Ideas about Science – 2022 GCSE 21st Chemistry B

1. May /2022/Paper_ J258/01/No.8

Sara compares two drain cleaners called 'Drainclear' and 'Noblock'.
Both drain cleaners contain a solution of sodium hydroxide.

Sara titrates the **same** volume of each drain cleaner with the **same** concentration of dilute hydrochloric acid.

(a) Which word describes the reaction between sodium hydroxide and hydrochloric acid?

Tick (✓) **one** box.

Oxidation ☐

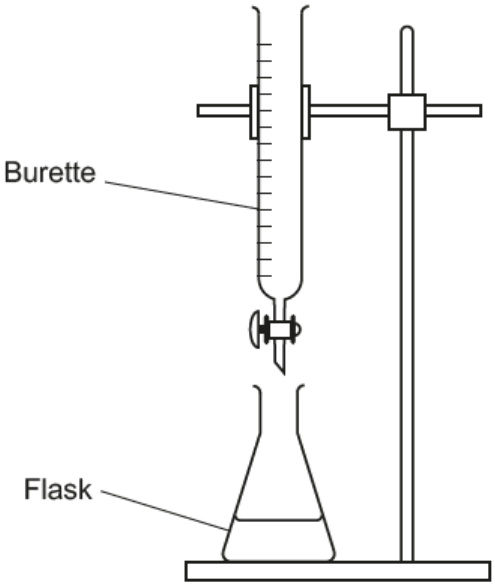
Reduction ☐

Neutralisation ☐

Condensation ☐

[1]

(b) This is a diagram of Sara's apparatus:



This is Sara's method:

- Put 25.0 cm^3 of drain cleaner into the flask.
- Add an indicator to the drain cleaner.

Write down the next **two** steps of Sara's method to get to the end-point of the titration.

1 .....

.....

2 .....

.....

[2]

(c) Here are Sara's results:

Drain cleaner	Accurate titration results (cm^3)			Mean volume of hydrochloric acid (cm^3)
Drainclear	6.85	6.80	6.75	6.80
Noblock	20.45		20.35	20.40

(i) Calculate the missing titration result for Noblock.

Answer = ... cm^3 **[1]**

(ii) Look at the mean volume of hydrochloric acid used for each drain cleaner.

What can you conclude about the amount of sodium hydroxide in Drainclear and Noblock?

Give **one** reason for your answer.

Conclusion .....

.....

Reason .....

.....

[2]

2. May /2022/Paper_ J258/01/No.10

Jamal has a sample of copper sulfate crystals.

The copper sulfate crystals have been accidentally mixed with graphite powder. Graphite is a form of carbon.

(a) Jamal dissolves the sample of copper sulfate crystals in water.

(i) Complete the sentence to explain why graphite can be separated by filtering it out.

Use **one** word from the list.

aqueous	**insoluble**	**non-aqueous**	**soluble**

Graphite can be separated by filtering it out because graphite is ..... in water.

[1]

(ii) Jamal is using mixtures and pure substances.

Complete **Table 10.1** to identify which are mixtures and which are pure substances.

Tick (✓) **one** box in each row.

	Mixture	**Pure substance**
Copper sulfate crystals		
Graphite powder		
Copper sulfate mixed with graphite powder		

Table 10.1

[2]

(b) **Table 10.2** shows **two** tests Jamal does on the copper sulfate solution:

Test	Result
Add sodium hydroxide solution	.....
Add acidified barium chloride solution	.....

