



**GCSE Maths**  
**Revision notes**  
**2020/2021**

## Contents

Approximations .....	3
Rounding.....	3
Percentages .....	4
Fractions.....	4
Decimals.....	4
Changing Between.....	4
Percentages .....	4
Indices.....	6
The 6 Rules.....	6
Standard Form .....	6
Indices in Algebra .....	6
Sequences.....	7
nth term .....	7
Angles.....	8
Bearings Notes.....	8
Trigonometry.....	9
Pythagoras' Theorem .....	9
Measurement.....	11
Volume .....	11
Metric/Imperial.....	12
Lotus.....	13
Polygons and Circles .....	14
Special types of triangle .....	14
Transformations.....	16
Similar shapes .....	16
Graphs.....	17

Linear graphs.....	17
Quadratic graphs .....	17
Cubic and reciprocal graphs.....	17
Graphs of simultaneous equations.....	18
Inequalities - regions on a graph.....	18
Travel graphs .....	18
Algebra - Equations and Inequalities.....	20
Linear Equations .....	20
Quadratic Equations.....	20
Rearranging Formulae .....	20
Simultaneous Equations.....	21
Inequalities .....	21
Representing Data .....	22
Gathering data .....	22
Analysing Data .....	22
Pie charts .....	22
Cumulative Frequency .....	23
Scatter Diagrams .....	24
Probability .....	25
Simple probability .....	25
Experimental probability.....	25
The 'and' rule .....	25
Tree diagrams.....	25
Calculator .....	26
Brackets and Memory .....	26
Powers and Roots.....	26
Standard Form .....	26
Fractions.....	26

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## Approximations

### Rounding

Decimal Places - count from the decimal point

#### *Significant Figures*

1. Count from the first digit.
2. Don't count zeros unless they're in-between non-zero digits.

#### *Estimating*

1. Use one significant figure unless you can be more accurate and still do it in your head.

#### *Error*

1. Measurement is only approximate.
2. The real answer can be half the rounded unit either way.
3. We call them upper and lower bounds.

#### **Maximum values of calculations:**

1. Addition and Multiplication - use all upper bounds.
2. Subtraction and Division - first number upper bound, second number lower bound.

Vice versa for minimum values of calculations.

#### *Trial and Improvement*

1. Use tables to display guesses and answers. Say whether too high or too low!
2. Be methodical.
3. If you know which two numbers the answer is between try the middle and that will tell you which one it is closer to.

## Percentages

### Fractions

Basic skills: Cancelling, improper to mixed numbers, multiplying, dividing, adding, subtracting.

Always change mixed numbers to improper fractions before doing calculations!

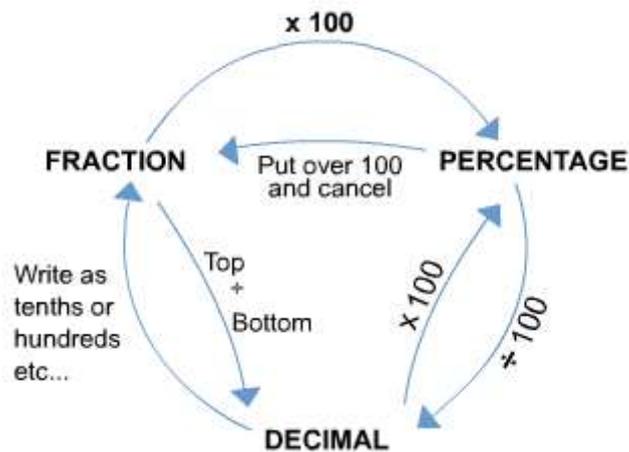
Finding fractions of quantities - multiply by the top, divide by the bottom.

Ratio - find the total number of parts before dividing.

### Decimals

Basic skills: Adding, subtracting, multiplying, dividing.

### Changing Between



## Percentages

**To write an amount as a percentage:**

$$\frac{\text{Amount}}{\text{Total}} \times 100$$

**Finding a percentage of a quantity:**

1. Change the % to a decimal (divide by 100).
2. Multiply by the original quantity.

**Increasing/decreasing a quantity by a percentage:**

1. Find new percentage after increase/decrease (100 - % increase/decrease).
2. Change it to a decimal (divide by 100).

3. Multiply by the original quantity.

**Compound interest:**

1. Add interest on to 100%.
2. Change to a decimal (divide by 100).
3. Multiply the original amount by this decimal for each year.

