GCSE Maths 29.3

Express the following in completed square form.

Give your answers in the form $b(x+a)^2+c$, use improper (top heavy) fractions rather than mixed fractions in your answers.

Part A $2x^2-8x+2$

$$2x^2-8x+2$$

The following symbols may be useful: x

Part B $3x^2-18x-7$

$$3x^2-18x-7$$

The following symbols may be useful: x

Graphs of Quadratic Functions 4

GCSE P P P A Level P P P

Essential GCSE Maths 27.4

Without drawing graphs, find for each function:

(i) the y-intercept (ii) where the graph crosses the x-axis.

Part A $y = x^2 + x - 2$

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

(i) the y-intercept

$y =$ ☐

(ii) the x-intercepts

lower value: $x =$ ☐

higher value: $x =$ ☐

Part B $y = x^2 + 6x + 5$

$$y = x^2 + 6x + 5$$

(i) the y-intercept

$y =$ ☐

(ii) the x-intercepts

lower value: $x =$ ☐

higher value: $x =$ ☐

Part C $y = x^2 - 8x + 15$

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

(i) the y-intercept

$y =$ ☐

(ii) the x-intercepts

lower value: $x =$ ☐

higher value: $x =$ ☐

Gameboard:

STEM SMART Double Maths 2 - Quadratic & Cubic Equations

Graphs of Quadratic Functions 11

GCSE C C C

A Level C C C

Essential GCSE Maths 27.11

The formula $s = ut + \frac{1}{2}at^2$ is used to calculate the height s of projectiles (such as balls) as a function of time.

Plot or sketch a graph of s against t for $0 \leqslant t \leqslant 7$, given that $u = 29.43\,\text{m/s}$ and $a = -9.81\,\text{m/s}^2$.

Part A What is the maximum height?

What is the maximum height reached? Give your answer to 3 sf.

Part B How long to return to its starting height?

How long does a projectile modelled by this graph take to return to its starting height? You may assume the projectile was launched at $t = 0$. Give your answer to 3 sf.

Part C What is the relative position of the projectile?

At $t = 7\,\text{s}$, what is the height of the projectile relative to its starting position? Give your answer to 3 sf.

Gameboard:
STEM SMART Double Maths 2 - Quadratic & Cubic Equations

Quadratics: Graphs and Discriminants 2ii

A Level

The quadratic equation $x^2 + kx + k = 0$ has no real roots for x.

Part A Find discriminant

Write down the discriminant of $x^2 + kx + k$ in terms of k.

The following symbols may be useful: k

Part B Possible values of k

Hence find the set of values k can take.

Construct your answer from the items below.

Items:

$<$ $>$ k $< k <$ $\leq k \leq$ $> k$ **or** $k >$ $\geq k$ **or** $k \geq$ $\leq$ $\geq$ -4 -3 -2 -1 0 1 2 3 4

Used with permission from UCLES, A Level, Paper 4721 (specimen).

Gameboard:

STEM SMART Double Maths 2 - Quadratic & Cubic Equations

Linear-Quadratic 3

GCSE C C C

A Level P P P

Pre-Uni Maths for Sciences B2.7

Solve the simultaneous equations $p^2 + 2pq + 4q^2 = 7$ and $2p = q + 1$.

If your answer is a decimal number, round it to **two decimal places**.

(____ , ____)

(____ , ____)

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Gameboard:

STEM SMART Double Maths 2 - Quadratic & Cubic Equations

Physics. You work it out.

Quadratic Inequalities

GCSE C C C

A Level P P P

Pre-Uni Maths for Sciences A2.5

Solve the following quadratic inequalities.

Part A $3x^2 - 2x - 8 \leq 0$

Solve the inequality $3x^2 - 2x - 8 \leq 0$.

Construct your answer from the items below.

