Yr12 Biology Summer Project

Good maths skills are essential in order to achieve the top grades in both AS and A2 Biology. Below are the mathematical requirements set out by the AQA exam board.

Task 1. Read through the mathematical requirements and identify any areas you are unsure of. (the points in **bold** are requirements for A2 Biology only)

Arithmetic and Computation	• recognise and use expressions in decimal and standard form • use ratios, fractions and percentages • make estimates of the results of calculations (without using a calculator) • understand the symbols > and < • use calculators to find and use mean, standard deviations and xn, $1/x$, $\sqrt{x}$
Handling data	• use an appropriate number of significant figures • find arithmetic means • construct and interpret frequency tables, bar charts and histograms • **understand the principles of sampling as applied to biological data** • **distinguish between chance and probability and understand the importance of chance and probability when interpreting data** • understand the terms mean, median and mode and standard deviation • use a scatter diagram to identify positive and negative correlation between two variables • **select and use a simple statistical test (see Teacher Resource Bank for further guidance)** • **Candidates are not required to recall statistical formulae but will be provided with an appropriate data sheet when necessary.**
Algebra	• change the subject of an equation • substitute numerical values into algebraic equations using appropriate units for physical quantities • understand the use of logarithms in relation to quantities that range over several orders of magnitude.
Graphs	• translate information between graphical and numerical forms • plot two variables from experimental or other data using appropriate Institute of Biology conventions • calculate rate of change from a graph showing a linear relationship • draw and use the slope of a tangent to a curve as a measure of rate of change.
Geometry	• visualise three dimensional forms from two dimensional representations of three dimensional objects • calculate circumferences and areas of circles, surface areas and volumes of regular blocks and cylinders when provided with appropriate formulae.

Standard Form.

Why use standard form?

Standard form is used to make very large or very small numbers easier to read.

It is difficult to put large or small numbers in order of size because of this. Standard form makes this easier.

Standard form shows the magnitude (size) of the number as powers of ten.

e.g.	1.234×10^4	1.234×10^{-4}
This means	$1.234 \times (10 \times 10 \times 10 \times 10)$	$1.234 \times(1 \div 10 \div 10 \div 10 \div 10)$
Which is	12340	0.0001234

An easy method to work out the actual value from standard form is by moving the decimal point in the appropriate direction the same number of times as the order of magnitude.

E.g 1.5×10^3 1.5 . . . so the answer is 1500

Task 2.

2a. Convert these numbers into normal form.

a) $5.239 \times 10^3 = 5.239 \times (10 \times 10 \times 10)$

b) 4.543×10^4 c) 9.382×10^2 d) 6.665×10^6

e) 1.951×10^2 f) 1.905×10^5 g) 6.005×10^3

2b. Convert these numbers to standard form.

a) 0.000567 b) 0.987 c) 0.0052

d) 0.0000605 e) 0.008 f) 0.0040302

Metric Conversion

Changing between m, mm, µm and nm.

1m = 1000mm	1mm = 1000µm
1m = 1000 000µm	1mm = 1000 000nm
1m = 1000 000 000nm	

1µm = 1000nm

This is very important for when you are calculating the actual

size or the image size of samples viewed underneath the microscope.

Task 3. Using the metric conversions in the table complete the following calculations.

a. A red blood cell is 7.5µm. How many mm?

b. Mitochondria are 0.5µm – 1.5µm. How many nm?

c. A nucleus is around 20 000nm. How many mm and µm?

