AQA Biology
GCSE Student calculation sheet B3.1

Name .... **Class** .... **Date** ....

Constructing line graphs

Specification references

- Mathematical requirement:
  2b – Find arithmetic means
  4a – Translate information between graphical and numeric form
  4c – Plot two variables from experimental or other data

Aims

It is often easier to see patterns in data when the information is displayed on a graph rather than in a table.

In this activity you will learn how to construct line graphs. Line graphs are normally used to represent continuous data – data where the independent variable can take any value within a range of data.

Learning outcomes

After completing this activity, you should be able to:

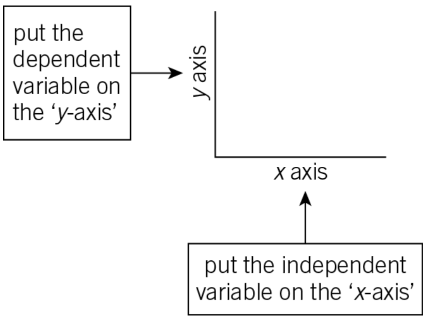
- translate information between graphical and numeric form
- construct line graphs.

Background

When studying the effect of temperature on an enzyme-controlled reaction, the data produced are continuous. Although you would only choose a few temperatures to investigate, there is a large variety that you could choose from.

How to construct a line graph:

1 Label the *x*-axis with the independent variable and the *y*-axis with the dependent variable. The units of measurement should be added after the description of the variable.



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2 Choose a sensible scale for each axis – your scale should be evenly spaced on your graph paper so that your graph fills the whole page.

Tip – The points plotted should occupy at least half of the graph paper in each direction (*x* and *y*).

Tip – Each large square on your paper should represent a simple value, for example, 1, 2, 5, or 10.

3 Plot your data values neatly and accurately – use a ruler to measure accurately across from the *y*-axis and up from the *x*-axis to find the position of your data value. Each data value should be plotted neatly as a little cross – do not use dots.

Tip – Make sure you use a sharp pencil to mark your data values. The crosses should be small, with the centre of the cross at the exact point given by your data.

4 Where appropriate, draw a line of best fit. When drawing a line of best fit, do not join your crosses up 'dot-to-dot'; instead, a smooth line should be drawn through the points. For further guidance on drawling lines of best fit refer to Chapter 3 – Student calculation sheet *Curved lines of best fit.*

Worked example

A student collected data on the time taken for hydrogen peroxide to decompose in the presence of a biological catalyst.

pH	Time to produce 1 cm^3 O_2 gas in s
4.5	8
5.0	14
5.5	20
6.0	26
6.5	32

To plot this data as a graph, first label the axes. The *x*-axis would be 'pH' and the *y*-axis 'time in s'
Choose a scale which will allow you to plot the points so that they occupy at least half of the graph paper. The *x*-axis in this case may cover the pH values 4–7.

Tip – Remember to state units when labelling axes.

Tip – Scales do not need to start at zero. If starting a scale using a different value, ensure the origin is clearly labelled with the appropriate value.

Plot the points. Where repeats have been used, plot the arithmetic mean value.

Join the points or add a line of best fit, as appropriate.

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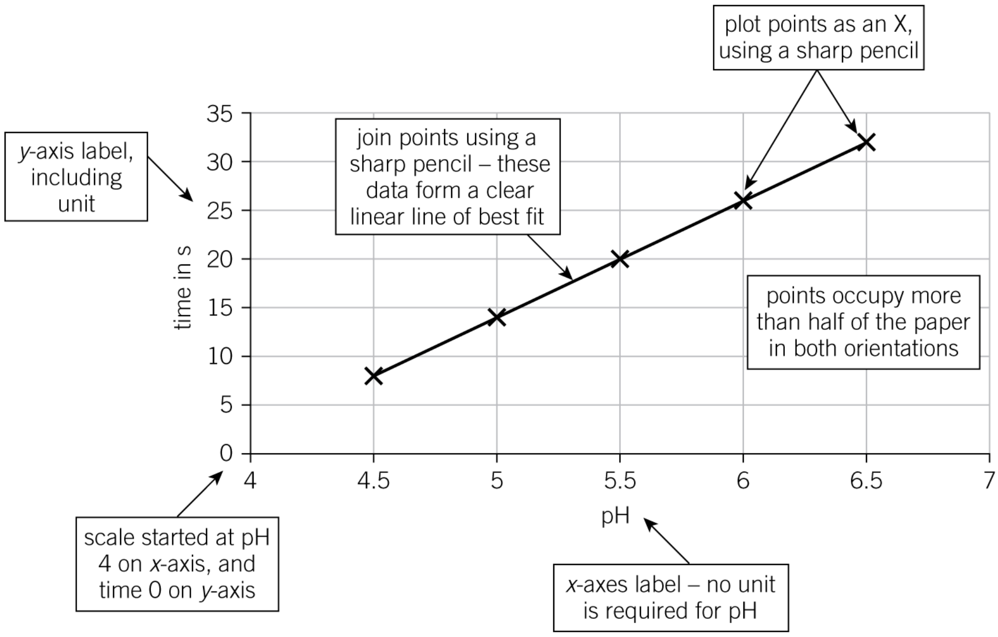
The following graph shows how your graph should be plotted.



