



CANDIDATE
NAME

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NUMBER

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0654/61

May/June 2023

1 hour 30 minutes

You must answer on the question paper.

No additional materials are needed.

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 60.
- The number of marks for each question or part question is shown in brackets [].

This document has **20** pages. Any blank pages are indicated.

- 1 A student investigates the use of an enzyme for the extraction of juice from apples.

(a) Procedure

The student:

- assembles two beakers, **A** and **B**, with the same volumes of apple puree in each beaker
- adds the same volume of enzyme solution to beaker **A** and water to beaker **B** as shown in Fig. 1.1

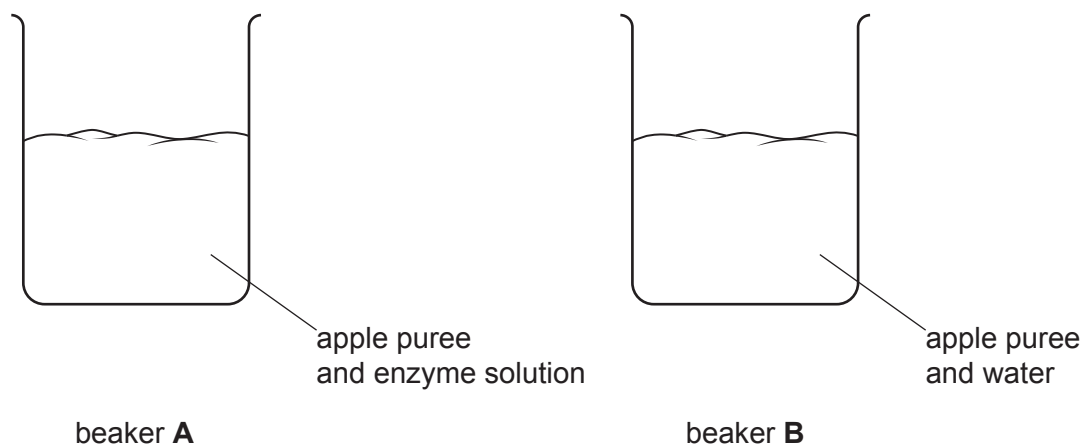


Fig. 1.1

- stirs the contents of each beaker with a glass rod
- leaves the beakers in a warm water-bath for 5 minutes
- after the 5 minutes, assembles the apparatus as shown in Fig. 1.2

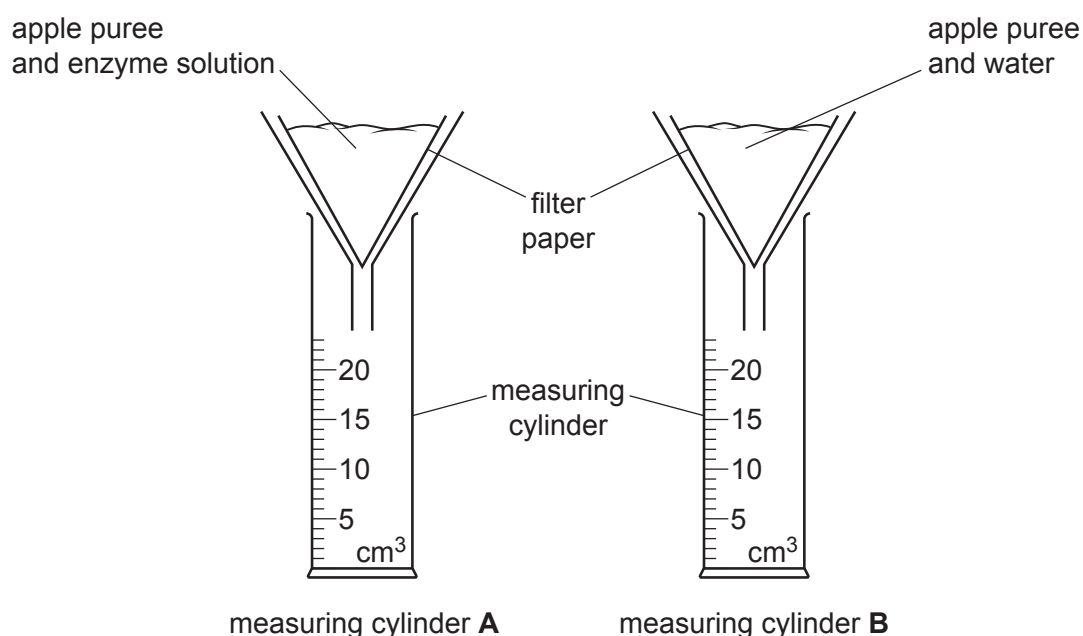


Fig. 1.2

- measures and records in Table 1.1 the total volume of juice collected in each measuring cylinder every 2 minutes for 8 minutes.