## Indices

### The 6 Rules

1. When you **multiply** powers of the same number you **add** the powers.
2. When you **divide** powers of the same number you **subtract** the powers.
3. When you put a power outside a bracket you **multiply** the powers.
4. **Negative** powers mean **reciprocal** or 'one over.....'
5. When the power is a **fraction** the top of the fraction is a **power** and the bottom of the fraction is a **root**.
6. Anything to the power of **zero** is simply equal to **1**.

### Standard Form

Any number can be written in the form  $a \times 10^n$  where **a** is a number between **1 and 10** and **b** is an **integer**.

### Indices in Algebra

Algebraic fractions can be **simplified** by following Rule 2 of Indices and taking the powers on the bottom away from the powers on the top or, in other words, **cancelling the powers**.

## Sequences

### nth term

$$\text{nth term} = dn + (a - d)$$

where **d** is the difference and **a** is the first term.

If the second difference is constant (and first difference changes),

$$\text{nth term} = a + (n - 1)d + \frac{1}{2}(n - 1)(n - 2)c$$

where **a** is the first term, **d** is the difference between the first and second terms and **c** is the **second difference**.

#### Alternatively:

1. If the first difference keeps changing but the second difference is constant then the formula is something to do with ' $n^2$ '. Make a table showing the first few terms of ' $n^2$ '.
2. In the next column of your table write the differences between the term of ' $n^2$ ' and your sequence.
3. Find the formula for **this** new sequence using  **$dn + (a - d)$**
4. Add it on to  $n^2$  to give you your final formula

#### Well-known sequences

Sequence	Name	nth term
2,4,6,8,...	Even numbers	$2n$
1,3,5,7,...	Odd numbers	$2n - 1$
1,4,9,16,25,...	Square numbers	$n^2$
1,8,27,64,125,...	Cube numbers	$n^3$
1,3,6,10,15,...	Triange numbers	$\frac{1}{2}n(n + 1)$
2,3,5,7,11,13,...	Prime numbers	Not known

1,1,2,3,5,8,13,... Fibonacci numbers Not needed

## Angles

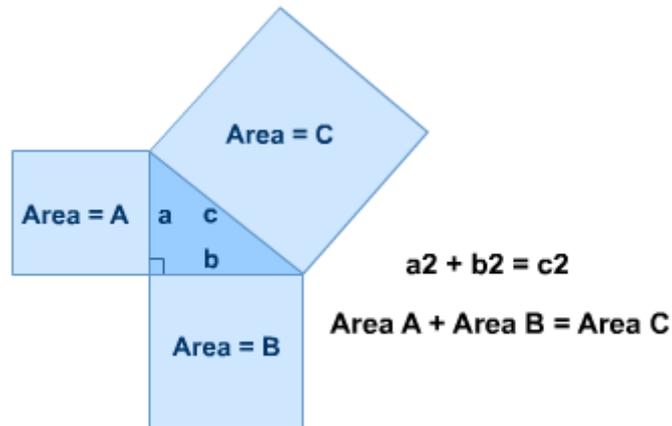
Types of Angles	What they do...
Round a point	Add up to $360^\circ$
On a straight line	Add up to $180^\circ$
Vertically Opposite	Equal
In a triangle	Add up to $180^\circ$
In a quadrilateral (4-sided polygon)	Add up to $360^\circ$
Alternate (Z-angles)	Equal
Corresponding (F-angles)	Equal
Supplementary (C or U angles)	Add up to $180^\circ$

## Bearings Notes

1. Always use three figures.
2. Always draw North lines.
3. Always measure from North being  $0^\circ$ .
4. Always measure clockwise.
5. Always put in pencil lines connecting the points and don't rub them out at the end.
6. Always put your protractor on the place you're measuring **from** and not to.
7. Be as accurate as your can (sharp pencil, lean over diagram!).