Items:

$<$ $>$ x $< x <$ $\leq x \leq$ $< x$ **or** $x <$ $\leq x$ **or** $x \leq$ $\leq$ $\geq$ $-\frac{4}{3}$ $\frac{4}{3}$ -2 2

Part B $-2x^2 + 5 < 7x + 11$

Solve the inequality $-2x^2 + 5 < 7x + 11$.

Construct your answer from the items below.

Items:

$<$ $>$ x $< x <$ $\leq x \leq$ $< x$ **or** $x <$ $\leq x$ **or** $x \leq$ $\leq$ $\geq$ $-\frac{3}{2}$ $\frac{3}{2}$ -2 2

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Gameboard:

STEM SMART Double Maths 2 - Quadratic & Cubic Equations

Quadratic Equations 5

GCSE C C C

A Level C C C

Pre-Uni Maths for Sciences B1.10

Show that the solution to the equation $mp^2 + bp + k = 0$ can be written as $p = -\gamma \pm \sqrt{\gamma^2 - \omega^2}$.

Part A Find an expression for γ

Hence find an expression for γ in terms of one or more of the constants m, b and k in the original equation.

The following symbols may be useful: `b, gamma, k, m, omega`

Part B Find an expression for ω

Also give an expression for ω in terms of one or more of the constants m, b and k.

The following symbols may be useful: `b, gamma, k, m, omega`

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Gameboard:

STEM SMART Double Maths 2 - Quadratic & Cubic Equations

Linear-Quadratic 6

GCSE C C C A Level P P P

Pre-Uni Maths for Science B2.10

A particle of mass M, travelling at speed u, collides head-on and elastically with a stationary particle of mass m. After the collision the particles of mass M and of mass m travel at (non-zero) speeds v and w respectively.

By applying the laws of conservation of momentum and kinetic energy we can write down two simultaneous equations for the collision: $Mu = Mv + mw$ and $\frac{1}{2}Mu^2 = \frac{1}{2}Mv^2 + \frac{1}{2}mw^2$

Part A w (speed of particle of mass m after collision)

Find an expression for w, the speed of the particle of mass m after the collision, in terms of u, M and m.

The following symbols may be useful: `M, m, u, v, w`

Part B v (speed of particle of mass M after collision)

Find the corresponding expression for v, the speed of the particle of mass M after the collision, in terms of u, M and m.

The following symbols may be useful: `M, m, u, v, w`

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Gameboard:
STEM SMART Double Maths 2 - Quadratic & Cubic Equations

Algebra and Roots: Cubics 2ii

Further A

The cubic equation $x^3 - 6x^2 + kx + 10 = 0$ has roots $p - q$, $p + q$ and p.

Part A p

Find p by considering the sum of roots.

The following symbols may be useful: p

Part B q

Find q by considering the product of roots. Take q to be positive.

The following symbols may be useful: q

Part C k

Find k.

The following symbols may be useful: k

Adapted with permission from UCLES, A Level, OCR FP1 Specimen paper, Paper 4725, Question 2.

Gameboard:

STEM SMART Double Maths 2 - Quadratic & Cubic Equations

Algebra and Roots: Cubics 1i

Further A

The cubic equation $3x^3 - 9x^2 + 6x + 2 = 0$ has roots α, β and γ.

Part A $\alpha + \beta + \gamma$

Give the value of $\alpha + \beta + \gamma$.

Part B $\alpha\beta + \alpha\gamma + \beta\gamma$

Give the value of $\alpha\beta + \alpha\gamma + \beta\gamma$.

Part C $\alpha\beta\gamma$

Give the value of $\alpha\beta\gamma$.

Part D Transformed cubic

The cubic equation $x^3 + ax^2 + bx + c = 0$ has roots α^2, β^2 and γ^2.

Find a.

The following symbols may be useful: a

Find b.

The following symbols may be useful: b

Find c.

The following symbols may be useful: c

Adapted with permission from UCLES, A Level, June 2012, Paper 4725, Question 10.