Transition Task. Chapter 1 - Algebraic Expressions. Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

Instruction – Transition Task

Aim to complete this booklet independently, as it is designed to help you develop your skills and understanding. If you find yourself needing support, you can refer to the written solutions available on the Urmston Grammar website. Once you have completed each section, make sure to mark all your work in green pen.

First few lessons at Urmston Grammar

During your first few lessons at Urmston Grammar, you will take part in two revision sessions in preparation for a skills test. Following the skills test, we may invite you to attend additional lunchtime support sessions. These are designed to help you build confidence and strengthen key skills, ensuring you get the most out of your time with us.
We are committed to supporting your learning and are here to help every step of the way to ensure you achieve your best in your mathematics A Level.

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

Diagnostic for Chapter 1 Algebraic Expressions

1 Simplify:

a $4m^2n + 5mn^2 - 2m^2n + mn^2 - 3mn^2$

b $3x^2 - 5x + 2 + 3x^2 - 7x - 12$

← GCSE Mathematics

2 Write as a single power of 2:

a $2^5 \times 2^3$ **b** $2^6 \div 2^2$

c $(2^3)^2$ ← GCSE Mathematics

1a) $2m^2n + 3mn^2$

b) $6x^2 - 12x - 10$

2a) 2^8

b) 2^4

c) 2^6

3 Expand:

a $3(x + 4)$ **b** $5(2 - 3x)$

c $6(2x - 5y)$ ← GCSE Mathematics

3a) $3x + 12$

b) $10 - 15x$

c) $12x - 30y$

4 Write down the highest common factor of:

a 24 and 16 **b** $6x$ and $8x^2$

c $4xy^2$ and $3xy$ ← GCSE Mathematics

4a) 8

b) $2x$

c) xy

5 Simplify:

a $\frac{10x}{5}$ **b** $\frac{20x}{2}$ **c** $\frac{40x}{24}$

5a) $2x$

b) $10x$

c) $\frac{5}{3}x$

1A Indices

1. Simplify $(a^3)^2 \times 2a^2$ $= a^6 \times 2a^2$
$= 2a^8$

2. Simplify $(4x^3y)^3$ $= 64x^9y^3$

3. Simplify $2x^2(3+5x) - x(4-x^2)$ $= 6x^2 + 10x^3 - 4x + x^3$
$= 11x^3 + 6x^2 - 4x$

4. Simplify $\frac{x^3-2x}{3x^2}$ $= \frac{x^3}{3x^2} - \frac{2x}{3x^2} = \frac{1}{3}x - \frac{2}{3}x^{-1}$
or $\frac{x}{3} - \frac{2}{3x}$

1B Brackets: Expanding

Expand and simplify the following

1. $(x+1)(x+2)(x+3)$ $= (x^2+3x+2)(x+3)$
$= x^3 + 3x^2 + 2x + 3x^2 + 9x + 6$
$= x^3 + 6x^2 + 11x + 6$

2. $(x+5)(x-2)(x+1)$ $= (x^2+3x-10)(x+1)$
$= x^3 + 3x^2 - 10x + x^2 + 3x - 10$
$= x^3 + 4x^2 - 7x - 10$

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3. $2(x-3)(x-4)$ $= 2(x^2 - 7x + 12)$
$= 2x^2 - 14x + 24$

4. $(2x-1)^3$ $= (2x-1)(2x-1)(2x-1)$
$= (4x^2 - 4x + 1)(2x-1)$
$= 8x^3 - 8x^2 + 2x - 4x^2 + 4x - 1$
$= 8x^3 - 12x^2 + 6x - 1$

1C Brackets: Factorising

1. $x^2 - 5x - 14$
$= (x-7)(x+2)$

2. $2x^2 + 5x - 12$
$(2x-3)(x+4)$

3. $4x^2 - 9$
$= (2x-3)(2x+3)$

4. $x^3 - x$
$= x(x^2-1)$
$= x(x+1)(x-1)$

5. $x^3 + 3x^2 + 2x$
$= x(x^2+3x+2)$
$= x(x+2)(x+1)$

1D Negative and Fractional Indices

1. Prove that $x^{\frac{1}{2}} = \sqrt{x}$

$x^{1/2} \times x^{1/2} = x^{1/2 + 1/2}$

$= x^1$

$\therefore x^{1/2} = \sqrt{x}$.

2. Evaluate $27^{-\frac{1}{3}}$

$(27^{1/3})^{-1} = 3^{-1}$

$= 1/3$

3. Evaluate $32^{\frac{2}{5}}$

$(32^{1/5})^2 = 2^2$

$= 4$

4. Simplify $\left(\frac{1}{9}x^6y\right)^{\frac{1}{2}}$

$\frac{1}{3}x^3y^{1/2}$

2. Evaluate $\left(\frac{27}{8}\right)^{-\frac{2}{3}}$ $= \left(\frac{8}{27}\right)^{2/3}$

$= \left(\frac{2}{3}\right)^2$

$= 4/9$

6. If $b = \frac{1}{9}a^2$, determine $3b^{-2}$ in the form ka^n where k, n are constants

$3b^{-2}$

$= 3\left(\frac{1}{9}a^2\right)^{-2}$

$= 3\left(\frac{a^2}{9}\right)^{-2}$

$= 3\left(\frac{9}{a^2}\right)^2$

$= 3\left(\frac{81}{a^4}\right)$

$= \frac{243}{a^4}$ OR $243a^{-4}$

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1E Surds:

Simplify:

1. $\sqrt{3} \times 2$

$2\sqrt{3}$

2. $3\sqrt{5} \times 2\sqrt{5}$

$6 \times 5 = 30$

3. $\sqrt{8} = 2\sqrt{2}$

4. $\sqrt{12} + \sqrt{27} = 2\sqrt{3} + 3\sqrt{3}$

$= 5\sqrt{3}$

2. $(\sqrt{8} + 1)(\sqrt{2} - 3) = \sqrt{16} + \sqrt{2} - 3\sqrt{8} - 3$

$= 4 + \sqrt{2} - 6\sqrt{2} - 3$

$= 1 - 5\sqrt{2}$

1F Rationalising the denominator:

1. $\frac{3}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = \frac{3\sqrt{2}}{2}$

2. $\frac{6}{\sqrt{3}} \times \frac{\sqrt{3}}{\sqrt{3}} = \frac{6\sqrt{3}}{3} = 2\sqrt{3}$

3. $\frac{7}{\sqrt{7}} \times \frac{\sqrt{7}}{\sqrt{7}} = \frac{7\sqrt{7}}{7} = \sqrt{7}$

4. $\frac{15}{\sqrt{5}} + \sqrt{5} = \frac{15\sqrt{5}}{5} + \sqrt{5}$

$= 3\sqrt{5} + \sqrt{5}$

$= 4\sqrt{5}$

More Complicated Rationalising the Denominator

1. $\frac{1}{\sqrt{2}+1} \times \frac{(\sqrt{2}-1)}{(\sqrt{2}-1)} = \frac{\sqrt{2}-1}{2+\sqrt{2}-\sqrt{2}-1} = \sqrt{2}-1$

this is called the conjugate

2. $\frac{3}{\sqrt{6}-2} \times \frac{(\sqrt{6}+2)}{(\sqrt{6}+2)} = \frac{3\sqrt{6}+6}{6+2\sqrt{6}-2\sqrt{6}-4} = \frac{3\sqrt{6}+6}{2}$

3. $\frac{4}{\sqrt{3}+1} \times \frac{(\sqrt{3}-1)}{(\sqrt{3}-1)} = \frac{4\sqrt{3}-4}{3-1} = 2\sqrt{3}-2$

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4. $\frac{3\sqrt{2}+4}{5\sqrt{2}-7} \quad \frac{(5\sqrt{2}+7)}{(5\sqrt{2}+7)} = \frac{15\times 2 + 20\sqrt{2} + 21\sqrt{2} + 28}{25\times 2 - 49}$

$= \frac{58 + 41\sqrt{2}}{1}$

$= 58 + 41\sqrt{2}$

5. Solve $y(\sqrt{3}-1) = 8$
Give your answer in the form $a + b\sqrt{3}$ where a and b are integers.

$y = \frac{8}{(\sqrt{3}-1)} \times \frac{(\sqrt{3}+1)}{(\sqrt{3}+1)} = \frac{8\sqrt{3}+8}{3-1} = 4\sqrt{3}+2$

Need a recap of the content in this chapter? Use this QR code to watch a Bicen maths YouTube video.

