

# BTEC Medical Science



At HGSS we are excited to start the new national BTECs referred to as advanced additional qualifications or AAQs. We will follow the AAQ BTEC level 3 extended certificate in **Medical Science**. It is the equivalent of one A level and can be studied alongside any other BTECs or A levels.

The core and specialist medical science knowledge, understanding and skills that students develop throughout the course, create a good foundation for transition to related degrees. Skills such as critical thinking and independent learning help students to be better prepared for the self-directed learning approach used in higher education and become more open minded to learning. Research skills, in combination with the other transferable skills, create a strong foundation for academic success.

This course is designed to lead onto further study at degree level for careers in medicine such as paramedic science, midwifery, physiotherapy, biomedical sciences, biomedical research, radiography and theater technician. In combination with appropriate A levels it can also prepare for careers in engineering and research. BTEC Nationals are widely recognized by higher education and industry, providing students with meaningful theory-based and practical learning experiences. The AAQ allows students to study the principles and applications of medical sciences across the examined units and enables students to further explore other areas in more detail through internally assessed coursework modules.

This course is designed to be taken alongside A Levels or other Level 3 applied qualifications. Subjects such as physical education, sociology, psychology, chemistry, child development, physics and maths would make a good combination.

## Course Organisation:

- We will be following the Pearson Level 3 AAQ BREC National (Extended Certificate) in Medical Science
- You will complete a baseline test in September to check your understanding of key topics
- You will sit two exams; one at the end of year 12 with re-sit opportunities in Y13 and the second exam in January of Y13, with a re-sit opportunity in the summer.
- In Y13 You will complete two units assessed by coursework

## Lesson information and expectations:

- You will attend 4 x 60 minute lessons each week
- Lessons and assessments will consist of both practical skills and theory content
- Homework must be completed and handed in on time
- Tests for the examined unit will take place at the end of each topic
- Coursework units are broken down into components and deadlines must be met in order to pass.

## Specification at a glance

Unit number	Unit title	GLH	Type	How assessed
1	Principles of Human Physiology, Anatomy and Pathology	90	Mandatory	External
2	Health Issues and Scientific Reporting	120	Mandatory	External
3	Practical Microbiology and Infectious Diseases	90	Mandatory	Internal
6	Human Reproduction and Fertility	60	Optional	Internal

**Unit 1:** In this unit, you will study how the human body functions at a cellular and tissue level. You will go on to gain understanding of the various organ systems that comprise the human body – nervous, endocrine musculoskeletal, cardiovascular, respiratory, renal and digestive systems – and gain some insight into how these systems interrelate.

**Unit 2:** In this unit you will be learning about contemporary health issues, including cancer and genetic disorders, alongside developing knowledge about scientific analysis, evaluation and reporting.

**Unit 3:** In this unit, you will carry out your own investigation into the effect of antimicrobial agents on the growth of microorganisms.

**Unit 4:** Undertake research to support the production materials discussing the organisation and function of the human reproductive system.

## Transition Tasks

On the following pages are a few review and research tasks to help you prepare for your start in BTEC Medical Science.

### Task 1:

Review your current knowledge by watching these videos by Miss Estruch:

[https://youtu.be/v\\_caROMN77c](https://youtu.be/v_caROMN77c)

