



Oxford Cambridge and RSA

Monday 9 June 2025 – Morning

**GCSE (9–1) Combined Science B
(Twenty First Century Science)**

J260/04 Combined Science (Foundation Tier)

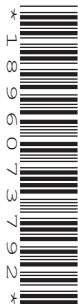
Time allowed: 1 hour 45 minutes

You must have:

- a ruler (cm/mm)
- the Data and Equation Sheet for GCSE (9–1)
Combined Science B (inside this document)

You can use:

- an HB pencil
- a scientific or graphical calculator



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

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Last name

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INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

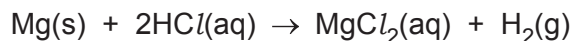
- The total mark for this paper is **75**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE

- Read each question carefully before you start your answer.

1 This question is about acids and metals.

(a) This is the symbol equation for the reaction between magnesium, and hydrochloric acid:



(i) Which gas is made when magnesium reacts with hydrochloric acid?

Tick (✓) **one** box.

Carbon dioxide

☐

Hydrogen

☐

Oxygen

☐

Steam

☐

[1]

(ii) Which salt is made when magnesium reacts with hydrochloric acid?

Tick (✓) **one** box.

Magnesium carbonate

☐

Magnesium chloride

☐

Magnesium hydroxide

☐

Magnesium oxide

☐

[1]

(iii) Complete the sentences to describe how magnesium bonds with chlorine.

Use words from the list.

gaining	ions	losing	molecules	polymers	sharing
---------	------	--------	-----------	----------	---------

Each Mg atom becomes Mg^{2+} by two electrons.

Each Cl atom becomes Cl^- by one electron.

The new particles formed, Mg^{2+} and Cl^- , are called

[3]

(b)

(i) Hydrochloric acid is made by dissolving hydrogen chloride in water.

What forms when acids dissolve in water?

Tick (✓) **one** box.

Cl^-

☐

Cl^+

☐

H^-

☐

H^+

☐

[1]

(ii) The list shows the order of reactivity of some elements from most reactive to least reactive.

Most –	Rubidium
	Potassium
	Magnesium
	Aluminium
	Carbon
	Zinc
	Iron
Least –	Copper

Why is magnesium extracted by electrolysis and **not** by reaction with carbon?

.....

..... [1]

- (c) A student investigates the reaction between magnesium and different concentrations of hydrochloric acid.

The student times how long it takes to collect 50 cm^3 of gas.

The results are shown in the table:

Concentration of hydrochloric acid (mol/dm^3)	Time taken (s)
0.2	60
0.4	30
0.6	10
0.8	5.0
1.0	2.5

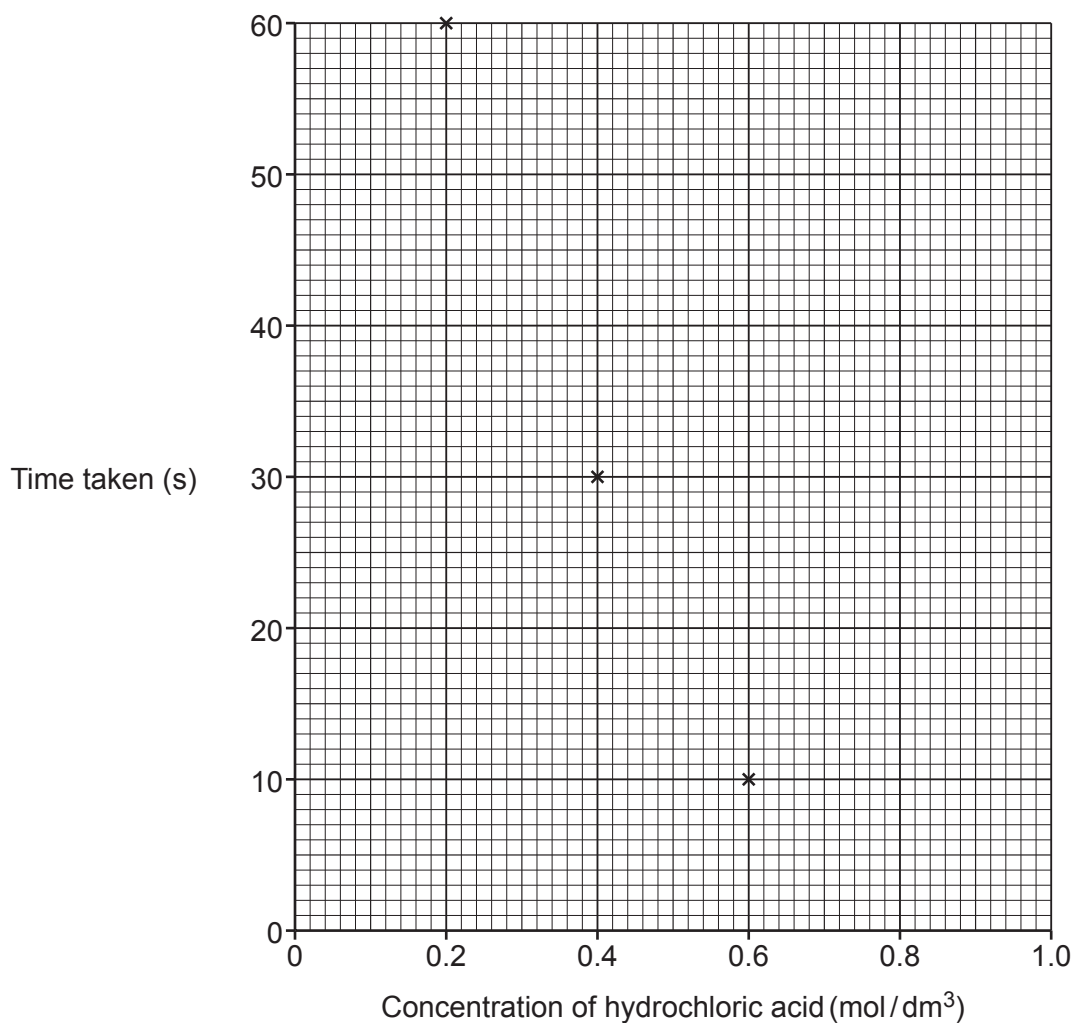
- (i) Plot the results from the table on the graph.