Exam Questions on Chapter 1

Q1.

a) Simplify

$\sqrt{32} + \sqrt{18}$

giving your answer in the form $a\sqrt{2}$, where a is an integer.

(2)

(b) Simplify

$$\frac{\sqrt{32}+\sqrt{18}}{3+\sqrt{2}}$$

giving your answer in the form $b\sqrt{2} + c$, where b and c are integers.

(4)

Total 6 marks

did it take you less than 6 mins?

a) $4\sqrt{2} + 3\sqrt{2}$

$= 7\sqrt{2}$ $\quad a = 7$

b). $\frac{\sqrt{32}+\sqrt{18}}{3+\sqrt{2}} = \frac{7\sqrt{2}}{(3+\sqrt{2})} \times \frac{(3-\sqrt{2})}{(3-\sqrt{2})}$

$= \frac{21\sqrt{2} - 14}{9-2}$

$= 3\sqrt{2} - 2$

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Q2.

(a) Evaluate $(32)^{\frac{3}{5}}$, giving your answer as an integer.

(2)

→ neg

(b) Simplify fully $\left(\frac{25x^4}{4}\right)^{-\frac{1}{2}}$

(2)

(Total 4 marks)

a) $(32^{1/5})^3 = 2^3$

$= 8$

b) $\left(\frac{4}{25x^4}\right)^{1/2} = \frac{2}{5x^2}$

Q3.

Given that $32\sqrt{2} = 2^a$, find the value of a.

(3)

(Total 3 marks)

$2^5 \times 2^{1/2} = 2^{11/2}$ $\quad a = \frac{11}{2}$ or 5.5

Q4.

(a) Expand and simplify $(7 + \sqrt{5})(3 - \sqrt{5})$

(3)

(b) Express $\frac{7+\sqrt{5}}{3+\sqrt{5}}$ in the form $a + b\sqrt{5}$, where a and b are integers.

(3)

(Total 6 marks)

a) $21 + 3\sqrt{5} - 7\sqrt{5} - 5$

$16 - 4\sqrt{5}$

b) $\frac{(7+\sqrt{5})(3-\sqrt{5})}{(3+\sqrt{5})(3-\sqrt{5})} = \frac{21 + 3\sqrt{5} - 7\sqrt{5} - 5}{9-5}$

$= \frac{16 - 4\sqrt{5}}{4}$

$= 4 - \sqrt{5}$

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Q5.

Simplify

(a) $(3\sqrt{7})^2$

(1)

(b) $(8 + \sqrt{5})(2 - \sqrt{5})$

(3)

(Total 4 marks)

a) $= 9 \times 7$

$= 63$

b) $16 + 2\sqrt{5} - 8\sqrt{5} - 5$

$11 - 6\sqrt{5}$

Q6.

Express 8^{2x+3} in the form 2^y, stating y in terms of x.

(2)

(Total 2 marks)

$(2^3)^{2x+3} = 2^{6x+9}$

$y = 6x + 9$

Diagnostic for Chapter 2 Quadratics

1 Solve the following equations:

a $3x + 6 = x - 4$
b $5(x + 3) = 6(2x - 1)$
c $4x^2 = 100$
d $(x - 8)^2 = 64$ ← GCSE Mathematics

a) $2x = -10$
$x = -5$

b) $5x + 15 = 12x - 6$
$21 = 7x$
$x = 3$

c) $x^2 = 25$
$x = \pm 5$

d) $x - 8 = \pm 8$ → $x = 16$ or $x = 0$

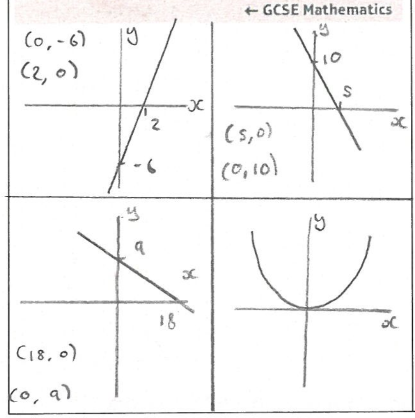
2 Factorise the following expressions:

a $x^2 + 8x + 15$ **b** $x^2 + 3x - 10$
c $3x^2 - 14x - 5$ **d** $x^2 - 400$

a) $(x + 3)(x + 5)$
b) $(x + 5)(x - 2)$
c) $(3x + 1)(x - 5)$
d) $(x - 20)(x + 20)$

3 Sketch the graphs of the following equations, labelling the points where each graph crosses the axes:

a $y = 3x - 6$ **b** $y = 10 - 2x$
c $x + 2y = 18$ **d** $y = x^2$ ← GCSE Mathematics



4 Solve the following inequalities:

a $x + 8 < 11$ **b** $2x - 5 \geqslant 13$
c $4x - 7 \leqslant 2(x - 1)$ **d** $4 - x < 11$ ← GCSE Mathematics

a) $x < 3$

b) $2x \geq 18$
$x \geq 9$

c) $4x - 7 \leq 2x - 2$
$2x \leq 9$
$x \leq 4.5$

d) $4 < 11 + x$
$-7 < x$
$x > -7$

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2A and 2B Solving Quadratic Equations

By factorisation

1. $x^2 + 5x - 6 = 0$

$(x + 6)(x - 1) = 0$

$x = -6$ $x = 1$

Using the Quadratic Formula

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

Using $a = 1$ $b = 5$ $c = -6$

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

$$x = \frac{-5 \pm \sqrt{5^2 - 4(1)(-6)}}{2(1)}$$

$x = 1$ or $x = -6$

Questions

1. $(x - 1)^2 = 5$

$x - 1 = \pm\sqrt{5}$

$x = 1 + \sqrt{5}$ or $x = 1 - \sqrt{5}$

2. Solve $x - 6\sqrt{x} + 8 = 0$

let $x = y^2$

$y^2 - 6y + 8 = 0$

$(y - 4)(y - 2) = 0$

$y = 4$ $y = 2$

$\therefore$ when $y = 4$
$x = 16$

$y = 2$
$x = 4$

3. $\sqrt{x + 3} = x - 3$

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

$x + 3 = x^2 - 6x + 9$

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

$0 = (x - 6)(x - 1)$

$x = 6$ or $x = 1$

4. $2x + \sqrt{x} - 1 = 0$

Can use $x = y^2$ if you like
OR use the $\sqrt{x}$.

$(2\sqrt{x} - 1)(\sqrt{x} + 1) = 0$.

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

$\sqrt{x} = \frac{1}{2}$ impossible.

$x = \frac{1}{4}$

Note if you used $x = y^2$

$2y^2 + y - 1 = 0$

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

$\therefore$ cont.