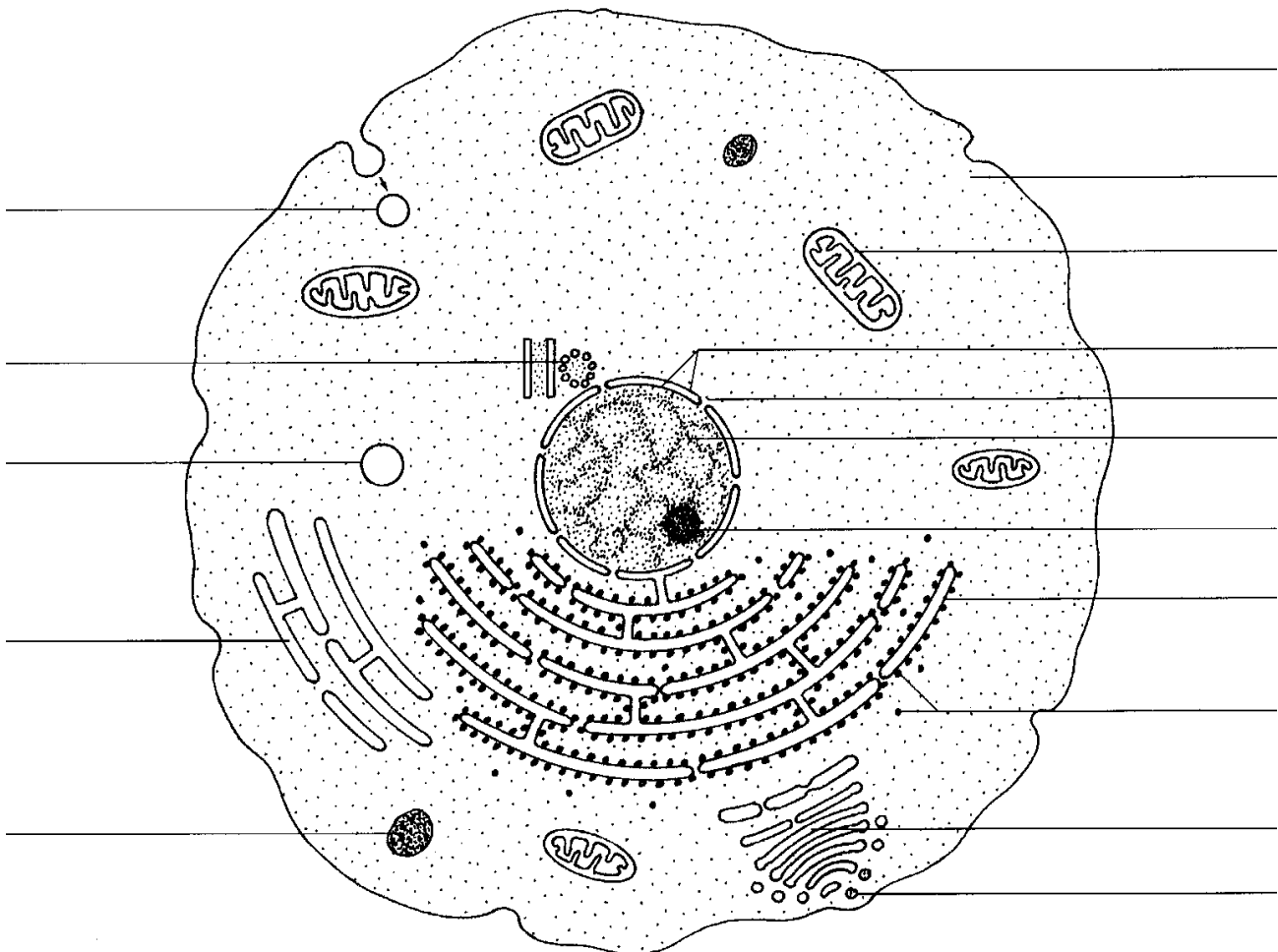
<https://youtu.be/Xn6VCOkxgmM>

<https://youtu.be/lguUZgWp3SE>

<https://youtu.be/WVYzHGSAkg0>

### Task 2:

Label the following cell structures:



Plasma membrane

Golgi apparatus

Centriole(s)

Nuclear membrane

Chromatin thread(s)

Nucleolus

Rough endoplasmic reticulum

Mitochondrion

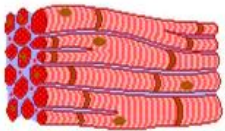


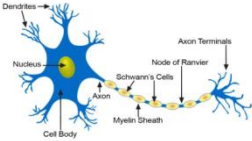
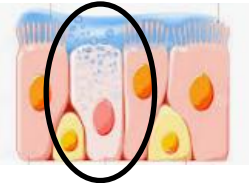
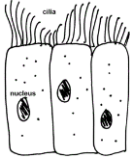

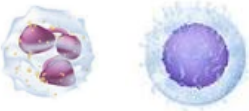
Microvilli

Smooth endoplasmic reticulum

### Task 3:

Watch the video and use the information to complete this table:

<https://www.youtube.com/watch?v=cj8dDTHGJBY>

Cell	Picture	function	Adaptation
Muscle cell			
Sperm cell			
Red blood cell			
Nerve cell			
Goblet cell			
Ciliated epithelial cell			
Egg cell (ovum)			
White blood cell			

## Task 4:

Essential math skills – Please complete the following pages

### 1 Numbers and units

#### 1.1 Units and prefixes

A key criterion for success in biological maths lies in the use of correct units and the management of numbers. The units scientists use are from the *Système Internationale* – the SI units. In biology, the most commonly used SI base units are metre (m), kilogram (kg), second (s), and mole (mol). Biologists also use SI derived units, such as square metre (m<sup>2</sup>), cubic metre (m<sup>3</sup>), degree Celsius (°C), and litre (l).

