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CO-ORDINATED SCIENCES

0654/62

Paper 6 Alternative to Practical

May/June 2024

1 hour 30 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- 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.

INFORMATION

- 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 glucose concentration of solution **S**.

Benedict’s solution is added to glucose solutions of different concentrations which are then heated.

The resulting colour observed is an indication of the glucose concentration.

(a) Procedure

The student:

- uses clean syringes to prepare five test-tubes as shown in Table 1.1

Table 1.1

test-tube	solution added
A	1 cm ³ of 0.0% glucose
B	1 cm ³ of 0.5% glucose
C	1 cm ³ of 1.0% glucose
D	1 cm ³ of 2.0% glucose
S	1 cm ³ of S

- adds 2 cm³ of Benedict’s solution to each test-tube
- places the test-tubes in a hot water-bath for 3 minutes
- records in Table 1.2 the final colour observed in each test-tube.

Table 1.2

test-tube	percentage glucose concentration	final colour observed
A	0.0	blue
B	0.5	green
C	1.0	orange
D	2.0	brick red
S	unknown	blue-green

(i) Suggest the percentage glucose concentration of solution **S**.

Explain your answer.

percentage =

explanation

.....

[1]

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(ii) State the initial colour of Benedict's solution.
 [1]

(iii) Suggest a suitable temperature for the hot water-bath in the procedure.
 °C [1]

(iv) State **and** explain **one** safety precaution the student takes when doing this investigation.
 precaution
 explanation
 [1]

(v) Suggest why clean syringes are used to add each glucose solution to the test-tubes.
 [1]

(vi) Suggest an improvement to this procedure to get a more accurate estimate of the percentage glucose concentration of solution **S**.

 [1]

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- (b) A student uses a piece of apparatus called a colorimeter to determine the percentage glucose concentration.

The higher the colorimeter reading, the lower the percentage glucose concentration.

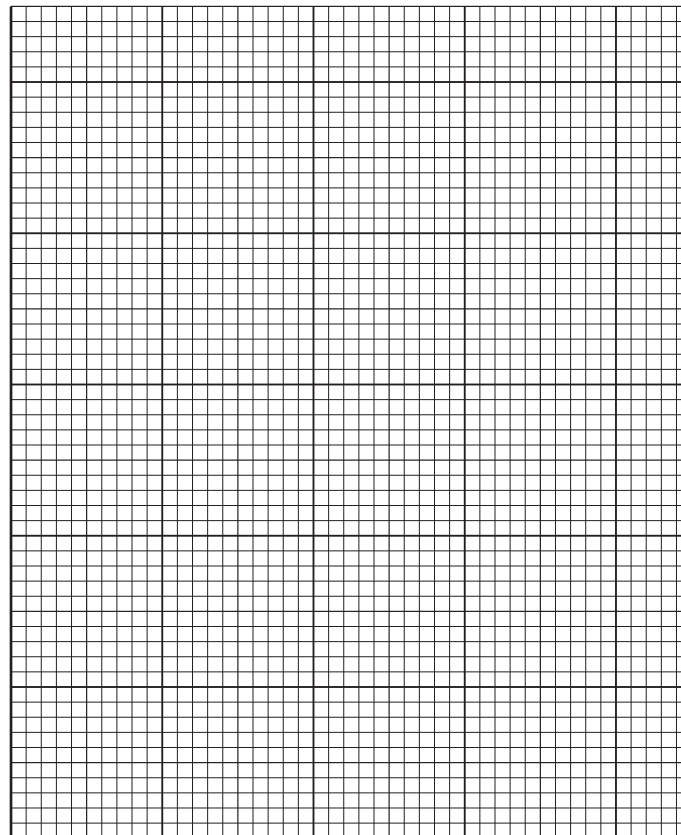
The colorimeter reading has no units.

The student's results are shown in Table 1.3.

Table 1.3

percentage glucose concentration	colorimeter reading
0.0	0.94
0.5	0.67
1.0	0.53
1.5	0.44
2.0	0.38

- (i) On the grid, plot a graph of colorimeter reading (vertical axis) against percentage glucose concentration.



- (ii) Draw the best-fit curve.

[3]

[1]





(iii) The student tests a sample of solution **S**.

The colorimeter reading is 0.72.

Use your graph to estimate the percentage glucose concentration in solution **S**.

Show your working on the graph.

percentage = [2]

(iv) The colorimeter gives a more accurate value than Benedict's solution for the percentage glucose concentration of solution **S**.

