DEC! MATHS *explained*

with

Drummond
COMMUNITY HIGH SCHOOL

design...
engineer...
construct!

classofyourown®

WELCOME

Here at Class Of Your Own, we're big believers in the value of applied mathematics. Young people often ask "When will I use this formula or equation?", and it's often hard to explain in the context of the world of work. This guide aims to support teachers in helping their students to understand and apply the mathematics involved in the Design Engineer Construct! Learning Programme, mapped to the Level 1 syllabus.

The methods of teaching maths outlined in this guide are as those taught in secondary schools in Scotland, however they are universally applicable and so should be familiar to all students, wherever they are.

DEC! is relevant, challenging, engaging, rewarding and definitely lots of fun. It offers a great way of making maths purposeful and accessible to a wide range of students. DEC! gives all students the chance to develop a love of maths, by discovering it's all around every room, building and bridge that they design, engineer and construct.

We think we've covered and explained all the aspects you will need to bring learning to life in your DEC! classroom.

Have fun ☺

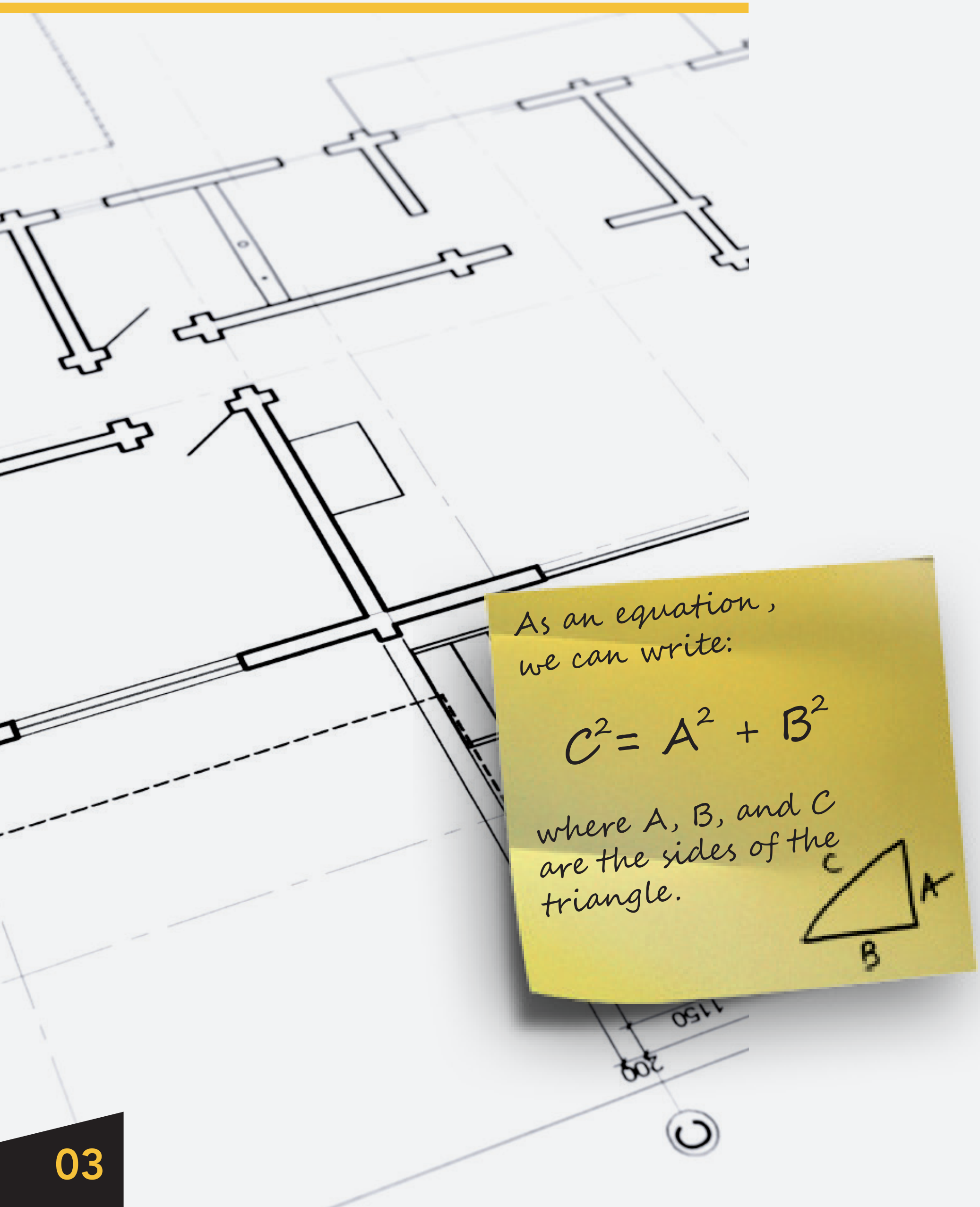
Drummond COMMUNITY HIGH SCHOOL

Super smashing teachers, Mr Holden (DEC!) and Mr Steele (Maths) of Drummond High School in Edinburgh, have done a fantastic job in mapping the Maths of DEC! and helping us to produce this guide. Gentlemen, on behalf of Class Of Your Own and DEC! teachers everywhere, a HUGE thank you for your brilliant efforts.

TOPCON

With sincere and grateful thanks to Topcon GB Limited, our friends and long time supporters of the Design Engineer Construct! Learning Programme, who kindly sponsored this excellent teaching resource.

CONTENTS

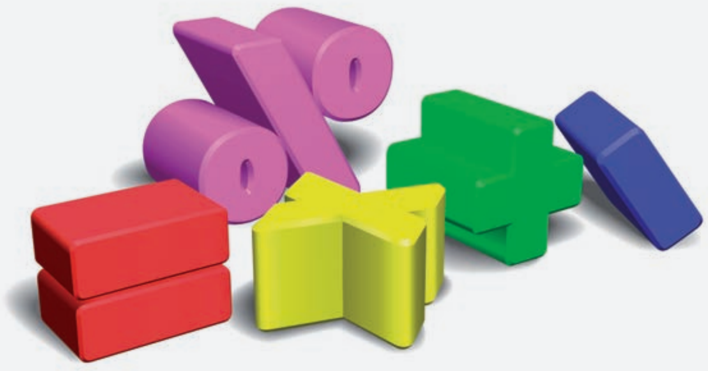


THE BASICS

DEC! SPECIFIC SKILLS

AREA

THE BASICS



We're all probably pretty confident in our adding ability, but we've included the first four basic topics for a few reasons:

1 **There are a range of methods that students can use, and are encouraged to use, in order to carry out these basic functions.**

We've tried to explain these so that:

a) we all understand each other
b) we can offer these methods to students who maybe need to try a different approach

2 **"Champions are brilliant at the basics" - John Wooden.**

Ok - this is a quote from a sports coach but it applies universally. Before we get onto some of the more complex maths later on, it pays to get the basics right. Everything you need should be here.

3 **Things have changed.**

There are more than a few things in here that have changed since this teacher recited his times tables.

It's useful for us to understand how students are approaching problems, so that we can support them in ways they can relate to.

Addition

Mental Methods

There are a number of mental strategies that pupils can use for addition. The same strategies can be used for whole numbers and decimals.

Example: Add 46 + 37

Method 1
'Decompose' terms into tens and units

40 + 30 = 70   6 + 7 = 13   70 + 13 = **83**

Method 2
Remove an 'ending' and complete a simpler calculation first, then add the ending back in

46 + 30 = 76   76 + 7 = **83**

Method 3
'Round off' the addition, then adjust at the end

46 + 40 = 86   86 – 3 = **83**

Written Methods

Pupils should be encouraged to lay working out like this:

Example 1: 2475 + 618

```
  2 4 7 5
+   6 1 8
  1   1
---------
  3 0 9 3
---------
```

Numbers are carried into the next column of numbers

Example 2: 13.6 + 2.9 + 7.7

```
  1 3 . 6
    2 . 9
+   7 . 7
  1 2
---------
  2 4 . 2
---------
```

Decimal points are in a line

Subtraction

PUPILS SHOULD EXCHANGE TENS FOR UNITS, HUNDREDS FOR TENS, ETC

Mental Methods

When considering subtraction, it is important that pupils understand the connection to addition.