To accommodate the huge range of dimensions in our measurements they may be further modified using appropriate prefixes. For example, one thousandth of a second is a millisecond (ms). Some of these prefixes are illustrated in the table below.

Multiplication factor	Prefix	Symbol
10 <sup>9</sup>	giga	G
10 <sup>6</sup>	mega	M
10 <sup>3</sup>	kilo	k
10 <sup>-2</sup>	centi	c
10 <sup>-3</sup>	milli	m
10 <sup>-6</sup>	micro	μ
10 <sup>-9</sup>	nano	n

#### Practice questions

- A burger contains 4 500 000 J of energy. Write this in:
  - kilojoules
  - megajoules.
- HIV is a virus with a diameter of between  $9.0 \times 10^{-8}$  m and  $1.20 \times 10^{-7}$  m. Write this range in nanometres.

#### 1.2 Powers and indices

Ten squared =  $10 \times 10 = 100$  and can be written as  $10^2$ . This is also called 'ten to the power of 2'.

Ten cubed is 'ten to the power of three' and can be written as  $10^3 = 1000$ .

The power is also called the index.

Fractions have negative indices:

one tenth =  $10^{-1} = 1/10 = 0.1$

one hundredth =  $10^{-2} = 1/100 = 0.01$

Any number to the power of 0 is equal to 1, for example,  $29^0 = 1$ .

If the index is 1, the value is unchanged, for example,  $17^1 = 17$ .

When multiplying powers of ten, you must *add* the indices.

So  $100 \times 1000 = 100\,000$  is the same as  $10^2 \times 10^3 = 10^{2+3} = 10^5$

When dividing powers of ten, you must *subtract* the indices.

So  $100/1000 = 1/10 = 10^{-1}$  is the same as  $10^2/10^3 = 10^{2-3} = 10^{-1}$

But you can only do this when the numbers with the indices are the same.

So  $10^2 \times 2^3 = 100 \times 8 = 800$

And you can't do this when adding or subtracting.

$10^2 + 10^3 = 100 + 1000 = 1100$

$10^2 - 10^3 = 100 - 1000 = -900$

**Remember:** You can only add and subtract the indices when you are multiplying or dividing the numbers, not adding or subtracting them.

**Practice questions**

3 Calculate the following values. Give your answers using indices.

a  $10^8 \times 10^3$                       b  $10^7 \times 10^2 \times 10^3$

c  $10^3 + 10^3$                       d  $10^2 - 10^{-2}$

4 Calculate the following values. Give your answers with and without using indices.

a  $10^5 \div 10^4$                       b  $10^3 \div 10^6$

c  $10^2 \div 10^{-4}$                       d  $100^2 \div 10^2$

**1.3 Converting units**

When doing calculations, it is important to express your answer using sensible numbers. For example, an answer of 6230  $\mu\text{m}$  would have been more meaningful expressed as 6.2 mm.

If you convert between units and round numbers properly, it allows quoted measurements to be understood within the scale of the observations.

To convert 488 889 m into km:

A kilo is  $10^3$  so you need to divide by this number, or move the decimal point three places to the left.

$488\,889 \div 10^3 = 488.889 \text{ km}$

However, suppose you are converting from mm to km: you need to go from  $10^3$  to  $10^{-3}$ , or move the decimal point six places to the left.

333 mm is 0.000 333 km

Alternatively, if you want to convert from 333 mm to nm, you would have to go from  $10^{-9}$  to  $10^{-3}$ , or move the decimal point six places to the right.