Suggest why the value is more accurate.

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

(c) The student uses some potato pieces to investigate the percentage glucose concentration in the cells of the potato.

When the glucose concentration outside the potato is the same as the glucose concentration inside the cells of the potato, the size of the potato piece does not change.

The student puts 40 mm lengths of potato into each of the four test-tubes **A**, **B**, **C** and **D** containing the concentration of glucose solutions shown in Table 1.4.

After one hour, the student records the final length of each piece of potato as shown in Table 1.4.

Table 1.4

test-tube	percentage glucose concentration	final length of potato /mm
A	0.0	
B	0.5	42
C	1.0	37
D	2.0	36

Fig. 1.1 shows the final length of the piece of potato in test-tube **A**, drawn actual size.



Fig. 1.1

(i) Record in Table 1.4 the final length of the piece of potato in millimetres. [1]

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(ii) Suggest a value for the percentage glucose concentration in the potato cells.

Explain your answer.

percentage =

explanation

.....

[1]

[Total: 15]

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2 A student tests solution **T** for the presence of two different nutrients.

The student does the tests shown in Table 2.1 on solution **T**.

Solution **T** tests negative with the biuret solution and positive with the iodine solution.

(a) State the initial colour of the testing solution and the final colour the student observes in each test.

Table 2.1

testing solution	initial colour of testing solution	final colour observed	conclusion
biuret			
iodine			

[3]

(b) Complete Table 2.1 by stating a conclusion for each observation.

[2]

[Total: 5]





- 3 A student determines the percentage by mass of magnesium in a mixture of magnesium and copper using two different calculations.

When the mixture of magnesium and copper is added to dilute hydrochloric acid, only the magnesium reacts.

Hydrogen gas is made which is collected and measured.

The copper in the mixture does **not** react and is separated from the reaction mixture at the end of the reaction by filtration.

The mass of the copper is measured.

(a) Procedure

The student:

- records in Table 3.1 the mass of an empty conical flask

Table 3.1

mass of empty conical flask/g	
mass of conical flask with mixture of magnesium and copper/g	
mass of mixture of magnesium and copper/g	

- adds the mixture of magnesium and copper to the conical flask
- records in Table 3.1 the mass of the conical flask with the mixture of magnesium and copper
- adds 50 cm³ of dilute hydrochloric acid (this is an excess) to the conical flask
- quickly assembles the apparatus as shown in Fig. 3.1

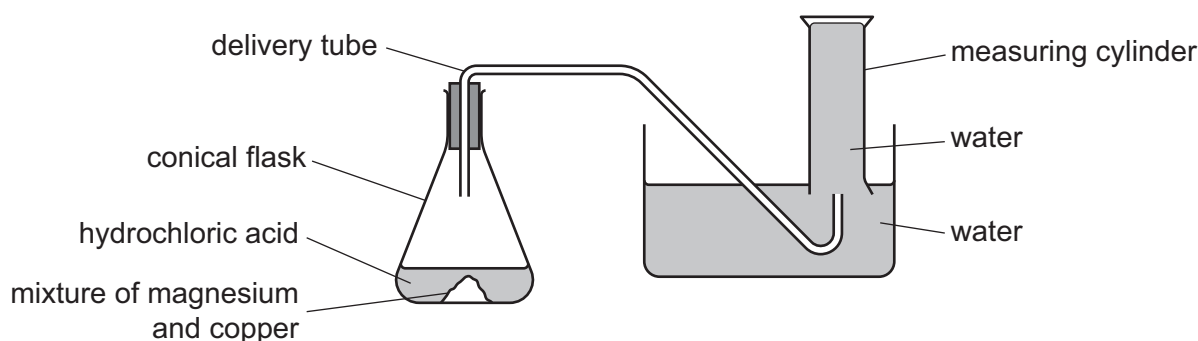


Fig. 3.1

- waits until the reaction has finished
- records in Table 3.2 the volume of hydrogen gas in the upturned measuring cylinder.



- (i) Fig. 3.2 shows the readings on the balance for the empty conical flask and the conical flask with the mixture of magnesium and copper.

