Name:

Redox and Electrolysis worksheet

A solution of copper(II) sulfate can be electrolysed using copper electrodes or carbon electrodes.

Which statements are correct?

1 Using copper electrodes, oxygen gas forms at the anode.

2 Using copper electrodes, copper atoms lose electrons at the anode.

3 Using carbon electrodes, copper metal forms at the cathode.

4 Using carbon electrodes, copper ions gain electrons at the cathode.

A 1 and 2 **B** 1 and 3 **C** 2, 3 and 4 **D** 4 only

Which statement about electrolysis is correct?

A Electrons move through the electrolyte from the cathode to the anode.

B Electrons move towards the cathode in the external circuit.

C Negative ions move towards the anode in the external circuit.

D Positive ions move through the electrolyte towards the anode during electrolysis.

In which reaction does reduction of the underlined substance take place?

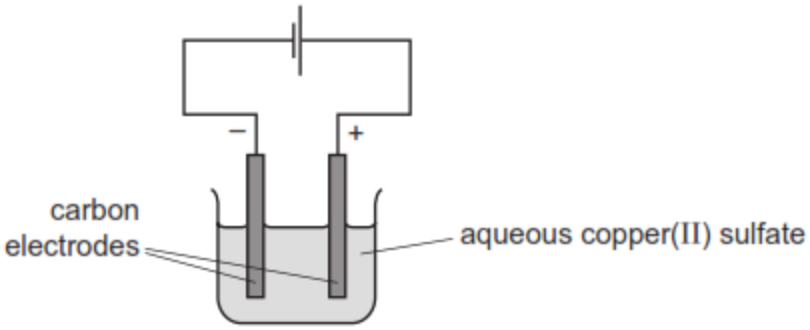
A $\underline{Cu_2O} + C \rightarrow 2Cu + CO$

B $\underline{2Cu_2O} + O_2 \rightarrow 4CuO$

C $\underline{2Cu} + O_2 \rightarrow 2CuO$

D $CuO + \underline{CO} \rightarrow Cu + CO_2$

The diagram shows the electrolysis of aqueous copper(II) sulfate.



Which statement is correct?

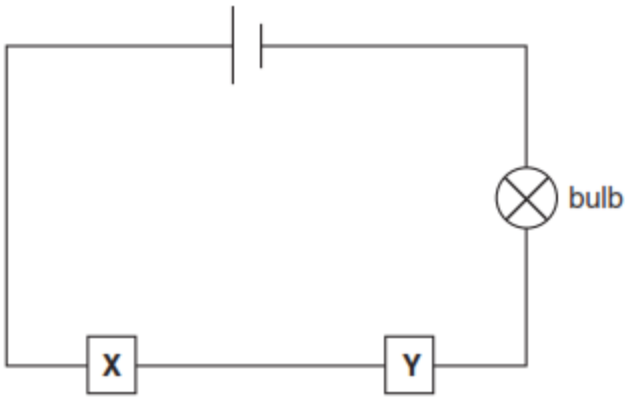
A Copper metal is deposited at the positive electrode.

B In the external circuit the electrons move from positive to negative.

C In the solution the electrons move from negative to positive.

D Oxygen gas is produced at the positive electrode.

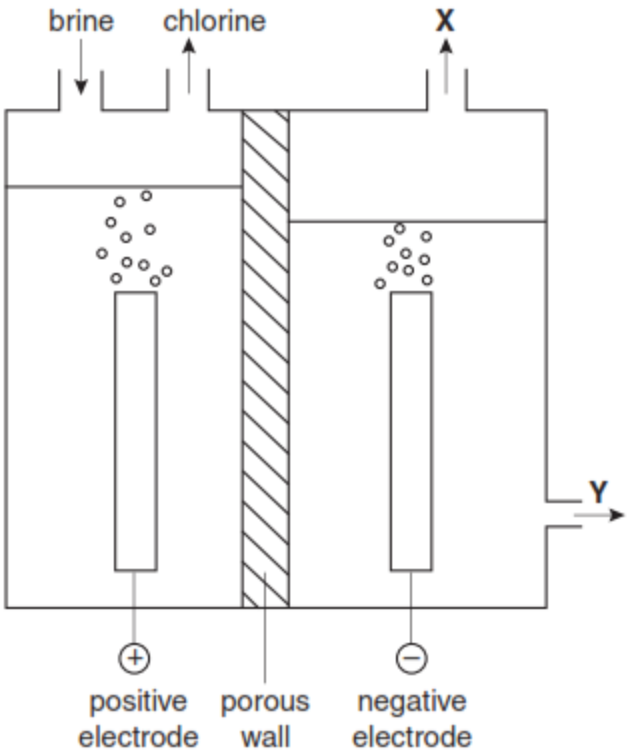
The diagram shows an electric circuit.



