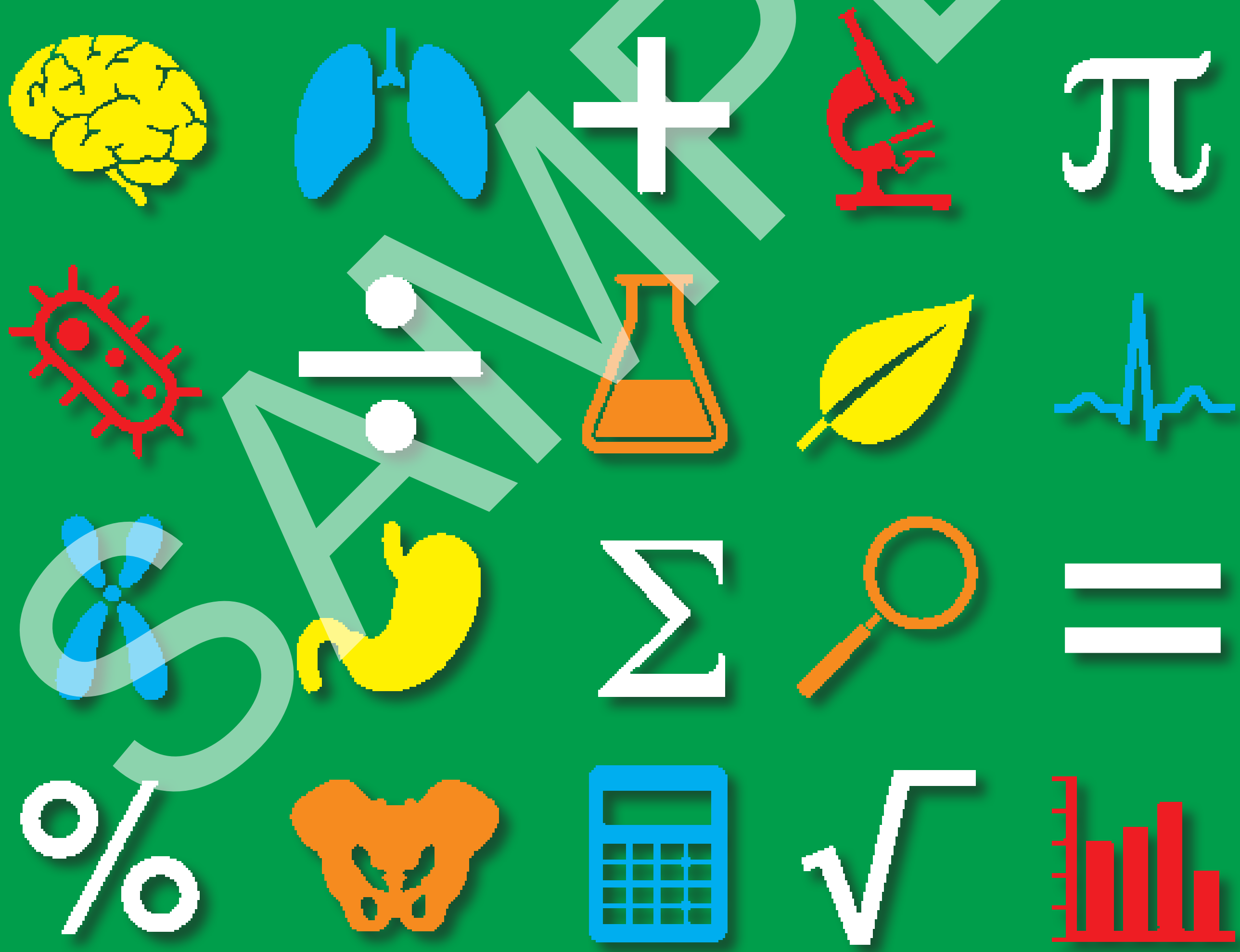
Essential Maths Skills

for AS/A-level

Biology

Dan Foulder



Series Editor Heather Davis
Educational Consultant with Cornwall Learning

PHILIP ALLAN FOR
HODDER EDUCATION
LEARN MORE

Contents

The listed content is assessed by the awarding bodies AQA, OCR, Pearson Edexcel and WJEC at AS and A-level. **The content listed in bold is only specified to be assessed at A-level.**

3 Algebra

Algebraic symbols

Change the subject of an equation

Logarithms in relation to quantities that range over several orders of magnitude

4 Graphs

Graphs and histograms

$y = mx + c$

Determining the intercept of a graph

Calculating rate of change from a graph showing a linear relationship

Measuring the rate of change with the slope of a tangent to a curve

5 Geometry and trigonometry

Circumferences, surface areas and volumes of regular shapes

Exam-style questions

Appendix: AS and A-level skills

1 Arithmetic and numerical computation

Appropriate units in calculations

Units are very important in biology. Without them numerical values are often meaningless and leaving them out will cost you marks in the exam. You should ensure you can use appropriate units across all calculations and data handling and interconvert different units. You should also be able to derive units where appropriate, for example, in a rate calculation.