Table 10.2

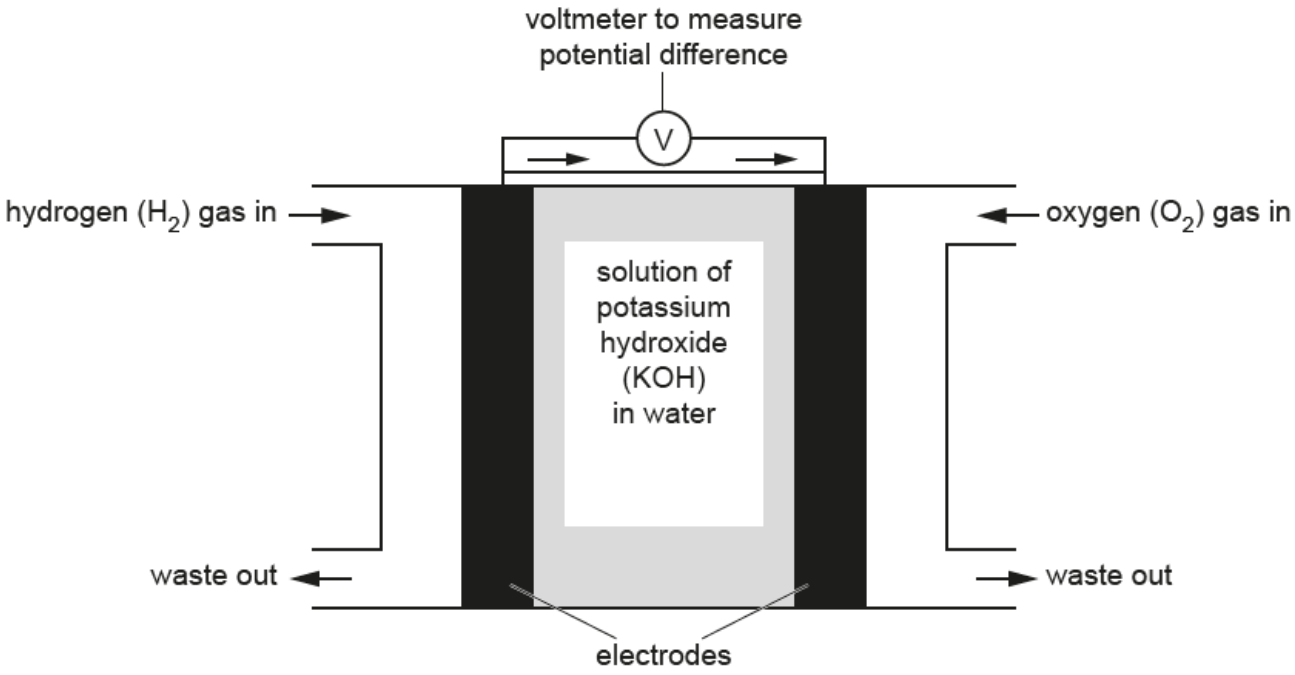
Complete the results in **Table 10.2** by writing what Jamal sees when he does the tests.

[2]

3. May /2022/Paper_ J258/02/No.3

Beth works for a company that makes hydrogen fuel cells.

She measures how much electrical energy a fuel cell produces by measuring its potential difference. She uses the cell shown.



(a) Before she sets up the cell, Beth tests each gas to check its identity.

Draw lines to connect each **gas** to its correct **test** and **result**.

Gas	Test	Result
	lime water	pops
hydrogen	glowing splint	goes blue
oxygen	lighted splint	goes milky
	damp pH paper	relights

[2]

(b) The fuel cell is filled with potassium hydroxide solution rather than pure water.

This is because potassium hydroxide solution is a better electrical conductor than pure water.

Which statement explains why potassium hydroxide solution is a better electrical conductor than pure water?

Tick (✓) **one** box.

Potassium hydroxide is acidic. ☐

Potassium hydroxide is a metal. ☐

Potassium hydroxide is very soluble in water. ☐

Potassium hydroxide solution contains charged ions. ☐

[1]

(c) This equation shows the reaction that happens in the fuel cell:

$2H_2 + O_2 \longrightarrow 2H_2O$

Beth does some experiments using different amounts of hydrogen in a fuel cell.

She records the masses of hydrogen and oxygen which are used and the mass of water made each time.

Her results are shown in **Table 3.1**.

Experiment	Mass of hydrogen used (g)	Mass of oxygen used (g)	Mass of water made (g)
1	0.1	0.8	0.9
2	0.4	3.2	3.6
3	0.5	4.0	.....
4	1.0	.....	.....

Table 3.1

(i) Complete **Table 3.1** by predicting the missing amounts for experiments 3 and 4. **[2]**

(ii) In each experiment, Beth notices that the potential difference of the cell decreases after a time.

Why does this happen?

Tick (✓) **one** box.

The concentration of potassium hydroxide solution increases. ☐

The hydrogen and oxygen are used up. ☐

The reaction takes in energy. ☐

Waste products are made. ☐

[1]

(d) Beth's company wants to use hydrogen fuel cells to provide power for a car.

Most cars use petrol as a fuel.

Beth looks at the information about hydrogen and petrol in **Table 3.2**.

	Hydrogen	**Petrol**
Energy released by 1 kg of fuel (MJ)	140	50
State at room temperature and pressure	gas	liquid
Volume of 1 kg of fuel (m^3)	12	0.001
Waste products	water	carbon dioxide and water
Other points	usually produced from electrolysis of water which needs electricity	petrol engines also produce carbon monoxide and nitrogen oxides

Table 3.2

(i) Use information from **Table 3.2** to explain **two** advantages of using hydrogen, rather than petrol, as a fuel for cars.

1 .....

.....

2 .....

.....