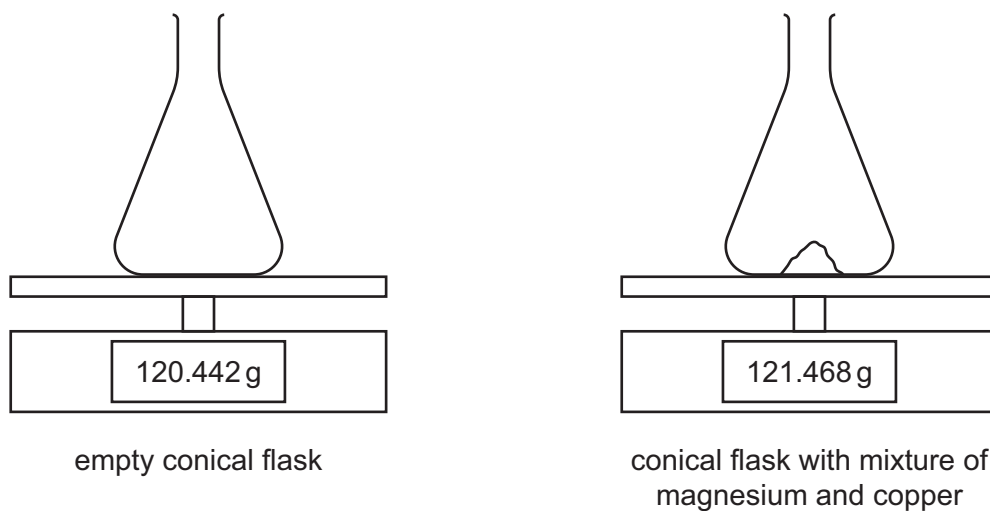


Fig. 3.2

Record in Table 3.1 these masses to **two** decimal places.

[2]

- (ii) Fig. 3.3 shows the volume of gas collected.

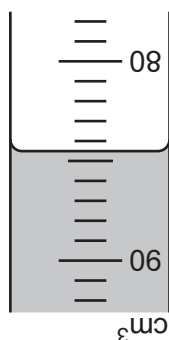


Fig. 3.3

Record in Table 3.2 this volume to the nearest 0.5 cm^3 .

Table 3.2

volume of hydrogen gas/ cm^3	
---------------------------------------	--

[1]

- (b) (i) Suggest how the student knows when the reaction is complete.

.....
 [1]





- (ii) Even though the student assembles the apparatus quickly, some hydrogen gas is still lost to the air and **not** collected.

Suggest how the student changes the procedure to give a more accurate value for the volume of hydrogen formed.

Do **not** include repeating the experiment.

.....
 [1]

- (iii) Using the values in Table 3.1, calculate the mass of the mixture of magnesium and copper added to the conical flask.

Record your value in Table 3.1. [1]

- (iv) Calculate the mass of magnesium in the mixture.

Use the equation shown.

$$\text{mass of magnesium} = \frac{\text{volume of hydrogen gas} \times 24}{24\,000}$$

mass of magnesium = g [1]

- (v) Calculate the percentage of magnesium in the mixture of magnesium and copper.

Use the equation shown.

$$\text{percentage of magnesium} = \frac{\text{mass of magnesium from (b)(iv)}}{\text{mass of mixture of magnesium and copper from Table 3.1}} \times 100$$

percentage of magnesium = [1]

(c) Procedure

The student:

- records in Table 3.3 the mass of a filter paper
- filters the contents of the conical flask from the end of the procedure in (a) to obtain the unreacted copper
- records in Table 3.3 the mass of the filter paper and copper.

Table 3.3

mass of filter paper/g	0.86
mass of filter paper and copper/g	
mass of copper/g	





(i) Fig. 3.4 shows the readings on the balance for the filter paper and copper.

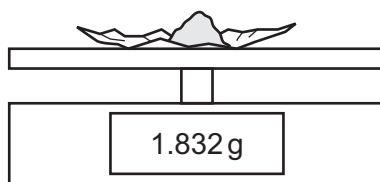


Fig. 3.4

Record in Table 3.3 this mass to **two** decimal places. [1]

(ii) Suggest how the student changes the procedure to give a more accurate value for the mass of copper on the filter paper.

Do **not** include repeating the experiment.

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

(iii) Use the values in Table 3.3 to calculate the mass of copper.

Record your value in Table 3.3. [1]

(iv) Calculate the percentage of magnesium in the mixture.

Use the equation shown, Table 3.1 and Table 3.3.

$$\text{percentage of magnesium} = 100 - \frac{\text{mass of copper}}{\text{mass of mixture of magnesium and copper}} \times 100$$

percentage of magnesium = [1]

(d) Draw a labelled diagram of the assembled filtration apparatus used to separate the copper solid from the aqueous mixture in the conical flask at the end of the experiment.