- (i) Fig. 1.3 shows the thermometer reading for the water-bath.

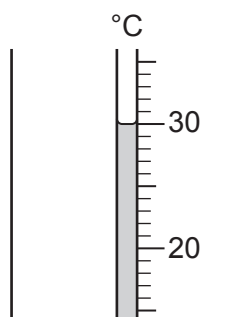


Fig. 1.3

Record the temperature of the water-bath to the nearest 0.5 °C.

temperature = °C [1]

- (ii) Suggest why it is important to clean the glass rod between stirring beaker **A** and beaker **B**.

.....
 [1]

- (iii) Explain why it is important to stir and mix the contents of the two beakers.

.....
 [1]

- (b) Table 1.1 shows the student's results.

Table 1.1

time /minutes	total volume of juice collected /cm ³	
	measuring cylinder A	measuring cylinder B
0	0.0	0.0
2	9.2	1.0
4	12.1	1.5
6	13.6	1.6
8	13.9	1.7

- (i) Beaker **B** is set up as a control.

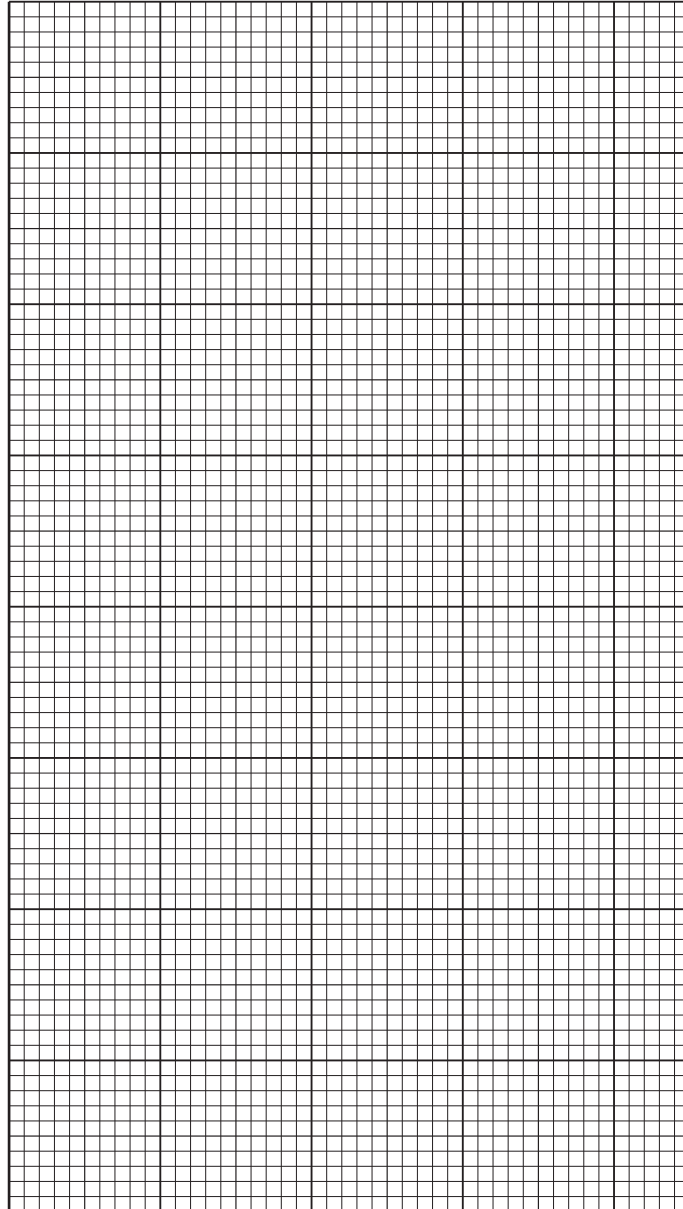
Explain why a control is used in this investigation.

.....
 [1]

- (ii) Use the results in Table 1.1 to suggest why an enzyme is used in the large-scale production of fruit juice.

