Cambridge Assessment International Education

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CHEMISTRY **0620/61**

Paper 6 Alternative to Practical **October/November 2023**

1 hour

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 40.
- The number of marks for each question or part question is shown in brackets [ ].
- Notes for use in qualitative analysis are provided in the question paper.

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1 A student uses chromatography to analyse samples of three different dyes. The apparatus the student uses is shown in Fig. 1.1.

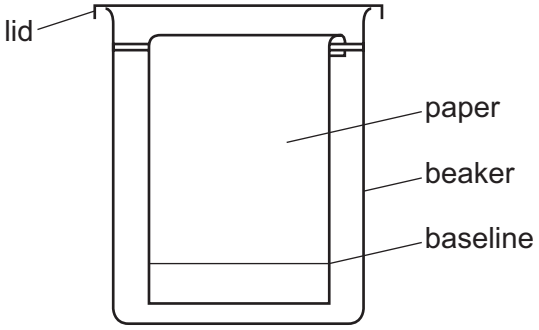

Fig. 1.1

(a) A spot of each dye is placed on the paper and some ethanol is poured into the beaker.

View solution

Draw on Fig. 1.1:

- **three** spots (●) to show where the three dyes are placed on the paper at the start of the experiment
- a line to show the level of ethanol in the beaker at the start of the experiment.

[2]

(b) During the experiment the ethanol moves up the paper.

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State when the student should remove the chromatography paper from the ethanol in the beaker.

..... [1]

(c) Fig. 1.2 shows the result of the chromatography experiment.

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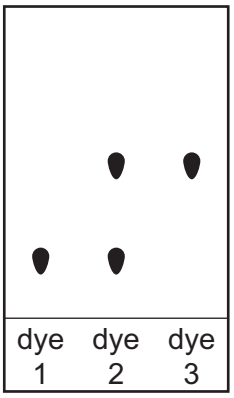

Fig. 1.2

State what conclusions can be made from this result.

.....

.....

..... [2]

[Total: 5]

2 Copper(II) carbonate reacts with dilute acids to make carbon dioxide gas.
Malachite is a mineral that contains copper(II) carbonate.
A student investigates the rate of reaction between powdered malachite and dilute ethanoic acid at different temperatures. The student does six experiments.

Experiment 1

- Use a measuring cylinder to pour 40 cm^3 of dilute ethanoic acid into a conical flask.
- Warm the dilute ethanoic acid by about 5 °C.
- Measure the temperature of the acid using a thermometer.
- Set the apparatus up as shown in Fig. 2.1.

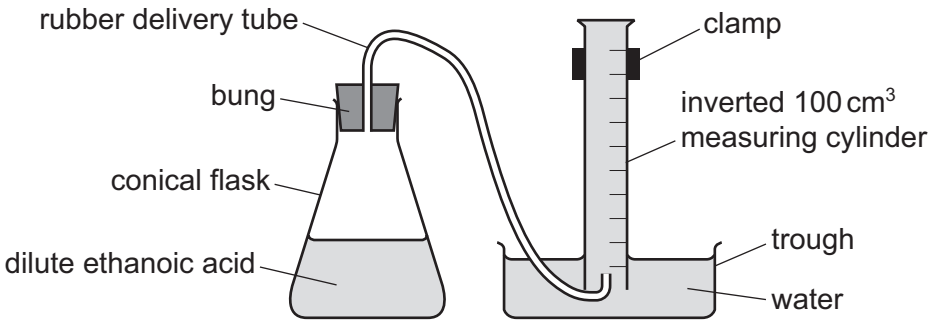

Fig. 2.1

- Remove the bung from the conical flask and add 1.0 g of powdered malachite to the conical flask, replace the bung and start a stop-clock.
- Record the time taken for 100 cm^3 of gas to be collected in the measuring cylinder.
- Empty the conical flask and rinse it with distilled water.

Experiment 2

- Repeat Experiment 1 but warm the dilute ethanoic acid by about 10 °C.

Experiment 3

- Repeat Experiment 1 but warm the dilute ethanoic acid by about 15 °C.

Experiment 4

- Repeat Experiment 1 but warm the dilute ethanoic acid by about 25 °C.

Experiment 5

- Repeat Experiment 1 but warm the dilute ethanoic acid by about 35 °C.