Three points have already been plotted.

[1]

- (ii) Draw a curve of best fit on the graph.

[1]



(iii) Describe the effect of changes in concentration on the time taken.

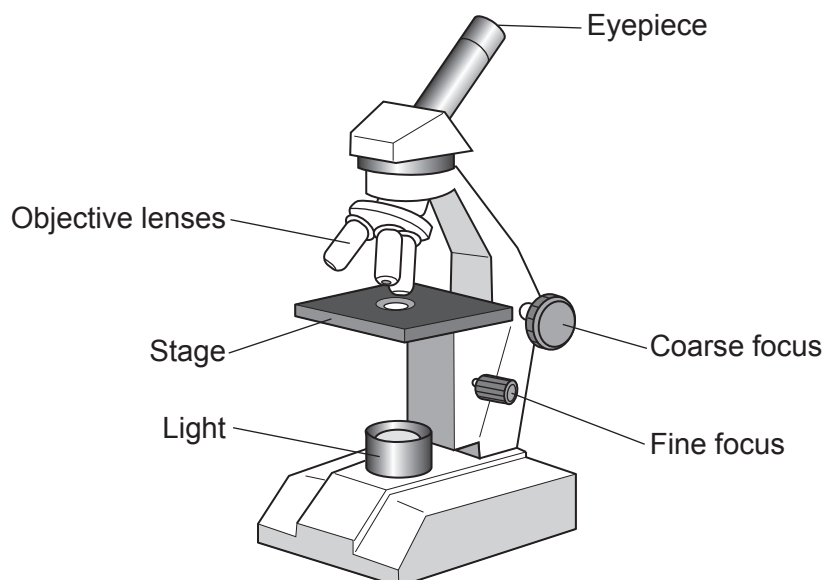
.....

.....

.....

..... [2]

- 2 A student is looking at stomata from a leaf using an optical microscope.



- (a) This is the student's method but it is **not** in the correct order:

- A Focus using the coarse focus knob.
- B Spread nail varnish on the underside of a leaf and allow to dry.
- C Place the glass slide in the middle of the stage.
- D Focus using the fine focus knob.
- E Peel off the dried nail varnish and place it on a glass slide.

Write the letters in the boxes to show the correct order of the statements.

The first one has been done for you.

B				
---	--	--	--	--

[2]

- (b) The magnification of the microscope's eyepiece is $\times 10$. The objective lens is $\times 40$.

What is the total magnification?

Use the equation:

total magnification = magnification of eyepiece lens $\times$ magnification of objective lens

Tick (✓) **one** box.

$\times 10$

☐

$\times 40$

☐

$\times 50$

☐

$\times 400$

☐

[1]

- (c) The student looks down the microscope and counts how many stomata they can see. They repeat this measurement in four other areas of the leaf.