[1]

[Total: 13]
[Turn over]



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4 Pure water boils at a temperature of 100 °C.

When salt is dissolved in the water, the boiling temperature increases.

Plan an experiment to find the relationship between the mass of salt added to water and the increase in boiling temperature.

You are provided with:

- pure water
- salt.

You may use any common laboratory apparatus.

Include in your plan:

- the apparatus you will use
- a brief description of the method and explain any safety precautions you will take
- what you will measure and how you will make these as accurate as possible
- which variables you will control
- how you will process your results and use them to draw a conclusion.

You may include a labelled diagram if you wish.

You may also include a table that can be used to record results. You are **not** required to include any results.





5 A student determines the mass of a piece of modelling clay by two different methods.

(a) Procedure

The student:

- moulds a piece of modelling clay into the approximate shape of a cube
- places the modelling clay on a metre rule so that the centre of the modelling clay is at a distance of 10.0 cm from the zero end of the rule
- places the rule on a pivot
- adjusts the position of the pivot so that the rule is as close to balance as possible.

Fig. 5.1 shows the arrangement of the apparatus.

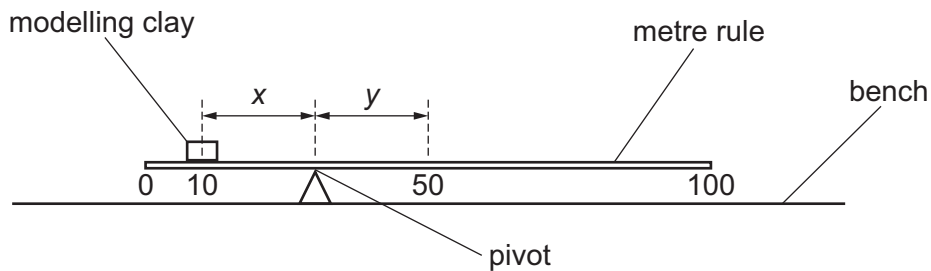


Fig. 5.1

Fig. 5.2 shows the position of the pivot at balance.

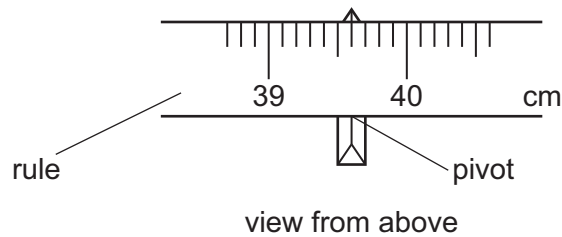


Fig. 5.2

(i) Record the reading on the rule for the position of the pivot in Fig. 5.2.

reading on rule = cm [1]

(ii) Calculate the distance x between the centre of the piece of modelling clay and the pivot as shown in Fig. 5.1.

x = cm [1]

(iii) Calculate the distance y from the pivot to the 50.0 cm mark as shown in Fig. 5.1.

y = cm [1]

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(b) The student uses a top-pan balance to measure the mass M of the metre rule.

Fig. 5.3 shows the reading on the top-pan balance.

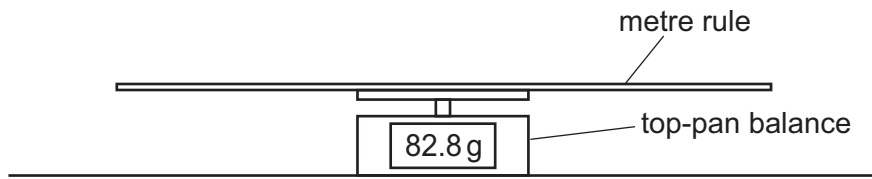


Fig. 5.3

Record the reading to the nearest gram.

$M = \dots\dots\dots$ g [1]

(c) Calculate the mass m_1 of the piece of modelling clay.

Use your answers to (a)(ii), (a)(iii) and (b) and the equation shown.

$$m_1 = \frac{M \times y}{x}$$

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

$m_1 = \dots\dots\dots$ g [2]

(d) Procedure

The student:

- pours 50 cm³ of water into a measuring cylinder
- immerses the modelling clay into the water in the measuring cylinder
- records the new reading V_2 on the measuring cylinder.

$V_2 = \dots\dots\dots 64 \dots\dots\dots$ cm³

(i) Calculate the volume V of the piece of modelling clay.