2C and 2D Solving by Completing the Square

1. $x^2 + 12x$

$(x+6)^2 - 36$

3. $x^2 - 2x$

$(x-1)^2 - 1$

2. $x^2 + 8x$

$(x+4)^2 - 16$

4. $x^2 - 6x + 7$

$(x-3)^2 - 9 + 7$

$(x-3)^2 - 2$

More complicated questions (a not equal to 1):

1. Express $2x^2 + 12x + 7$ in the form $a(x+b)^2 + c$

$2[x^2 + 6x] + 7$ → lose square brackets to identify clearly what I am completing the square of.

$2[(x+3)^2 - 9] + 7$

$2(x+3)^2 - 18 + 7$

$2(x+3)^2 - 11$

2. Express $5 - 3x^2 + 6x$ in the form $a - b(x+c)^2$

$5 - 3[x^2 - 2x]$

$5 - 3[(x-1)^2 - 1]$

$5 - 3(x-1)^2 + 3$

$8 - 3(x-1)^2$

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3. Express $3x^2 - 18x + 4$ in the form $a(x+b)^2 + c$

$3[x^2 - 6x] + 4$

$3[(x-3)^2 - 9] + 4$

$3(x-3)^2 - 27 + 4$

$3(x-3)^2 - 23$

4. Express $20x - 5x^2 + 3$ in the form $a - b(x+c)^2$

$-5[x^2 - 4x] + 3$

$-5[(x-2)^2 - 4] + 3$

→ $-5(x-2)^2 + 20 + 3$

$23 - 5(x-2)^2$

Solving by Completing the Square:

Note: Previously we factorised out the 3. This is because $3x^2 - 18x + 4$ on its own is an **expression,** so dividing by 3 (instead of factorising) would change the expression. However, in an equation, we can divide both sides by 3 without affecting the solutions. ← If we wanted to.

1.Solve the equation $3x^2 - 18x + 4 = 0$ by completing the square.

↑ Same as above.

$3(x-3)^2 - 23 = 0$

$3(x-3)^2 = 23$

$(x-3)^2 = \frac{23}{3}$

$x - 3 = \pm\sqrt{\frac{23}{3}}$

$x = 3 + \sqrt{\frac{23}{3}}$ or $x = 3 - \sqrt{\frac{23}{3}}$

Alt:

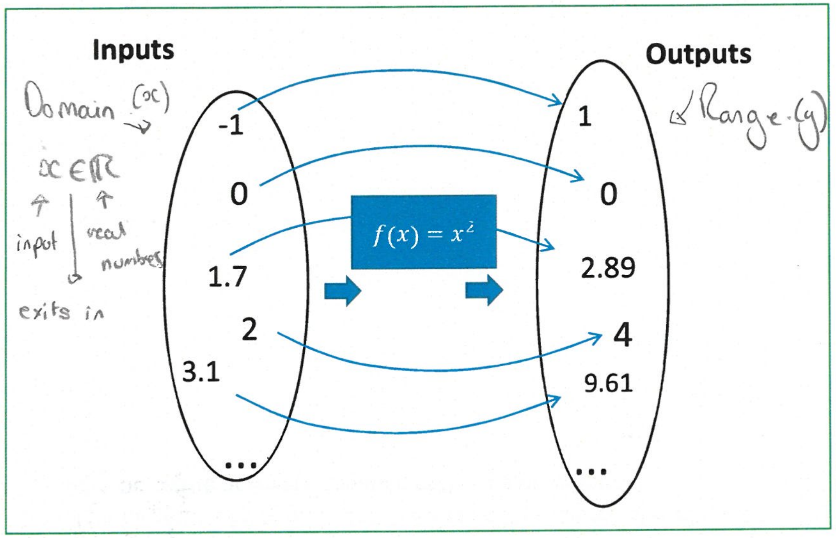
$(x-3)^2 - \frac{23}{3} = 0$

$(x-3)^2 = \frac{23}{3}$

$x - 3 = \pm\sqrt{\frac{23}{3}}$

$x = 3 \pm \sqrt{\frac{23}{3}}$

2E Functions:



Questions

1. If $f(x) = x^2 - 3x$ and $g(x) = x + 5, \quad x \in \mathbb{R}$
   a) Find $f(-4)$
   b) Find the values of x for which $f(x) = g(x)$
   c) Find the roots of $f(x)$.
   d) Find the roots of $g(x)$.

a) $f(-4) = (-4)^2 - 3(-4)$
$= 16 + 12$
$= 28$

b) $x^2 - 3x = x + 5$
$x^2 - 4x - 5 = 0$
$(x - 5)(x + 1) = 0$
$x = 5$ or $x = -1$

c) $f(x) = x(x - 3)$
$0 = x(x - 3)$
$x = 0$ or $x = 3$

d) $0 = x + 5$
$x = -5$

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2. Determine the minimum value of the function $f(x) = x^2 - 6x + 2$, and state the value of x for which this minimum occurs.

Min point → use completing the square

$f(x) = (x - 3)^2 - 9 + 2$
$= (x - 3)^2 - 7$ → think graph transformations

min $(3, -7)$ ∴ $x = 3$ at min point

3. Find the minimum value of $f(x) = 2x^2 + 12x - 5$ and state the value of x for which this occurs.

$f(x) = 2[x^2 + 6x] - 5$
$= 2[(x + 3)^2 - 9] - 5$
$= 2(x + 3)^2 - 18 - 5$
$= 2(x + 3)^2 - 23$

min $(-3, -23)$.
∴ $x = -3$ at min point

4. Find the roots of the function $f(x) = 2x^2 + 3x + 1$

$f(x) = (2x + 1)(x + 1)$
$0 = (2x + 1)(x + 1)$
$x = -\frac{1}{2}$ $\quad x = -1$

5. Find the roots of the function $f(x) = x^4 - x^2 - 6$

$(x^2 - 3)(x^2 + 2) = 0$
$x^2 = 3$ $\quad x^2 = -2$
$x = \pm\sqrt{3}$ $\quad$ ↑ impos

Alt let $y = x^2$.
$y^2 - y - 6 = 0$
$(y - 3)(y + 2) = 0$
$y = 3$ $\quad y = -2$
$x^2 = 3$ $\quad x^2 = -2$
$x = \pm\sqrt{3}$ $\quad$ ↑ impos

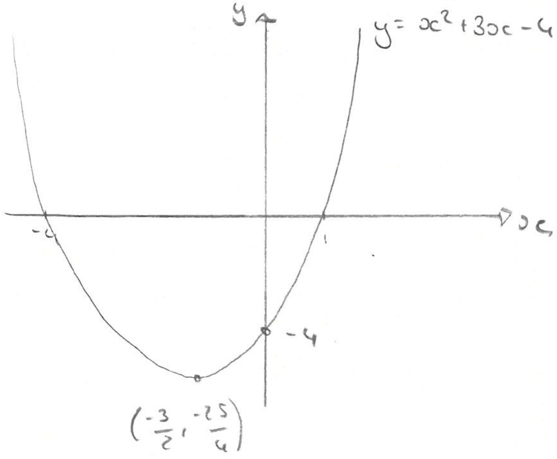
2F Quadratic Graphs:

1. Sketch the graph of $y = x^2 + 3x - 4$ and find the coordinates of the turning point.

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

$y = \left(x + \frac{3}{2}\right)^2 - \frac{25}{4}$

min $\left(-\frac{3}{2}, -\frac{25}{4}\right)$



$y = (x+4)(x-1)$

roots $x = -4$ $\quad x = 1$

when $x = 0$ $\quad y = -4$ $\quad (0, -4)$ y intercept

2. Sketch the graph of $y = 4x - 2x^2 - 3$ and find the coordinates of the turning point. Write down the equation of the line of symmetry.