333 mm is 333 000 000 nm

**Practice question**

5 Calculate the following conversions:

a 0.004 m into mm                      b 130 000 ms into s

c 31.3 ml into  $\mu\text{l}$                       d 104 ng into mg

6 Give the following values in a different unit so they make more sense to the reader.

Choose the final units yourself. (Hint: make the final number as close in magnitude to zero as you can. For example, you would convert 1000 m into 1 km.)

a 0.000 057 m                      b 8 600 000  $\mu\text{l}$                       c 68 000 ms                      d 0.009 cm



## 2.3 Significant figures

When you use a calculator to work out a numerical answer, you know that this often results in a large number of decimal places and, in most cases, the final few digits are 'not significant'. It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

Numbers to 3 significant figures (3 s.f.):

7.88   25.4   741

Bigger and smaller numbers with 3 significant figures:

0.000 147   0.0147   0.245   39 400   96 200 000 (notice that the zeros before the figures and after the figures are *not* significant – they just show you how large the number is by the position of the decimal point).

Numbers to 3 significant figures where the zeros *are* significant:

207   4050   1.01 (any zeros between the other significant figures *are* significant).

Standard form numbers with 3 significant figures:

$9.42 \times 10^{-5}$     $1.56 \times 10^8$

If the value you wanted to write to 3.s.f. was 590, then to show the zero was significant you would have to write:

590 (to 3.s.f.) or  $5.90 \times 10^2$

**Remember:** For calculations, use the same number of figures as the data in the question with the lowest number of significant figures. It is not possible for the answer to be more accurate than the data in the question.

### **Practice question**

6 Write the following numbers to **i** 2 s.f. and **ii** 3 s.f.

**a** 7644 g

**b** 27.54 m

**c** 4.3333 g

**d**  $5.995 \times 10^2 \text{ cm}^3$

7 The average mass of oxygen produced by an oak tree is 11800 g per year.

Give this mass in standard form and quote your answer to 2 significant figures.

### 3 Working with formulae

It is often necessary to use a mathematical formula to calculate quantities. You may be tested on your ability to substitute numbers into formulae or to rearrange formulae to find specific values.

#### 3.1 Substituting into formulae

Think about the data you are given in the question. Write down the equation and then think about how to get the data to substitute into the equation. Look at this worked example.

A cheek cell has a 0.06 mm diameter. Under a microscope it has a diameter 12 mm. What is the magnification?

$$\text{magnification} = \text{image size (mm)} \div \text{object size (mm)} \quad \text{or} \quad M = \frac{I}{O}$$

Substitute the values and calculate the answer:

$$M = 12 \text{ mm} / 0.06 \text{ mm} = 12 / 0.06 = 200$$

Answer: magnification =  $\times 200$  (magnification has no units)

Sometimes an equation is more complicated and the steps need to be carried out in a certain order to succeed. A general principle applies here, usually known by the mnemonic BIDMAS. This stands for **B**rackets, **I**ndices (functions such as squaring or powers), **D**ivision, **M**ultiplication, **A**ddition, **S**ubtraction.

#### Practice questions

- 1 Calculate the magnification of a hair that has a width of 6.6 mm on a photograph. The hair is 165  $\mu\text{m}$  wide.
- 2 Estimate the area of a leaf by treating it as a triangle with base 2 cm and height 9 cm.
- 3 Estimate the area of a cell by treating it as a circle with a diameter of 0.7  $\mu\text{m}$ . Give your answer in  $\mu\text{m}^2$ .
- 4 An *Amoeba* population starts with 24 cells. Calculate how many *Amoeba* cells would be present in the culture after 7 days if each cell divides once every 20 hours. Use the equation  $N_t = N_0 \times 2^n$  where  $N_t$  = number after time  $t$ ,  $N_0$  = initial population,  $n$  = number of divisions in the given time  $t$ .
- 5 In a quadrat sample, an area was found to contain 96 aphids, 4 ladybirds, 22 grasshoppers, and 3 ground beetles. Calculate the diversity of the site using the equation  $D = 1 - \sum \left( \frac{n}{N} \right)^2$  where  $n$  = number of each species,  $N$  = grand total of all species, and  $D$  = diversity.

**Remember:** In this equation there is a part that needs to be done several times then summed, shown by the symbol  $\Sigma$ .