[2]

(ii) Use information from **Table 3.2** to explain **two** reasons why hydrogen is more difficult to use as a fuel for cars than petrol.

1 .....

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2 .....

.....

[2]

4. May /2022/Paper_ J258/03/No.10

Nina is given some diluted drain cleaner called 'Drainclear'. 'Drainclear' contains sodium hydroxide.

Nina titrates 25.0 cm^3 of diluted 'Drainclear' with dilute hydrochloric acid and an indicator.

(a) Nina uses a burette to measure out the dilute hydrochloric acid in the titration.

Nina wants to minimise errors in her method.

Describe **one** thing she should do when taking burette readings.

.....

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

(b) The table shows Nina's results:

	Rough	**Titration 1**	**Titration 2**	**Titration 3**
2nd reading (cm^3)	14.05	20.55	10.60	22.05
1st reading (cm^3)	3.00	10.05	0.05	11.60
Volume (cm^3)	11.05	10.50	10.55	10.45
Mean (cm^3)		10.50		

Explain why Nina's results are repeatable but **not** reproducible.

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

(c) In her titration, Nina used 25.0 cm^3 of diluted 'Drainclear' with 0.20 mol/dm^3 hydrochloric acid. A symbol equation for the reaction is:

$$NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$$

Calculate the concentration of sodium hydroxide, NaOH, in the diluted 'Drainclear'.

Use the equation: concentration $(mol/dm^3) = \frac{\text{number of moles of solute}}{\text{volume } (dm^3)}$

Use Nina's mean result of 10.50 cm^3.

Concentration of sodium hydroxide = ... mol/dm^3 **[3]**

(d) Nina says:

'I would have preferred my titration result to be larger than 10.50 cm^3.
This would reduce the percentage uncertainty in my titration result.'

Explain how Nina could get a larger titration result without changing her apparatus.

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

5. May /2022/Paper_ J258/03/No.12

Eve has some copper sulfate crystals. The formula of copper sulfate is $CuSO_4$.

(a) Eve says, 'Copper sulfate is a mixture of several elements. It is not a pure substance.'

Explain why Eve is wrong.

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

(b) Eve dissolves the copper sulfate crystals in water.
She does two tests on the copper sulfate solution.

(i) In **test 1** she adds sodium hydroxide solution to the solution of copper sulfate.
She sees a blue precipitate of copper hydroxide.

Write a **word** equation for the formation of copper hydroxide.

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

(ii) In **test 2** she adds acidified barium chloride solution to the solution of copper sulfate.
She sees a white precipitate of barium sulfate.

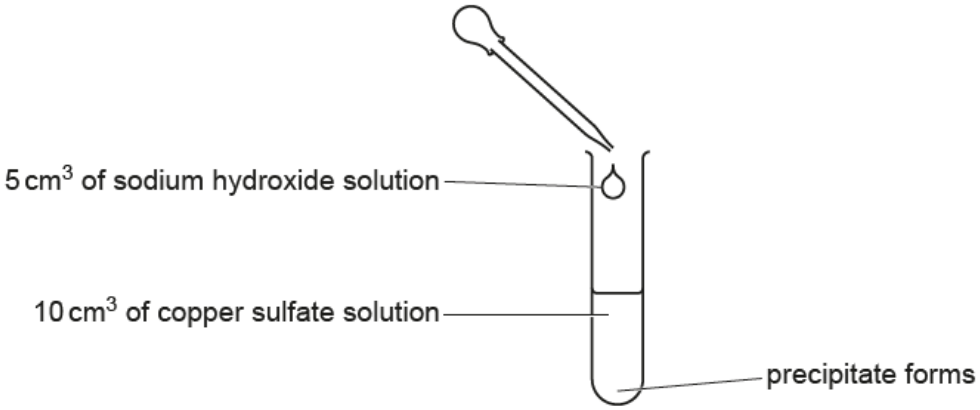
Write an **ionic** equation for the formation of the white precipitate.

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

6. May /2022/Paper_ J258/4/No.7

Jane does an experiment.

She puts 10 cm^3 of copper sulfate solution in a boiling tube. She adds 5 cm^3 of sodium hydroxide solution. A precipitate of copper hydroxide forms.



(a) Complete the **word** and **symbol** equations for the reaction in the boiling tube by filling in the name of the missing product and the state symbols for each substance.

copper sulfate + sodium hydroxide → copper hydroxide + ...

.....

$CuSO_4$(.....) + 2NaOH(.....) → $Cu(OH)_2$(.....) + Na_2SO_4(.....)

[3]

(b) The final mixture contains a precipitate of copper hydroxide mixed with a solution of other dissolved substances.