Experiment 6

- Repeat Experiment 1 but warm the dilute ethanoic acid by about 40 °C.

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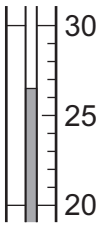
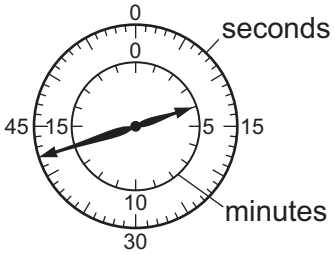
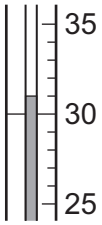
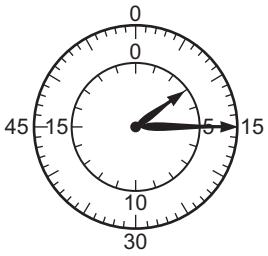
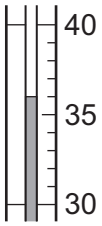
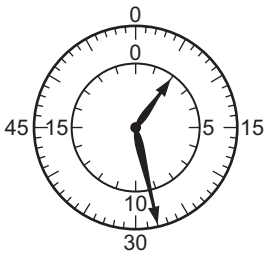
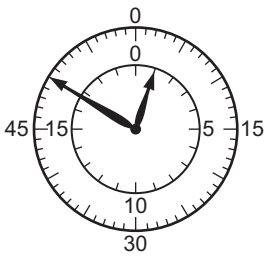
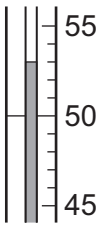
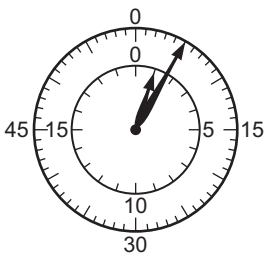
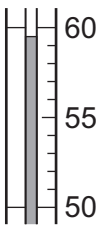
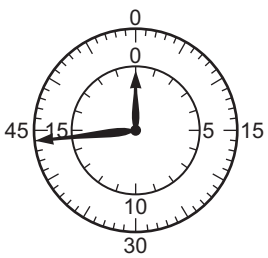
(a) Use the thermometer and stop-clock diagrams to complete Table 2.1.

View solution

Table 2.1

experiment	thermometer diagram	temperature of ethanoic acid / °C	stop-clock diagram	time taken to collect 100 cm^3 of gas / s
1				
2				
3				
4				
5				
6				

[5]

(b) Complete a suitable scale on the *y*-axis and plot the results from Experiments 1 to 6 on Fig. 2.2.

Draw a line of best fit through your points.