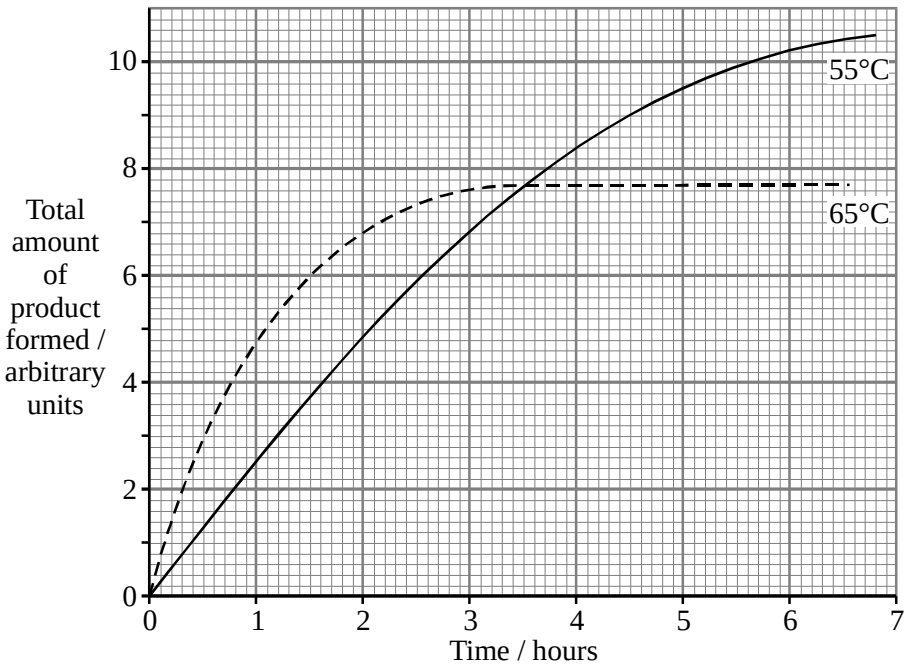
Task 4. Complete the following mathematical questions.

a) When one mole of glucose is burned, 2800 kJ of energy are released. However, when one mole of glucose is respired aerobically, only 40% of the energy released is incorporated into ATP. Each mole of glucose respired aerobically produces 38 moles of ATP.

   Calculate how much energy is incorporated into each mole of ATP. Show your working.

Answer ..... kJ

b) The total amount of product formed in an enzyme-controlled reaction was investigated at two different temperatures, 55 °C and 65 °C. The results are shown in the graph.



Explain how you would calculate the rate of the reaction at 55 °C over the first 2 hours of the investigation.

c) The roots of two groups of pea plants were placed in solutions containing radioactive potassium ions. For the experimental plants a respiratory inhibitor was added to the solution. The control plants had no respiratory inhibitor added. At regular intervals the solutions surrounding the roots were tested for radioactive potassium ions.
The table shows the results of this investigation.

Time from placing roots in solution / minutes	Concentration of radioactive potassium ions in the solutions surrounding the roots / arbitrary units	
	Experimental plants	Control plants
0	7.5	7.5
15	6.6	3.3
30	6.4	2.9
60	6.3	2.4
120	6.3	1.2
240	6.3	0.6

(i) The rate of uptake of potassium ions by the experimental plants in the first 15 minutes was 0.06 units per minute.
Calculate the rate of uptake of potassium ions by the control plants over the same time period.

Rate of uptake by control plants =.....

(1)

d) The table shows the number of cases of tuberculosis in different regions of England between 2000 and 2005

Region	**Number of cases of tuberculosis per 100 000 of the population**				
	2000	**2001**	**2002**	**2003**	**2004**
East Midlands	10.6	11.1	11.9	7.9	9.9
West Midlands	13.7	13.1	14.9	15.0	16.2
North East	5.7	7.7	6.4	6.1	6.7
North West	10.0	10.0	9.4	9.0	9.3
South East	6.1	6.6	7.3	7.4	7.3
South West	4.6	4.0	4.8	4.5	5.3

Calculate the percentage increase on the number of cases of tuberculosis in the south west region of England from 2000 to 2004. Show your working.

Answer.....

(2)

e) **Table A** shows the nitrogen input on a dairy farm. Table **B** shows what happens to this nitrogen.

Table A

Nitrogen input	Nitrogen content/ kg per hectare
Inorganic fertiliser and manure	259
Animal food	60
Fixation	19
Total	338

Table B

Fate of nitrogen	Nitrogen content/ kg per hectare
In plants	112
In milk and meat	67
Leaching	56
Denitrification	55
Released to air as ammonia	48
Total	338

(a) Calculate the percentage of the total nitrogen input incorporated into milk and meat.

.....%

f) Fur seals live in Antarctic seas. They feed on fish and shrimp-like animals called krill. During the summer the fur seals come ashore to breed. The table shows the number of fur seals breeding on an Antarctic island from 1956 to 1986.

Year	Number of adult fur seals
1956	100
1964	100
1970	200
1975	100
1976	1600
1981	2900
1983	3100
1986	11700

(a) (i) Calculate the mean annual growth rate of this fur seal population over the period 1981 – 1986. Show your working.

Answer .....

