AQA Biology

Transition from GCSE to A Level

Moving from GCSE Science to A Level can be a daunting leap. You’ll be expected to remember a lot more facts, equations, and definitions, and you will need to learn new maths skills and develop confidence in applying what you already know to unfamiliar situations.

This worksheet aims to give you a head start by helping you:

- to pre-learn some useful knowledge from the first chapters of your A Level course
- understand and practice of some of the maths skills you’ll need.

Learning objectives

After completing the worksheet you should be able to:

- define practical science key terms
- recall the answers to the retrieval questions
- perform maths skills including:
  - converting between units, standard form, and prefixes
  - using significant figures
  - rearranging formulae
  - magnification calculations
  - calculating percentages, errors, and uncertainties
  - drawing and interpreting line graphs.
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Retrieval questions

You need to be confident about the definitions of terms that describe measurements and results in A Level Biology.

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

**Practical science key terms**

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>When is a measurement valid?</td>
<td>when it measures what it is supposed to be measuring</td>
</tr>
<tr>
<td>When is a result accurate?</td>
<td>when it is close to the true value</td>
</tr>
<tr>
<td>What are precise results?</td>
<td>when repeat measurements are consistent/agree closely with each other</td>
</tr>
<tr>
<td>What is repeatability?</td>
<td>how precise repeated measurements are when they are taken by the same person, using the same equipment, under the same conditions</td>
</tr>
<tr>
<td>What is reproducibility?</td>
<td>how precise repeated measurements are when they are taken by different people, using different equipment</td>
</tr>
<tr>
<td>What is the uncertainty of a measurement?</td>
<td>the interval within which the true value is expected to lie</td>
</tr>
<tr>
<td>Define measurement error</td>
<td>the difference between a measured value and the true value</td>
</tr>
<tr>
<td>What type of error is caused by results varying around the true value in an unpredictable way?</td>
<td>random error</td>
</tr>
<tr>
<td>What is a systematic error?</td>
<td>a consistent difference between the measured values and true values</td>
</tr>
<tr>
<td>What does zero error mean?</td>
<td>a measuring instrument gives a false reading when the true value should be zero</td>
</tr>
<tr>
<td>Which variable is changed or selected by the investigator?</td>
<td>independent variable</td>
</tr>
<tr>
<td>What is a dependent variable?</td>
<td>a variable that is measured every time the independent variable is changed</td>
</tr>
<tr>
<td>Define a fair test</td>
<td>a test in which only the independent variable is allowed to affect the dependent variable</td>
</tr>
<tr>
<td>What are control variables?</td>
<td>variables that should be kept constant to avoid them affecting the dependent variable</td>
</tr>
</tbody>
</table>
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### Biological molecules