View solution

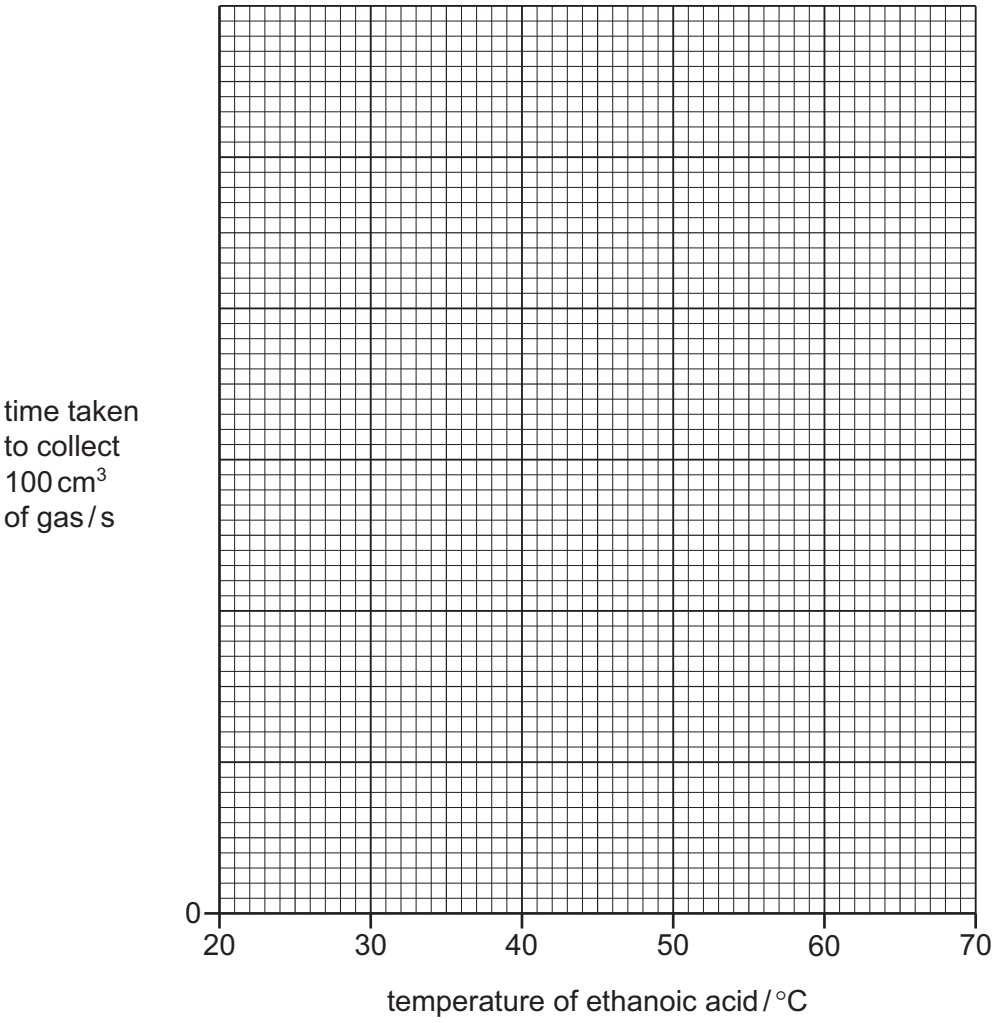


Fig. 2.2

[4]

(c) The average rate of reaction in an experiment can be calculated using the equation shown.

View solution

$$\text{average rate of reaction} = \frac{\text{volume of gas collected}}{\text{time taken to collect the gas}}$$

(i) Use this equation to calculate the average rate of reaction in Experiment 6.
Give the units for the rate you have calculated.

average rate = ... units .....

[2]

(ii) Deduce in which experiment, 1, 2, 3, 4, 5 or 6, the rate of reaction is greatest.

..... [1]

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(d) Extend the line on your graph in Fig. 2.2.
Deduce the time taken to collect 100 cm^3 of gas when the temperature of the ethanoic acid is 65 °C.

Show clearly on Fig. 2.2 how you worked out your answer.

View solution

..... s
[3]

(e) The 40 cm^3 of ethanoic acid used in each experiment is measured using a measuring cylinder.
Measuring cylinders are available in the following sizes.

10 cm^3 **25 cm^3** **50 cm^3** **100 cm^3** **500 cm^3**

View solution

Draw a circle around the size of measuring cylinder which would be most suitable to measure 40 cm^3 of ethanoic acid. [1]

(f) Most of the gas collected in the measuring cylinder is air rather than carbon dioxide.

View solution

(i) Explain why air is collected in the measuring cylinder.

.....

..... [1]

(ii) Explain why this does **not** affect the accuracy of the results.

View solution

.....

..... [1]

(g) During each experiment the temperature of the acid decreases slowly.

View solution

Give a reason why the temperature of the acid decreases and suggest a change to the apparatus used that would minimise the decrease in temperature.

reason temperature decreases .....

.....

change to apparatus .....

.....
[2]

[Total: 20]

3 A student tests two substances: solid **M** and solid **N**.

Tests on solid M

Solid **M** is hydrated chromium(III) nitrate.

Complete the expected observations.

(a) The student places half of solid **M** in a boiling tube and heats it strongly.

View solution

(i) The student holds a piece of anhydrous cobalt(II) chloride paper at the mouth of the boiling tube.

observations .....

..... [1]

(ii) The student inserts a glowing splint into the mouth of the boiling tube. The splint bursts into flames.

Identify the gas given off by heating solid **M** which causes this result.

View solution

..... [1]

(b) The student dissolves the remaining solid **M** in water to form solution **M**.