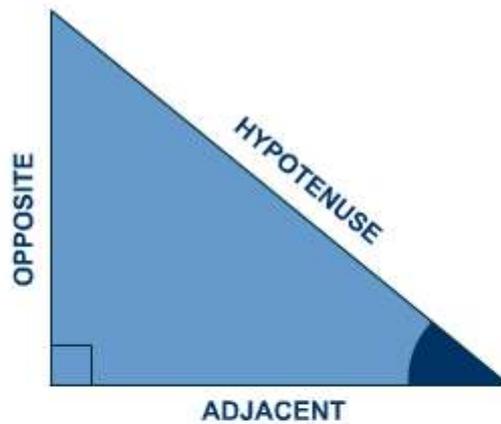
## Trigonometry

### Pythagoras' Theorem



*Note:* Don't forget to **square-root!**

Sin, Cos, Tan



$$\sin x = \frac{\text{OPPOSITE}}{\text{HYPOTENUSE}}$$

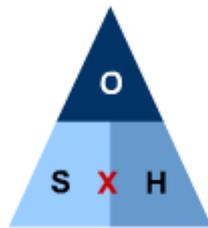
$$\cos x = \frac{\text{ADJACENT}}{\text{HYPOTENUSE}}$$

$$\tan x = \frac{\text{OPPOSITE}}{\text{ADJACENT}}$$

Notes:

1. Ways to remember:

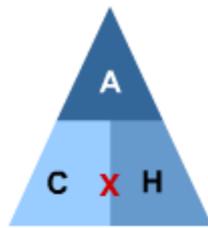
- SOH-CAH-TOA
- Silly Old Horses Chase After Hens That Offer Advice
- Formula Triangles



$$\sin x = \frac{\text{opp}}{\text{hyp}}$$

$$\text{opp} = \sin x \times \text{hyp}$$

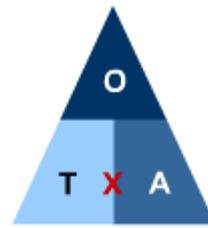
$$\text{HYP} = \frac{\text{opp}}{\sin x}$$



$$\cos x = \frac{\text{adj}}{\text{hyp}}$$

$$\text{adj} = \cos x \times \text{hyp}$$

$$\text{HYP} = \frac{\text{adj}}{\cos x}$$



$$\tan x = \frac{\text{opp}}{\text{adj}}$$

$$\text{opp} = \tan x \times \text{adj}$$

$$\text{ADJ} = \frac{\text{opp}}{\tan x}$$

2. Sin, Cos and Tan are always with an angle.

3. If you're looking for an angle you need to use the **inverses** -  $\sin^{-1}$ ,  $\cos^{-1}$ ,  $\tan^{-1}$ ,

## Measurement

Shape:

Area:

**Square**

Length x Length

**Rectangle**

Length x Width

**Triangle**

$\frac{1}{2}$  x Base x Perpendicular Height

**Parallelogram**

Base x Perpendicular Height

**Trapezium**

Average of parallel sides x distance between them

**Cylinder (curved surface)**  $2\pi rh$

**Cone (curved surface)**  $\pi rl$

**Sphere (surface area)**  $4\pi r^2$

## Volume

**Cube** Length<sup>3</sup>

**Cuboid** Length x Width x Height

**Prism** Area of cross-section x Length

**Cylinder**  $\pi r^2h$

**Sphere**  $\frac{4}{3}\pi r^3$

**Cone**  $\frac{1}{3}\pi r^2h$

**Dimensions:** note that the area formulae all have a length squared in them and the volume formulae all have a length cubed. Constants (numbers) have no dimensions.

*Remember:* Measurement is only approximate. It can be up to half the rounded unit up or down!

## Metric/Imperial

- 1cm = 10mm
- 1m = 100cm
- 1km = 1000m
- 1kg = 1000g
- 1 tonne = 1000kg
- 1 litre = 1000ml = 1000cm<sup>3</sup>

*Note:* Although 1m = 100cm, remember 1m<sup>2</sup> = 10,000cm<sup>2</sup> and 1m<sup>3</sup> = 1,000,000cm<sup>3</sup>

- 1 foot = 12 inches
- 1 yard = 3 feet
- 1 mile = 1760 yards
- 1 pound = 16 ounces
- 1 stone = 14 pounds
- 1 ton = 160 stones (or 2240 pounds)

Note the different spellings of tonne (metric) and ton (imperial).

