Maths Knowledge Organiser

Year 8 Algebra

Expression and equations

Simplify by collecting like terms

Like terms are terms who's variable (letter) are the same

These are like terms → $e \quad 5e \quad -3e \quad \frac{2}{3}e$

These are **not** like terms → 6t $\quad t^2 \quad 5ty \quad 8y$

To simply identify and collect

$4a + 7b - a - 3b \equiv 3a + 4b$

$5a^2 - 3a - 4 + a \equiv 5a^2 - 2a - 4$

Expanding brackets

This is the process to remove brackets by multiplying – use the grid method to help

$5r(3r - 6) \rightarrow$
$= 15r^2 - 30r$

$\times$	$3r$	-6
$5r$	$15r^2$	$-30r$

$(3x + 2)(2x - 5) \rightarrow$
$= 6x^2 - 11x - 10$

$\times$	$2x$	-5
$3x$	$6x^2$	$-15x$
$+2$	$+4x$	-10

Index law

$x^0 = 1$

$x^n \times x^m = x^{n+m}$

$x^n \div x^m = x^{n-m}$

$(x^n)^m = x^{nm}$

$x^{-n} = \frac{1}{x^n}$

$x^{\frac{n}{m}} = \sqrt[m]{x^n}$

Substitution

Means to swop a unknown (letter) for a numerical value.

If a = 4 b = -2 and c= 0.5

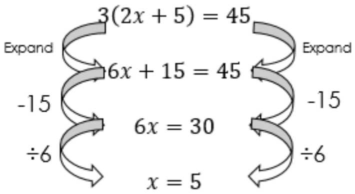
7a = 7x(4) = 28

a + b = 4 + -2 = 2

abc = 4 x -2 x 0.5 = -4

Solving equations

Use inverse operations (opposites) and balancing to find the value of the unknown (letter)


$3(2x + 5) = 45$

$6x + 15 = 45$

$6x = 30$

$x = 5$

Expression, equations, formula and identities

A formula is a rule written using symbols that describe a relationship between different quantities. Typical maths formulae include

An expression is a group of mathematical symbols representing a number or quantity. Expressions never have equality or inequality signs like =, >, <, ≠ ,≥ ,≤. Some examples

An identity is an equation that is always true, no matter what values are chosen.

An equation is a mathematical statement that shows that two expressions are equal. It always includes an equals sign.

Factorising – single bracket

This is the process to putting brackets into expressions, find the highest common factors first

HCF of $6x \text{ and } 10 \text{ is } 2$

HCF of $12x \text{ and } 4xy \text{ is } 4x$

HCF of $10t^2 \text{ and } 15tr \text{ is } 5t$

Place the HCF on the outside and divide to calculate inside

$10t^2 + 15t = 5t(2t + 3)$

$12x + 4xy = 4x(3 + y)$

Maths Knowledge Organiser

Year 8 Algebra

Quadratics, inequalities, formulae and algebraic fractions

Factorising – double bracket

When there is no highest common factor we use double brackets

Split the middle term into its product/sum pair

$\overbrace{6x^2 \underbrace{-x}_{\text{sum}} - 15}^{\text{multiply}}$ Multiply = -90 Sum = -1 -10 and 9

$$\underbrace{6x^2 - 10x}\ \underbrace{+ 9x - 15}$$

$$2x(3x-5) + 3(3x-5) \rightarrow (2x+3)(3x-5)$$

Inverse operations

+ ↔ -

x ↔ ÷

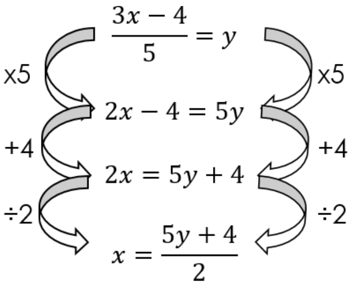
square (x^2) ↔ square root ($\sqrt{x}$)

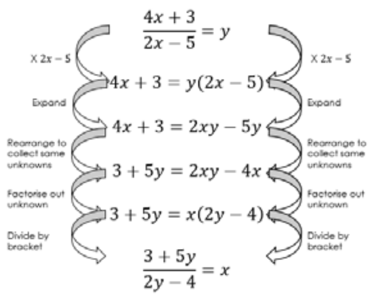
cube (x^3) ↔ cube root ($\sqrt[3]{x}$)

Rearranging formula

Use inverse operations (opposites) and balancing to make another variable the subject

Make x the subject:


$$\frac{3x-4}{5} = y$$
$$2x - 4 = 5y$$
$$2x = 5y + 4$$
$$x = \frac{5y+4}{2}$$


$$\frac{4x+3}{2x-5} = y$$
$$4x + 3 = y(2x-5)$$
$$4x + 3 = 2xy - 5y$$
$$3 + 5y = 2xy - 4x$$
$$3 + 5y = x(2y-4)$$
$$\frac{3+5y}{2y-4} = x$$

