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## 0620/61

May/June 2023

**1 hour**

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.

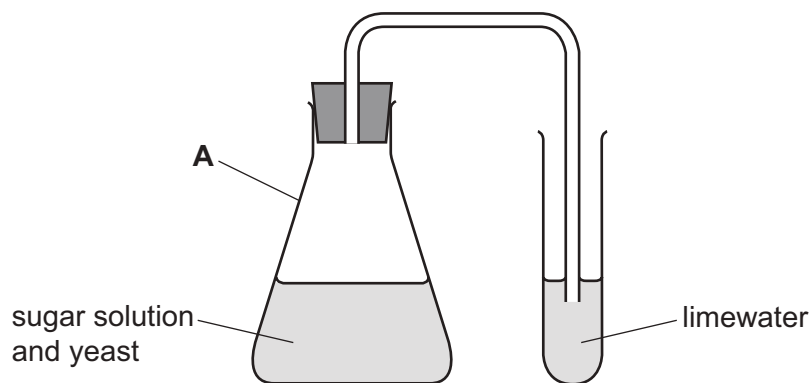
- The total mark for this paper is 40.
- The number of marks for each question or part question is shown in brackets [ ].
- Notes for use in qualitative analysis are provided in the question paper.

This document has **12** pages.

- 1 Ethanol can be made by fermentation of sugars found in plants. A by-product of fermentation is carbon dioxide gas.

A student made some ethanol using the following method.

- step 1** Cut up some sugar cane and crush it.  
**step 2** Add hot water to the sugar cane and stir to dissolve the sugar in the sugar cane.  
**step 3** Remove the solids from the mixture to obtain sugar solution.  
**step 4** Let the sugar solution cool and then add yeast.  
**step 5** Place the mixture obtained in the apparatus shown in Fig. 1.1.  
**step 6** Leave the apparatus until fermentation is complete.



**Fig. 1.1**

- (a) Name the item of apparatus labelled **A** in Fig. 1.1.

..... [1]

- (b) Explain why hot water rather than cold water is used in **step 2**.

..... [1]

- (c) Name the method used to remove the solids from the mixture in **step 3** and draw a diagram to show how this is done.

name of process .....

diagram

[2]

(d) State why the sugar solution is allowed to cool before the yeast is added in **step 4**.

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

(e) Describe how the appearance of the limewater changes as fermentation takes place.

..... [1]

(f) Describe how the student could tell that fermentation is complete.

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

(g) Name the process used to separate ethanol from the mixture obtained by fermentation.

..... [1]

[Total: 8]

- 2 A student investigates the reaction between aqueous ammonia and two different aqueous solutions of copper(II) sulfate labelled **A** and **B**. Solutions **A** and **B** have different concentrations.

The student does two experiments.

#### Experiment 1

- Fill a burette with solution **A**.
- Run some of solution **A** out of the burette so that the level of solution **A** is on the burette scale and record the initial burette reading.
- Use a measuring cylinder to pour  $25\text{ cm}^3$  of aqueous ammonia into a conical flask.
- Stand the conical flask on a white tile.
- Slowly add solution **A** from the burette to the conical flask, while swirling the flask, until the mixture in the conical flask just starts to become cloudy.
- Record the final burette reading.

#### Experiment 2

- Empty the conical flask and rinse it with distilled water.
- Empty the burette and rinse it with distilled water.
- Rinse the burette with solution **B**.
- Repeat Experiment 1 using solution **B** instead of solution **A**.

- (a) Use the burette diagrams in Fig. 2.1 and Fig. 2.2 to complete Table 2.1.