- 1 gallon = 8 pints

*Kilometres and Miles:*

- km to miles - Multiply by 5 and divide by 8
- miles to km - Multiply by 8 and divide by 5

*Kilometres and Pounds:*

- 1kg = 2.2 pounds
- 1 pound = 0.454kg
- So basically there's about 2 pounds in a kilogram

*Litres, Pints and Gallons:*

- 1 pint is about half a litre (1 pint = 0.568 litres)
- 1 litre = 0.22 gallons

*Metres, Centimetres, Feet and Inches:*

1 inch is about 2.5cm so a 30cm ruler is about 12 inches (which is a foot!)

1 metre is about 40 inches which is just over 3 feet so 1 metre is slightly bigger than 1 yard!

## **Lotus**

A **locus** is simply a set of points that satisfy some sort of condition.

*Distance from a point*

A circle around the point!

*Distance from two points*

**A perpendicular line straight down the middle of the points:**

1. Set your compasses so that they are **roughly** the same as the distance between the points (or less if you don't have a lot of room!).
2. Put the point of the compasses on the first cross and do two arcs - one above the points and one below.
3. Put the point on the second cross and do the same thing so that you cross the first arcs (making sure you keep the compasses the same distance apart).
4. Now simply draw a line straight down the middle through the points where the arcs cross.

*Distance from two lines*

**The set of points that are the same distance from two lines is a straight line down the middle which bisects the angle (cuts it in half):**

1. Get a pair of compasses and place the point where the two lines meet. Draw little arcs that cross each of the lines.
2. Now, keeping the compasses set, put the point on each line where your arc has crossed it and draw another little arc in-between the two lines. You should now have another two little arcs in the middle.
3. Draw a straight line from the angle through the point where your little arcs cross and you've done it!

## Polygons and Circles

For a regular polygon with 'n' sides:

**External angle =  $360/n$**

For a regular polygon with 'n' sides:

**Internal angle =  $180 - 360/n$**

Polygon:	Number of sides:	External angles:	Internal angles:
Triangle	3	120	60
Square	4	90	90
Pentagon	5	72	108
Hexagon	6	60	120
Heptagon	7	51.4	128.6
Octagon	8	45	135
Nonagon	9	40	140
Decagon	10	36	144
Undecagon	11	32.7	147.3
Dodecagon	12	30	150

### Special types of triangle

*Sides:*

**Equilateral** - All 3 sides equal and all 3 angles equal (to  $60^\circ$ ).

**Isosceles** - Two sides the same and the angles at the bottom of those sides are equal.

**Scalene** - No sides or angles equal.

*Angles:*

**Acute-angled** - All angles are acute (less than  $90^\circ$ ).

**Right-angled** - One angle is  $90^\circ$ .

**Obtuse-angled** - One angle is obtuse (greater than  $90^\circ$ ).

*Quadrilaterals:*

**Square** - All sides equal, all angles  $90^\circ$ , 4 lines of symmetry, rotation symmetry of order 4.

**Rectangle** - Two pairs of equal and parallel sides, all angles  $90^\circ$ , two lines of symmetry, rotation symmetry of order 2.

**Rhombus** - All sides equal, opposite sides parallel, two lines of symmetry, rotation symmetry of order 2. (Basically a square leaning over. Sometimes referred to as a diamond!)

**Parallelogram** - Two pairs of equal and parallel sides, opposite angles equal, no lines of symmetry, rotation symmetry of order 2. (Basically a rectangle leaning over.)

**Trapezium** - One pair of parallel sides, no symmetry.

**Kite** - Two pairs of equal sides next to each other, one line of symmetry, no rotation symmetry, string (only joking!).

*Circles*

Circumference =  $2\pi r$

**Or, if you want to use the diameter:**

Circumference =  $\pi d$

Area =  $\pi r^2$

## Transformations

There are 4 types of transformation:

1. **Reflection** - mirror line.
2. **Rotation** - angle, direction, centre.
3. **Enlargement** - scale factor, centre.
4. **Translation** - vector.