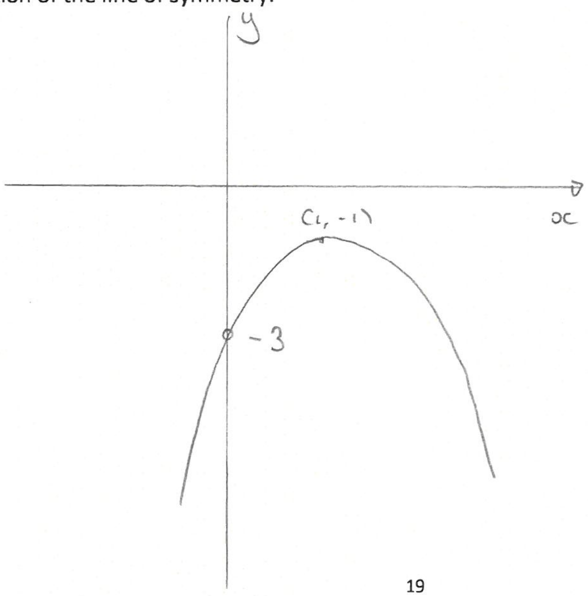
$y = -2x^2 + 4x - 3.$

$y = -2\left[x^2 - 2x\right] - 3$

$y = -2\left[(x-1)^2 - 1\right] - 3$

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

max $(1, -1)$.



Quadratic formula.

$x = \dfrac{-4 \pm \sqrt{16 - 4(-2)(-3)}}{2(-2)}.$

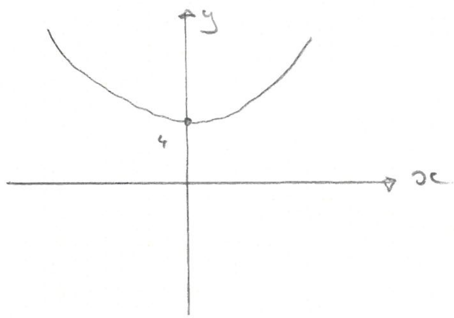
$x = \dfrac{-4 \pm \sqrt{-8}}{-4}.$

No roots as the discriminant < 0.

Sketch the following, indicating any intercepts with the axis, the turning point and the equation of the line of symmetry.

1. $y = x^2 + 4$

graph transformation of $y = x^2$ $\begin{pmatrix} 0 \\ 4 \end{pmatrix}$



no roots.

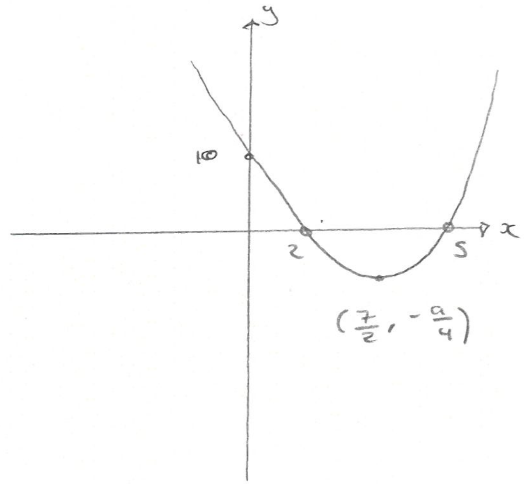
line of symmetry $x = 0$

2. $y = x^2 - 7x + 10$

$y = \left(x - \frac{7}{2}\right)^2 - \frac{49}{4} + 10$

$y = \left(x - \frac{7}{2}\right)^2 - \frac{9}{4}$

min $\left(\frac{7}{2}, -\frac{9}{4}\right)$



$y = (x-5)(x-2)$

$x = 5$ and $x = 2$. $\Rightarrow$ roots

line of symmetry $\Rightarrow x = \frac{7}{2}$

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

y intercept (0, 3)

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

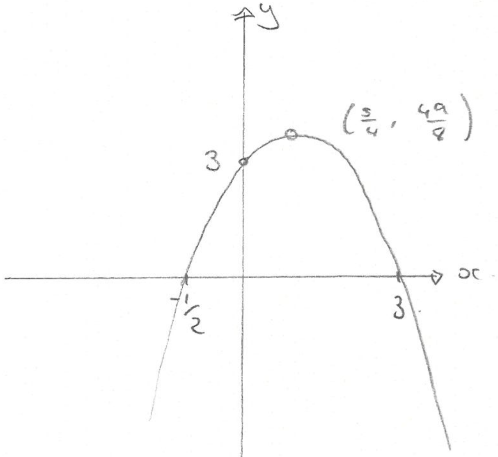
$y = -2\left[x^2 - \frac{5}{2}x\right] + 3$

$y = -2\left[\left(x - \frac{5}{4}\right)^2 - \frac{25}{16}\right] + 3$.

$y = -2\left(x - \frac{5}{4}\right)^2 + \frac{25}{8} + \frac{24}{8}$

$y = -2\left(x - \frac{5}{4}\right)^2 + \frac{49}{8}$

max $\left(\frac{5}{4}, \frac{49}{8}\right)$.



$y = (-2x - 1)(x - 3)$.

$x = -\frac{1}{2}$ $\quad$ $x = 3$.

$x = \frac{5}{4}$ line of symmetry

4. $y = x^2 + 4x + 11$

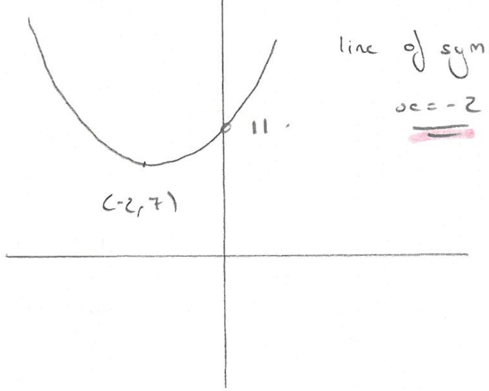
$y = (x+2)^2 - 4 + 11$

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

(-2, 7). min

line of symmetry

$x = -2$



Roots

$x = \frac{-4 \pm \sqrt{4^2 - 4(1)(11)}}{2(1)}$

$x = \frac{-4 \pm \sqrt{-28}}{2}$

No roots as the discriminant is negative

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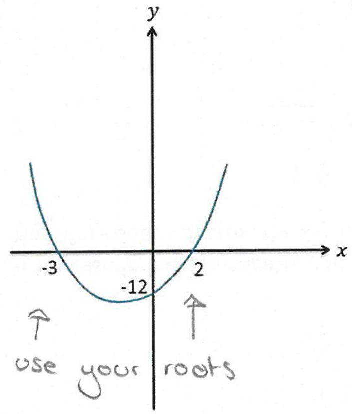
Determine the equation of this quadratic graph in the form $y = ax^2 + bx + c$



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

when $x = 0$ $\quad$ $y = -12$

$-12 = a(3)(-2)$

$+2 = a$

$y = 2(x+3)(x-2)$.

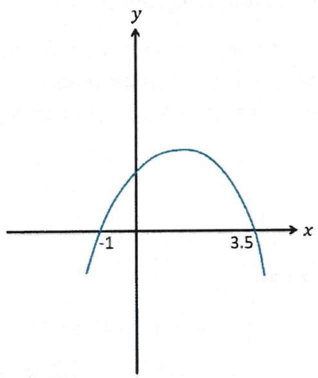
$y = 2(x^2 + x - 6)$

$y = 2x^2 + 2x - 12$

Determine the equation of this quadratic graph in the form $y = ax^2 + bx + c$

$y = a(x+1)(x-3.5)$.