.....
 [1]

- (c) (i) On the grid, plot a graph of total volume of juice collected (vertical axis) against time for **only** measuring cylinder **A**.



[3]

- (ii) Draw the best-fit curve. Label the curve **A**. [1]
- (iii) Use your graph to estimate the volume of juice produced at 5 minutes.

Show your working on your graph.

volume of juice produced at 5 minutes =cm³ [2]

- (iv) Increasing the temperature to 40 °C increases the rate of apple juice production.

The student repeats the procedure for beaker **A** at the higher temperature of 40 °C.

On the grid, draw a curve to predict the results the student obtains.

Label the curve **T**. [1]

- (v) The enzyme used in this investigation denatures (stops working) at temperatures above 50 °C.

The student repeats the procedure for beaker **A** at 80 °C.

On the grid, draw a curve to predict the results the student obtains.

Label the curve **N**. [2]

[Total: 14]

2 The student tests some apple juice for its nutrient content.

(a) The apple juice tests positive with Benedict's solution and negative with biuret solution.

(i) Record in Table 2.1 the final colours the student observes.

Table 2.1

testing solution	final colour observed	conclusion
Benedict's		
biuret		

[2]

(ii) Complete Table 2.1 by stating a conclusion for the result obtained with each testing solution. [2]

(b) Name the reagents used to test for the presence of fat.

State the observation for a positive result.

reagents and

observation

[2]

[Total: 6]

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- 3 A student investigates the rate of the reaction between solutions **H** and **K**.

When solutions of **H**, **K** and starch are mixed together, a blue-black colour is observed after a period of time.

(a) Procedure

Experiment 1

The student:

- Step 1** adds 10 cm³ of solution **H** into a conical flask
Step 2 adds 5 drops of starch solution into the conical flask
Step 3 adds 2 cm³ of distilled water into the conical flask
Step 4 adds 10 cm³ of solution **K** into the conical flask, swirls the flask and immediately starts a stop-watch
Step 5 stops the stop-watch when the mixture in the conical flask turns blue-black
Step 6 records in Table 3.1 the time taken in seconds to the nearest second for the mixture to turn blue-black.

The student repeats the procedure for experiment 2.

Table 3.1

experiment number	volume of solution H /cm ³	drops of starch solution	extra solution added	volume of solution K /cm ³	time taken /s
1	10	5	2 cm ³ distilled water	10	92
2	10	5	2 cm ³ distilled water	10	86
3	10	5	2 cm ³ aqueous iron(II) chloride	10	
4	10	5	2 cm ³ aqueous sodium chloride	10	90
5	10	5	2 cm ³ aqueous iron(III) chloride	10	11
6	10	5	2 cm ³ aqueous copper chloride	10	

- (i) Suggest a piece of apparatus suitable for measuring accurately solutions **H** and **K**.

..... [1]

- (ii) Experiment 2 is a repeat of experiment 1.

This is done to check the reliability of the experiment.

Two results are considered to be equal, within the limits of experimental error, if they are within 10% of each other.

Suggest if experiments 1 and 2 give reliable results.

Include data and a calculation in your answer.

.....
 [2]

- (iii) The substance made when solutions **H** and **K** react together turns the starch solution blue-black.

Identify the substance made in the reaction.

..... [1]

- (iv) All experiments use the same volume of extra solution added.

Explain why experiments 1 and 2 use the same volume of solution **H**, the same volume of solution **K** and the same number of drops of starch.

.....
 [1]

- (b) The student repeats the procedure in (a) for experiments 3, 4, 5 and 6, using the solutions in Table 3.1.

- (i) The readings on the stop-watch for experiments 3 and 6 are shown in Fig. 3.1.



Fig. 3.1

Record in Table 3.1 these times in seconds to the nearest second.

[2]

- (ii) A student suggests that another experiment is needed.

“Each of the four additional solutions, aqueous iron(II) chloride, aqueous sodium chloride, aqueous iron(III) chloride and aqueous copper chloride, need to be tested with starch alone.”

Suggest why this improves the investigation with solutions **H** and **K**.

.....
 [1]

- (iii) The reading of a volume of solution **K** is shown in Fig. 3.2.

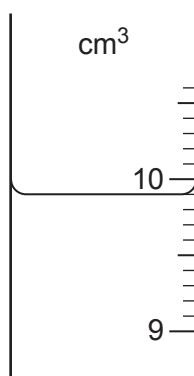


Fig. 3.2

State if the volume of solution **K** is 10 cm³.