For which two substances at **X** and **Y** does the bulb light up?

	X	Y
A	copper	graphite
B	copper	poly(ethene)
C	rubber	graphite
D	rubber	poly(ethene)

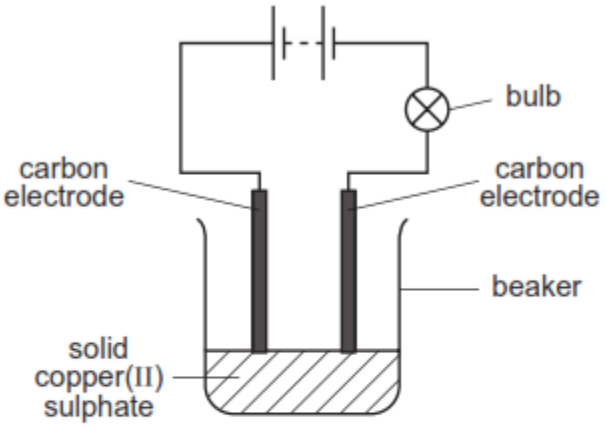
The diagram represents the electrolysis of brine (aqueous sodium chloride).



What are products **X** and **Y**?

	X	Y
A	hydrogen	aqueous sodium hydroxide
B	hydrogen	hydrochloric acid
C	oxygen	aqueous sodium hydroxide
D	oxygen	hydrochloric acid

In the circuit shown the bulb does not light.



Which change would cause the bulb to light?

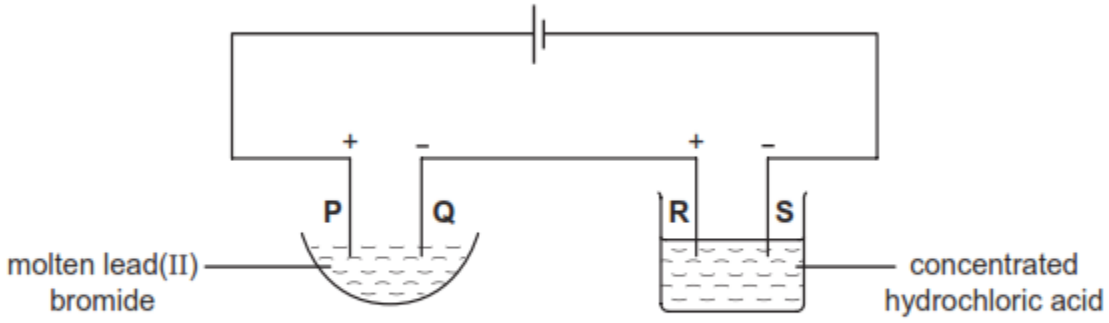
A add more solid copper(II) sulphate to the beaker

B add water to dissolve the copper(II) sulphate

C replace the carbon electrodes with copper electrodes

D reverse the connections to the electrodes

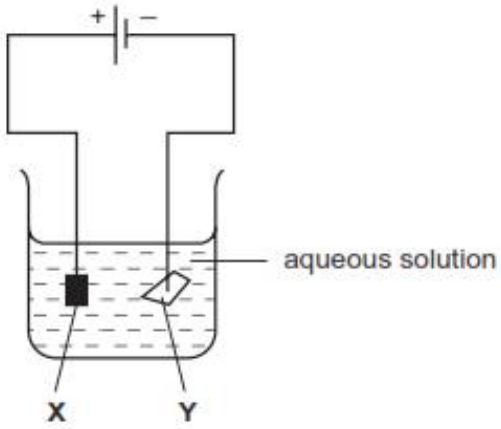
The following electrolysis circuit is set up, using inert electrodes **P, Q, R** and **S**.



At which of the electrodes is a Group VII element produced?

A P only **B** P and R **C** Q only **D** Q and S

The diagram shows an electrolysis experiment using metals **X** and **Y** as electrodes.



One of the metals becomes coated with copper.

Which metal becomes coated and which aqueous solution is used?

	metal	aqueous solution
A	**X**	$CrCl_3$
B	**X**	$CuCl_2$
C	**Y**	$CrCl_3$
D	**Y**	$CuCl_2$

Aluminium is extracted from its oxide by electrolysis.

Which words correctly complete the spaces?

The oxide is dissolved in .....1..... cryolite and aluminium is deposited at the .....2.....

	space 1	space 2
A	aqueous	negative cathode
B	aqueous	positive anode
C	molten	negative cathode
D	molten	positive anode

Copper is refined by the electrolysis of aqueous copper(II) sulphate using copper electrodes. Describe the change that occurs at the electrodes.

(i) cathode (pure copper) .....

.....[1]

(ii) anode (impure copper) .....

.....[1]

(iii) Write an ionic equation for the reaction at the cathode.