$y = a(x^2 - 2.5x - 3.5)$

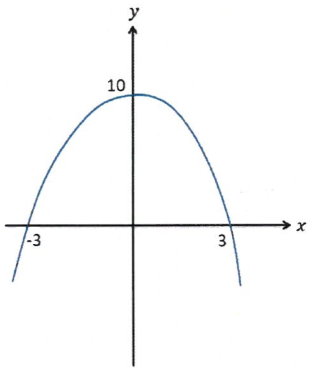


multiple answers as we don't know the y-intercept but 'a' must be negative

eg $a = -2$.

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

Determine the equation of this quadratic graph in the form $y = ax^2 + bx + c$



$y = a(x+3)(x-3)$

$y = a(x^2 - 9)$

when $x = 0$ $y = 10$

$10 = a(-9)$

$\frac{10}{-9} = a$

$\therefore\ y = \frac{10}{9}x^2 - 10$

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

2G The Discriminant

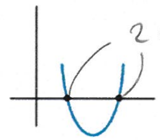
The **quadratic formula** is used to solve any quadratic equation of the form

ax² + bx + c = 0, and it looks like this:

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

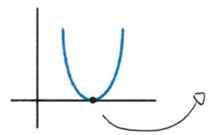
The part under the square root, **b² - 4ac**, is called the **discriminant**. It helps us understand what kind of solutions the quadratic equation will have *before* solving it. Here's what the discriminant tells us:

- **If the discriminant is positive (b² - 4ac > 0)**: There are **two real solutions**. Intercepts the x-axis twice.



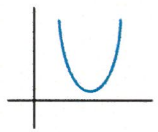
2 roots

- **If the discriminant is zero (b² - 4ac = 0)**: There is **one real solution**. Touches the x- axis once and has a repeated root.



repeated root

- **If the discriminant is negative (b² - 4ac < 0)**: There are **no real solutions,** therefore does not cross the x-axis.



no roots.

Understanding the discriminant helps you quickly predict the number and type of solutions before going through the full solving process.

Quick fire questions:

Equation	Discriminant b^2-4ac	No. of distinct real roots
$x^2+3x+4=0$	-7	0
$x^2-4x+1=0$	12	2
$x^2-4x+4=0$	0	1
$2x^2-6x-3=0$	60	2
$x-4-3x^2=0$	-47	0
$1-x^2=0$	4	2

Harder Exam Question

8. The equation $x^2+2px+(3p+4)=0$, where p is a positive constant, has equal roots.

(a) Find the value of p. **(4)**

$b^2-4ac=0$

(b) For this value of p, solve the equation $x^2+2px+(3p+4)=0$. **(2)**

Using $b^2-4ac=0$

$(2p)^2-4(1)(3p+4)=0$

$4p^2-12p-16=0$

$p^2-3p-4=0$

$(p-4)(p+1)=0$

$p=4$ or $p=-1$ can't be neg.

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

$x^2+8x+16=0$

$(x+4)^2=0$

$x=-4$ twice

Harder Exam Questions

1. $x^2+5kx+(10k+5)=0$ where k is a positive constant.

Given that this equation has equal roots, determine the value of k.

$\hookrightarrow b^2-4ac=0$

$(5k)^2-4(1)(10k+5)=0$

$25k^2-40k-20=0$

$5k^2-8k-4=0$

$(5k+2)(k-2)=0$

$k=-\frac{2}{5}$ $k=2$

2. Find the range of values of k for which $x^2+6x+k=0$ has two distinct real solutions.

$\hookrightarrow b^2-4ac>0$

$6^2-4(1)k>0$

$36-4k>0$

$36>4k$

$k<9$

2H Modelling

Example

A spear is thrown over level ground from the top of a tower.

The height, in metres, of the spear above the ground after t seconds is modelled by the function: $h(t) = 12.25 + 14.7t - 4.9t^2, \quad t \geq 0$

a) Interpret the meaning of the constant term 12.25 in the model.

when $t = 0$ $\quad h(0) = 12.25$.

ie the initial height of the spear

b) After how many seconds does the spear hit the ground?

when $h(t) = 0$

$0 = -4.9t^2 + 14.7t + 12.25$

$t = -0.679$ or $t = 3.68$

t can't be neg

I solve via my alevel cal

you can use quadratic formula.

c) Write $h(t)$ in the form $A - B(t - C)^2$, where A, B and C are constants to be found.

$h(t) = 12.25 + 14.7t - 4.9t^2$

$h(t) = 12.25 - 4.9(t^2 - 3t)$

$= 12.25 - 4.9\left[(t + \frac{3}{2})^2 - \frac{9}{4}\right]$

$= 12.25 - 4.9(t - \frac{3}{2})^2 - \frac{441}{40}$

$= 23.275 - 4.9(t - \frac{3}{2})^2$.

d) Using your answer to part c or otherwise, find the maximum height of the spear above the ground, and the time at which this maximum height is reached?

turning point $\left(\frac{3}{2}, 23.275\right)$

$\therefore$ max height 23.275 m

at 1.5 seconds

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

Quadratics exam style question

A ball is thrown upwards from a rooftop 80m above the ground. It will reach a maximum vertical height and then fall back to the ground.

The height of the ball from ground at time t is h, given by the formula:

$h = -16t^2 + 64t + 80$

a) Calculate the height reached by the ball after 1 second.

$t = 1$ $\quad h = -16(1)^2 + 64(1) + 80$

$h = 128$

b) Calculate the maximum height reached by the ball and after how many seconds from when it is thrown this maximum height is reached.

$h = -16[t^2 - 4t] + 80$

$h = -16[(t-2)^2 - 4] + 80$

$h = -16(t-2)^2 + 64 + 80$

$h = -16(t-2)^2 + 144$.

max $(2, 144)$.

at $t = 2$ max height 144m

c) Calculate how long will it take before the ball hits the ground.

$0 = -16t^2 + 64t + 80$

$0 = t^2 - 4t - 5$

$0 = (t - 5)(t + 1)$

$t = 5$ $\quad t = -1$ ×

Need a recap of the content in this chapter? Use this QR code to watch a Bicen maths YouTube video.

Exam Questions on Chapter 2

Q1.

The equation

$(p - 1)x^2 + 4x + (p - 5) = 0$, where p is a constant

has no real roots.

(a) Show that p satisfies $p^2 - 6p + 1 > 0$

(3)

(b) Hence find the set of possible values of p.

(4)

(Total for question = 7 marks)

a) no real roots $b^2-4ac < 0$

$4^2 - 4(p-1)(p-5) < 0$

$16 - 4(p^2 - 6p + 5) < 0$

$16 - 4p^2 + 24p - 20 < 0$

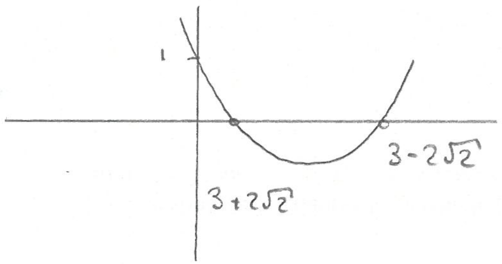
$-4p^2 + 24p - 4 < 0$

$p^2 - 6p + 1 > 0$

when you divide by a neg change the inequality

b) $p^2 - 6p + 1 = 0$

$p = 3 + 2\sqrt{2}$ $p = 3 - 2\sqrt{2}$



Set of possible values

$\{p \in \mathbb{R} : p < 3 + 2\sqrt{2} \cup p > 3 - 2\sqrt{2}\}$

in set notation

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

Q2.

In this question you must show all stages of your working.

Solutions relying on calculator technology are not acceptable.

(i) Solve the equation

$$x\sqrt{2} - \sqrt{18} = x$$

writing the answer as a surd in simplest form.