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are monomers?</td>
<td>smaller units from which larger molecules are made</td>
</tr>
<tr>
<td>What are polymers?</td>
<td>molecules made from a large number of monomers joined together</td>
</tr>
<tr>
<td>What is a condensation reaction?</td>
<td>a reaction that joins two molecules together to form a chemical bond</td>
</tr>
<tr>
<td></td>
<td>whilst eliminating of a molecule of water</td>
</tr>
<tr>
<td>What is a hydrolysis reaction?</td>
<td>a reaction that breaks a chemical bond between two molecules and</td>
</tr>
<tr>
<td></td>
<td>involves the use of a water molecule</td>
</tr>
<tr>
<td>What is a monosaccharide?</td>
<td>monomers from which larger carbohydrates are made</td>
</tr>
<tr>
<td>How is a glycosidic bond formed?</td>
<td>a condensation reaction between two monosaccharides</td>
</tr>
<tr>
<td>Name the three main examples of polysaccharides.</td>
<td>glycogen, starch, cellulose</td>
</tr>
<tr>
<td>Describe Benedict's test for reducing sugars</td>
<td>gently heat a solution of a food sample with an equal volume of</td>
</tr>
<tr>
<td></td>
<td>Benedict's solution for five minutes, the solution turns orange/brown if</td>
</tr>
<tr>
<td></td>
<td>reducing sugar is present</td>
</tr>
<tr>
<td>Name the two main groups of lipids</td>
<td>phospholipids, triglycerides (fats and oils)</td>
</tr>
<tr>
<td>Give four roles of lipids</td>
<td>source of energy, waterproofing, insulation, protection</td>
</tr>
<tr>
<td>What is an ester bond?</td>
<td>a bond formed by a condensation reaction between glycerol and a</td>
</tr>
<tr>
<td></td>
<td>fatty acid</td>
</tr>
<tr>
<td>Describe the emulsion test for lipids</td>
<td>mix the sample with ethanol in a clean test tube, shake the sample,</td>
</tr>
<tr>
<td></td>
<td>add water, shake the sample again, a cloudy white colour indicates</td>
</tr>
<tr>
<td></td>
<td>that lipid is present</td>
</tr>
<tr>
<td>What are the monomers that make up proteins?</td>
<td>amino acids</td>
</tr>
<tr>
<td>Draw the structure of an amino acid</td>
<td></td>
</tr>
<tr>
<td>How is a peptide bond formed?</td>
<td>a condensation reaction between two amino acids</td>
</tr>
<tr>
<td>What is a polypeptide?</td>
<td>many amino acids joined together</td>
</tr>
<tr>
<td>Describe the biuret test for proteins</td>
<td>mix the sample with sodium hydroxide solution at room temperature,</td>
</tr>
<tr>
<td></td>
<td>add very dilute copper(II) sulfate solution, mix gently, a purple colour</td>
</tr>
<tr>
<td></td>
<td>indicates that peptide bonds are present</td>
</tr>
<tr>
<td>How does an enzyme affect a reaction?</td>
<td>it lowers the activation energy</td>
</tr>
<tr>
<td>Give five factors which can affect enzyme action</td>
<td>temperature, pH, enzyme concentration, substrate concentration,</td>
</tr>
<tr>
<td></td>
<td>inhibitor concentration</td>
</tr>
<tr>
<td>What is a competitive inhibitor?</td>
<td>a molecule with a similar shape to the substrate, allowing it to occupy</td>
</tr>
<tr>
<td></td>
<td>the active site of the enzyme</td>
</tr>
<tr>
<td>What is a non-competitive inhibitor?</td>
<td>a molecule that changes the shape of the enzyme by binding</td>
</tr>
</tbody>
</table>
somewhere other than the active site.
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Maths skills

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 International – 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 (m²), cubic metre (m³), 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.

<table>
<thead>
<tr>
<th>Multiplication factor</th>
<th>Prefix</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>10⁹</td>
<td>giga</td>
<td>G</td>
</tr>
<tr>
<td>10⁶</td>
<td>mega</td>
<td>M</td>
</tr>
<tr>
<td>10³</td>
<td>kilo</td>
<td>k</td>
</tr>
<tr>
<td>10⁻²</td>
<td>centi</td>
<td>c</td>
</tr>
<tr>
<td>10⁻³</td>
<td>milli</td>
<td>m</td>
</tr>
<tr>
<td>10⁻⁶</td>
<td>micro</td>
<td>µ</td>
</tr>
<tr>
<td>10⁻⁹</td>
<td>nano</td>
<td>n</td>
</tr>
</tbody>
</table>

Practice questions

1. A burger contains 4 500 000 J of energy. Write this in:
   a kilojoules   b megajoules.

2. HIV is a virus with a diameter of between 9.0×10⁻⁸ m and 1.20×10⁻⁷ m.
   Write this range in nanometres.

1.2 Powers and indices

Ten squared = 10 × 10 = 100 and can be written as 10². This is also called ‘ten to the power of 2’.

Ten cubed is ‘ten to the power of three’ and can be written as 10³ = 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, 2⁰ = 1.
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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 $10^5 + 10^4$
- b $10^3 + 10^6$
- c $10^2 + 10^{-4}$
- d $100^2 + 10^2$

1.3 Converting units

When doing calculations, it is important to express your answer using sensible numbers. For example, an answer of 6230 μm 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.