Algebraic fractions

A fraction which involves unknowns (letters)

As they are like normal fractions we can:

- simplify them:

Factorise first

$$\frac{x^2+7x-18}{4x-8} = \frac{(x+9)\cancel{(x-2)}}{4\cancel{(x-2)}} = \frac{x-2}{4}$$

Add and subtract them

$$\frac{x+3}{3} + \frac{x-5}{2} = \frac{2(x+3)+3(x-5)}{3\times 2} = \frac{2x+6+3x-15}{6} = \frac{5x+9}{6}$$

$$\frac{7}{x+3} + \frac{8}{x-4} = \frac{7(x-4)+8(x+3)}{(x+3)(x-4)} = \frac{7x-28+8x+24}{x^2+3x-4x-12} = \frac{15x-4}{x^2-x-12}$$

Solve quadratic equations

Quadratic equations are equations with more than one solution

Factorise and solve each bracket

$$x^2 + 5x + 6 = 0$$
$$(x+3)(x+2) = 0$$
$$x + 3 = 0 \quad x + 2 = 0$$
$$x = -3 \qquad x = -2$$

Ensure equations is equal to zero, if not rearrange

$$x^2 = x + 30$$
$$\mathbf{x^2 - x - 30 = 0}$$
$$(x-6)(x+5) = 0$$
$$x - 6 = 0 \quad x + 5 = 0$$
$$x = 6 \qquad x = -5$$

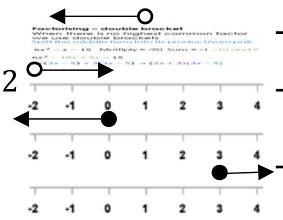
Inequalities on a number line

$x < 1$

$y > -2$

$z \leq 0$

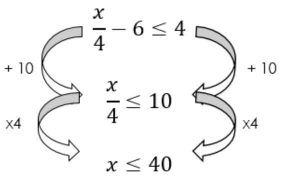
$t \geq 3$

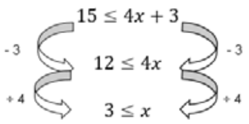


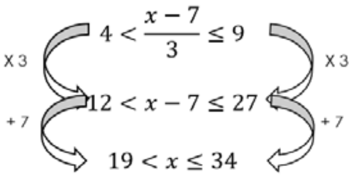
<	Less than	○
>	Greater than	○
≤	Less than and equal to	●
≥	Greater than and equal to	●

Solving inequalities

Just like solving equations


$$\frac{x}{4} - 6 \leq 4$$
$$\frac{x}{4} \leq 10$$
$$x \leq 40$$


$$15 \leq 4x + 3$$
$$12 \leq 4x$$
$$3 \leq x$$


$$4 < \frac{x-7}{3} \leq 9$$
$$12 < x - 7 \leq 27$$
$$19 < x \leq 34$$

Maths Knowledge Organiser

Year 8 Algebra

Sequences

Sequences

A pattern of numbers that follow a rule

Special sequences

Odd → 1,3,5,7,9,11…
Even → 2,4,6,8,10,12
Square → 1, 4, 9, 16, 25, 26, …
Cube → 1, 8, 27, 64, 125, …
Triangular → 1, 3, 6, 10, 15, 21,….
Fibonacci → 1, 1, 2, 3, 5, 8, 13, 21,…

Sequences

Calculate the term to term rule to help find missing numbers

5, 11, …, 23, …, 35 → add 6 → 5, 11, 17, 23, 29, 35

20, 16, …, 8, …, 0 → subtract 4 → 20, 16, 12, 8, 4, 0

3, …, 12, 24, …, 98 → doubling → 3, 6, 12, 24, 48, 96

…, 8.1, 9, …, 10.8 → adding 0.9 → 7.2, 8.1, 9, 9.9, 10.8

Generating a sequence

Substitution the position you want to find into the nth term

When looking for the 3^{rd} → n = 3
If nth term was 4n – 1 → 4 x 3 – 1 = 11
If nth term was 5n+11 → 5 x 3 + 11 = 26
If nth term was 10 – 2n → 10 – 2 x 3 = 41

A *linear* sequence involves no powers

A *quadratic* has a highest power of 2 (squared)

The first 3 terms of the sequence $3n^2$ are:
$3 \times (1)^2 = 3 \times 1 = \mathbf{3}$
$3 \times (2)^2 = 3 \times 4 = \mathbf{12}$
$3 \times (3)^2 = 3 \times 9 = \mathbf{27}$

Calculating nth term - linear

Find the common difference and find the difference between that numbers time tables and the original sequence