Jane wants to separate pure copper hydroxide from this mixture. She wants to make sure that she removes any traces of other dissolved substances from the precipitate.

(i) Describe how she can separate pure copper hydroxide from the final mixture.

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

(ii) Jane leaves the copper hydroxide to dry in a warm oven. After 30 minutes she weighs the copper hydroxide on a balance.

Jane is not sure if the copper hydroxide is completely dry.

Suggest how Jane can use the oven and the balance to show that the copper hydroxide is completely dry.

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.....

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

(c) Jane does more experiments.

She adds a different volume of sodium hydroxide solution to 20 cm^3 of copper sulfate solution each time.

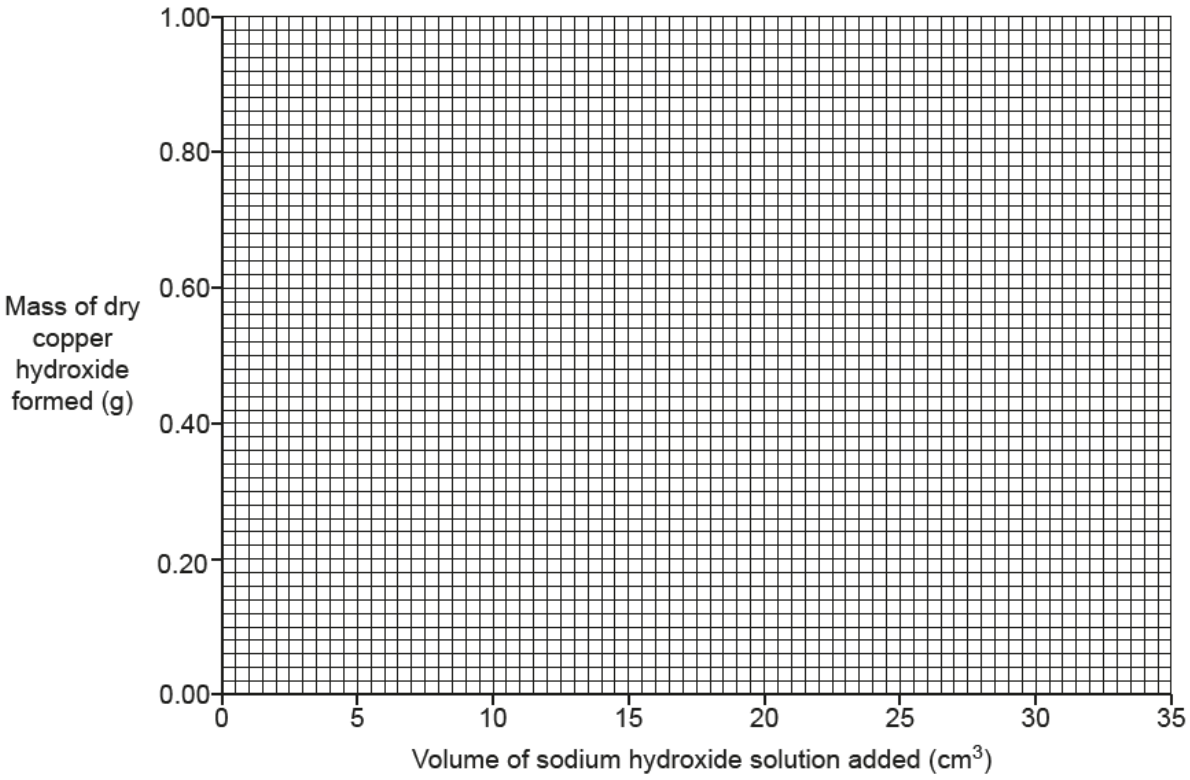
She records the mass of dry copper hydroxide that forms in each experiment.

The table shows her results.

Volume of copper sulfate solution (cm^3)	Volume of sodium hydroxide solution added (cm^3)	Mass of dry copper hydroxide formed (g)
20	5	0.25
20	10	0.49
20	15	0.75
20	20	0.98
20	25	0.98
20	30	0.98

(i) Plot Jane's results on the graph.

Draw lines of best fit to show the pattern in the results. **[3]**



(ii) Suggest why the mass of the dry precipitate does not continue to increase when more than 20 cm^3 of sodium hydroxide solution is added.

.....

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

(iii) Jane and Alex look at the table and the equation for the reaction:

$CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

They disagree about the results.

Jane says, 'I think the concentration of copper sulfate solution is the same as the concentration of sodium hydroxide solution.'

Alex says, 'I think the sodium hydroxide solution is double the concentration of the copper sulfate solution.'