Example: Calculate 135 - 58

Method 1

'Decomposing' terms into tens and units

135 - 50 = 85   85 - 8 = **77**

Method 2

'Counting on'

58 + ? = 135

58 → 60 → 100 → 135
(+2, +40, +35)

2 + 40 +35 = **77**

Written Methods

Example 1: 2485 - 638

```
 1     7
 2̶ ¹4  8̶ ¹5
 -  6  3  8
 ----------
 1  8  4  7
 ----------
```

Numbers are exchanged for ten in the lower column of numbers

In this example 8 tens becomes 7 tens and 10 units as 80 = 70+10

Example 2: 20.7 - 8.9

```
 1  9
 2̶ ¹0̶ .¹7
 -  8 . 9
 ---------
 1  1 . 8
 ---------
```

If there is a zero, an exchange to make in into a ten is required - it can then exchange with the lower column

Multiplication by single digit

Pupils should be encouraged to know all of their times tables from 1 to 10.

Example 1: 725 x 6

```
    7  2  5
       x  6
 4  1  3
 ----------
 4  3  5  0
 ----------
```

Numbers are carried into the column to the left and added after the next multiplication

Example 2: 29.6 x 3

```
 2 9 . 6
     x 3
  2  1
 --------
 8 8 . 8
 --------
```

Decimal points are in a line

Division by single digit

Example 1: 2592 ÷ 8

$$\begin{array}{r} 3\;2\;4 \\ 8\,\overline{)\,2\;{}^{2}5\;{}^{1}9\;{}^{3}2} \end{array}$$

Remainders are placed into the column to the right

Example 2: 15.3 ÷ 6

$$\begin{array}{r} 2\,.\;5\;5 \\ 6\,\overline{)\,1{}^{1}5\,.{}^{3}3{}^{3}0} \end{array}$$

Pupils should put zeros at the end if the number does not divide exactly - a remainder should not be left

Multiplication by double (or more) digits

Method 1

Using the distributive law

Example: 126 x 32

Numbers are decomposed into their hundreds, tens and units etc.

100	20	6	
3000 (100 x 30)	600 (20 x 30)	180 (6 x 30)	30
200 (100 x 2)	40 (20 x 2)	12 (6 x 2)	2

Then add each part

```
  3 0 0 0
    6 0 0
    1 8 0
    2 0 0
      4 0
  +   1 2
  -------
  4 0 3 2
```

Method 2

Long multiplication

```
        4 3
      x 7 5
      -----
      2 1 5    ← 1 - multiply 43 x 5
  + 3 0 1 0    ← 2 - place a zero here as we are multiplying by 70
  ---------
    3 2 2 5    ← 4 - multiply the two answers
```

3 - multiply 43 x 7 (→ 3 0 1)

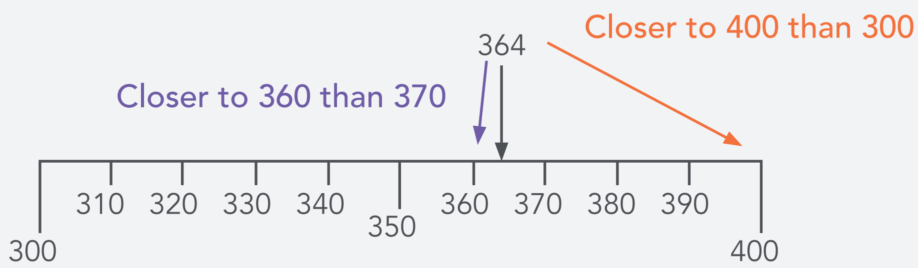
1 - multiply 43 x 5

2 - place a zero here as we are multiplying by 70

4 - multiply the two answers

Estimation and Rounding

Numbers can be rounded to give an approximate answer. Pupils are encouraged to think about a number line.



364 rounded to the nearest 100 is 400.

364 rounded to the nearest 10 is 360.

Look at the digit **after** the place you would like the number rounded. This will show what it is nearer on the number line:

- 5 or more, round up to the next number
- 4 or less, round back to the last number

Example 1: To the nearest hundred

a) 256.8 → 300

b) 3487 → 3500

Example 2: To the nearest whole number

a) 84.271→ 84

b) 29.9524198 → 30

Example 3: To one decimal place

a) 298.76 → 298.8

b) 24.5555555 → 24.6

UNLESS OTHERWISE STATED, PUPILS SHOULD ONLY ROUND A FINAL ANSWER

The **highlighted digits** are the important digits. They will allow the pupil to identify whether to round up or down. Any digits after this can be ignored.

Multiplying or Dividing by 10, 100, 1000 etc.

REMEMBER

- Pupils should be taught that **the numbers move**, not the decimal point
- Pupils should **not** be told to "add a zero"

To multiply by 10, move every digit one place to the left.

To multiply by 100, move every digit two places to the left.

To divide by 10, move every digit one place to the right.

To divide by 100, move every digit two places to the right.

Example 1:
54 x 100 = **5400**

Th	H	T	U
		5	4
5	**4**	**0**	**0**

Example 2:
2.54 x 10 = **25.4**

T	U	.	t	h
	2	.	5	4
2	**5**	**.**	**4**	

Example 3:
720 ÷ 10 = **72**

H	T	U
7	2	0
	7	**2**

Example 4:
954.3 ÷ 100 = **9.543**

H	T	U	.	t	h	th
9	5	4	.	3		
		9	**.**	**5**	**4**	**3**

The following metric measurements can then be investigated:

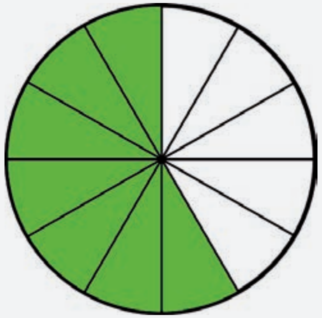
Mass	**Length**	**Volume**
1kg = 1000g	1km = 1000m	1 litre = 1000ml
	1m = 1000mm	1ml = 1cm^3

Fractions

$\frac{a}{b}$

a ← Number of equal parts required (numerator)

b ← Total number of equal parts in a whole (denominator)



Writing a Fraction

Example:

7 out of 12 equal parts are shaded.

Therefore $\frac{7}{12}$ of this shape is shaded.

Fractions of a Quantity

Pupils should split a number into the total number of parts (divide) then calculate the number of parts they require (multiply).

Example 1:

Find of $\frac{1}{8}$ 256

$\frac{1}{8}$ is 256 ÷ 8 = **32**

Example 2:

Find $\frac{4}{7}$ of 36.4

$\frac{1}{7}$ is 36.4 ÷ 7 = **5.2**

$\frac{4}{7}$ are 5.2 x 4 = **20.8**

Simplifying Fractions

It is often necessary to simplify a fraction to make the numbers easier to work with.

To simplify a fraction, divide the numerator and denominator of the fraction by the same number.

Example 1:

Simplify $\frac{7}{14}$

$$\frac{7}{14} \div \frac{7}{7} = \mathbf{\frac{1}{2}}$$

Example 2:

Simplify $\frac{160}{200}$

$$\frac{160}{200} \div \frac{10}{10} = \frac{16}{20} \div \frac{4}{4} = \mathbf{\frac{4}{5}}$$

Percentages

Fractions and Percentages

Percent means "out of 100". This can be used to convert a percentage to an equivalent fraction (or decimal).

PUPILS ARE ENCOURAGED TO USE EQUIVALENT FRACTIONS AND PERCENTAGES TO HELP THEM WITH CALCULATIONS

$10\% = \frac{1}{10}$

$1\% = \frac{1}{100}$

$25\% = \frac{1}{4}$

$33\frac{1}{3}\% = \frac{1}{3}$

$50\% = \frac{1}{2}$

$20\% = \frac{1}{5}$

$75\% = \frac{3}{4}$

$66\frac{2}{3}\% = \frac{2}{3}$

To change any fraction to a percentage, divide numerator by denominator and then multiply by 100.

Example 1

Will got $\frac{33}{40}$ in a test. Write this as a percentage.

$\frac{33}{40} = 33 \div 40 = 0.825 = \mathbf{82.5\%}$

divide numerator by denominator

multiply by 100 to get percentage

Example 2

A ruler is bought for 60p and sold for 75p.
Calculate the percentage increase.

75 – 60 = 15p

$\frac{15}{60} = 15 \div 60 = 0.25 =$ **25% increase**

Percentages: without a calculator

Pupils should calculate 10% or 50% first:

$10\% = \frac{1}{10}$ → divide by 10

$50\% = \frac{1}{2}$ → divide by 2

These can then be used to calculate other percentages

Example 1

Find 30% of £240

10% → 240 ÷ 10 = 24
30% → 24 x 3 = **£72**

Example 2

Find 5% of 180kg

10% → 180 ÷ 10 = 18
5% → 18 ÷ 2 = **9kg**

Example 3

Find 25% of 6m

50% → 6 ÷ 2 = 3
25% → 3 ÷ 2 = **1.5m**

Example 4

Find 60% of $42

50% → 42 ÷ 2 = 21
10% → 42 ÷ 10 = 4.2
60% → 21 + 4.2 = **$25.20**

Percentages: with a calculator

Pupils are encouraged to convert the percentages to decimals, but other methods are suitable.