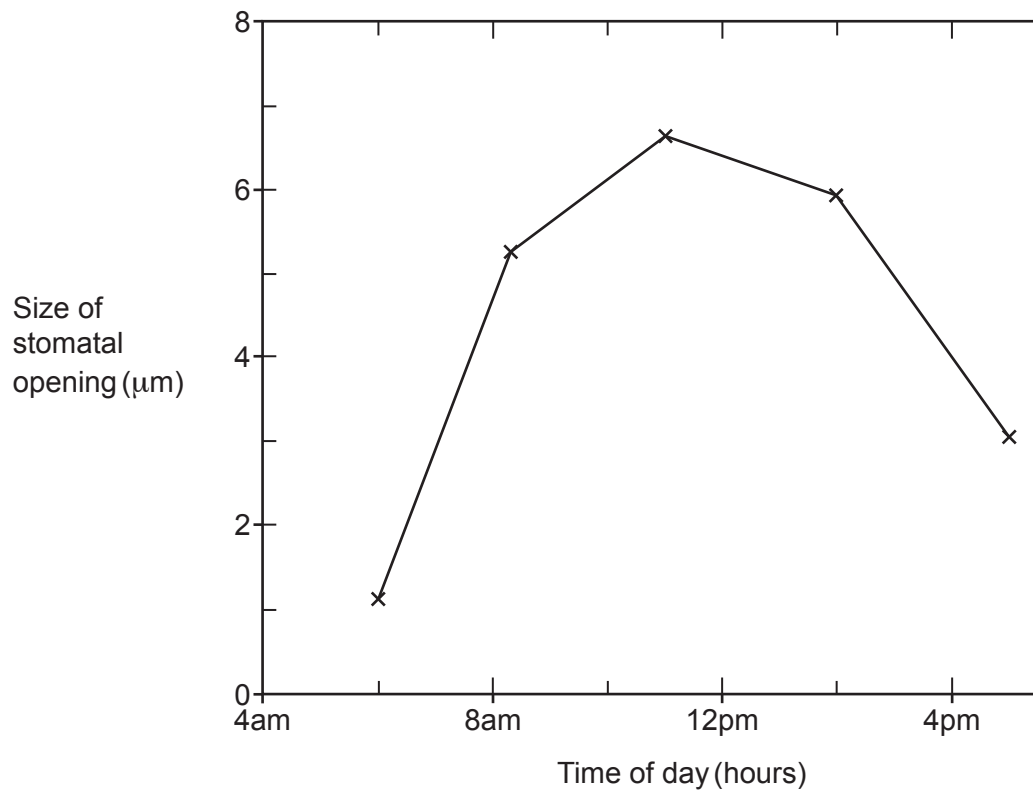
The table shows their results:

Area sampled	1	2	3	4	5
Number of stomata	36	35	32	33	34

Calculate the mean number of stomata.

Mean number of stomata = [2]

- (d) Scientists have examined how the size of a stomatal opening changes during the day. Their results are shown in the graph.



- (i) Describe the trend shown by the graph.

.....
..... [1]

- (ii) Stomata may open and close in response to environmental conditions.

Use the graph to suggest **one** environmental condition that may cause stomata to open.

..... [1]

- (e) Studies have shown that some plant species in **warming climates** have reduced the number of stomata on their leaves.

Complete the sentences to explain how this change occurred through evolution.

Use terms from the list.

chloroplasts	die	natural selection	no change
nucleus	selective breeding	survive	variation

In a population of plants, there is in the number of stomata each plant has.

Plants with lower numbers of stomata lose less water. This makes them more likely to and reproduce. Some plant species have evolved to have fewer stomata through the process of

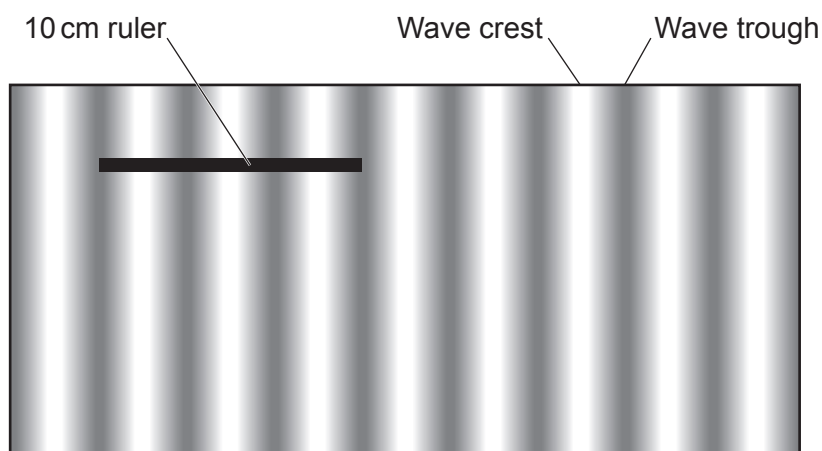
Plants rely on stomata for gas exchange.