Circle the correct answer.

yes no

Explain your answer.

.....
 [1]

- (c) A catalyst is a substance that increases the rate of a chemical reaction.

State which extra solutions added are catalysts for the reaction between solutions **H** and **K**.

Explain your answer with reference to data in Table 3.1.

solutions

explanation

.....

[2]

- (d) The pH of a solution can be measured using a pH meter.

Describe **one** other way the student can find the pH of aqueous iron(III) chloride.

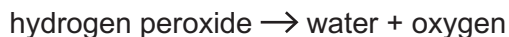
.....

.....

..... [2]

[Total: 13]

- 4 Aqueous hydrogen peroxide is a solution that breaks down slowly into water and oxygen gas.



A catalyst is a substance that increases the rate of a chemical reaction.

Manganese(IV) oxide is a catalyst for this reaction.

The reaction is too fast to count the bubbles of gas formed.

Plan an investigation to find the relationship between the mass of manganese(IV) oxide added and the rate of this reaction.

You are provided with:

- aqueous hydrogen peroxide
- manganese(IV) oxide solid.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus needed
- a brief description of the method, with an explanation of any safety precautions
- the measurements you will make, including how to make them as accurate as possible
- the variables you will control
- how you will use your results to draw a conclusion.

You may include a diagram if it helps to explain your plan.

You may include a results table. You are **not** required to include any results.

- 5 A student investigates the stretching of a spring.

The student assembles the spring and a metre rule as shown in Fig. 5.1.

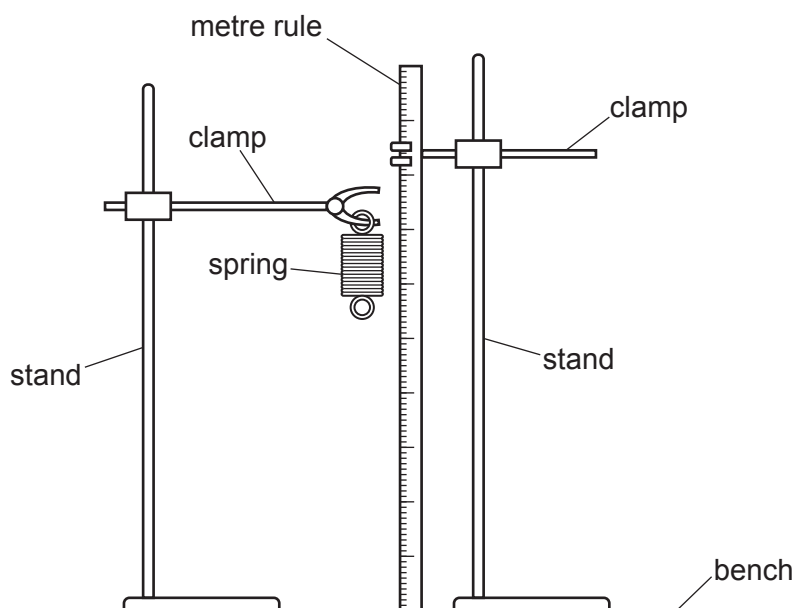


Fig. 5.1 (not to scale)

Fig. 5.2 shows a full-size diagram of the unstretched spring and part of the metre rule.

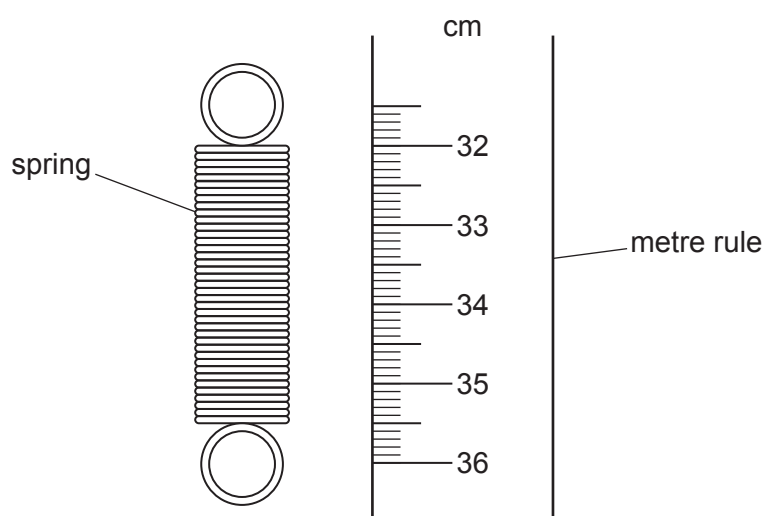


Fig. 5.2

- (a) (i) Take readings from the metre rule of the top and the bottom of the coiled part of the spring. Do **not** include the loops at the ends of the spring.