4n	4	8	12	16
Sequence	1	5	9	13
Difference	-3	-3	-3	-3

→ **4n – 3**

-2n	-2	-4	-6	-8
Sequence	13	11	9	7
Difference	+15	+15	+15	+15

→ **-2n + 15**

Calculating nth term - quadratic

Find the second difference and half it to find differences

Sequence	→ 7, 25, 53, 91
1^{st} difference	→ 18 28 38
2^{nd} difference	→ 10 10

$5n^2$	5	20	45	80
Sequence	7	25	53	91
Difference	+2	+5	+8	+11

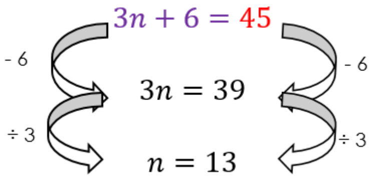
→ 3n-1

$5n^2 + 3n – 1$

Using the nth term

The nth can be used to work out any number in a sequence or prove that a number is in a sequence

Is the number 45 in the sequence 3n+6



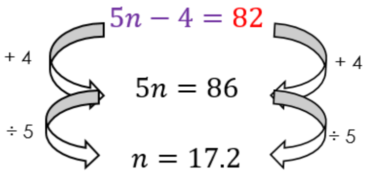
$3n + 6 = 45$

$3n = 39$

$n = 13$

This means that 45 is the 13^{th} term, so yes is in the sequence

Is the number 82 in the sequence 5n – 4



$5n - 4 = 82$

$5n = 86$

$n = 17.2$

This means that 82 is the 17.2^{nd} term, this does not exits as its decimal

Maths Knowledge Organiser

Year 8 Algebra

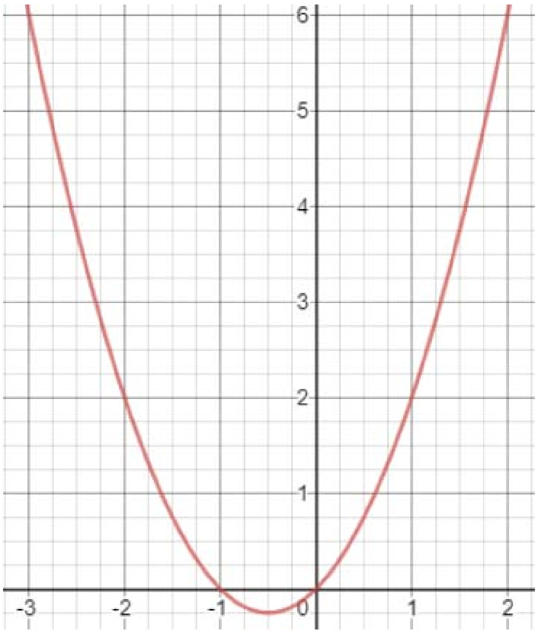
Straight line graphs

Plotting graphs

Use a xy table
x coordinates come from x axis on graph
y coordinates come from the equation

$$y = x^2 + x$$

x	-2	-1	0	1	2
y	2	0	0	2	6



Equations of a line between 2 points

(1,6) and (3,14)

$$\frac{Difference\ in\ y}{Difference\ in\ x} = \frac{14-6}{3-1} = \frac{8}{2} = 4$$

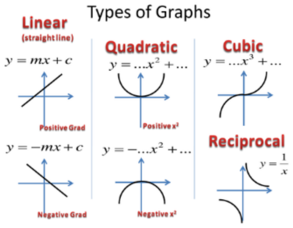
y = 4x + c
Input any of the 2 coordinates (1,6)
6 = 4(1) + c
6 = 4 + c
x = 2

y = 4x + 2

Midpoint between 2 points

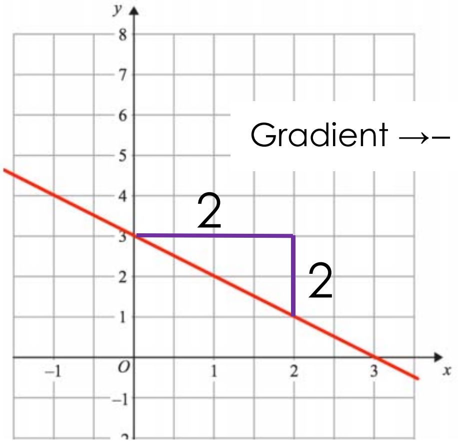
(1,6) and (3,14)
Add and divide by 2

$$\left(\frac{1+3}{2}, \frac{6+14}{2}\right) = (2,10)$$



Straight lines

Every straight line can be written in the form y = mx + c
m – is the gradient (steepness)
c – is the y-intercept



Gradient $\rightarrow -\frac{2}{2} = -1$

Gradient → (0,3) (2,1)

$$\frac{Difference\ in\ y}{Difference\ in\ x} = \frac{1-3}{2-0} = \frac{-2}{2} = -1$$