(3)

(ii) Solve the equation

$$4^{3x-2} = \frac{1}{2\sqrt{2}}$$

$2\sqrt{2} = 2 \times 2^{1/2} = 2^{3/2}$

(3)

(Total for question = 6 marks)

i) $x\sqrt{2} - x = \sqrt{18}$

$x(\sqrt{2} - 1) = 3\sqrt{2}$

$x = \frac{3\sqrt{2}}{(\sqrt{2}-1)} \frac{(\sqrt{2}+1)}{(\sqrt{2}+1)}$

$x = \frac{6 + 3\sqrt{2}}{2-1} = 6 + 3\sqrt{2}$

ii) $(2^2)^{3x-2} = 2^{-3/2}$

$2(3x-2) = -\frac{3}{2}$

$6x - 4 = -\frac{3}{2}$

$6x = \frac{5}{2}$

$x = \frac{5}{12}$

a) $-1[(x^2-4x)] - 5$

$-1[(x-2)^2-4]-5$

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

Q3.

$$4x - 5 - x^2 = q - (x + p)^2$$

where *p* and *q* are integers.

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

(a) Find the value of *p* and the value of *q*. $q = -1$ $p = -2$

(3)

(b) Calculate the discriminant of $4x - 5 - x^2$ $4^2 - 4(-1)(-5)$

$= 16 - 20 = -4$

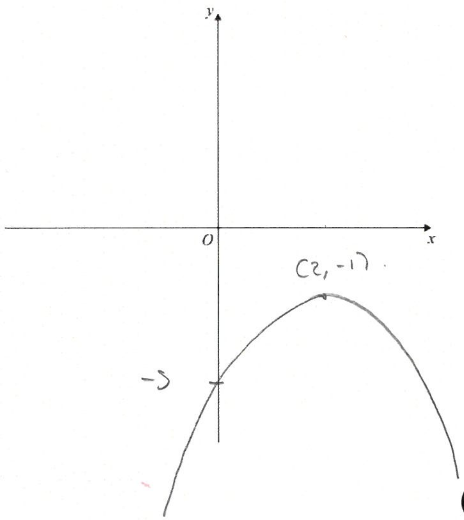
(2)

(c) On the axes on page 17, sketch the curve with equation $y = 4x - 5 - x^2$ showing clearly the coordinates of any points where the curve crosses the coordinate axes.

neg discriminant

no real roots.

(3)



(Total 8 marks)

Transition Task. Chapter 1 - Algebraic Expressions.
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Q4.

$$f(x) = x^2 + (k + 3)x + k$$

where *k* is a real constant.

(a) Find the discriminant of f(*x*) in terms of *k*.

(2)

(b) Show that the discriminant of f(*x*) can be expressed in the form $(k + a)^2 + b$, where *a* and *b* are integers to be found.

(2)

(c) Show that, for all values of *k*, the equation f(*x*) = 0 has real roots.

(2)

(Total 6 marks)

a) $b^2 - 4ac = (k+3)^2 - 4(1)(k)$

$= k^2 + 6k + 9 - 4k$

$= k^2 + 2k + 9$

b) $(k+1)^2 - 1 + 9$

$(k+1)^2 + 8$

c). Real roots $\rightarrow b^2 - 4ac > 0$

as $(k+1)^2 + 8 > 0$

square number is always positive or 0

+ 8 means always positive

Q5.

The equation $x^2 + 3px + p = 0$, where p is a non-zero constant, has equal roots.

Find the value of p.

(4)
(Total 4 marks)

$b^2 - 4ac = 0$

$(3p)^2 - 4(1)(p) = 0$

$9p^2 - 4p = 0$

$p(9p - 4) = 0$

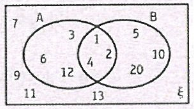
$p = 0$ or $p = \frac{4}{9}$

$\times$

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

Diagnostic for Chapter 3 Equations and Inequalities

1 A = {factors of 12}
B = {factors of 20}
Write down the numbers in each of these sets:
a $A \cap B$ **b** $(A \cup B)'$



a) $A \cap B = \{1, 2, 4\}$

b) $(A \cup B)' = \{7, 9, 11, 13\}$

2 Simplify these expressions.
a $\sqrt{75}$ **b** $\frac{2\sqrt{45} + 3\sqrt{32}}{6}$

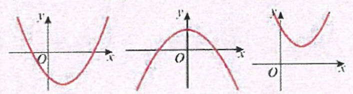
2a) $5\sqrt{3}$

b) $\frac{2(3\sqrt{5}) + 3(4\sqrt{2})}{6}$

$\frac{6\sqrt{5} + 12\sqrt{2}}{6}$

$= \sqrt{5} + 2\sqrt{2}$

3 Match the equations to the correct graph. Label the points of intersection with the axes and the coordinates of the turning point.
a $y = 9 - x^2$ **b** $y = (x - 2)^2 + 4$
c $y = (x - 7)(2x + 5)$



a) $y = 9 - x^2$ neg shape $\cap$

$y = (3 - x)(3 + x)$

$x = 3$ $x = -3$.

crosses at & TP

$(3,0)$ $(-3,0)$ $(0,9)$

$(a \to ii)$

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

$x = 0$ $y = 8$ $(0, 8)$.

TP at $(2, 4)$.

$y = 0$ $x = 2 \pm \sqrt{-4}$

no roots. impos.

$(b \to iii)$.

c) $y = 0$ $x = 7$ $x = -\frac{5}{2}$

$x = 0$ $y = -35$.

$(c \to i)$

3A Simultaneous Equations

You can do this on your calculator – check every question on your calculator, make sure you come at the beginning of the year with an A-Level standard calculator.

Solve the simultaneous equations

$$3x + y = 8$$
$$2x - 3y = 9$$

Method 1 : Elimination

① $3x + y = 8$
② $2x - 3y = 9$
+ ① × 3 $9x + 3y = 24$
$11x = 33.$
$x = 3.$
sub into ①
$3(3) + y = 8$
$y = -1$
$(3, -1)$

Method 2: Substitution

① ⇒ $y = 8 - 3x$
$2x - 3(8 - 3x) = 9$
$2x - 24 + 9x = 9$
$11x - 24 = 9.$
$11x = 33$
$x = 3.$
sub into ①.
$3(3) + y = 8$
$y = -1$
$(3, -1)$

Check on your calc!

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

3B Linear and Quadratic

1.Solve the simultaneous equations:

① $x + 2y = 3$
② $x^2 + 3xy = 10$

① ⇒ $x = 3 - 2y$
Sub into ②
$(3-2y)^2 + 3(3-2y)y = 10$
$9 - 12y + 4y^2 + 9y - 6y^2 = 10$
$0 = 2y^2 + 3y + 1$
$0 = (2y + 1)(y + 1)$
$y = -\frac{1}{2}$ $y = -1$

When $y = -\frac{1}{2}$
$x = 3 - 2(-\frac{1}{2})$
$x = 4$
when $y = -1$
$x = 3 - 2(-1)$
$x = 5.$
$(4, -\frac{1}{2})$ $(5, -1)$

2. Solve the simultaneous equations: $3x^2 + y^2 = 21$ ② and $y = x + 1$ ①

Sub ① into ②
$3x^2 + (x+1)^2 = 21$
$3x^2 + x^2 + 2x + 1 = 20$
$4x^2 + 2x - 20 = 0$
$2x^2 + x - 10 = 0$
$(2x + 5)(x - 2) = 0$
$x = \frac{-5}{2}$ $x = 2$

when $x = -\frac{5}{2}$ $y = -\frac{3}{2}$
$x = 2$ $y = 3$
$(-\frac{5}{2}, -\frac{3}{2})$ $(2, 3)$

3C Simultaneous Equations and Graphs

1a. On the same axes, draw the graphs of $2x + y = 3$ and $y = x^2 - 3x + 1$

$2x + y = 3$.