Carbon dioxide is used in the as a reactant in photosynthesis.

[4]

- 3 A student is using a ripple tank to investigate how the speed of water waves depends on the depth of the water.

(a) The image shows the observations from one experiment.



Estimate the wavelength of the waves.

Wavelength = cm [2]

(b) The waves are generated by a vibrating bar.

The mean number of waves leaving the vibrating bar in five seconds is 18.3.

Calculate the frequency of the waves.

Frequency = Hz [2]

- (c) The student repeats the experiment with a different depth of water, and obtains new results:

Wavelength (cm)	2.5
Frequency (Hz)	4.0

Calculate the speed of these water waves.

Give your answer in **cm/s**.

Use the Data and Equation Sheet.

Speed of water waves = cm/s **[3]**

4 This question is about cardiovascular health and fitness.

(a) A student is measuring their pulse rate. They count their pulse over 60 seconds.

Describe how the student can measure their pulse.

.....
 [1]

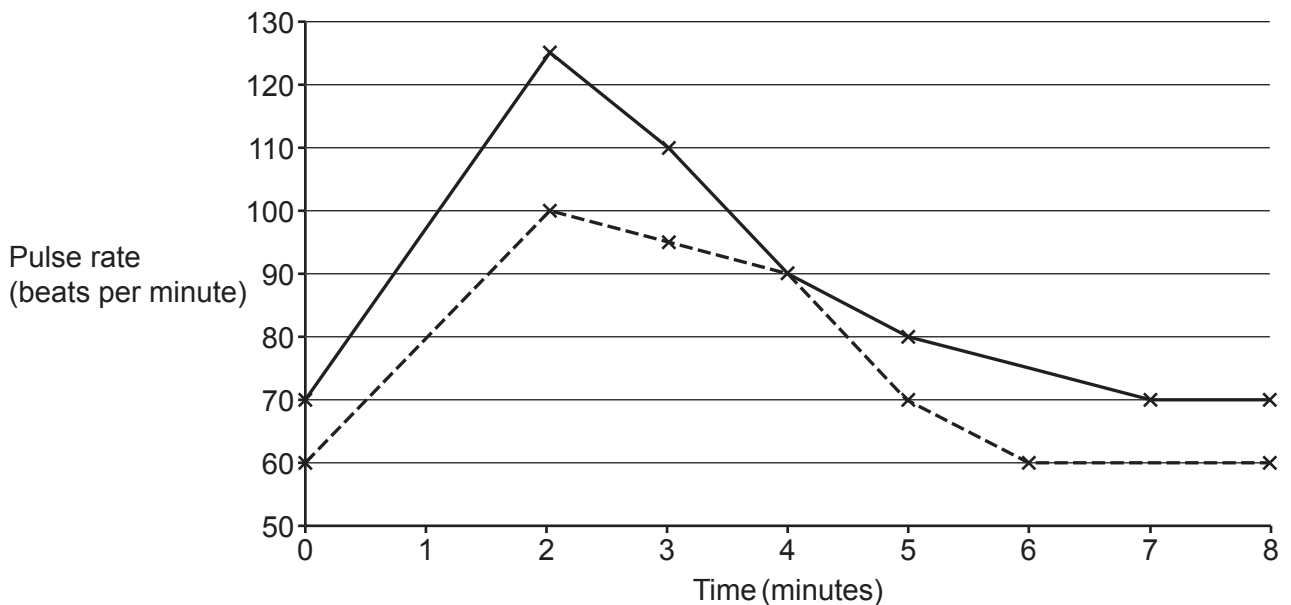
(b) Two students are investigating recovery rates using this method:

- Measure resting pulse rates.
- Exercise for 2 minutes.
- Measure pulse rate immediately after exercise.
- Measure pulse rate every minute until it returns to the resting pulse rate.

The graph shows their results.

— Student A

---- Student B



- (i) The students conclude that student **B** had a greater fitness level.

Which **two** statements support this conclusion?

Tick (✓) **two** boxes.

Student B has a lower resting pulse rate.

☐

Student B's pulse rate increased faster.

☐

Student B's pulse rate peaked at a higher value.

☐

Student B's pulse rate returned to resting sooner.

☐

[2]

- (ii) To be more confident in their conclusion, they decide to repeat their experiment.

Suggest **one** improvement to their method to increase the validity of their conclusion.

.....
 [1]

- (c) High blood pressure is a risk factor for cardiovascular disease.

Enalapril is a drug that can lower blood pressure. A doctor has recommended a patient begin taking this drug.

- (i) Suggest **one** health-related question the **patient** may ask the doctor before they begin taking this drug.