*Remember:* whatever you are doing, move the shape point by point!

### Similar shapes

Similar shapes are enlargements of one another.

$$\text{Scale Factor} = \frac{\text{New Length}}{\text{Old Length}}$$

In enlargements, **angles don't change!**

## Graphs

### Linear graphs

Linear functions can be written in the form  $y = mx + c$  where  $y$  and  $x$  are variables and  $m$  and  $c$  are constants (numbers).

If you write them like this then  $m$  is the **gradient** and  $c$  is the **y-intercept** (point where it crosses the y-axis). The graphs of linear functions are **straight lines**.

#### To find $m$ :

Pick any two points.

$$m = \frac{\text{change in y-values}}{\text{change in x-values}}$$

#### To find $c$ :

$c$  is the point where the graph crosses the y-axis.

### Quadratic graphs

Quadratic functions can be written in the form:

$$y = ax^2 + bx + c$$

where  $a$ ,  $b$  and  $c$  are constants and ' $a$ ' doesn't equal zero.

Quadratic graphs are always **parabolas** ('U' shapes).

The really important bits of a quadratic are:

**Where it turns (the bottom of the 'U')**

**Where it crosses the x-axis (if it does!)**

The solutions of a quadratic are where the graph crosses the x-axis!

### Cubic and reciprocal graphs

#### You need to be able to:

1. Plot and draw these.
2. Recognise the shapes.
3. Read the solutions from the graph (cubics only).

*Cubics* can be written in the form:

$$y = ax^3 + bx^2 + cx + d$$

*Reciprocals* are where the x is on the bottom of a fraction.

Drawing their graphs - **Table - Axes - Plot - Draw - Label**

The *solutions* of a cubic are where it crosses the x-axis and it can have up to 3.

## Graphs of simultaneous equations

As simultaneous equations at GCSE are **linear** (can both be written in the form  $y = mx + c$ ) their graphs will be straight lines.

The solution (x-value and y-value) is where the straight lines intersect (cross one another).

## Inequalities - regions on a graph

**To draw a graph:**

1. Change the inequality sign to an '=' sign.
2. By choosing 4 or 5 different values for x, make a table of co-ordinates.
3. Draw and label the line (make it dotted if the inequality sign is < or >).
4. Choose a test point (not on the line!).
5. Put the x and y values of the test point into the inequality.
6. If it works, shade and label that side of the line with the inequality.
7. If it doesn't work, shade and label the other side.

## Travel graphs

*Distance/time*

If you show a graph of a journey showing distance travelled (on the y-axis) against time (on the x-axis):

- The **gradient** (or slope) of the graph represents the **speed**.
- A horizontal section indicates that you have stopped.
- A section sloping up means that you are going away.
- A section sloping down means you are coming back.
- The steeper the line, the faster you are going.

*Speed/time*

- The **gradient** (or slope) of the graph represents the **acceleration**.
- The **area** under the graph (for any section) is the **distance travelled** (in that section).
- A horizontal section indicates constant speed (no acceleration).
- A section sloping up means accelerating.
- A section sloping down means slowing down.

- The steeper the line, the quicker the acceleration.

## Algebra - Equations and Inequalities

### Linear Equations

*Golden Rule:* You must always do the same thing to both sides.

Try following our simple steps to solve any linear equation:

1. Get rid of any brackets by multiplying out.
2. Get rid of any fractions by multiplying **all terms** by the denominator.
3. Rearrange by collecting letters on one side and numbers on the other. Remember that every term has its own sign in front of it. Negative terms need to be added to both sides to get rid of them.
4. Divide both sides by the number in front of the variable.

### Quadratic Equations

*Factorising*

You need to find a number to go in each bracket. Use the following conditions to find the two numbers you need:

1. They must **multiply** to give 'c'.
2. They must **add** to give 'b'.
3. If 'c' is positive both numbers must have the same sign (both positive or both negative). If 'c' is negative then the numbers must be of opposite sign.