$V = \dots\dots\dots$ cm³ [1]

(ii) Describe how the student avoids a line-of-sight (parallax) error when reading the scale of the measuring cylinder.

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

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(e) The density ρ of the modelling clay is 1.9 g/cm^3 .

Calculate the mass m_2 of the modelling clay.

Use your answer from (d)(i) and the equation shown.

$$m_2 = V \times \rho$$

$$m_2 = \dots\dots\dots \text{ g [1]}$$

(f) Two values are considered to be equal within the limits of experimental accuracy if they are within 10% of each other.

Compare your value m_1 from (c) with your value m_2 from (e).

State if your values for the mass of the modelling clay are equal, within the limits of experimental accuracy.

Justify your statement with a calculation.

statement

justification

.....

.....

[2]

[Total: 11]

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6 A student investigates the rate of cooling of hot water.

(a) Fig. 6.1 shows the reading on a thermometer to measure room temperature.

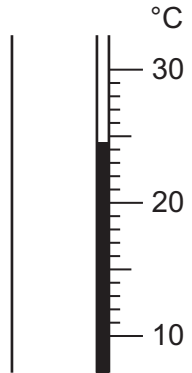


Fig. 6.1

Record the room temperature θ_R to the nearest 0.5°C.

$\theta_R = \dots\dots\dots$ °C [1]

(b) Procedure

The student:

- pours 200 cm³ of hot water into a beaker
- assembles the apparatus shown in Fig. 6.2

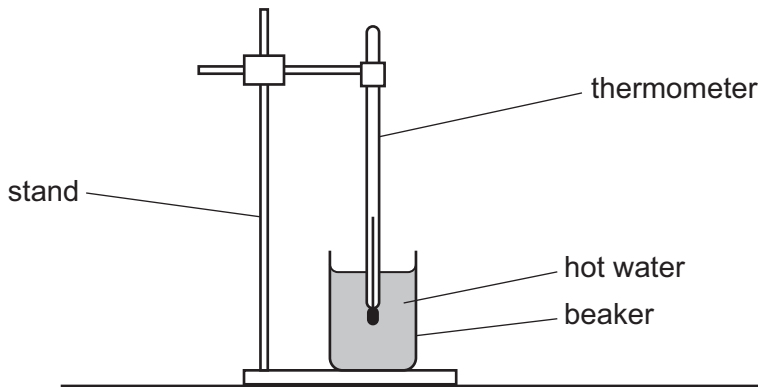


Fig. 6.2

- waits for 30 s
- records in Table 6.1 the temperature θ to the nearest 0.5°C at time $t = 0$
- starts the stop-watch
- records in Table 6.1 the temperature of the water every minute for 6 minutes.

(i) Explain why the student waits for 30 s before measuring the initial temperature of the hot water.

.....

..... [1]

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(ii) State **and** explain **one** safety precaution the student takes when using hot water.

precaution

explanation

.....

[1]

(c) Fig. 6.3 shows the reading on the thermometer after 2 minutes.

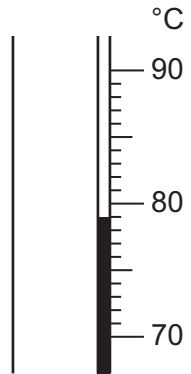


Fig. 6.3

Record in Table 6.1 the temperature to the nearest 0.5 °C.

Table 6.1

time t /minutes	temperature θ /°C
0	85.5
1	82.0
2	
3	76.0
4	74.0
5	72.5
6	71.0

[1]

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(d) (i) Calculate the temperature decrease $\Delta\theta_F$ of the water during the **first 3** minutes of cooling.

Use the readings in Table 6.1.

$\Delta\theta_F = \dots\dots\dots^\circ\text{C}$ [1]

(ii) Calculate the temperature decrease $\Delta\theta_L$ of the water during the **last 3** minutes of cooling.

Use the readings in Table 6.1.

$\Delta\theta_L = \dots\dots\dots^\circ\text{C}$ [1]

(e) Use the results to write a conclusion about the rate at which hot water in a beaker cools.

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

(f) (i) Use your answers to (d) to estimate the temperature of the water after it cools for **9** minutes.

temperature = $\dots\dots\dots^\circ\text{C}$ [1]

(ii) Predict the final temperature of the water after it has been allowed to cool for 3 hours.

final temperature = $\dots\dots\dots^\circ\text{C}$ [1]

[Total: 9]

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