Example 1

Find 40% of £280

0.4 x 280 = **£112**

Example 2

Find 27% of 1920kg

0.27 x 1920 = **518.4kg**

Alternative Method 1:
Writing percentage as a fraction

$\frac{40}{100}$ x 280 = **£112**

$\frac{27}{100}$ x 1920 = **518.4kg**

Alternative Method 2:
Finding 1% first

280 ÷ 100 x 40 = **£112**

1920 ÷ 100 x 27 = **518.4kg**

Increase or Decrease by a Percentage

Pupils often need to calculate an increase or a decrease by a certain percentage.

Again, they are encouraged to write the increase or decrease as a percentage which can be turned into a single decimal, called the 'multiplier:

Think of the original amount as 100%

Increase → 'Multiplier' more than 1 (1·…)
An increase will give us more than 100%

Decrease → 'Multiplier' less than 1 (0·…)
A decrease will give us less than 100%

Examples:
12% increase → 100 + 12 = 112% = **1·12**
3.6% increase → 100 + 3.6 = 103.6% = **1·036**
24% decrease → 100 - 24 = 76% = **0·76**
4.5% decrease → 100 - 4·5 = 95.5% = **0·955**

This 'multiplier' can then be used within the context of a question.

Example 1

A house was bought for £150,000. It increases in value by 5% in the next year. How much is it now worth after a year?

5% increase → 100 + 5 = 105% = 1.05

New value = 1.05 x 150000 = **£157,500**

We are trying to find 105% of what we started with

Example 2

Car insurance has reduced by 13.5% this year?
If it cost £260 last year, what does it cost this year?

13.5% decrease → 100 – 13.5 = 86.5% = 0.865

New value = 0.865 x 260 = **£224·90**

We are trying to find 86.5% of what we started with

Ratio

Ratios are very closely related to fractions. They show how two quantities are compared. They can be simplified like fractions to make the numbers easier to work with.

Example:

There are 20 apples and 15 oranges in a fruit bowl. Write this relationship as a ratio in its simplest form.

Apples : Oranges

(÷5) 20 : 15 (÷5)

4 : 3

It is often useful to draw a simple picture to show the relationship and solve problems...

Example 1:

The ratio of male to female teachers in a school is 2:3

If there are 28 male teachers in the school, how many female teachers are there?

← 28 →

M	M	F	F	F

2 + 3 = **5 shares**

This means that 2/5 of the teachers are male and 3/5 of the teachers are female

One share = 28 ÷ 2 = 14

Female teachers = 3 x 14 = **42**

Example 2:

The ratio of boys to girls in a class is 5:3

If there are 24 pupils in the class, how many are boys and how many are girls?

5 + 3 = **8 shares**

← 24 →

B	B	B	B	B	G	G	G

This means that 5/8 of class of are boys and 3/8 of the class are girls

One share = 24 ÷ 8 = 3

Boys = 5 x 3 = **15**   Girls = 3 x 3 = **9**

Ratio: Working to scale

Classroom Plan

Task 1

Using the table, convert the size of the objects using a scale of 1 : 25

(1mm on the plan is the same as 25mm in real life).

The first has been done for you:
9000 ÷ 25 = 360; 7000 ÷ 25 = 280

Task 2

Draw each scale object onto squared paper.

	Real		Scale Drawing	
Object	Length (mm)	Breadth (mm)	Length (mm)	Breadth (mm)
Room	9000	7000	360	280
Door	800	50		
Windows (x5)	650	50		
Whiteboard	3300	150		
SmartBoard	1300	100		
Small Radiators (x2)	900	150		
Large Radiators (x2)	2500	150		
Side desk	5500	750		
Hooks	600	100		
Pupil desks (x18)	1200	600		
Teacher desk	1600	800		
Small desks (x2)	600	600		
Overflow desk	1100	600		
Bookshelf	1050	400		
Small cupboard	1000	400		
Back cupboard	1000	400		
Teacher cupboard	1000	500		
Filing cabinet	650	500		
Tray trolley	550	450		

Perimeter

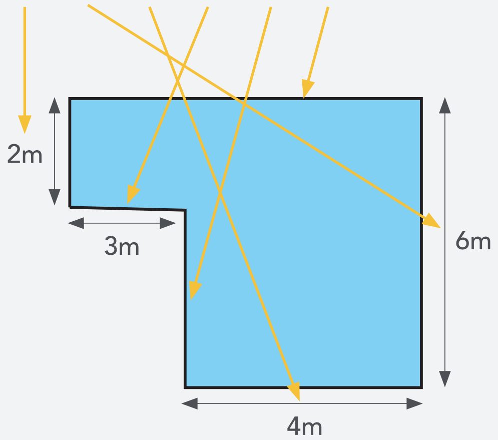
Perimeter is the measurement of the outside of something. For example, how much fencing is needed to go around a garden, or how much wallpaper is needed to cover all the walls around a room.

How to work out perimeter

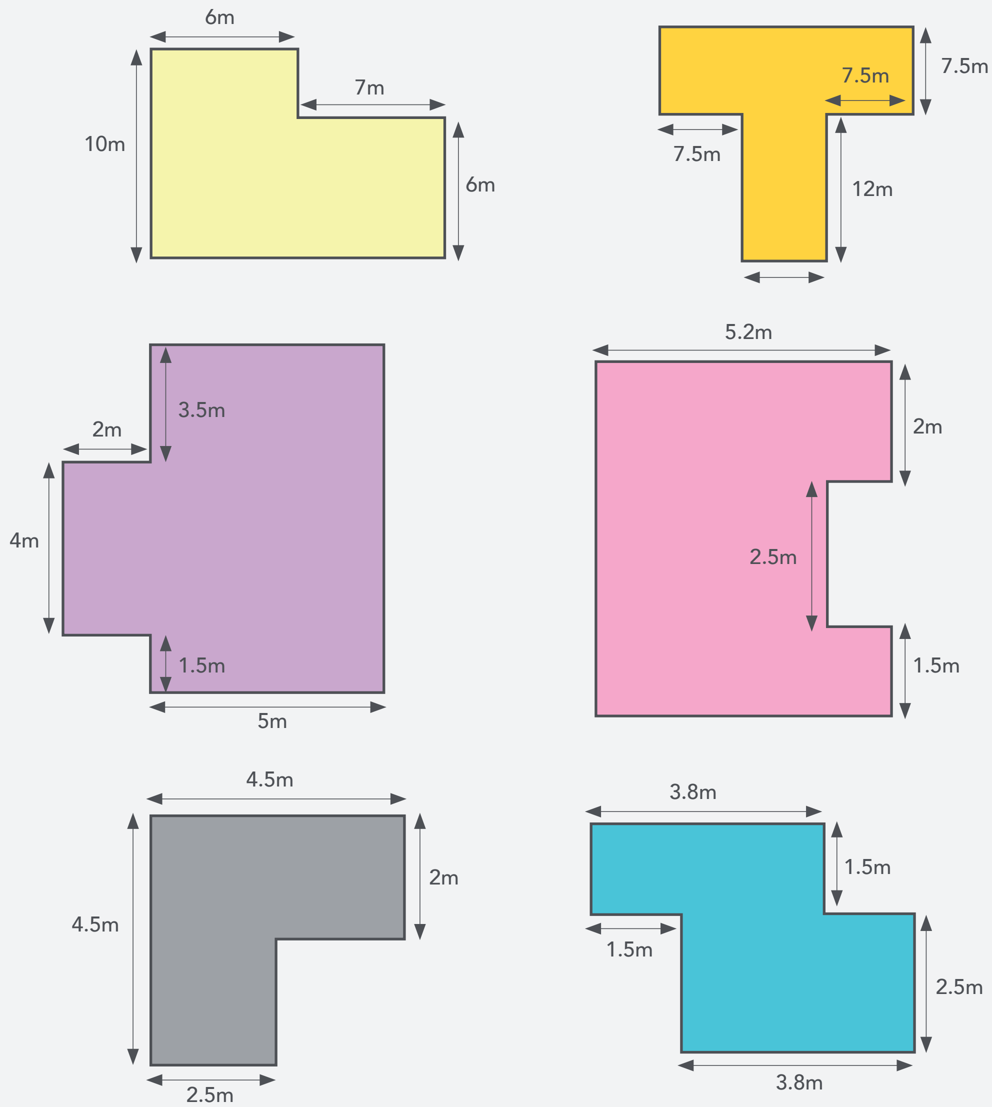
Add together the lengths of all the outside edges of a shape.