There's no magic solution. You just need to **practise, practise, practise!**

Then, as the brackets multiply to give zero **one of the brackets must be zero!**

**This gives you your solution(s).** (Quadratics will either have 0, 1 or 2 solutions).

*The Quadratic Formula*

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

If  $b^2 - 4ac$  is **positive**, there are **two** solutions.

If  $b^2 - 4ac$  is **zero**, there is **one** solution.

If  $b^2 - 4ac$  is **negative**, there are **no** solutions.

### Rearranging Formulae

1. Get rid of any square roots by squaring both sides.

2. Get rid of any brackets by multiplying out.
3. Get rid of any fractions by multiplying **all terms** by the denominator.
4. Rearrange by collecting the letter you want on one side and everything else on the other. Remember that every term has its own sign in front of it. Negative terms need to be added to both sides to get rid of them.
5. Factorise the side your variable is on so there is only one of it.
6. Divide both sides by whatever the variable is multiplied by.

## Simultaneous Equations

7. Rewrite both equations in the form  $ax + by = c$
8. Match up the number of Xs or Ys in both equations by multiplying one (or both!) of the equations.
9. Merge the equations by adding them together or subtracting them. *Tip!* If the amount of the variable you have matched up is the **same sign** then **subtract**. If the amount of the variable is **opposite signs** (one positive and one negative) then **add**.
10. Solve the resulting linear equation.
11. Substitute your answer into one of the original equations to find the value of the other variable.
12. Put both answers into the **other** original equation to check they work.
13. **Celebrate!**

## Inequalities

- < means 'is less than'
- > means 'is greater than'
- $\leq$  means 'is less than or equal to'
- $\geq$  means 'is greater than or equal to'

You can solve them in exactly the same way you solve linear equations with one extra rule that it is very important to remember!

*If you multiply or divide the terms in an inequality by a negative number the inequality sign swaps round.*

## Representing Data

### Gathering data

There are two types of number data: **Discrete** and **Continuous**.

**Discrete** data can only take specific values and not the values in-between.

**Continuous** data can take any value within your range of accuracy.

*Questionnaires*

1. Questions must be specific.
2. Questions must not be leading.

### Analysing Data

**Always rearrange the data in ascending order!**

Then learn these definitions:

**Mean** is the total of all the items divided by the number of items.

**Median** is the middle value.

**Mode** is the most common value.

**Range** is the difference between the smallest and the biggest value.

*Comparing two sets of data*

Either compare **their means and their ranges** or **their medians and their ranges**.

*Grouped data*

**Mean** - assume all the items in a group take the **mid-point** of the group so for each group you do **mid-point x frequency**. Add them all up and divide by the **Total Frequency**.

**Median** - you cannot find the median, only the group that it is in.

**Modal group** - the group with the highest frequency.

### Pie charts

*Making Pie Charts*

**To work out the angle needed for each section:**

$$\text{Angle} = \frac{\text{Frequency}}{\text{Total Frequency}} \times 360$$

*Reading Pie Charts*

**To find out the frequency that each section represents, measure the angle for the section then:**

$$\text{Frequency} = \frac{\text{Angle}}{360} \times \text{Total Frequency}$$

*Frequency Diagrams*

These are sometimes called **bar charts**.

These are a good way of looking at the **spread** of data and are very easy to draw.

*Line Graphs*

Line Graphs are only used for discrete data and are simply a line (instead of a bar) for each data value showing total frequency.

*Frequency Polygons*

Again, these are done in the same way as Frequency Diagrams but you do not draw the bars.

Instead you put a little cross where the middle of the bar would have been then join all the crosses together.

## Cumulative Frequency

*Key Points*

1. Cumulative frequency simply means adding the frequencies up as you go along.
2. When plotting the graph, always plot points using the **upper value** of each group.
3. Cumulative frequency is always plotted on the vertical axis (up the side) and the range of data goes across the bottom.
4. The shape of a cumulative frequency curve looks like a 'stretched S' and is called an **ogive**.

The more 'stretched-out' the 'S' is the more spread out the data is. An 'S' with a very steep middle section indicates the data being tightly grouped around the median.