#### 3.2 Rearranging formulae

Sometimes you will need to rearrange an equation to calculate the answer to a question. For example, the relationship between magnification, image size, and actual size of specimens in micrographs usually uses the equation  $M = \frac{I}{O}$ , where  $M$  is magnification,  $I$  is size of the image, and  $O$  = actual size of the object.

#### Practice questions

- 1 A Petri dish shows a circular colony of bacteria with a cross-sectional area of 5.3  $\text{cm}^2$ . Calculate the radius of this area.
- 2 The cardiac output of a patient was found to be 2.5  $\text{dm}^3 \text{ min}^{-1}$  and their heart rate was 77 bpm. Calculate the stroke volume of the patient. Use the equation: cardiac output = stroke volume  $\times$  heart rate.
- 11 In a food chain, efficiency =  $\frac{\text{biomass transferred}}{\text{biomass taken in}} \times 100$

A farmer fed 25 kg of grain to his chicken. The chicken gained weight with an efficiency of 0.84. Calculate the weight gained by the chicken.

## 4 Magnification

To look at small biological specimens you use a microscope to magnify the image that is observed. The microscope was developed in the 17th century. Anton van Leeuwenhoek used a single lens and Robert Hooke used two lenses. The lenses focus light from the specimen onto your retina to produce a magnified virtual image. The magnification at which observations are made depends on the lenses used.

### 4.1 Calculating the magnifying power of lenses

Lenses each have a magnifying power, defined as the number of times the image is larger than the real object. The magnifying power is written on the lens.

To find the magnification of the virtual image that you are observing, multiply the magnification powers of each lens used. For example, if the eyepiece lens is  $\times 10$  and the objective lens is  $\times 40$  the total magnification of the virtual image is  $10 \times 40 = 400$ .

#### Practice questions

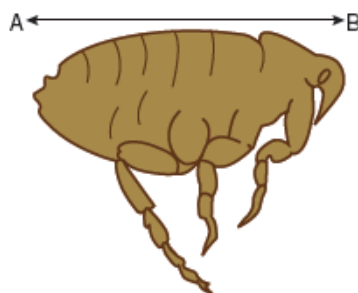
- Calculate the magnification of the virtual image produced by the following combinations of lenses:
  - objective  $\times 10$  and eyepiece  $\times 12$
  - objective  $\times 40$  and eyepiece  $\times 15$

### 4.2 Calculating the magnification of images

Drawings and photographs of biological specimens should always have a magnification factor stated. This indicates how much larger or smaller the image is compared with the real specimen.

The magnification is calculated by comparing the sizes of the image and the real specimen. Look at this worked example.

The image shows a flea which is 1.3 mm long. To calculate the magnification of the image, measure the image (or the scale bar if given) on the paper (in this example, the body length as indicated by the line A–B).



For this image, the length of the image is 42 mm and the length of the real specimen is 1.3 mm.

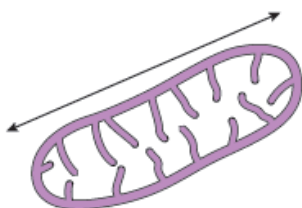
$$\text{magnification} = \frac{\text{length of image}}{\text{length of real specimen}} = 42/1.3 = 32.31$$

The magnification factor should therefore be written as  $\times 32.31$

**Remember:** Use the same units. A common error is to mix units when performing these calculations. Begin each time by converting measurements to the same units for both the real specimen and the image.

#### Practice question

- Calculate the magnification factor of a mitochondrion that is 1.5  $\mu\text{m}$  long.



### 4.3 Calculating real dimensions

Magnification factors on images can be used to calculate the actual size of features shown on drawings and photographs of biological specimens. For example, in a photomicrograph of a cell, individual features can be measured if the magnification is stated. Look at this worked example.

The magnification factor for the image of the open stoma is  $\times 5000$ .

This can be used to find out the actual size of any part of the cell, for example, the length of one guard cell, measured from A to B.

**Step 1:** Measure the length of the guard cell as precisely as possible. In this example the image of the guard cell is 52 mm long.

**Step 2:** Convert this measurement to units appropriate to the image. In this case you should use  $\mu\text{m}$  because it is a cell.