Example:

2 + 6 + 4 + 3 + 4 + 7 = **26m**



Task: Work out the perimeter of these rectangles



7.5m

Area: Squares and rectangles

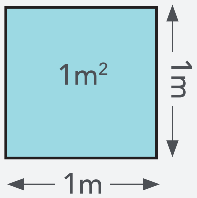
REMEMBER

AREA IS MEASURED IN SQUARE METRES (M^2)

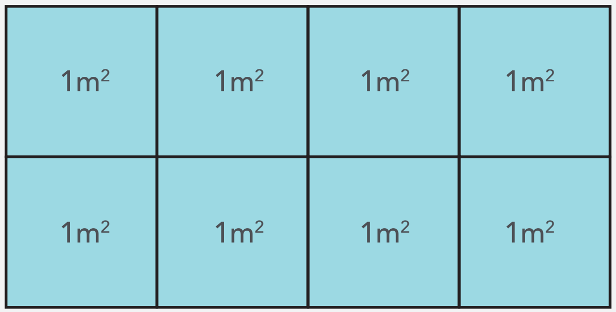
Area is the amount of space something flat takes up. We will usually measure area in metres. Since we are measuring a space that is both long AND wide, rather than a straight line, we measure it in square metres.

What is a square metre?

It's exactly what it sounds like
- a square 1m wide and 1m long.



If a room, or a garden, is 8 square metres, that means that we could fit 8 of these 1m x 1m squares into it.



$8 \times 1m^2 = 8m^2$

Using maths to work out large areas

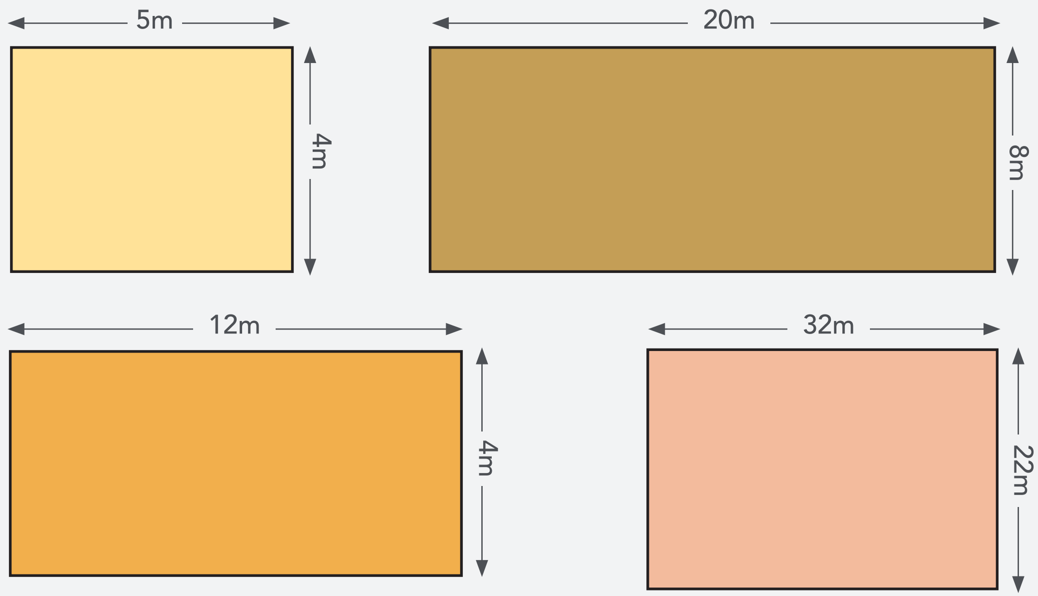
Often we'll have to measure large areas, and dividing the area into squares and counting them would take forever. Instead, we can use maths to work out the area.

Look at the $8m^2$ room above.
How long is the room altogether?
How wide is it altogether?

It's 2m long and 4m wide.
What do we get if we multiply 4 x 2?
The answer = 8

Using this method of multiplying the length by the width, we can quickly work out area of a rectangular space.

Task: Work out the area of these rectangles



Area: Irregular shapes

Areas that we want to measure aren't always in rectangles.

Let's have a look at the other shapes we might need to measure.

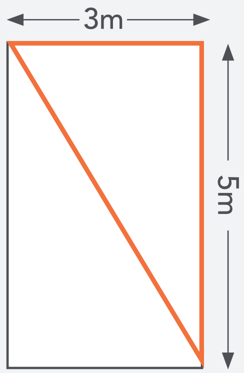
Triangles:

The trick to working out triangles is pretty easy.

Look...

Any right angled triangle is HALF of a rectangle.

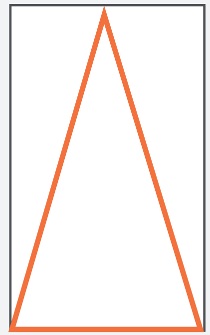
So all we need to do is work out the area of the rectangle and divide it by 2:

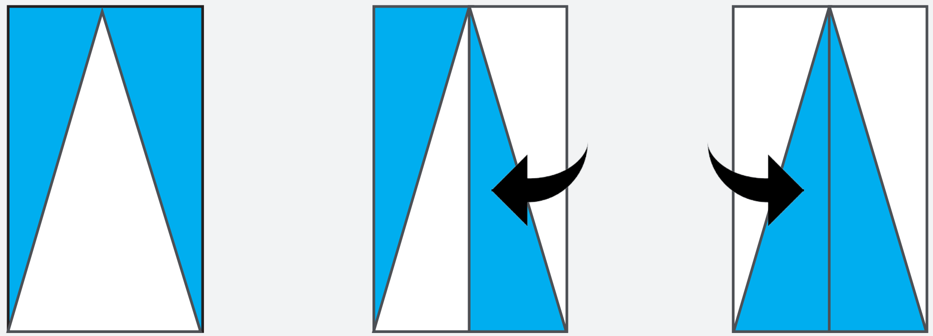


$3 \times 5 = 15m^2$
$15 \div 2 = \mathbf{7.5m^2}$

But what about triangles that aren't 90 degrees?

Well, it still works. The bits of the rectangle left over still go together to make up half the rectangle:



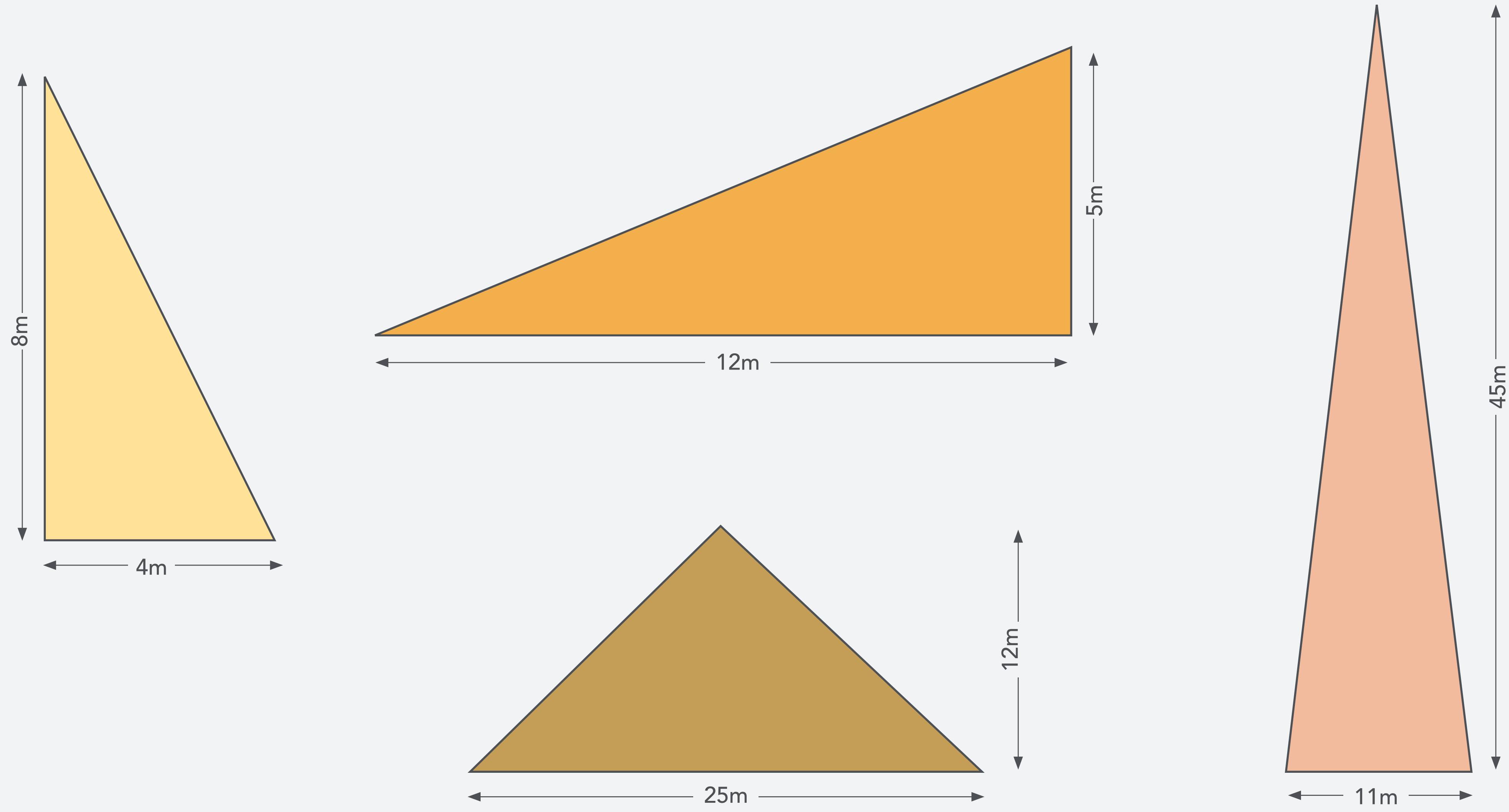


So our formula still applies:

(Length x Breadth) ÷ 2

Area: Practice 1

Task: Work out the area of these triangles



Area: Circles

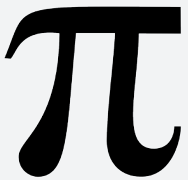
Working out the area of a circle from scratch would be really, really, really, really, REALLY, really hard.

Don't worry though - thankfully some incredibly clever people have done the hardest bit for us. It's all got to do with a crazy long magic number that's the ratio of a circle's width to its circumference (perimeter).

It's so hard in fact that we can't actually work it out completely - but thankfully, no-one has to be that precise, so we'll just be rounding it.

It's so important that people have been trying to get it right for a very long time - it's referred to in the Bible, Ancient Greek mathematician Archimedes got pretty close using polygons, and the Babylonians and Egyptians used it to build things like the pyramids.

Thankfully, in 1706, a maths teacher called William Jones came up with the version of the magic number that we use today. The magic number is called **pi** and we write it like this:



pi

And here's some of it...

We only use the first bit of the number - and in fact, most of your calculators / phones will have a button that has the symbol and knows the number anyway. When we're using pi however we just round it to 3.14

We use it like this:

$$A = \pi r^2$$

A the area of the circle (what we're trying to find)
pi 3.14
r the RADIUS of the circle
2 the square of r (r multiplied by itself)

IMPORTANT

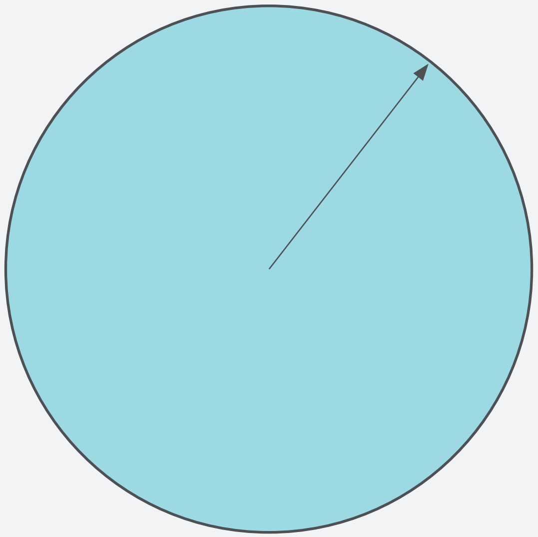
Sometimes we won't have the radius of a circle to work with - often we'll just be told how wide the circle is. The whole width of a circle is called the DIAMETER.

If the diameter of a circle is the whole distance across it, and the radius is the distance from the edge to the MIDDLE - we can easily work out that the radius is half of the diameter.

Make sure when you're performing calculations that this doesn't catch you out - make sure you're using the RADIUS and not the diameter.

Area: Practice 2

Example:

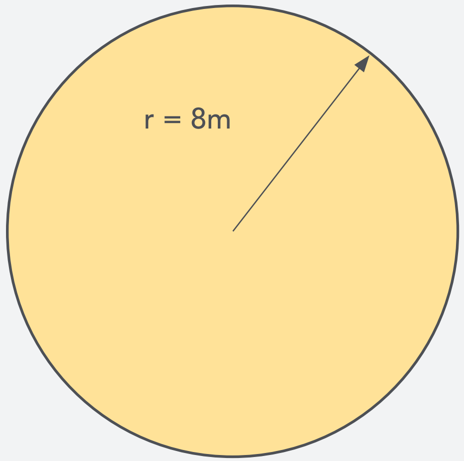


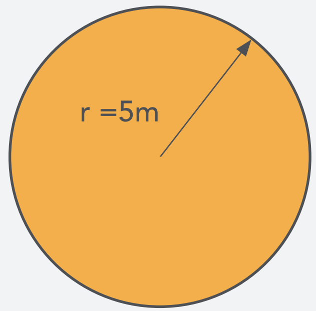
$A = \pi r^2$

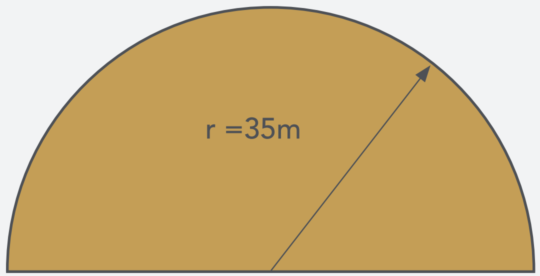
A = 3.14 x 12 x 12

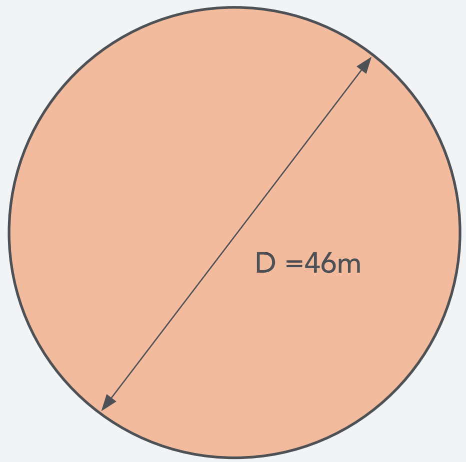
A = **452.16m²**

Task: Work out the area of these circles



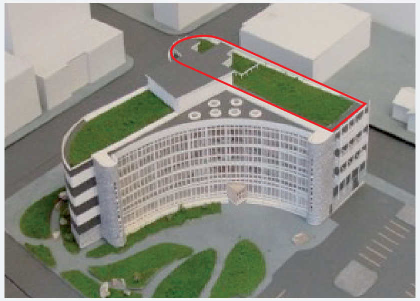






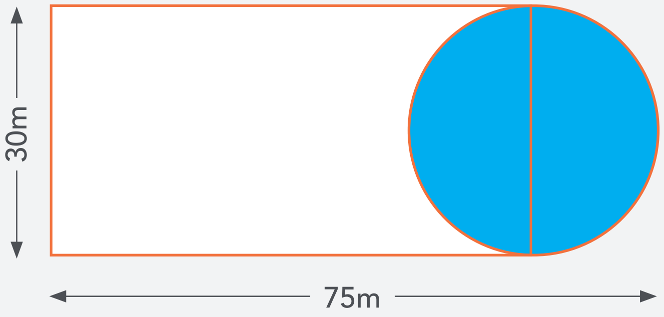
Area: Irregular shapes

Often when we are designing buildings we end up with irregular spaces. Finding the area of these needs a bit of trickery. One way to do this is to break the shape down into regular shapes or bits of regular shapes.



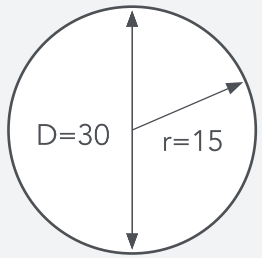
Here's the Greenstone building in Canada. If we wanted to find the area of the highlighted section, we'd be looking at a shape like this:

The next step is to break the area down into regular shapes. In this case, a rectangle and a circle. With some measurements, and a bit of detective work, we can start to figure out the area.