1. **Median** - go halfway up the cumulative frequency axis, read across and down then read the median from the **bottom scale**.

2. **Lower Quartile** - go a quarter of the way up the cumulative frequency axis, read across and down then read the Lower Quartile from the **bottom scale**.
3. **Upper Quartile** - go three-quarters of the way up the cumulative frequency axis, read across and down then read the Upper Quartile from the **bottom scale**.
4. **Inter-Quartile Range** - the difference between the Lower Quartile and the Upper Quartile.

## Scatter Diagrams

Simply plot crosses on a graph for the two things you are looking at.

If the data follows a 'trend' or '**correlation**' we can draw a **line of best fit** showing the general slope of the data.

You can then get further information from the graph by using your line of best fit.

# Probability

## Simple probability

1. We call 'something happening' an **event**. For example, getting a 6 with the roll of a dice.
2. Probability should always be written as a **fraction, decimal or percentage**, never '1 in 10' or '3 chances out of 5'.
3. The probability of something happening must be between 0 and 1 (unless you are using percentage - 0 to 100).
4. The sum of the probabilities of every possible outcome is 1.
5. The probability of something **not happening** is 1 minus the probability of it happening.

If we call a particular event 'A' then:

$$p(A) = \frac{\text{number of different ways A can happen}}{\text{Total number of outcomes}}$$

$$p(\text{not A}) = 1 - p(A)$$

## Experimental probability

If you can do something a certain number of times and record the results you can write down **estimates** for the probabilities of each outcome.

These estimates are also known as **Relative Frequencies**.

## The 'and' rule

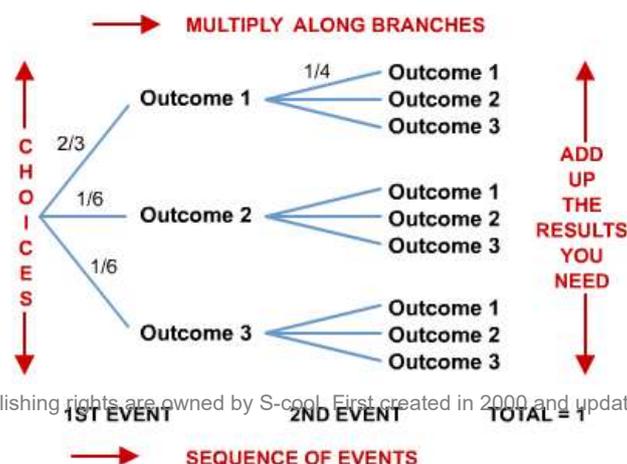
If you want one outcome **or** another outcome then you **add their probabilities together**.

*For example:*

For two events A and B,  $p(A \text{ or } B) = p(A) + p(B)$

The two events must be 'mutually exclusive'

## Tree diagrams



## Calculator

### Brackets and Memory

Your calculator operates what we call **BODMAS**:

- **B**rackets
- **O**f
- **D**ivision
- **M**ultiplication
- **A**ddition
- **S**ubtraction

This is the order it will do operations in. **So be careful!**

**The way you can avoid any mistakes is by:**

1. Using the Memory.
2. Using the Bracket buttons.
3. Pressing the '=' sign after each operation.

### Powers and Roots

$$\boxed{x^y} \quad \text{or} \quad \boxed{y^x} \quad \text{or} \quad \boxed{\wedge}$$

$$2^6 \longrightarrow \boxed{2} \quad \boxed{x^y} \quad \boxed{6} \quad \boxed{=}$$

### Standard Form

Your calculator **Standard Form** buttons will probably say EXP or EE. If you can't find this, have a look at your instruction book.

Remember: your calculator may not show the 'x 10' bit on the screen. The power of 10 is usually a 2-digit number on the far top right.

However, when you write the answers down you must write them in full including the 'x 10' bit!

### Fractions

As you probably know, fractions are divisions and you can do them on your calculator by using the divide button.

However, your calculator will then work in decimals which are sometimes not as accurate and, anyway, we might need to write the answer as a fraction.



Learn how to use your calculator fraction buttons and what the fractions look like on your screen. Above all, **don't forget to take your calculator with you to your exam!!!**



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