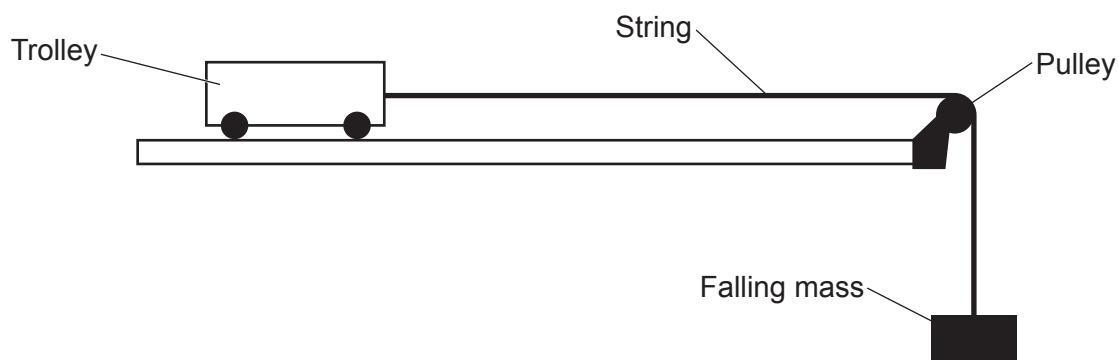
.....
 [1]

- (ii) Suggest **one** question the **doctor** should ask the patient before they prescribe them this drug.

.....
 [1]

- 5 A student is investigating how the resultant force acting on a trolley affects its acceleration.

The diagram shows the apparatus used by the student in their investigation.



(a)

- (i) Describe how the pulling force of the string on the trolley can be increased.

.....
 [1]

- (ii) Describe how the friction of the wheels of the trolley can be reduced.

.....
 [1]

- (b) The student measures the time taken for the trolley to travel a distance of 1.0 m.

- (i) Why does the student repeat this time measurement three times and then calculate the mean?

Tick (✓) **one** box.

To reduce the effect of air resistance on the result.

☐

To reduce the effect of friction on the result.

☐

To reduce the effect of random errors on the result.

☐

To reduce the effect of systematic errors on the result.

☐

[1]

- (ii) For a particular resultant force, it takes the trolley a mean time of 2.0 s to travel a distance of 1.0 m.

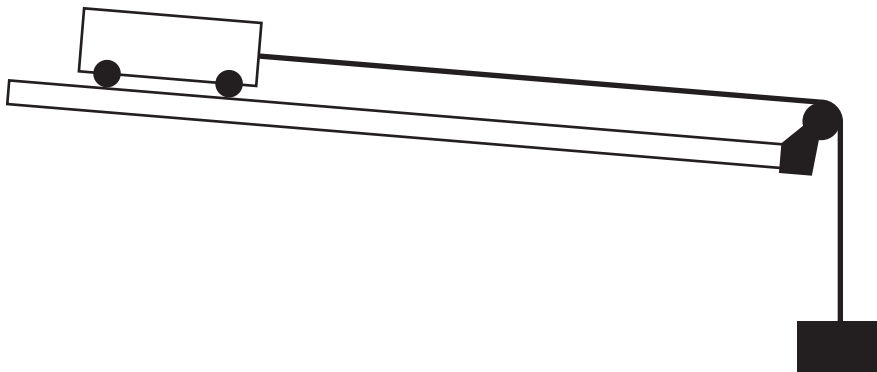
Calculate the acceleration of the trolley.

Use the equation: $\text{acceleration} = \frac{2 \times \text{distance}}{\text{time}^2}$.

Acceleration = m/s² [2]

- (c) The student raises one end of the table to compensate for friction so that the resultant force acting on the trolley is equal to the pulling force of the string.

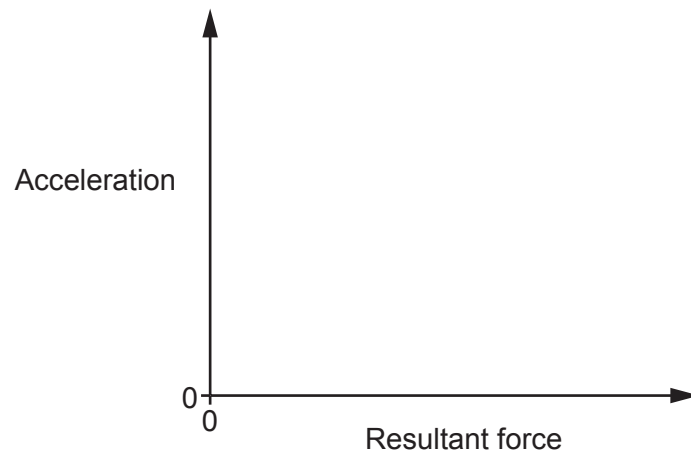
The diagram shows this change.