#### Experiment 1

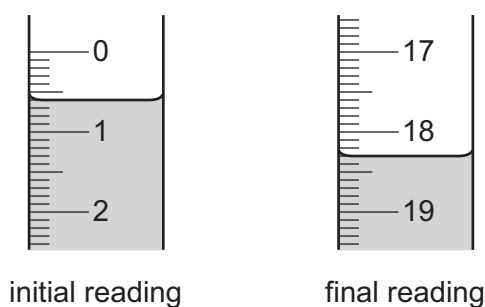


Fig. 2.1

#### Experiment 2

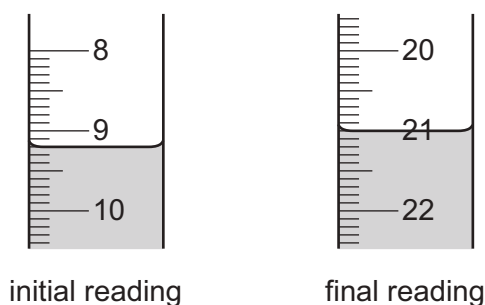


Fig. 2.2

Table 2.1

|                                                                 | Experiment 1<br>using solution <b>A</b> | Experiment 2<br>using solution <b>B</b> |
|-----------------------------------------------------------------|-----------------------------------------|-----------------------------------------|
| final burette reading / cm <sup>3</sup>                         |                                         |                                         |
| initial burette reading / cm <sup>3</sup>                       |                                         |                                         |
| volume of aqueous<br>copper(II) sulfate added / cm <sup>3</sup> |                                         |                                         |

[4]

(b) Explain why a white tile is used during the titration.

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

(c) In Experiment 2, the burette and the conical flask are both rinsed with water. The burette is then rinsed with solution **B**.

(i) State why both the burette and the conical flask are rinsed with water.

..... [1]

(ii) Explain why the burette is then rinsed with solution **B**.

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

(iii) Describe how the result of Experiment 2 would be different if the conical flask is rinsed with aqueous ammonia after rinsing with water.  
 Explain your answer.

.....  
 ..... [2]

- (d) (i) Deduce which solution of copper(II) sulfate, **A** or **B**, is more concentrated. Explain your answer.

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

- (ii) Deduce how many times more concentrated this solution of copper(II) sulfate is than the other solution of copper(II) sulfate.

..... [1]

- (e) Describe how the reliability of the results obtained can be checked.

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

- (f) Deduce the volume of solution **A** required when Experiment 1 is carried out with 10 cm<sup>3</sup> of aqueous ammonia.

..... [2]

- (g) In Experiments 1 and 2, the volume of aqueous ammonia is measured using a measuring cylinder.

Give an advantage and a disadvantage of using a volumetric pipette instead of a measuring cylinder to measure the volume of aqueous ammonia.

advantage .....

disadvantage ..... [2]

[Total: 16]

**Question 3 starts on the next page.**

- 3 A student tests two solids: solid **E** and solid **F**.

### Tests on solid **E**

Table 3.1 shows the tests and the student's observations.

**Table 3.1**

| tests                                                                                                                                                                                                                                                         | observations                                                                       |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>test 1</b><br><br>Gently heat half of solid <b>E</b> in a boiling tube.                                                                                                                                                                                    | a solution forms, steam is given off and condensation forms at the top of the tube |
| <b>test 2</b><br><br>Dissolve the remaining solid <b>E</b> in water to form solution <b>E</b> .<br>Divide solution <b>E</b> into three portions.<br><br>To the first portion of solution <b>E</b> , add aqueous sodium hydroxide dropwise and then in excess. | a brown precipitate forms which remains when excess is added                       |
| <b>test 3</b><br><br>Warm the product of <b>test 2</b> and test any gas produced.                                                                                                                                                                             | the gas turns red litmus paper blue                                                |
| <b>test 4</b><br><br>To the second portion of solution <b>E</b> , add 1 cm depth of dilute nitric acid followed by a few drops of aqueous silver nitrate.                                                                                                     | no change                                                                          |
| <b>test 5</b><br><br>To the third portion of solution <b>E</b> , add 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate.                                                                                                      | white precipitate                                                                  |

- (a) State what conclusion can be made about solid **E** from the observations in **test 1**.

..... [1]

- (b) Identify the gas produced in **test 3**.

..... [1]

(c) State what conclusion can be made about solid **E** from the observations in **test 4**.

..... [1]

(d) Identify the **three** ions in solid **E**.