View solution

(i) The student adds aqueous sodium hydroxide dropwise and then in excess to solution **M**.

observations adding dropwise .....

observations in excess .....

[2]

(ii) The student adds a piece of aluminium foil to the product from **(b)(i)**. The mixture is then warmed. The student tests for any gas produced.

observations .....

.....

..... [1]

View solution

Tests on solid N

Table 3.1 shows the tests and the student's observations for solid **N**.

Table 3.1

tests	observations
test 1 Do a flame test on solid **N**.	light green flame
test 2 Dissolve the remaining solid **N** in water to form solution **N**. Divide solution **N** into four portions. To the first portion of solution **N**, add dilute sulfuric acid.	white precipitate
test 3 To the second portion of solution **N**, add about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous silver nitrate.	pale yellow precipitate
test 4 To the third portion of solution **N**, add about 1 cm^3 of dilute nitric acid followed by a few drops of aqueous barium nitrate.	no visible change
test 5 To the fourth portion of solution **N**, add about 1 cm^3 of aqueous chlorine.	brown solution

(c) Describe how to carry out a flame test.

View solution

.....

.....

..... [2]

(d) Identify solid **N**.

View solution

.....

..... [2]

[Total: 9]

4 *Greaseaway* and *Kitchenclean* are two solutions used as household cleaners that contain aqueous ammonia.

Plan an investigation to find which of the two household cleaners contains aqueous ammonia with the highest concentration. Assume that aqueous ammonia is the only alkali in the cleaners.

View solution

Include in your plan:

- the method you will use
- how your results will be used to determine which household cleaner contains aqueous ammonia with the highest concentration.

You are provided with common laboratory apparatus and chemicals.

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..... [6]

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Notes for use in qualitative analysis

Tests for anions

anion	test	test result
carbonate, CO_3^{2-}	add dilute acid, then test for carbon dioxide gas	effervescence, carbon dioxide produced
chloride, Cl^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	white ppt.
bromide, Br^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	cream ppt.
iodide, I^- [in solution]	acidify with dilute nitric acid, then add aqueous silver nitrate	yellow ppt.
nitrate, NO_3^- [in solution]	add aqueous sodium hydroxide, then aluminium foil; warm carefully	ammonia produced
sulfate, SO_4^{2-} [in solution]	acidify with dilute nitric acid, then add aqueous barium nitrate	white ppt.
sulfite, SO_3^{2-}	add a small volume of acidified aqueous potassium manganate(VII)	the acidified aqueous potassium manganate(VII) changes colour from purple to colourless

Tests for aqueous cations

cation	effect of aqueous sodium hydroxide	effect of aqueous ammonia
aluminium, Al^{3+}	white ppt., soluble in excess, giving a colourless solution	white ppt., insoluble in excess
ammonium, NH_4^+	ammonia produced on warming	–
calcium, Ca^{2+}	white ppt., insoluble in excess	no ppt. or very slight white ppt.
chromium(III), Cr^{3+}	green ppt., soluble in excess	green ppt., insoluble in excess
copper(II), Cu^{2+}	light blue ppt., insoluble in excess	light blue ppt., soluble in excess, giving a dark blue solution
iron(II), Fe^{2+}	green ppt., insoluble in excess, ppt. turns brown near surface on standing	green ppt., insoluble in excess, ppt. turns brown near surface on standing
iron(III), Fe^{3+}	red-brown ppt., insoluble in excess	red-brown ppt., insoluble in excess
zinc, Zn^{2+}	white ppt., soluble in excess, giving a colourless solution	white ppt., soluble in excess, giving a colourless solution

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Tests for gases

gas	test and test result
ammonia, NH_3	turns damp red litmus paper blue
carbon dioxide, CO_2	turns limewater milky
chlorine, Cl_2	bleaches damp litmus paper
hydrogen, H_2	‘pops’ with a lighted splint
oxygen, O_2	relights a glowing splint
sulfur dioxide, SO_2	turns acidified aqueous potassium manganate(VII) from purple to colourless

Flame tests for metal ions

metal ion	flame colour
lithium, Li^+	red
sodium, Na^+	yellow
potassium, K^+	lilac
calcium, Ca^{2+}	orange-red
barium, Ba^{2+}	light green
copper(II), Cu^{2+}	blue-green

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