$y = 0 \quad x = 3/2$

$x = 0 \quad y = 3$.

cover up method

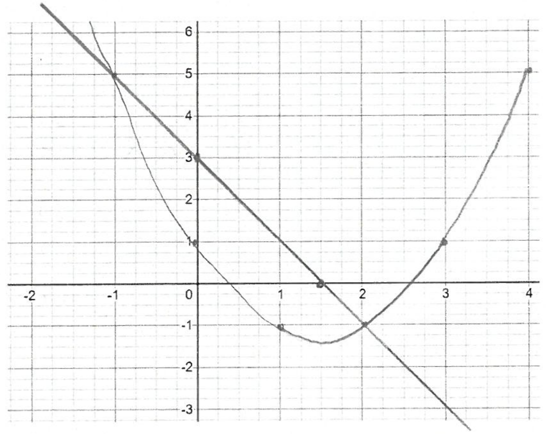
$y = -2x + 3$

x	$f(x)$
-2	11
-1	5
0	1
1	-1
2	-1
3	1
4	5

Use your calc to create a table of values. to get this.

from calc find roots.

$(2.62, 0)$ and $(0.382, 0)$



1b. Use your graph to write down the solutions to the simultaneous equations

crosses at $(-1, 5)$ and $(2, -1)$.

1c. What algebraic method could we have used to show the graphs would have intersected twice?

$y = 3 - 2x \qquad y = x^2 - 3x + 1$

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

$0 = x^2 - x - 2$.

Use $b^2 - 4ac > 0$

for multiple real roots

$(1)^2 - 4(1)(-2)$

$= 9 > 0$

$\therefore$ multiple real roots.

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

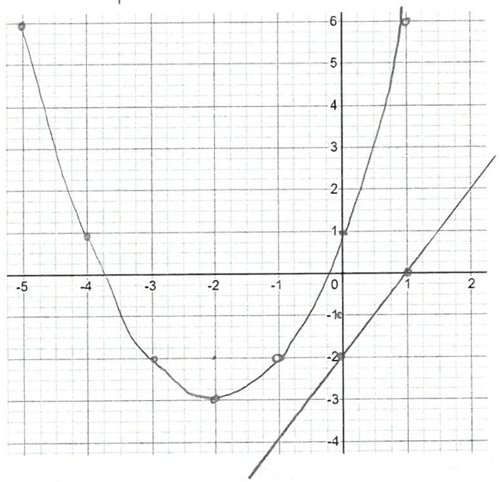
2.a) On the same axes, draw the graphs of:

$y = 2x - 2 \qquad y = x^2 + 4x + 1$

x	$f(x)$
-2	-6
-1	-4
0	-2
1	0
2	2

Use calc to create tables of values

x	$f(x)$
-5	6
-4	1
-3	-2
-2	-3
-1	-2
0	1
1	6 .



Can see this from graph.
But we still need to prove it.
$\therefore b^2 - 4ac < 0$ for no roots.

b) Prove algebraically that the lines never meet

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

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

$b^2 - 4ac = (2)^2 - 4(1)(3)$

$= 4 - 12$

$= -8 < 0 \quad \therefore$ no real roots.

Exam Style Question

The line with equation $y = 2x + 1$ meets the curve with equation $kx^2 + 2y + (k - 2) = 0$ at exactly one point. Given that k is a positive constant:

a) Find the value of k. → $b^2 - 4ac = 0$

b) For this value of k, find the coordinates of this point of intersection

Sub $y = 2x + 1$ into $kx^2 + 2y + (k - 2) = 0$

$kx^2 + 2(2x + 1) + k - 2 = 0$

$kx^2 + 4x + k = 0$

Using $b^2 - 4ac$

$(4)^2 - 4(k)(k) = 0$

$16 - 4k^2 = 0$

$4k^2 = 16$

$k^2 = 4$

$k = \pm 2$

k is positive $\therefore$ $k = 2$

b) if $k = 2$

$2x^2 + 4x + 2 = 0$ → subbed into

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

$(x + 1)^2 = 0$

$x = -1$

$y = 2(-1) + 1$

$y = -1$

$(-1, -1)$

Question wants coord.

3D 3E Set Builder Notation

Recap from GCSE:

- We use curly braces to list the values in a set, e.g. $A = \{1,4,6,7\}$
- If A and B are sets then $A \cap B$ is the **intersection** of A and B, giving a set which has the elements in A **and** B.
- $A \cup B$ is the **union** of A and B, giving a set which has the elements in A **or** in B.
- $\emptyset$ is the empty set, i.e. the set with nothing in it.
- Sets can also be infinitely large. $\mathbb{N}$ is the set of natural numbers (all positive integers), $\mathbb{Z}$ is the set of all integers (including negative numbers and 0) and $\mathbb{R}$ is the set of all real numbers (including all possible decimals).
- We write $x \in A$ to mean "x is a member of the set A". So $x \in \mathbb{R}$

Quick Fire Examples

$\{1,2,3\} \cap \{3,4,5\} = \{3\}$

$\{1,2,3\} \cup \{3,4,5\} = \{1, 2, 3, 4, 5\}$

$\{1,2\} \cap \{3,4\} = \emptyset$ → empty set

1. $\{2x : x \in \mathbb{Z}\}$

→ $\mathbb{Z}$ means integers ie $\{\ldots -3, -2, -1, 0, 1, 2, 3 \ldots\}$

all even integers.

$\{\ldots -6, -4, -2, 0, 2, 4, 6 \ldots\}$

2. $\{2^x : x \in \mathbb{N}\}$

→ Natural numbers ie $\{1, 2, 3 \ldots\}$

$\{2, 4, 8, 16 \ldots\}$

3. $\{xy: x, y \text{ are prime}\}$

→ $\{2, 3, 5, 7, 11, 13 \ldots\}$

→ $\{4, 6, 9, 10, 15, 25 \ldots\}$

Solving Inequalities

Linear inequalities

1. $2x + 1 > 5$

$2x > 4$

$x > 2$

2. $3(x - 5) \geq 5 - 2(x - 8)$

$3x - 15 \geq 5 - 2x + 16$

$5x \geq 36$

$x \geq 7.2$

3. $-x \geq 2$

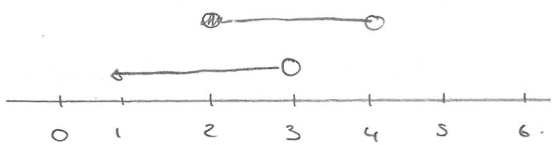
$x \leq -2$

Combining Inequalities

When combining inequalities always draw a number line to help!

Example:

If $x < 3$ and $2 \leq x < 4$, what is the combined solution set?



$2 \leq x < 3$

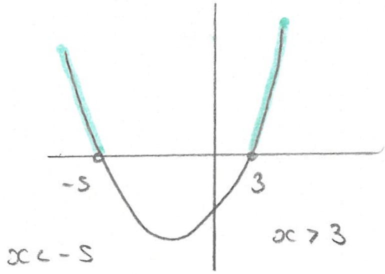
Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

Quadratic Inequalities:

1. Solve $x^2 + 2x - 15 > 0$

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

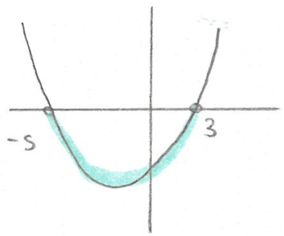
$x = -5 \qquad x = 3$



Set notation.