$488,889 \div 10^3 = 488.889$ 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
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5. Calculate the following conversions:
   a. 0.004 m into mm
   b. 130 000 ms into s
   c. 31.3 ml into μl
   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 μl
   c. 68 000 ms
   d. 0.009 cm

2 Decimals, standard form, and significant figures

2.1 Decimals numbers

A decimal number has a decimal point. Each figure before the point is a whole number, and the figures after the point represent fractions.

The number of decimal places is the number of figures after the decimal point. For example, the number 47.38 has 2 decimal places, and 47.380 is the same number to 3 decimal places.

In science, you must write your answer to a sensible number of decimal places.

Practice questions

1. New antibiotics are being tested. A student calculates the area of clear zones in Petri dishes in which the antibiotics have been used. List these in order from smallest to largest.
   0.0214 cm$^2$  0.03 cm$^2$  0.0218 cm$^2$  0.034 cm$^2$

2. A student measures the heights of a number of different plants. List these in order from smallest to largest.
   22.003 cm  22.25 cm  12.901 cm  12.03 cm  22 cm

2.2 Standard form

Sometimes biologists need to work with numbers that are very small, such as dimensions of organelles, or very large, such as populations of bacteria. In such cases, the use of scientific notation or standard form is very useful, because it allows the numbers to be written easily.

Standard form is expressing numbers in powers of ten, for example, $1.5 \times 10^7$ microorganisms.

Look at this worked example. The number of cells in the human body is approximately 37 200 000 000 000. To write this in standard form, follow these steps:

Step 1: Write down the smallest number between 1 and 10 that can be derived from the number to be converted. In this case it would be 3.72

Step 2: Write the number of times the decimal place will have to shift to expand this to the original number as powers of ten. On paper this can be done by hopping the decimal over each number like this:

until the end of the number is reached.

In this example that requires 13 shifts, so the standard form should be written as

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3.72 × 10^{13}.

For very small numbers the same rules apply, except that the decimal point has to hop backwards. For example, 0.000 000 45 would be written as 4.5 × 10^{-7}.

Practice questions

3. Change the following values to standard form.
   a 3060 kJ   b 140 000 kg   c 0.000 18 m   d 0.000 004 m

4. Give the following numbers in standard form.
   a 100   b 10 000   c 0.01   d 21 000 000

5. Give the following as decimals.
   a 10^6   b 4.7 × 10^9   c 1.2 × 10^{12}   d 7.96 × 10^{-4}

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   74.1

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 × 10^{-5}   1.56 × 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 × 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?

\[
\text{magnification} = \frac{\text{image size (mm)}}{\text{object size (mm)}} \quad \text{or} \quad M = \frac{12}{0.06} = 200
\]

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 Brackets, Indices (functions such as squaring or powers), Division, Multiplication, Addition, Subtraction.

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 \( D \)

\[
\text{where } n = \text{number of each species}, \quad N = \text{grand total of all species}, \quad \text{and } D = \text{diversity}.
\]
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Remember: In this equation there is a part that needs to be done several times then summed, shown by the symbol Σ.

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.

You can use the algebra you have learnt in Maths to rearrange equations, or you can use a triangle like the one shown.

Cover the quantity you want to find. This leaves you with either a fraction or a multiplication:

\[
M = \frac{I}{O} \quad O = \frac{I}{M} \quad I = M \times O
\]

Practice questions

6 A fat cell is 0.1 mm in diameter. Calculate the size of the diameter seen through a microscope with a magnification of \( \times50 \).

7 A Petri dish shows a circular colony of bacteria with a cross-sectional area of 5.3 cm\(^2\). Calculate the radius of this area.

8 In a photograph, a red blood cell is 14.5 mm in diameter. The magnification stated on the image is \( \times2000 \). Calculate the real diameter of the red blood cell.

9 Rearrange the equation \( 34 = \frac{2a}{135} \times 100 \) and find the value of \( a \).