So the magnified image is  $52 \times 1000 = 52\,000 \mu\text{m}$

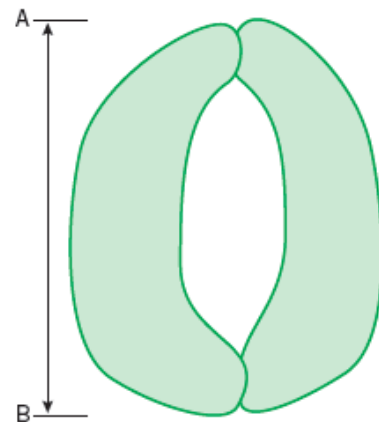
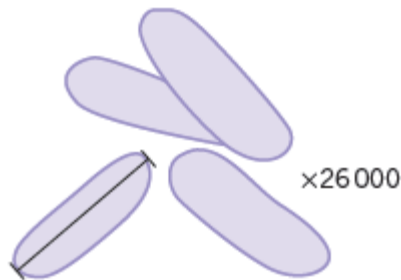
**Step 3:** Rearrange the magnification equation (see Topic 3.2) to get:

real size = size of image/magnification =  $52\,000/5000 = 10.4$

So the real length of the guard cell is  $10.4 \mu\text{m}$ .

#### **Practice question**

3 Use the magnification factor to determine the actual size of a bacterial cell.



## 5 Percentages and uncertainty

A percentage is simply a fraction expressed as a decimal. It is important to be able to calculate routinely, but is often incorrectly calculated in exams. These pages should allow you to practise this skill.

### 5.1 Calculating percentages as proportions

To work out a percentage, you must identify or calculate the total number using the equation:

$$\text{percentage} = \frac{\text{number you want as a percentage of total number}}{\text{total number}} \times 100\%$$

For example, in a population, the number of people who have brown hair was counted.

The results showed that in the total population of 4600 people, 1800 people had brown hair.

The percentage of people with brown hair is found by calculating:

$$\begin{aligned} & \frac{\text{number of people with brown hair}}{\text{total number of people}} \times 100 \\ & = \frac{1800}{4600} \times 100 = 39.1\% \end{aligned}$$

### Practice questions

- 1 The table below shows some data about energy absorbed by a tree in a year and how some of it is transferred.

Energy absorbed by the tree in a year	3 600 000 kJ/m <sup>2</sup>
Energy transferred to primary consumers	2240 kJ/m <sup>2</sup>
Energy transferred to secondary consumers	480 kJ/m <sup>2</sup>

Calculate the percentage of energy absorbed by the tree that is transferred to  
**a** primary consumers                      **b** secondary consumers.

- 2 One in 17 people in the UK has diabetes.

Calculate the percentage of the UK population that have diabetes.

### 5.2 Calculating the percentage change

When you work out an increase or a decrease as a percentage change, you must identify, or calculate, the total original amount:

$$\% \text{ increase} = \frac{\text{increase}}{\text{original amount}} \times 100$$

$$\% \text{ decrease} = \frac{\text{decrease}}{\text{original amount}} \times 100$$

**Remember:** When you calculate a percentage change, use the total *before* the increase or decrease, not the final total.

### Practice questions

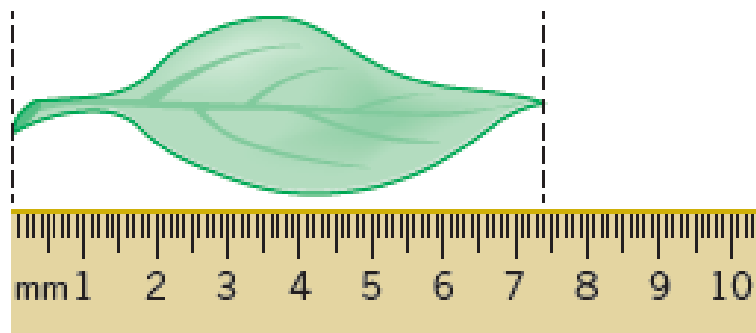
3 Convert the following mass changes as percentage changes.

Sucrose conc. / mol dm <sup>-3</sup>	Initial mass / g	Final mass / g	Mass change / g	Percentage change in mass
0.9	1.79	1.06		
0.7	1.86	1.30		
0.5	1.95	1.70		
0.3	1.63	1.76		
0.1	1.82	2.55		

### 5.3 Measurement uncertainties

When you measure something, there will always be a small difference between the measured value and the true value. This may be because of the size of the scale divisions on your measuring equipment, or the difficulty of taking the measurement. This is called an uncertainty.