$\{x : x < -5 \cup x > 3\}$

2. Solve $x^2 + 2x - 15 \leq 0$



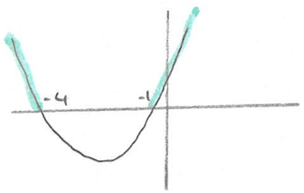
$\{x : -5 \leq x \leq 3\}$

3. Solve $x^2 + 5x \geq -4$

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

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

$x = -4 \qquad x = -1$

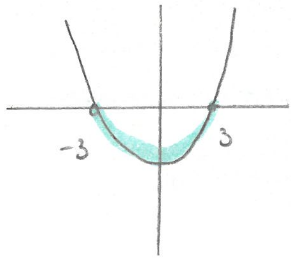


$\{x : x \leq -4 \cup x \geq -1\}$

4. Solve $x^2 < 9$

$x = \pm\sqrt{9}$

$x = \pm 3$



$\{x : -3 < x < 3\}$

3D 3E Division by x

Find the set of values for which $\frac{6}{x} > 2, \quad x \neq 0$

we can't multiply by x as we do not know if it is negative or positive to get around this we multiply by x^2

$\frac{6}{x} > 2$

$6x > 2x^2$

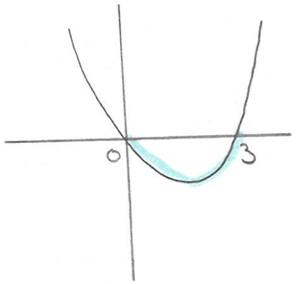
$0 > 2x^2 - 6x$

$0 > x(2x - 6)$

$0 = x(2x - 6)$

$x = 0 \quad x = 3$

$\therefore \{x : 0 < x < 3\}$



3F 3G Sketching Inequalities:

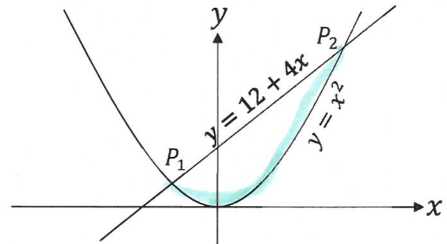
1. L_1 has equation $y = 12 + 4x$. L_2 has equation $y = x^2$.

The diagram shows a sketch of L_1 and L_2 on the same axes.

a) Find the coordinates of P_1 and P_2, the points of intersection.

b) Hence write down the solution to the inequality

$12 + 4x > x^2$.



a)

$L_1 = L_2$

$x^2 = 12 + 4x$

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

$(x - 6)(x + 2) = 0$

$x = 6 \quad x = -2$

$x = -2 \quad y = 12 + 4(-2)$

$y = 4$

$x = 6 \quad y = 12 + 4(6)$

$y = 36$

$(-2, 4) \quad (6, 36)$

b) $12 + 4x > x^2$

linear > quadratic

$-2 < x < 6$

2. Shade the region that satisfies the inequalities:

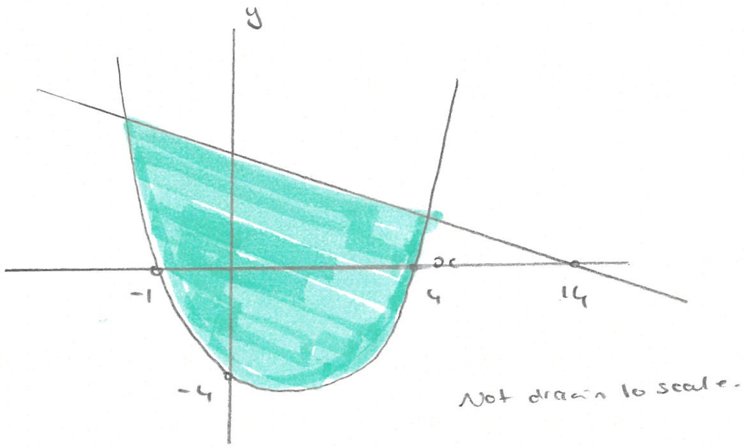
$$2y + x < 14$$

$$y \geq x^2 - 3x - 4$$

$2y + x = 14$

$y = 0 \quad x = 14$

$x = 0 \quad y = 7$



$y = x^2 - 3x - 4$

$y = (x - 4)(x + 1)$

$x = 4 \quad x = -1$

Need a recap of the content in this chapter? Use this QR code to watch a Bicen maths YouTube video.

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

Exam Style Questions

Q1.

Find the set of values of *x* for which

(a) $2(3x + 4) > 1 - x$

(2)

(b) $3x^2 + 8x - 3 < 0$

(4)

(Total 6 marks)

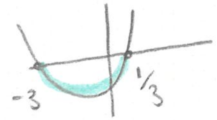
a) $6x + 8 > 1 - x$

$7x > -7$

$\{x : x > -1\}$

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

$x = \frac{1}{3} \quad x = -3$



$\{x : -3 < x < \frac{1}{3}\}$

Q2.

Find the set of values of x for which

(a) $4x - 3 > 7 - x$

(2)

(b) $2x^2 - 5x - 12 < 0$

(4)

(c) **both** $4x - 3 > 7 - x$ **and** $2x^2 - 5x - 12 < 0$

(1)

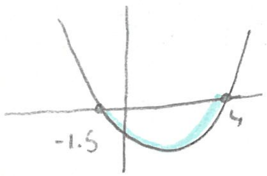
(Total 7 marks)

a) $5x > 10$

$\{x : x > 2\}$

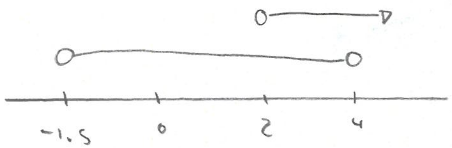
b) $(2x + 3)(x - 4) = 0$

$x = -\frac{3}{2}$ $\quad x = 4$



$\{x : -1.5 < x < 4\}$

c). both.



$\{x : 2 < x < 4\}$

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

Q3.

The equation $\rightarrow (k+3)x^2 + 6x + (k-5) = 0$

$$(k + 3)\,x^2 + 6x + k = 5, \text{ where } k \text{ is a constant,}$$

has two distinct real solutions for x.

(a) Show that k satisfies

$$k^2 - 2k - 24$$

(4)

(b) Hence find the set of possible values of k.

(3)

(Total 7 marks)

a) $b^2 - 4ac > 0$

$6^2 - 4(k+3)(k-5) > 0$

$36 - 4(k^2 - 2k - 15) > 0$

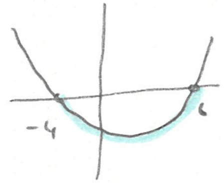
$36 - 4k^2 + 8k + 60 > 0$

$4k^2 - 8k - 96 < 0$

$k^2 - 2k - 24 < 0$

b). $(k - 6)(k + 4) = 0$

$k = 6 \quad k = -4$



$-4 < k < 6$

Transition Task. Chapter 1 - Algebraic Expressions.
Chapter 2 – Quadratics. Chapter 3 - Equations and Inequalities

Q4.

Find the set of values of x for which

(a) $3x - 7 > 3 - x$

(2)

(b) $x^2 - 9x \leq 36$

(4)

(c) **both** $3x - 7 > 3 - x$ **and** $x^2 - 9x \leq 36$

(1)

(Total 7 marks)

a) $4x > 10$

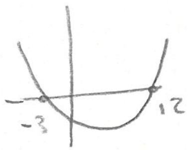
$\{x : x > 2.5\}$

b) $x^2 - 9x - 36 \leq 0$

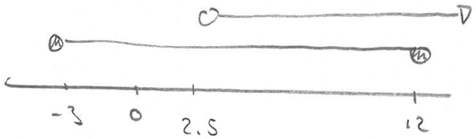
$(x - 12)(x + 3) = 0$

$x = 12 \quad x = -3$

$\{x : -3 \leq x \leq 12\}$



c) both



$\{x : 2.5 < x \leq 12\}$