We can tell from the measurements that the circle has a diameter of 30m. To work out its area, we need the radius. Since the radius is half the diameter, the radius is 15m.

Now we can use our circular area formula πr^2



Pi = 3.14

r= 15

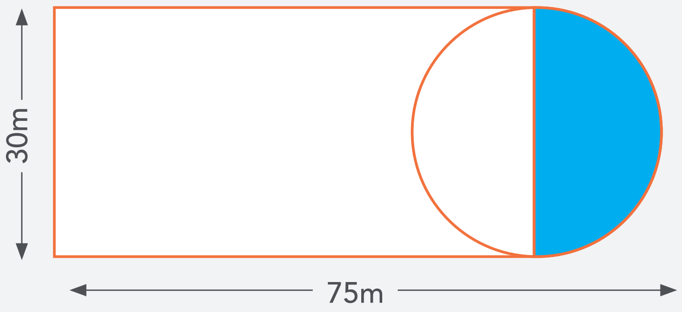
πr^2

3.14 x 15 x 15

= 706.5m²

But wait!.........

If we look at the shape, it's not a rectangle plus a circle - it's a rectangle plus HALF a circle:



So it's a rectangle plus HALF the area of the circle:
706.5 ÷ 2 = **353.25m²**

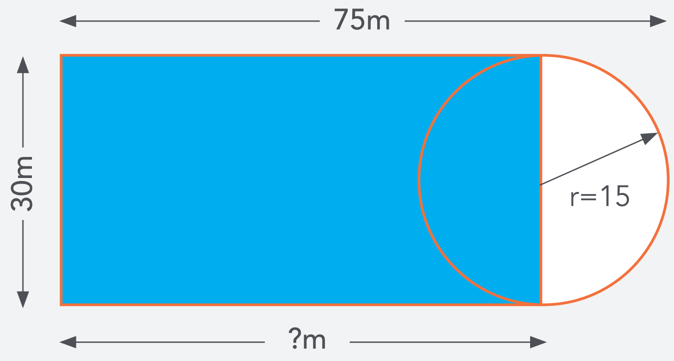
Now we need the area of the rectangle.
We get this by multiplying length by breadth.

The breadth is 30m - but what's the length?

This is where the detective work comes in...

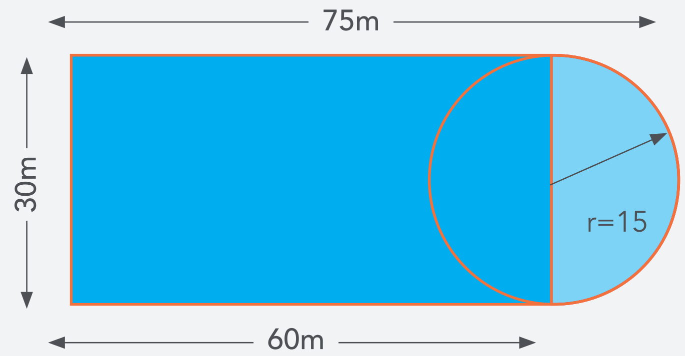
The rectangle isn't 75m long, as it only makes up **some** of the length of the shape.

We know the radius of the circle (measurement from the centre of the circle to the edge) is 15m.



We can see the rectangle stops at the halfway point of the circle (it hits the highest and lowest point) so we know the rectangle is the total length of the building (75m) minus half the width of the circle (15m): 75 - 15 = **60m**

Now that we know both dimensions for the rectangle, we can work out its area: 30 x 60 = **1800m²**

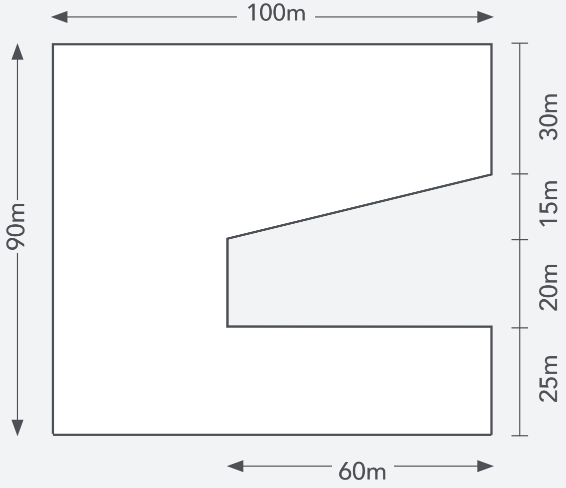


Our last job is to add the area of the rectangle (1800m²) to the area of the semicircle (353.25m²) to get our total area:
1800 + 353.25 = **2123.25m²**

Calculating area with subtraction

We can also calculate area with subtraction which can sometimes be easier.

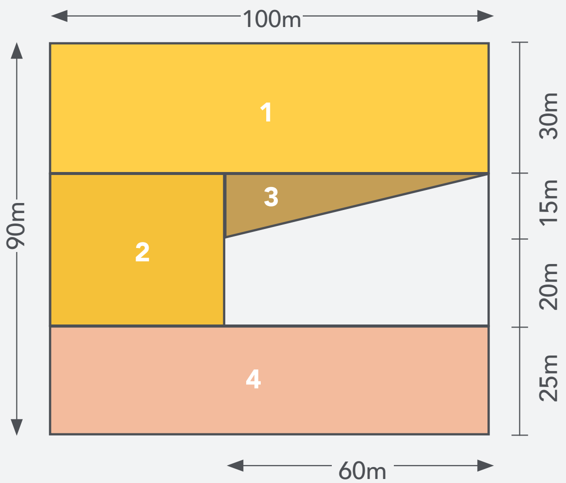
If we look at this building plan - we could split the area into 3 rectangles and a triangle and add them all together:



This would mean working out 4 areas and adding them together.

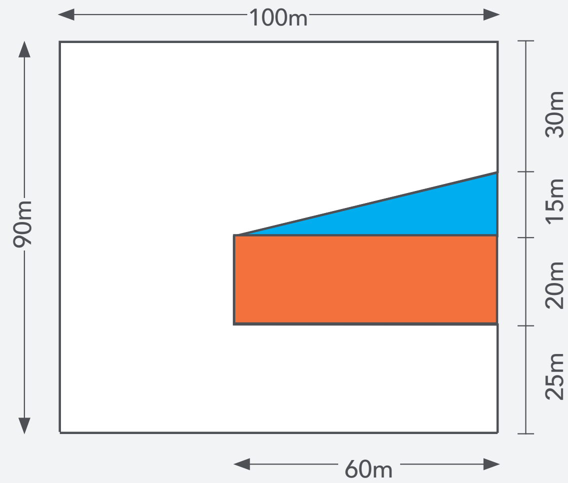
Sometimes its easier to TAKE AWAY part of the area.

Watch...



Work out the area of the building as if it were a complete rectangle (ie. without the chunk missing):
Length x Breadth: 100 x 90 = **9000m²**

Now work out the area of the "missing chunk". This will be a rectangle plus a triangle:



Length x breadth = 60 x 20 = 1200m²

(Length x breadth) ÷ 2 = (60 x 15) ÷ 2 = (900) ÷ 2 = 450m²

1200 + 450 = **1650m²**

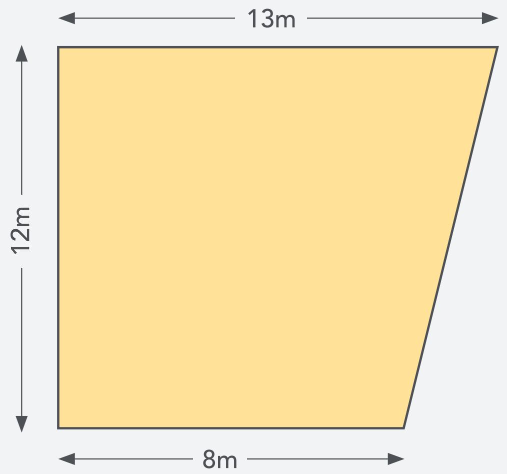
Now we just subtract the area of the "missing chunk" (1650m²) from the size of the whole rectangle (9000m²):

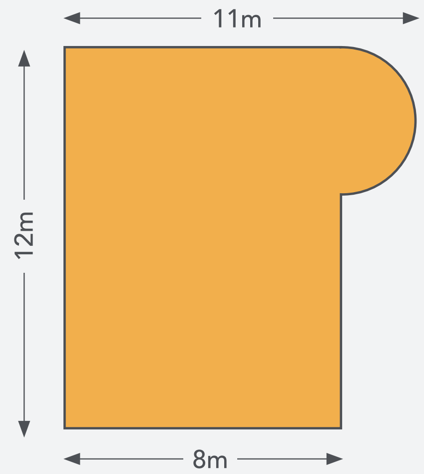
9000 - 1650 = **7350m²**

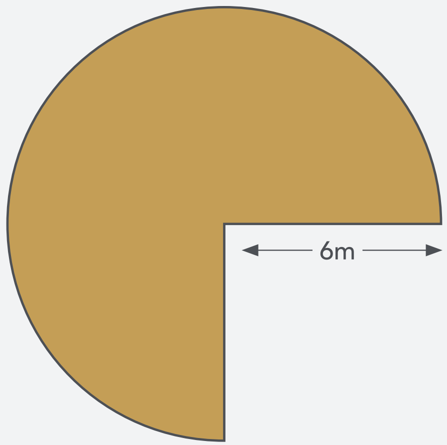
This way we only have to work out 3 areas instead of 4, so sometimes it's more efficient to subtract areas from a whole rather than add them all together.