.....

..... [3]

### Tests on solid **F**

Solid **F** is zinc sulfite.

Complete the expected observations.

The student dissolves solid **F** in water to form solution **F**.

The student divides solution **F** into three portions.

(e) To the first portion of solution **F**, the student adds aqueous ammonia dropwise until it is in excess.

observations adding dropwise .....

observations in excess ..... [2]

(f) To the second portion of solution **F**, the student adds a few drops of acidified aqueous potassium manganate(VII).

observations .....

..... [1]

(g) To the third portion of solution **F**, the student adds 1 cm depth of dilute nitric acid followed by a few drops of aqueous barium nitrate.

observations .....

..... [1]

[Total: 10]

- 4 Solid cobalt(II) oxide is a base which is insoluble in water. It reacts very slowly with cold dilute sulfuric acid to form a solution of cobalt(II) sulfate.

Describe how to make pure, dry crystals of hydrated cobalt(II) sulfate.

You are provided with cobalt(II) oxide, dilute sulfuric acid and common laboratory apparatus.

[6]

## Notes for use in qualitative analysis

### Tests for anions

| anion                                        | test                                                              | test result                                                                             |
|----------------------------------------------|-------------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| carbonate, $\text{CO}_3^{2-}$                | add dilute acid, then test for carbon dioxide gas                 | effervescence, carbon dioxide produced                                                  |
| chloride, $\text{Cl}^-$<br>[in solution]     | acidify with dilute nitric acid, then add aqueous silver nitrate  | white ppt.                                                                              |
| bromide, $\text{Br}^-$<br>[in solution]      | acidify with dilute nitric acid, then add aqueous silver nitrate  | cream ppt.                                                                              |
| iodide, $\text{I}^-$<br>[in solution]        | acidify with dilute nitric acid, then add aqueous silver nitrate  | yellow ppt.                                                                             |
| nitrate, $\text{NO}_3^-$<br>[in solution]    | add aqueous sodium hydroxide, then aluminium foil; warm carefully | ammonia produced                                                                        |
| sulfate, $\text{SO}_4^{2-}$<br>[in solution] | acidify with dilute nitric acid, then add aqueous barium nitrate  | white ppt.                                                                              |
| sulfite, $\text{SO}_3^{2-}$                  | 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, $\text{Al}^{3+}$     | white ppt., soluble in excess, giving a colourless solution                | white ppt., insoluble in excess                                            |
| ammonium, $\text{NH}_4^+$       | ammonia produced on warming                                                | —                                                                          |
| calcium, $\text{Ca}^{2+}$       | white ppt., insoluble in excess                                            | no ppt. or very slight white ppt.                                          |
| chromium(III), $\text{Cr}^{3+}$ | green ppt., soluble in excess                                              | green ppt., insoluble in excess                                            |
| copper(II), $\text{Cu}^{2+}$    | light blue ppt., insoluble in excess                                       | light blue ppt., soluble in excess, giving a dark blue solution            |
| iron(II), $\text{Fe}^{2+}$      | 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), $\text{Fe}^{3+}$     | red-brown ppt., insoluble in excess                                        | red-brown ppt., insoluble in excess                                        |
| zinc, $\text{Zn}^{2+}$          | white ppt., soluble in excess, giving a colourless solution                | white ppt., soluble in excess, giving a colourless solution                |

**Tests for gases**

| gas                           | test and test result                                                       |
|-------------------------------|----------------------------------------------------------------------------|
| ammonia, $\text{NH}_3$        | turns damp red litmus paper blue                                           |
| carbon dioxide, $\text{CO}_2$ | turns limewater milky                                                      |
| chlorine, $\text{Cl}_2$       | bleaches damp litmus paper                                                 |
| hydrogen, $\text{H}_2$        | 'pops' with a lighted splint                                               |
| oxygen, $\text{O}_2$          | relights a glowing splint                                                  |
| sulfur dioxide, $\text{SO}_2$ | turns acidified aqueous potassium manganate(VII) from purple to colourless |

**Flame tests for metal ions**

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

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