Questions

1 A student investigates how the temperature of an enzyme affects the time taken for starch to be digested into glucose. The student collates her data, and plots a graph of the data.

a State why a line graph would be an appropriate choice of graph for this investigation.

.... (1 mark)

b State an appropriate label for the *x*-axis and *y*-axis.

....

.... (2 marks)

2 The following set of data shows the link between the height of a plant and its mass:

Height of plant in cm	Mass of plant in g
2	8
4	16
7	28
11	40
16	58

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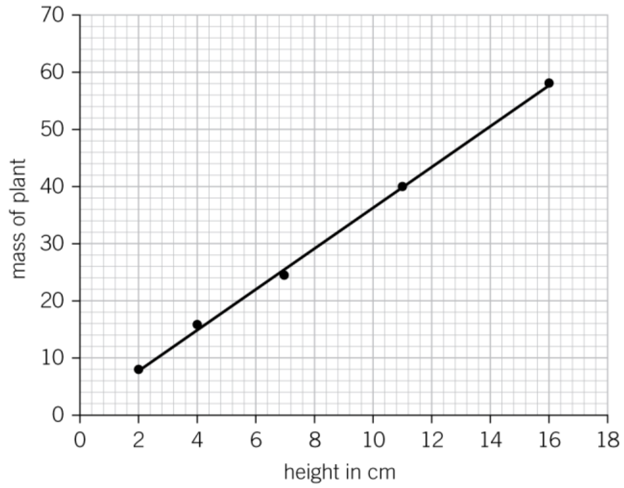
The data were plotted graphically, as follows:



a There are three errors in the student's graph. Label the errors on the graph. (3 marks)

b State the corrections which should be made to ensure the graph is correct.

....

....

.... (3 marks)

3 Steven collected data on how the enzyme concentration affects the rate of an enzyme-controlled reaction. His results are below:

Relative enzyme concentration	Rate of reaction (s^{-1})		
	Repeat 1	Repeat 2	Mean
0.0	0.00	0.00	
0.5	0.06	0.04	
1.0	0.12	0.08	
1.5	0.15	0.15	
2.0	0.22	0.18	

a Complete the table by calculating the mean rate of reaction for each result. (1 mark)

b Create an appropriate graph to display these data. (4 marks)

c State the conclusion that the student can draw from this graph.

....

.... (2 marks)

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Exam-style question

Lactose is a sugar found in milk. The enzyme lactase breaks down lactose into the simple sugar glucose. A scientist investigated how the pH of the lactose solution affects the time taken (in seconds) to produce 30 mg of glucose through this digestion process.

4 a Suggest two variables the scientist should control to enable valid data is generated.

....

.... (*1 mark*)

The scientist collected the following results:

pH	Time in s				Rate of reaction (s^{-1})
	Repeat 1	Repeat 2	Repeat 3	Mean	
1	NR	NR	NR	NR	0.000
4	89	88	93		
5	28	31	31		
7	16	16	13		
9	60	57	63		
10	248	238	234		
13	NR	NR	NR	NR	0.000

NR = no result

b Calculate the mean reaction time for each lactose solution pH value.

....

.... (*2 marks*)

c Use the following equation to calculate the mean rate of reaction for each lactose pH value:

$$\text{rate of reaction} = \frac{1}{\text{time}}$$

....

.... (*2 marks*)

d Plot a graph of pH against rate of reaction. (*4 marks*)

e Using your graph, identify the optimum pH for the enzyme lactase.

.... (*1 mark*)

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f Suggest one improvement the scientist could make to the experiment to identify the optimum pH of lactase more accurately.

....

.... (*1 mark*)