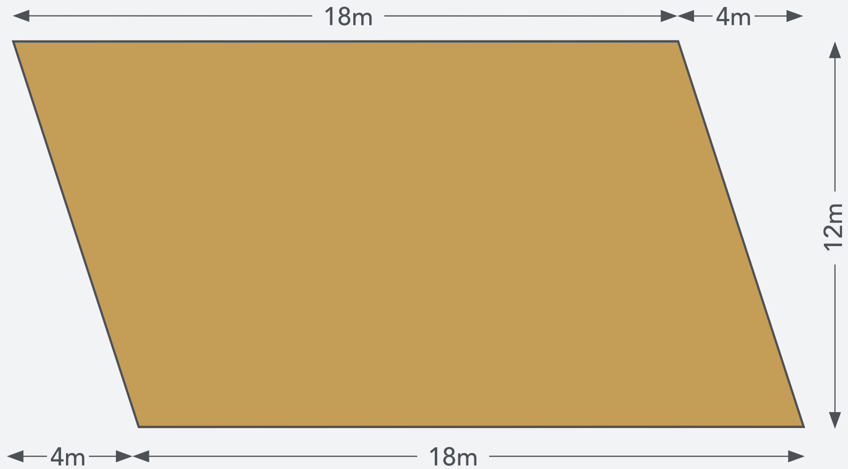
Area: Practice 3

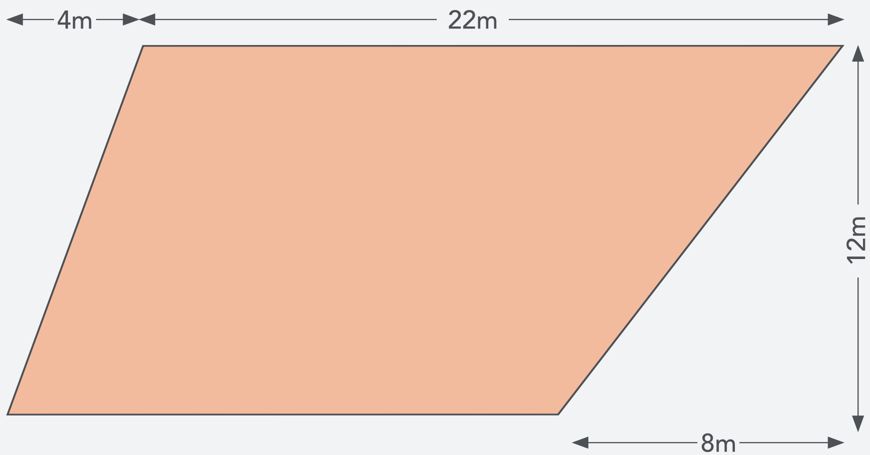
Task: Work out the area of these irregular shapes











Area: Real life applications

On the next page there is a "birds eye view" plan of a house, with the roof removed. Its scale is 1:150

Task 1
measure the rooms in the drawing.

Task 2
Use the scale to figure out the area of each room in real life (ie. 150 times bigger)

Use the information provided to "cost" (work out how much money you will need) the job of redecorating the house.

Floors
Wooden flooring: Kitchen/dining room, hall
Carpet: Sitting room, front bedroom, back bedroom, study
Tiles: Bathroom

Paint - Each wall has a height of 3m
White: Bathroom & hall
Mustard: Kitchen & back bedroom
Purple: Front bedroom
Olive: Study & sitting room

Wood Flooring
£40.95/m^2

Carpet
£33.00/m^2

Tiles
£7.84/box of 6 tiles

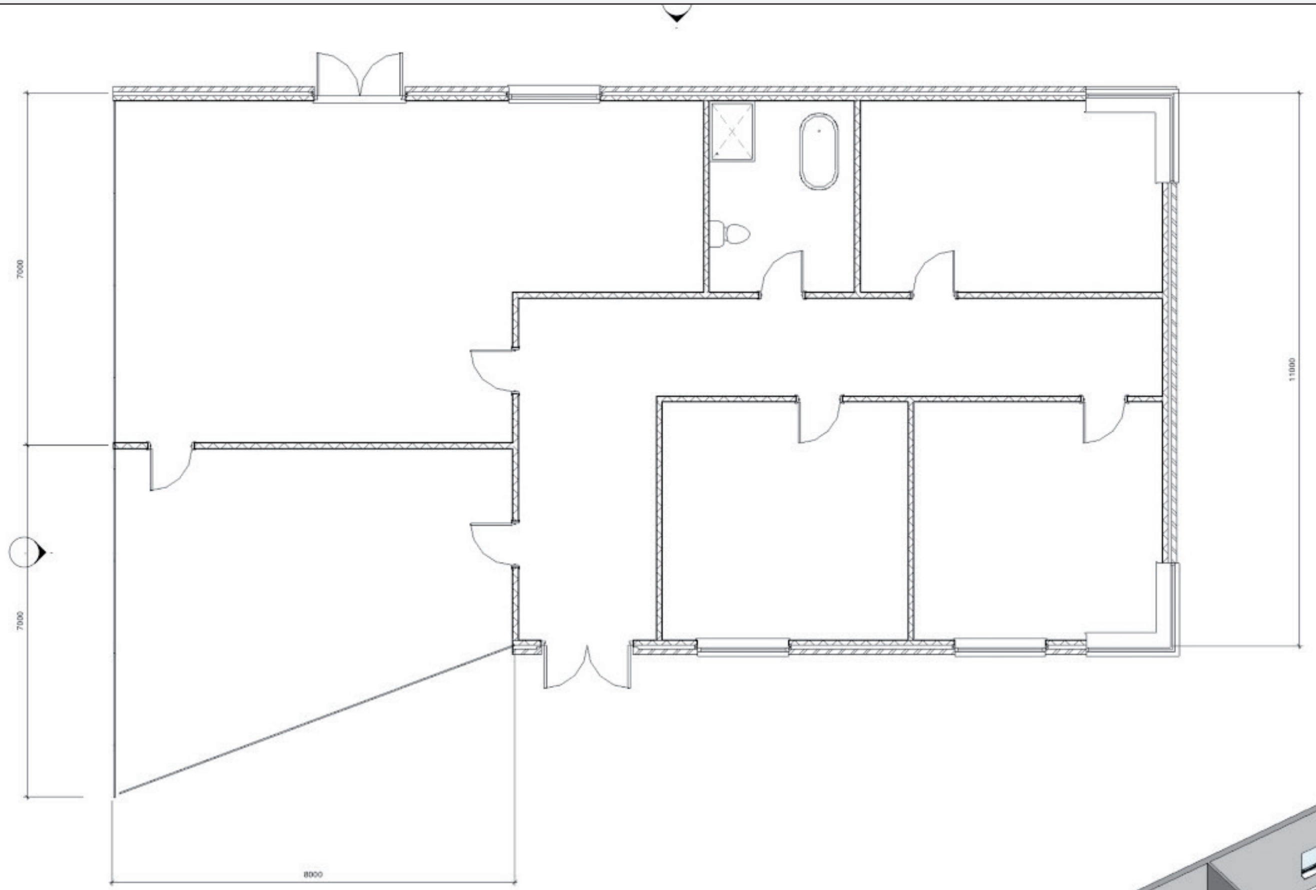
Note: 10 tiles per m^2 - how many boxes will you need?