A huge range of units is used in biology. You should use the internationally recognised SI units whenever possible (see Table 1.1).

The following table shows how prefixes can be used to give bigger and smaller versions of SI units for length (m), mass (g), volume (m^3) and surface area (m^2).

Table 1.1 SI units

Prefix	Factor	Examples
Deci (d)	1×10	dm^3
Kilo (k)	1×1000	kg, km, km^2
Centi (c)	$\frac{1}{100}$	cm, cm^3
Mili (m)	$\frac{1}{1000}$	mm, mg, mm^3
Micro (μ)	$\frac{1}{100\,000}$	μm, μg
Nano (n)	$\frac{1}{1\,000\,000\,000}$	nm, ng

Using the SI unit for length:

0.001 km = 1 m = 100 cm = 1000 mm = 1 000 000 μm = 1 000 000 000 nm

It's important that you select the appropriate unit for each situation. Clearly it would be inappropriate to give the length of an organism in kilometres and, similarly, only the smallest organisms or structures would have their lengths measured in micrometres.

In some cases it is not appropriate to apply a unit to a numerical value, for example, the absorbance measured by a colorimeter. In these cases arbitrary units (sometimes abbreviated to AU) can be given. These units are not standard, cannot be interconverted with any other units and apply only to the results of that particular piece of equipment.

A Worked examples

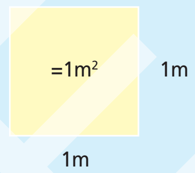
a What is the length in mm of a bacteria 50 µm long?

As there are 1000 µm in 1 mm you simply divide the value by 1000.

$$= \frac{50}{1000}$$

$$= 0.05\ \text{mm}$$

b The total surface area of alveoli in a human lung was estimated at 35 m². What is this in cm²? Show your working.



- Areas are given by lengths squared (e.g. m², cm², mm²).
- As 1 m contains 100 cm, 1 m² = 100 cm × 100 cm or 10 000 cm².
- Similarly 1 cm² = 10 mm × 10 mm = 100 mm².

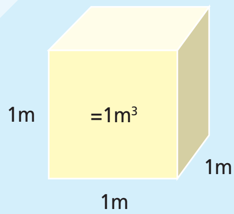
In this case as 1 m² = 10 000 cm² you must multiply 35 by 10 000.

$$= 35 \times 10\,000$$

$$= 350\,000\ \text{cm}^2$$

c The human body contains 4700 cm³ of blood. What is this volume in m³? Show your working.

Volumes are given by m³ or 1m × 1m × 1m.



- As 1m contains 100cm, 1m³ = 100cm × 100cm × 100cm or 1 000 000cm³.
- Similarly 1 cm³ = 10 mm × 10 mm × 10 mm = 1000 mm³.

In this case as 1 m³ = 1 000 000 cm³ you must divide 4700 by 1 000 000.

$$= \frac{4700}{1\,000\,000}$$

$$= 0.0047\ \text{m}^3$$

You can also get the correct answer by 4700 × 0.000 001. This is because 1 cm³ = 0.000 001 m³.

d In an enzyme investigation 10 g of product was produced in 30 minutes. What unit would be most appropriate for the rate of this reaction? Calculate the rate of the reaction.

- When measuring mass produced in time, the unit needs to include both mass and time.
- When calculating a rate, the time always goes second in the unit, e.g. mass per time.
- In this case it seems most appropriate to use grams per minute which should be written as g min⁻¹.

To calculate the rate of the reaction you need to divide the mass by the time.

$$\text{Rate} = \frac{\text{mass}}{\text{time}}$$

$$= \frac{10}{30}$$

$$= 0.33$$

This gives us a rate of 0.33 g min⁻¹.

This can be converted into g per second by multiplying by 60. This gives a rate of 19.8 g s⁻¹

B Guided questions

Copy out the workings and complete the answers on a separate piece of paper.

1 **What is the mass in grams of a 15 kg soil sample?**

As there are 1000 g in 1 kg you simply multiply the mass in g by 1000.

$= 15 \times 1000$

$=$ ________________ g

2 **The volume of solution in an investigation was given as 650 mm^3. What is the volume of this solution in cm^3?**

There are 1000 mm^3 in 1 cm^3.

3 **A student was carrying out an investigation into the rate of change in volume of air in the lungs during a period of exercise. What would be the most appropriate unit to use in this investigation?**

As the student is investigating rate the unit will require a volume component and a time component.

C Practice questions

4 A sample of water from a lake exhibiting signs of eutrophication had a volume of 3.6 dm^3. What is the volume of this sample in cm^3?

5 In an A-level biological investigation it would be unusual to see volumes given in m^3. Explain why.

6 A measuring cylinder would not be an appropriate piece of apparatus to measure a volume in mm^3. Explain why.

7 a An ecologist was comparing the flow of energy in a small woodland and a larger area of grassland over several years. When drawing pyramids of energy to compare these two areas what would be the most suitable unit to use?

b This same unit would not be suitable for studying energy flow in aquatic ecosystems. Explain why.