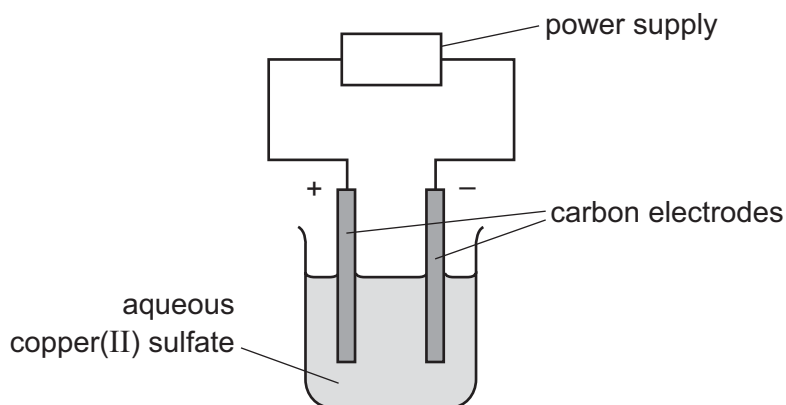


ELECTROLYSIS OF COPPER SULFATE

1 A student electrolyses aqueous copper(II) sulfate using the apparatus shown.



Oxygen gas forms at the positive electrode (anode).

(i) Write an ionic half-equation for the reaction at the negative electrode (cathode). Include state symbols.

..... [3]

(ii) Describe what the student observes at the negative electrode.

..... [1]

(iii) Give **two other** observations which the student makes during the electrolysis.

1

2 [2]

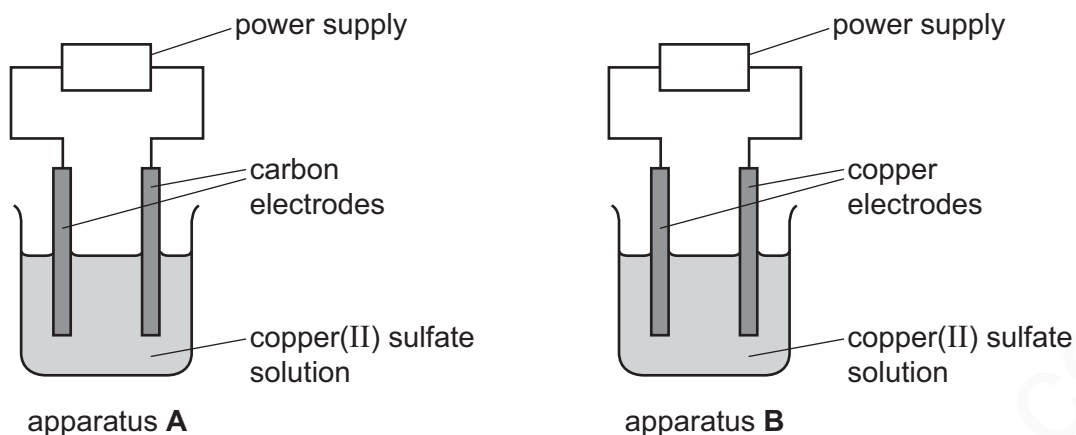
(iv) What difference would the student observe at the positive electrode if the aqueous copper(II) sulfate were replaced by concentrated aqueous copper(II) chloride?

..... [1]

MARKING SCHEME:

(i)	$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$ 1 mark for any equation which has Cu as the product or Cu^{2+} ions on left 1 mark for correct species 1 mark for correct state symbols	3
(ii)	(a pink / brown) solid / deposit forms	1
(iii)	bubbles / fizzing (at the anode)	1
	solution becomes paler / less blue / colourless	1
(iv)	a green gas would be seen (on the anode)	1

2 A student electrolysed copper(II) sulfate solution using the two sets of apparatus shown.



In apparatus **A** the student used carbon electrodes.
 In apparatus **B** the student used copper electrodes.

The student made the following observations.

apparatus A	apparatus B
The mass of the negative electrode increased.	The mass of the negative electrode increased.
The mass of the positive electrode stayed the same.	The mass of the positive electrode decreased.
Bubbles were seen at the positive electrode.	No bubbles were seen at the positive electrode.