Who is right?

Jane ☐

Alex ☐

Use information from the table and the equation to explain your choice.

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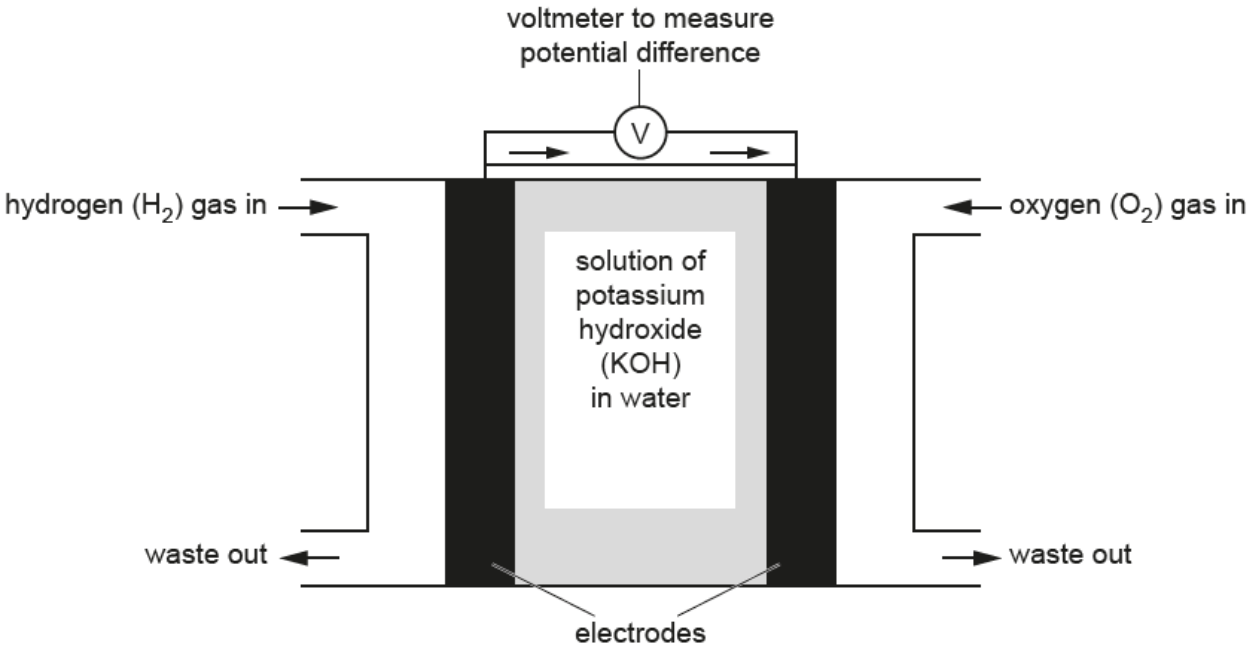
..... **[2]**

7. May /2022/Paper_ J258/04/No.8

Beth works for a company that makes hydrogen fuel cells.

She measures the potential difference of the cell shown.



(a) Before she sets up the cell, Beth tests each gas to check its identity.

Describe the tests and the results for hydrogen and oxygen gas.

hydrogen test .....

result .....

oxygen test .....

result .....

[2]

(b) These half equations show the reactions that happen at each electrode in the fuel cell:

at the hydrogen electrode: $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$

at the oxygen electrode: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

(i) Beth wants to make sure that she gets the highest possible potential difference from the fuel cell.

She makes sure that she uses double the volume of hydrogen compared to oxygen.

Use the half equations to explain why she needs to do this.

.....

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

(ii) Use the half equations to write an overall equation for the reaction that happens in the fuel cell.

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

(iii) A fuel cell filled with potassium hydroxide solution works better than a fuel cell filled with pure water.

One reason it works better is because potassium hydroxide solution is a better electrical conductor than pure water.

Explain why potassium hydroxide solution is a better electrical conductor than pure water.

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

(iv) Use the equations to suggest one other reason why using potassium hydroxide solution helps the fuel cell to work better.

.....

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

(c) Beth uses a fixed amount of hydrogen and oxygen gas. After a time the potential difference of the cell decreases.

Explain why this happens.

.....

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

(d) Beth's company want to use the cell to provide power for a submarine.

Submarines travel deep under the surface of the sea.

Most submarines have engines that burn diesel fuel.

Beth thinks that submarines that burn diesel fuel produce waste that is much more harmful to the sea than submarines that use hydrogen fuel cells.

(i) Explain why she is correct.

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

(ii) Give one **disadvantage** of using a hydrogen fuel cell rather than diesel for a submarine.

.....

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