To estimate the uncertainty of a measurement with an instrument with a marked scale such as a ruler, a good rule of thumb is to let the uncertainty be equal to half the smallest division on the scale being used.



Using a ruler with a mm scale, the length of the leaf seems to be 74 mm. The smallest division is 1 mm, so the uncertainty is 0.5 mm.

The true length is therefore 74 mm  $\pm$  0.5 mm.

#### Practice question

4 Give the uncertainty for the following pieces of equipment:

- a large measuring cylinder with 2 cm<sup>3</sup> divisions
- b digital stopwatch timer measuring to the nearest hundredth of a second
- c thermometer with 0.1 °C divisions.

### 5.4 Calculating percentage uncertainties

The uncertainty is the range of possible error either side of the true value due to the scale being used, so the value recorded for the measurement = closest estimate  $\pm$  uncertainty.

The difference between the true value and the maximum or minimum value is called the **absolute error**.

Once the absolute error has been established for a particular measurement, it is possible to express this as a percentage uncertainty or **relative error**. The calculation to use is:

$$\text{relative error} = \frac{\text{absolute error}}{\text{measured value}} \times 100\%$$

In the leaf example above, the absolute error is  $\pm 0.5$  mm.

The relative error is therefore:

$$0.5/74 \times 100\% = 0.7\%$$

### Practice questions

5 Complete the table to show the missing values in the last two columns.

Measurement made	Equipment used	Absolute error	Relative error
Length of a fluid column in a respirometer is 6 mm	mm scale	0.5 mm	
Volume of a syringe is 12 cm <sup>3</sup> of liquid	0.5 cm <sup>3</sup> divisions		
Change in mass of 1.6 g	balance with 2 d.p.		

## 6 Scatter graphs and lines of best fit

The purpose of a scatter graph with a line of best fit is to allow visualisation of a trend in a set of data. The graph can be used to make calculations, such as rates, and also to judge the correlation between variables. It is easy to draw such a graph but also quite easy to make simple mistakes.

### 6.1 Plotting scatter graphs

The rules when plotting graphs are:

- Ensure that the graph occupies the majority of the space available:
  - In exams, this means more than half the space
  - Look for the largest number to help you decide the best scale
  - The scale should be based on 1, 2, or 5, or multiples of those numbers
- Ensure that the dependent variable that you measured is on the y-axis and the independent variable that you varied is on the x-axis
- Mark axes using a ruler and divide them clearly and equidistantly (i.e. 10, 20, 30, 40 not 10, 15, 20, 30, 45)
- Ensure that both axes have full titles and units are clearly labelled
- Plot the points accurately using sharp pencil 'x' marks so the exact position of the point is obvious
- Draw a neat best fit line, either a smooth curve or a ruled line. It does not have to pass through all the points. Move the ruler around aiming for:
  - as many points as possible on the line
  - the same number of points above and below the line
- If the line starts linear and then curves, be careful not to have a sharp corner where the two lines join. Your curve should be smooth
- Confine your line to the range of the points. Never extrapolate the line beyond the range within which you measured
- Add a clear, concise title.

**Remember:** Take care, use only pencil and check the positions of your points.

**Practice questions**

- 1 Use your calculated data in Topic 5.2 question 3 to plot a graph of % mass change against sucrose concentration.
- 2 For each of the tables of data:
  - a Plot a scatter graph
  - b Draw a line of best fit
  - c Describe the correlation

Turbidity of casein samples at different pH	
pH	% transmission (blue light)
9.00	99
8.00	99
6.00	87
5.00	67
4.75	26
4.50	30
4.00	24
3.75	43
3.50	64

Sodium bicarbonate concentration / %	Rate of oxygen production by pondweed / $\text{mm}^3 \text{s}^{-1}$
6.5	1.6
5.0	2.1
3.5	1.2
2.0	0.8
1.0	0.5
0.5	0.2

**Pupil Background Information**



Name	
GCSE results	
Why you chose to study science BTEC	
What are you most looking forward to about studying Science BTEC?	
What are you most apprehensive about studying BTEC?	
What areas of Biology interest you the most?	

**Please bring the completed background info sheet to your first lesson**