(i) Explain why the mass of the negative electrode increased in **both** sets of apparatus.

.....
 [1]

(ii) Name the gas that formed the bubbles seen in apparatus **A**.

..... [1]

(iii) Explain why the mass of the positive electrode decreased in apparatus **B**.

.....
 [1]

- (iv) Suggest what happens to the colour of the solution in apparatus **A** and apparatus **B** as the electrolysis progresses.
Explain your answer.

colour of the solution in apparatus **A**

colour of the solution in apparatus **B**

explanation

.....

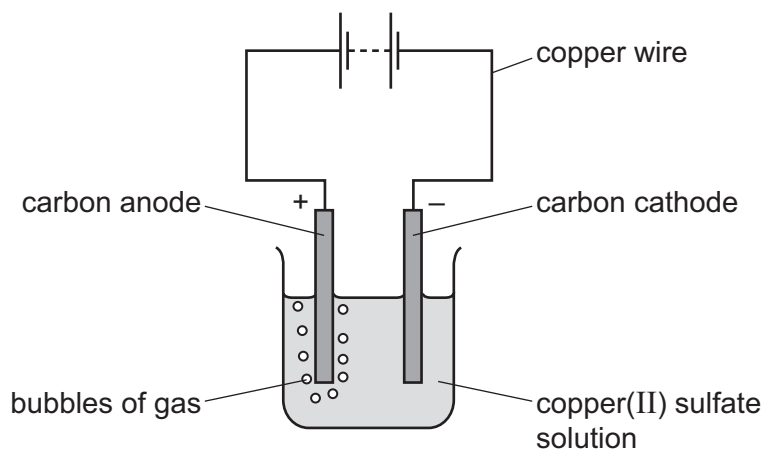
.....

[3]

MARKING SCHEME:

(i)	copper formed/copper deposited	1
(ii)	oxygen	1
(iii)	copper removed or copper lost or copper forms ions	1
(iv)	any three from: (apparatus A): solution becomes paler/fades in A (apparatus B): solution stays the same colour in B (explanation): copper ions removed (but not added) copper ions not replaced in A OR copper ions both removed and added (at the same rate) copper ions are being replaced (continually)	3

3 Copper(II) sulfate solution was electrolysed using the apparatus shown.



(a) A gas was formed at the anode.

Identify this gas and give the test for this gas.

gas

test

result of test

[3]

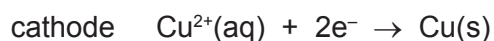
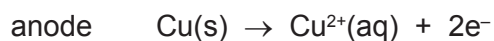
(b) During electrolysis, electricity passes through the copper(II) sulfate solution.

Solid copper(II) sulfate does not conduct electricity.

Explain **both** of these statements.

.....
.....
.....
.....
.....
..... [3]

(c) The electrolysis was repeated using copper electrodes in place of carbon electrodes. The ionic half-equations for the reactions at the two electrodes are shown.



(i) Which species is reduced during the electrolysis? Explain your answer.

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

(ii) The masses of the copper electrodes changed during the electrolysis.

State how **and** explain why the masses of the **two** copper electrodes changed. Use the ionic half-equations to help you.

.....
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.....
.....
.....
.....
.....
..... [3]

(iii) Explain why, during the electrolysis, the colour of the copper(II) sulfate solution does **not** change.

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

[Total: 12]

MARKING SCHEME:

(a)	(gas) oxygen (test) glowing splint (result of test) relights	1 1 1
(b)	reference to ions / ionic ions cannot move in solid OR are in fixed positions in solid ions can move when in solution	1 1 1
(c)(i)	copper ions / Cu^{2+} gain of electrons / oxidation number decreases	1 1
(c)(ii)	any 3 from: anode decreases (in mass) copper removed (from anode) / solid (copper from anode) becomes aqueous cathode increases (in mass) copper deposited / added / Cu^{2+} deposited as Cu (on cathode)	3
(c)(iii)	copper is both added and removed (at same rate) OR the concentration (of copper ions) does not change	1