- (i) When the pulling force of the string is zero, the trolley travels at a constant speed down the slope.

The student repeats the experiment by changing the pulling force of the string multiple times.

Draw a line on the axes to show the expected results of the student's experiment.



[2]

- (ii) Explain your answer to (c)(i).

.....

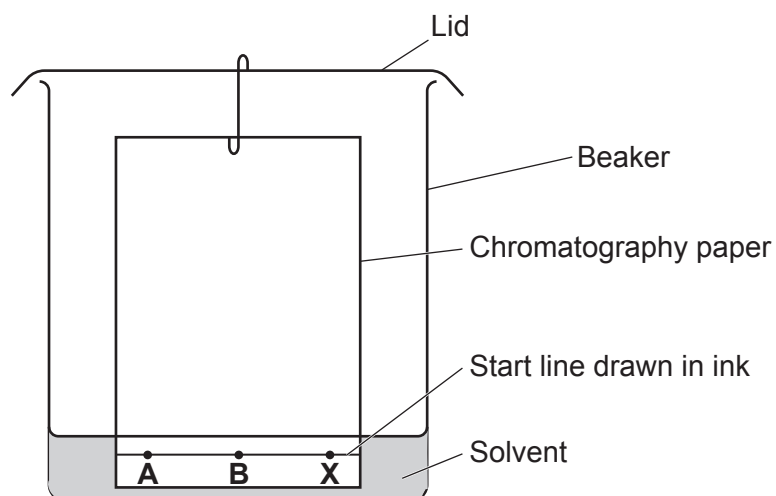
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..... [2]

6 A student is investigating the composition of some ink samples **A**, **B** and **X**, using chromatography.

(a) The student sets up the experiment as shown in the diagram.



Identify **two** mistakes that the student has made.

1.

.....

2.

.....

[2]

- (b) The student corrects their mistakes.

Ink Sample **A** is pure.

- (i) Ink Sample **X** is a mixture.

One of the substances in Ink Sample **X** travels 24 mm on the chromatogram.
The solvent travels 39 mm.

Calculate the R_f value of this substance in Ink Sample **X**.

Use the equation: $R_f = \frac{\text{distance travelled by the solute}}{\text{distance travelled by the solvent}}$

Give your answer to **2** significant figures.

R_f value = [3]

- (ii) How could you conclude from the chromatogram that Ink Sample **X** is a mixture?

.....
..... [1]

- (c) Another substance in Ink Sample **X** does **not** travel up the chromatography paper.

Suggest **one** change to the experiment that would cause this substance to travel up the paper.

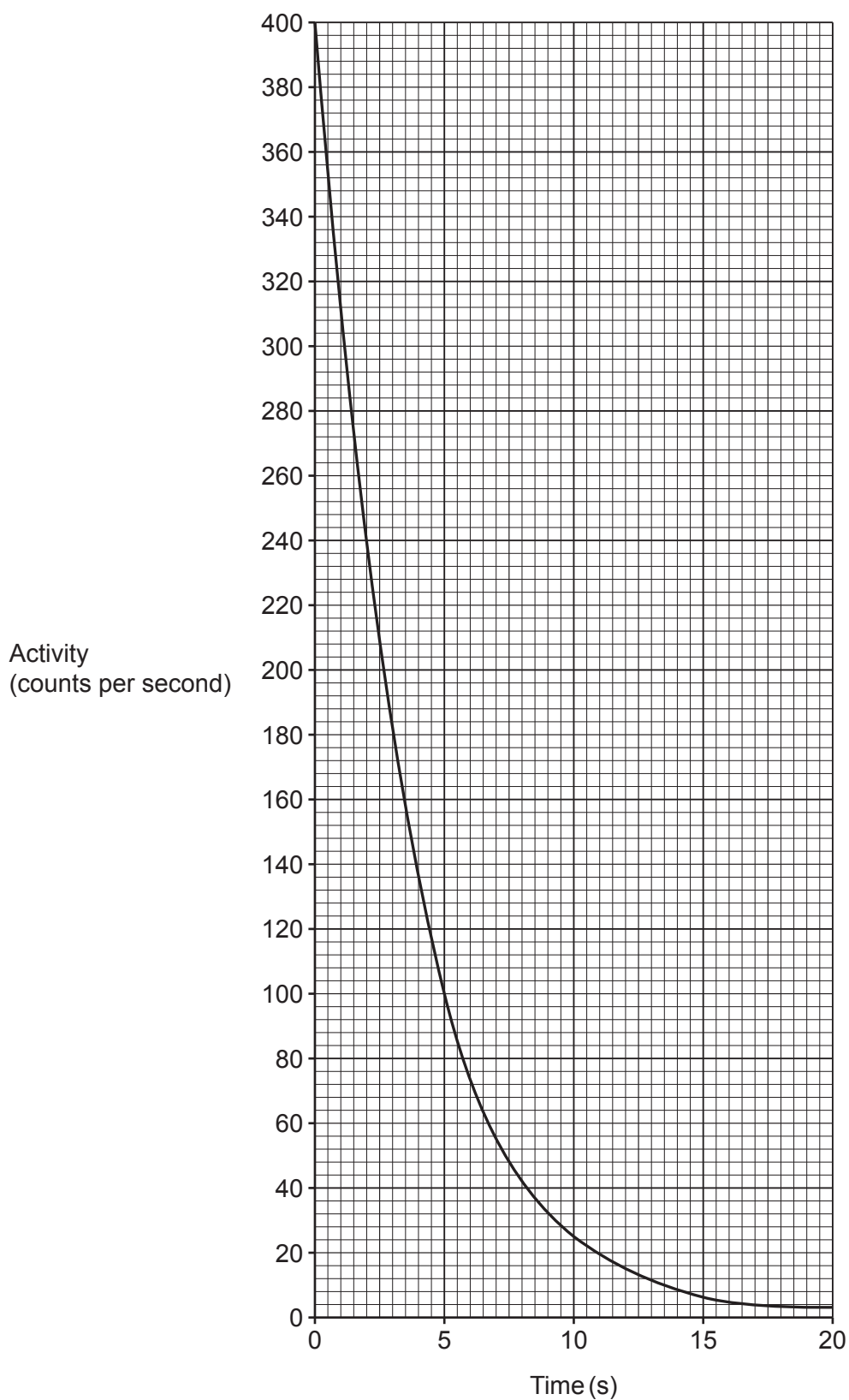
.....
..... [1]