Enzyme Activity and Lactose Intolerance

You have covered enzymes at GCSE as part of your B2 specification. Before you begin with the A level task, answer the quick questions on A4 paper to refresh your memory of the topic of enzymes:

Task 1: GCSE quick re-cap

1. What are enzymes made from?

2. What part of the enzyme has a very unique shape?

3. What fits into this part of the enzyme?

4. What structure is formed when they fit together?

5. Why does enzyme activity increase when the temperature is increased from 0-38°C?

6. What happens to an enzyme after approximately 40°C and why is it not functional after this point?

7. What other factor can cause enzymes to do this?

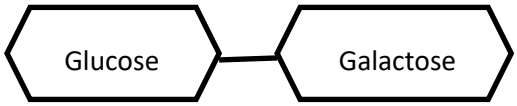
8. Name three enzymes inside the body. Identify their substrates and what is formed by each one once the reaction has being catalysed.

Task 2: Lactose Intolerance

Glucose is a type of sugar known as a **monosaccharide.** Fructose and galactose are also monosaccharides. This means that they are single units of sugar.

A monosaccharide

Lactose is a molecule known as a **disaccharide.** It is made up of two sugar units; one of them being glucose and the other one being galactose. They are joined together by a glycosidic bond.



Lactose (a disaccharide)

Lactose is a sugar found in milk. Babies produce large amounts of an enzyme called lactase because milk is their only food source. This is an enzyme that breaks down lactose (a disaccharide) by breaking the glycosidic bond. This breaks it down into glucose and galactose (monosaccharides). During childhood, the ability to produce lactase diminishes and adults produce much less than babies. However, in some adults the ability to produce lactase completely stops and they are not able to produce the enzyme at all. They are known as being lactose intolerant. This means that they have no means of breaking down the lactose, which can be problematic for them.

Read the information on the following web link:

http://www.nhs.uk/conditions/lactose-intolerance/pages/introduction.aspx

Read through the symptoms, causes, diagnosis and treatment section of the NHS website.

Use the information to explain what lactose intolerance is and what it is caused by. It is expected that you explain it in as much **scientific detail** as possible. You may wish to use other websites for part of your research.

Task 3: Enzymes in Unit 1 AS Biology

Enzymes are also a topic in AS Biology.

Complete the exam questions at the end of this section on enzymes. Remember – these exam questions are AS level standard, not GCSE.

1. Lactose is a sugar which is found in milk. It can spoil milk products such as ice cream by producing an unpleasant sandy texture. Lactase is an enzyme which is used in making ice cream. It breaks down lactose to glucose and galactose. When ice cream is made, lactase is added to milk and left for about a day at 5 °C. The reaction is very slow.

(a) Use your knowledge of enzymes to explain why the rate of this reaction is very slow at
5 °C.

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.....(3)

(b) Adult cats are unable to digest lactose. Lactase is used to reduce the amount of lactose in milk for cats. The milk is heated to sterilise it. It is then cooled and the lactase added before packaging. Explain why lactase is added after cooling the milk rather than before heating it.

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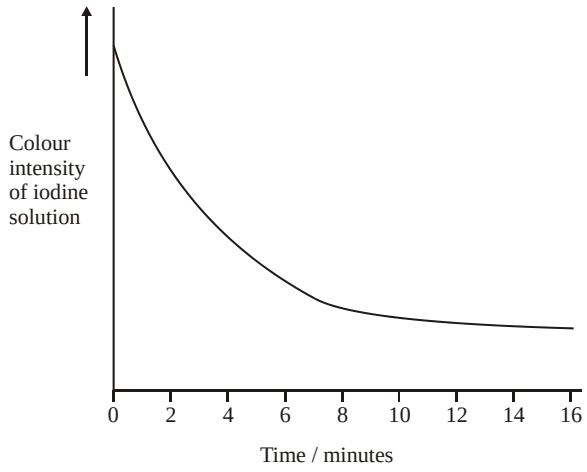
(2)

2. In an investigation into carbohydrase activity, the contents from part of the gut of a small animal were collected. The contents were added to starch solution at pH 7 and kept in a water bath at 25°C. At one-minute intervals, samples were removed and added to different test tubes containing dilute iodine solution. The colour intensity of each sample was determined. The graph shows the results.



(a) Explain the change in colour intensity.

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.....(2)

(b) Draw clearly labelled curves on the graph to show the expected result if the experiment was repeated

(i) at 35 °C;

(ii) at pH 2.

(2)

(c) Explain how

(i) raising the temperature to 35 °C affects carbohydrase activity;

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(ii) decreasing the pH affects carbohydrase activity.

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