Y-intercept → Where it crosses y axis (0,3)
Equation → $y = -1x + 3$

Parallel lines

Parallel lines never meet which means they have same gradient

All these lines are parallel

y = 3x – 5	y = 3x + 102
y = 3x	y + 7 = 3x

Perpendicular lines

Lines that meet at 90°
Line A → y = 3x – 5
Line A and B both meet at (4,7)
Line B →
Take the gradient of A → 3
Find its negative reciprocal → $\frac{-1}{3}$

$y = \frac{-1}{3}x + c$ substitute the coordinate in

$$7 = \frac{-1}{3}(4) + c$$

$$7 = \frac{-4}{3} + c$$

$$8\frac{1}{3} = c$$

$$\boldsymbol{y = \frac{-1}{3}x + 8\frac{1}{3}}$$

Maths Knowledge Organiser

Year 8 Algebra

Real life and non-linear graphs

Conversion graphs

Graphs which help us convert one unit of measure to another
To plot simply take the given information and join with a straight line

To use the conversion graph simply use your ruler

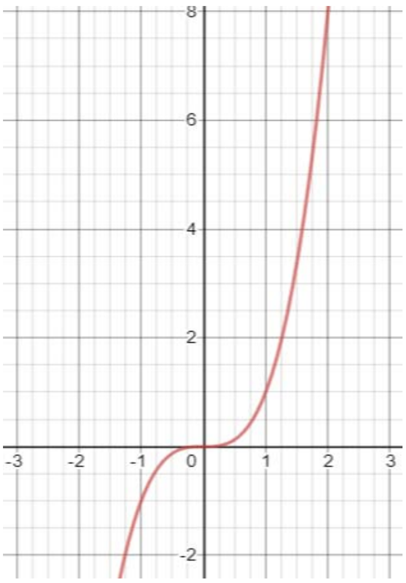
1) 120 miles is 2 hours
2) 3.5 hours is 210 miles

Plotting graphs/functions

Use a xy table
x coordinates come from x axis on graph
y coordinates come from the equation

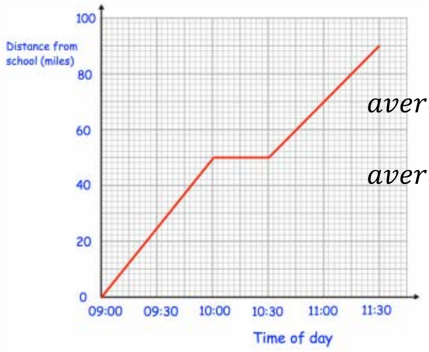
$$y = x^3$$

x	-2	-1	0	1	2
y	-8	-1	0	1	8



Distance time graphs

Graphs which describe a journey, straight line equals constant speed.
Horizontal line mean stationary (no speed)



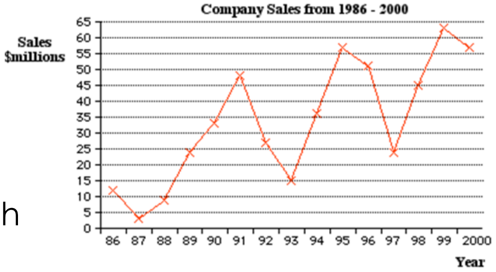
$$speed = \frac{distance}{time}$$

$$average\ speed = \frac{total\ distance}{total\ time}$$

$$average\ speed = \frac{90}{2.5} = 36mph$$

Time series graphs

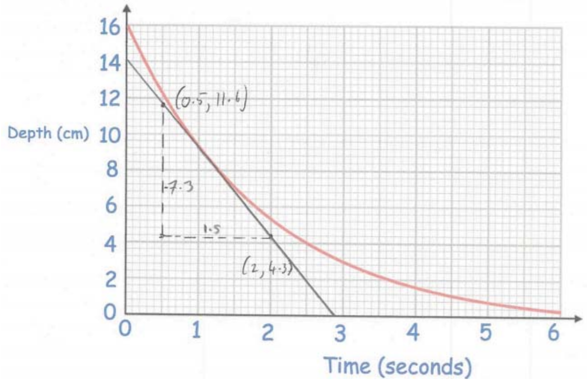
Graphs which show a period of time.



1999 had the most sales
1987 had the least sales
There was a general increase from 1886 to 200

Rates of change

When given a curved graph draw a line (tangent) at the point required. Then calculate the gradient



$$gradient \approx \frac{-7.3}{1.5} \approx -4.86 \ldots$$

$$\begin{array}{ccc} & 5n - 4 = 82 & \\ +\ 4 & & +\ 4 \\ & 5n = 86 & \\ \div\ 5 & & \div\ 5 \\ & n = 17.2 & \end{array}$$