White
1 Litre (13m^2/l)
£8.99

Mustard
1 Litre (10m^2/l)
£6.99

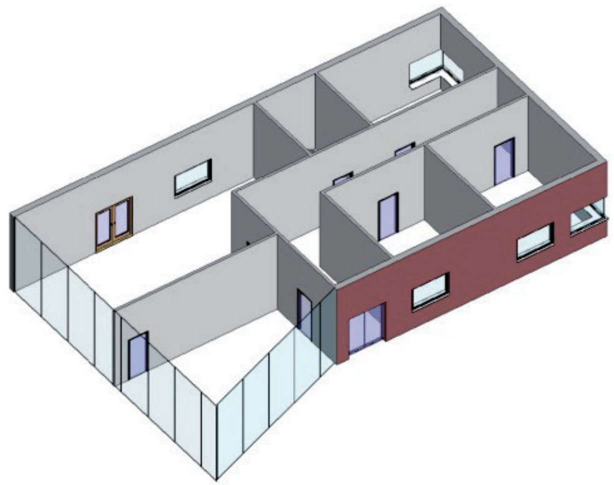
Purple
1 Litre (12m^2/l)
£9.99

Olive
1 Litre (12m^2/l)
£10.99



Level 0

1 : 50



2 {3D}

Rev	Description	Date

CODE | SUITABILITY DESCRIPTION

STATUS | PURPOSE OF ISSUE

AUTODESK

PROJECT

0

TITLE

CLIENT

DRAWN BY	CHECKED BY	DATE

SCALE (@ A1)	PROJECT NUMBER
000	0

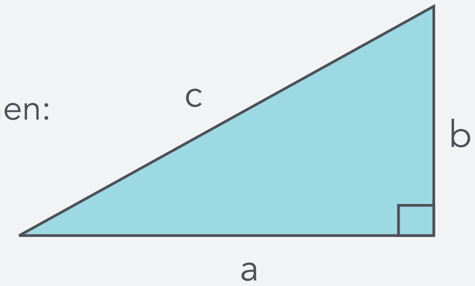
DRAWING NUMBER	REV

Pythagoras

Rule of pythagoras

If a triangle is right angled, then:

$$c^2 = a^2 + b^2$$

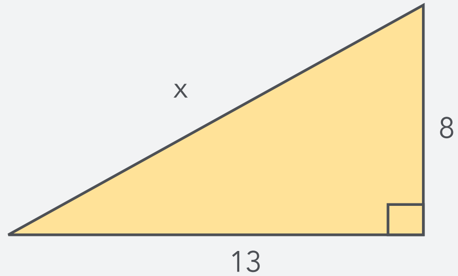


Square both short sides then add them together.
This equals the square of the long side **(hypotenuse).**

Pythagoras can be used to:

- find the length of a missing side of any right angled triangle
- prove that a triangle is right angled

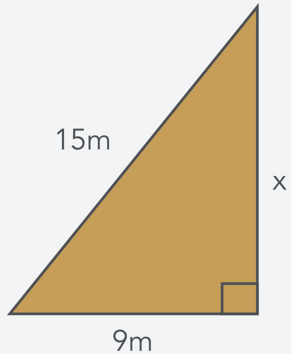
Finding the hypotenuse



Example
Calculate x

STEP 1:
Substitute in what you know $x^2 = 13^2 + 8^2$
STEP 2: Square each number $x^2 = 169 + 64$
STEP 3: Add the squares $x^2 = 233$
STEP 4: Square root x =
STEP 5: Solve (with rounding) x = **15.3**

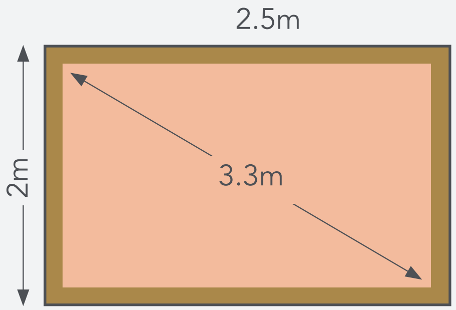
Finding a short side



Example
Calculate x.

STEP 1: Substitute in what you know $15^2 = x^2 + 9^2$
STEP 2: Rearrange $x^2 = 15^2 – 9^2$
STEP 3: Square each number $x^2 = 225 – 81$
STEP 4: Add the squares $x^2 = 144$
STEP 5: Square root x =
STEP 6: Solve (with rounding) x = **12m**

Proving a right angle



Example

Alan makes a frame with sides of 2.5m and 2m.

To check whether or not it is rectangular, he measures the diagonal. This measures 3.3m.

Is the frame rectangular?

STEP 1: Identify the question Is $3.3^2 = 2.5^2 + 22$?
STEP 2: Calculate left hand side LHS $= 3.3^2 = 10.89$
STEP 3: Calculate right hand side RHS $= 2.5^2 + 2^2 = 10.25$
STEP 4: Statement comparing values $10.89 \neq 10.25$
STEP 5: Explanation Pythagoras does NOT work

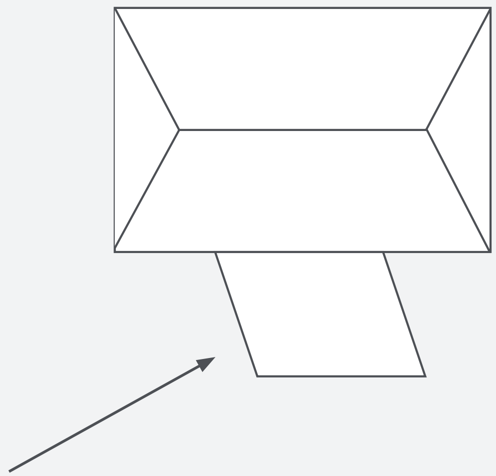
Triangle is NOT right angled

So - this is all very clever, and it proves for sure that Pythagorus was a very clever man. But what use is it?

What do I need to know Pythagoras for?

FINALLY you'll have the answer to the second* most asked question in school.

Imagine someone lives in this lovely house.



What they really want is an extension. They know the dimensions of the house, and the dimensions of the extension.

However, without Pythagoras, their extension may end up looking like this:

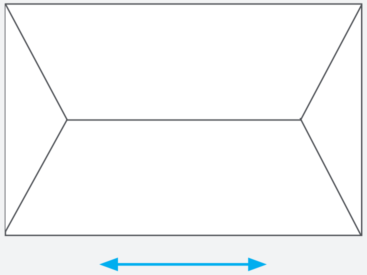
*The most asked question in school is "can I go to the toilet"

How to make sure buildings are square

What's happened is that the builders have made the extension the correct size, but it isn't straight.

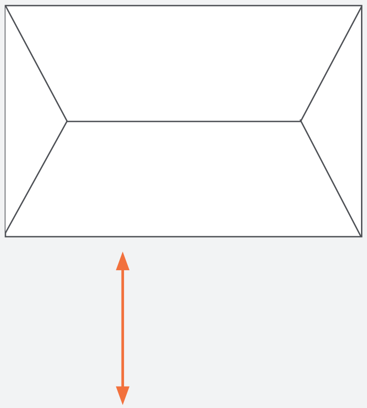
To avoid this, we use Pythagoras to ensure our rectangle - or more specifically the triangles that make it up - are right angled.

Firstly, we take the measurement of the edge we know.
In this case, the width of the extension where it joins the house.



Next we take the measurement of the edge 90 degrees to this:

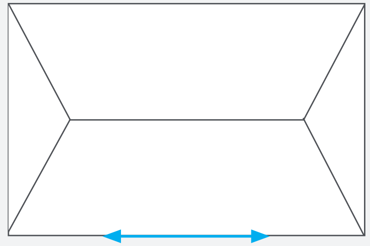
On this occasion, that's the length of the extension.



Now, using these measurements as the length and breadth (width) of a right angled triangle, we can work out what the hypoteneuse would be.

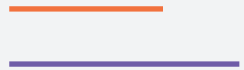
Here's the clever bit.

If we marked out the width of the triangle - let's call this the base.

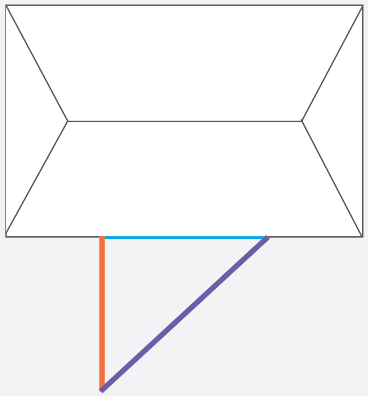


Then cut two pieces of string:

One the Length of the triangle
One the length of the hypoteneuse.



Attach the length string to one end of the base, and the hypoteneuse string to the other:



We can then drag these pieces of string towards each other, and the ONLY place where they meet is when we have a right angled triangle.

Hence, no wonky extensions!