Record your readings to the nearest 0.1 cm.

reading of top of spring = cm

reading of bottom of spring = cm
[2]

- (ii) Calculate the length l_0 of the coiled part of the spring.

Show your working.

Record in Table 5.1 this value of l_0 for load $L = 0.0\text{ N}$.

Table 5.1

load L /N	0.0	1.0	2.0	3.0	4.0	5.0
length l /cm		6.3	1.9	11.9	14.7	17.5

[1]

(b) Procedure

The student:

- places a load $L = 1.0\text{ N}$ on the spring
- records in Table 5.1 the length l of the coiled part of the spring
- repeats this procedure for load $L = 2.0\text{ N}$, 3.0 N , 4.0 N and 5.0 N .

The student records the length l of the coiled part of the spring, produced by one of the loads, incorrectly.

State for which load the incorrect length has been recorded.

load = N

Deduce the length that the student should have recorded.

length cm
[2]

- (c) Line of sight (parallax) errors can occur when readings are taken from the metre rule.

State two practical precautions that the student takes to ensure that accurate readings are taken from the metre rule.

precaution 1

.....

precaution 2

.....

[2]

- (d) Another student suggests that the stretched length l of the spring is proportional to load L .

State if the readings support this suggestion.

Use values from Table 5.1 to justify your answer.

statement

justification

.....

[1]

- (e) A student wants to stretch the spring to four times the length l_0 of the unstretched spring.

Use the results in Table 5.1 to predict the load L the student needs to add to the spring.

predicted load $L =$ N [1]

- (f) Stretched springs are potentially dangerous because of the elastic energy stored in them.

State **and** explain **one** safety precaution that the student takes when doing the experiment.

precaution

explanation

.....

[1]

[Total: 10]

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6 A student investigates the cooling of hot water in a beaker.

(a) **Procedure**

The student:

- measures the room temperature as 22.0°C
- pours 200 cm^3 of hot water into a beaker
- places a thermometer into the hot water
- waits for 30 seconds
- stirs the water and measures its initial temperature T
- continues recording in Table 6.1 the temperature of the water every 60 seconds for 360 seconds.

The reading on the thermometer at time $t = 60$ seconds is shown in Fig. 6.1.

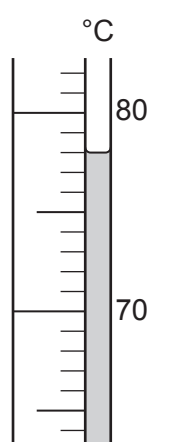


Fig. 6.1

Record this value of T to the nearest 0.5°C in Table 6.1 for time $t = 60\text{ s}$.

Table 6.1

time t /s	temperature T / $^{\circ}\text{C}$
0	82.5
60	
120	74.0
180	70.5
240	67.0
300	64.0
360	61.0

[1]

- (b) (i) State why it is good experimental technique for the student to wait for 30 seconds before measuring the initial temperature of the hot water.

.....
 [1]

- (ii) State why the student stirs the water before taking the reading.

.....
 [1]

- (c) (i) Use the temperature values in Table 6.1 to calculate the average rate of cooling of the water during the first 180 seconds of cooling.

Use the equation shown.

$$\text{average rate of cooling} = \frac{\text{temperature decrease during the first 180 seconds}}{180}$$

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

average rate of cooling during the first 180 seconds = °C/s [2]

- (ii) Use the temperature values in Table 6.1 to calculate the average rate of cooling of the water during the last 180 seconds of cooling.

average rate of cooling during the last 180 seconds = °C/s [1]

- (d) Write a conclusion about the rate at which hot water cools in a beaker.

.....
 [1]

- (e) The student completes the experiment and leaves the water in the beaker.

Predict the temperature T of the water 1 hour later.

$T =$ °C [1]

- (f) The experiment is repeated by another student.

Suggest two changes the student makes to **reduce** the rate of cooling of the water during the experiment.

change 1

change 2

[2]

[Total: 10]

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