- (d) Ink Sample **B** is also a mixture. All of the components of Ink Sample **B** have similar solubility in the solvent, but have different boiling points.

Explain why simple distillation should be used instead of chromatography to separate this ink sample.

.....
..... [1]

- 7 Carbon-15 is a radioactive isotope that emits beta particles.
The graph shows the activity of a sample of carbon-15.

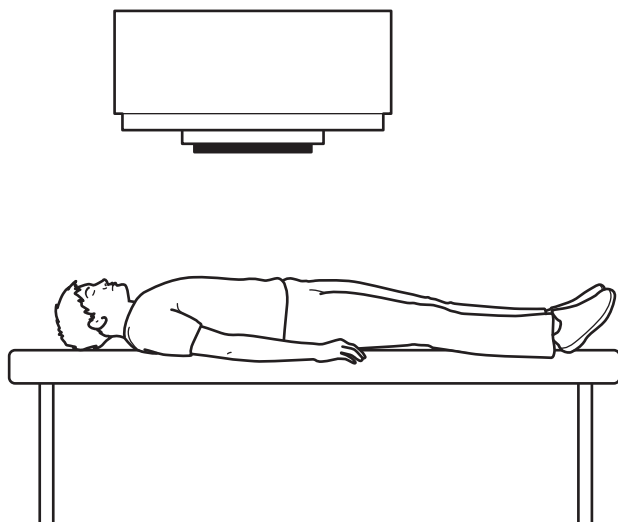


- (a) Use the graph to find the half-life of carbon-15.

Half-life = s [2]

(b)* A patient goes to a radiology department in a hospital to have a kidney scan.

A radioactive tracer is injected into the patient's arm. After a few hours, a set of images are taken on a camera. The camera uses the radiation emitted by the radioactive tracer to form an image of the kidney.



The table shows information about some radioactive isotopes that are used in radioactive tracers.

Isotope	Radiation emitted	Half-life
actinium-225	alpha particles	10 days
bromine-82	beta particles	36 hours
iodine-131	beta particles and gamma radiation	8 days
technetium-99m	gamma radiation	6 hours

Which isotope should be used for injection into the patient's arm?

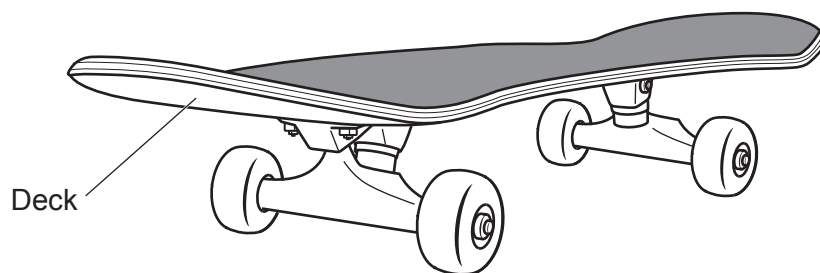
Explain your answer.

You should also consider:

- penetrating power
- ionising power.

[6]

- 8 A skater wants to buy a new skateboard.



The table shows information about three different skateboards.

Skateboard	Deck material	Tensile strength (MPa)	Stiffness (GPa)	Density (kg/m^3)
A	Wood	4	10	700
B	Glass	3400	75	2500
C	Composite	350	10	900

- (a) Suggest why the skater chooses to buy Skateboard **C**.

.....

.....

.....

..... [2]

- (b) State why the development of composite materials is beneficial when designing new products.

.....

..... [1]

- (c) The skater decides to recycle the old skateboard so that it does not take up space in landfill.

State **one** other factor that should also be considered when disposing of a skateboard.

.....
 [1]

- (d) The skateboards are transported to shops in lorries that burn diesel.

- (i) One gas that forms when diesel burns is sulfur dioxide.

Explain **one** problem caused by increased amounts of sulfur dioxide in the atmosphere.

.....

 [2]

- (ii) Carbon monoxide and nitrogen monoxide are also formed when diesel burns.

Catalytic converters help to decrease these emissions into the atmosphere by converting:

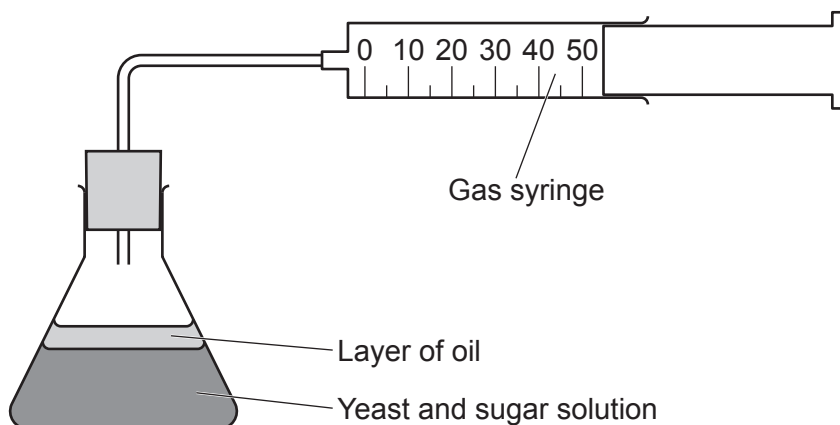
- nitrogen monoxide into nitrogen
- carbon monoxide into carbon dioxide.

Complete the equation to show the reaction that occurs in a catalytic converter.



- 9 A student is investigating the rate of anaerobic respiration in yeast using this method and the apparatus shown:

- Add glucose to a yeast solution.
- Add a layer of oil on top to prevent oxygen reaching the yeast.
- Measure the volume of carbon dioxide made in 20 minutes.
- Repeat using sucrose and maltose.



- (a) The student controls the temperature of the yeast and sugar solution to make sure their comparisons are valid.

Describe **how** the student should control the temperature.

.....
 [1]

The student's results are shown in the table:

Type of sugar	Volume of carbon dioxide collected in 20 minutes (cm ³)
Glucose	35
Sucrose	25
Maltose	30

- (b) Explain how the student could improve the accuracy of the gas volume measurements.

.....

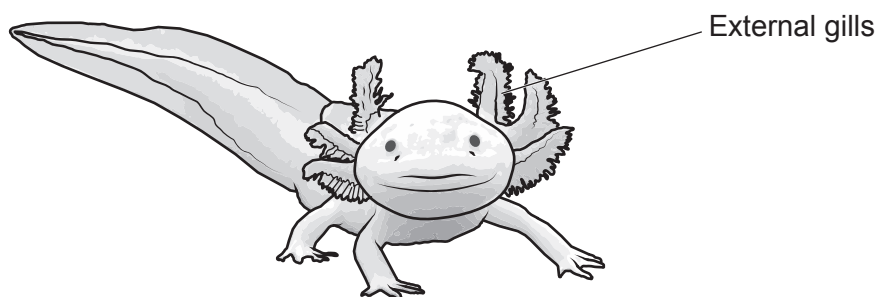
 [2]

- (c) Calculate the rate of carbon dioxide production for the yeast and **glucose** solution.

Rate of carbon dioxide production = $\text{cm}^3/\text{minute}$ [2]

- (d) Yeast cells absorb oxygen across their cell membranes.

An axolotl is a multicellular animal that lives in water. It has external gills for gas exchange.



Explain why an axolotl needs external gills for gas exchange.

Use ideas about surface area to volume ratios in your answer.

.....

.....

.....

.....

.....

..... [3]

END OF QUESTION PAPER

[illegible]

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