.....[1]

(iv) If carbon electrodes are used, a colourless gas is given off at the anode and the electrolyte changes from a blue to a colourless solution.

The colourless gas is ..... .

The solution changes into ..... . [2]

(b) Aqueous copper(II) sulphate solution can be electrolysed using carbon electrodes. The ions present in the solution are as follows.

$Cu^{2+}(aq)$, $SO_4^{2-}(aq)$, $H^+(aq)$, $OH^-(aq)$

(i) Write an ionic equation for the reaction at the negative electrode (cathode).

..... [1]

(ii) A colourless gas was given off at the positive electrode (anode) and the solution changes from blue to colourless.

Explain these observations.

.....

..... [2]

(c) Aqueous copper(II) sulphate can be electrolysed using copper electrodes. The reaction at the negative electrode is the same but the positive electrode becomes smaller and the solution remains blue.

(i) Write a word equation for the reaction at the positive electrode.

..... [1]

(ii) Explain why the colour of the solution does not change.

.....

..... [2]

(iii) What is the large scale use of this electrolysis?

..... [1]

The electrolysis of concentrated aqueous sodium chloride produces three commercially important chemicals hydrogen, chlorine and sodium hydroxide.

(a) The ions present are $Na^+(aq)$, $H^+(aq)$,$Cl^-(aq)$ and $OH^-(aq)$.

(i) Complete the ionic equation for the reaction at the negative electrode (cathode).

..... + ... $\longrightarrow H_2$ [1]

(ii) Complete the ionic equation for the reaction at the positive electrode (anode).

..... – ..... $\longrightarrow Cl_2$ [1]

(iii) Explain why the solution changes from sodium chloride to sodium hydroxide.

..... [1]

(b) **(i)** Why does the water supply industry use chlorine?

..... [1]

In the following list of ionic equations, the metals are in order of reactivity.

$\square \rightarrow \square + \square$

$Zn \rightarrow Zn^{2+} + 2e^-$

$Sn \rightarrow Sn^{2+} + 2e^-$

$Hg \rightarrow Hg^{2+} + 2e^-$

$Ag \rightarrow Ag^+ + e^-$

reactivity of metals increases

(a) (i) In the space at the top of the series, write an ionic equation that includes a more reactive metal. [1]

(ii) Define *oxidation* in terms of electron transfer.

.....

[1]

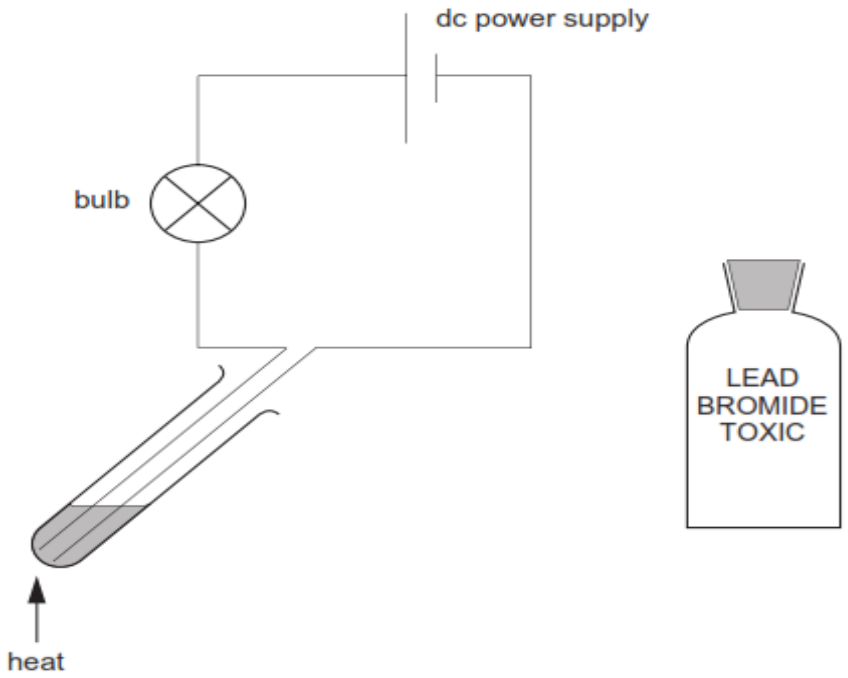
(iii) Explain why the positive ions are likely to be oxidising agents.

[1]

(iv) Which positive ion(s) can oxidise mercury metal (Hg)?

[1]

Lead bromide was placed in a tube and connected to an electrical circuit as shown below.



The lead bromide was heated until molten. A brown gas was given off.

(a) State one other expected observation.

.....

[1]

(b) **(i)** Suggest a suitable material for the electrodes.

.....

(ii) Indicate on the diagram the negative electrode (cathode). [2]

(c) Name the brown gas. At what electrode will the gas be given off?

name .....

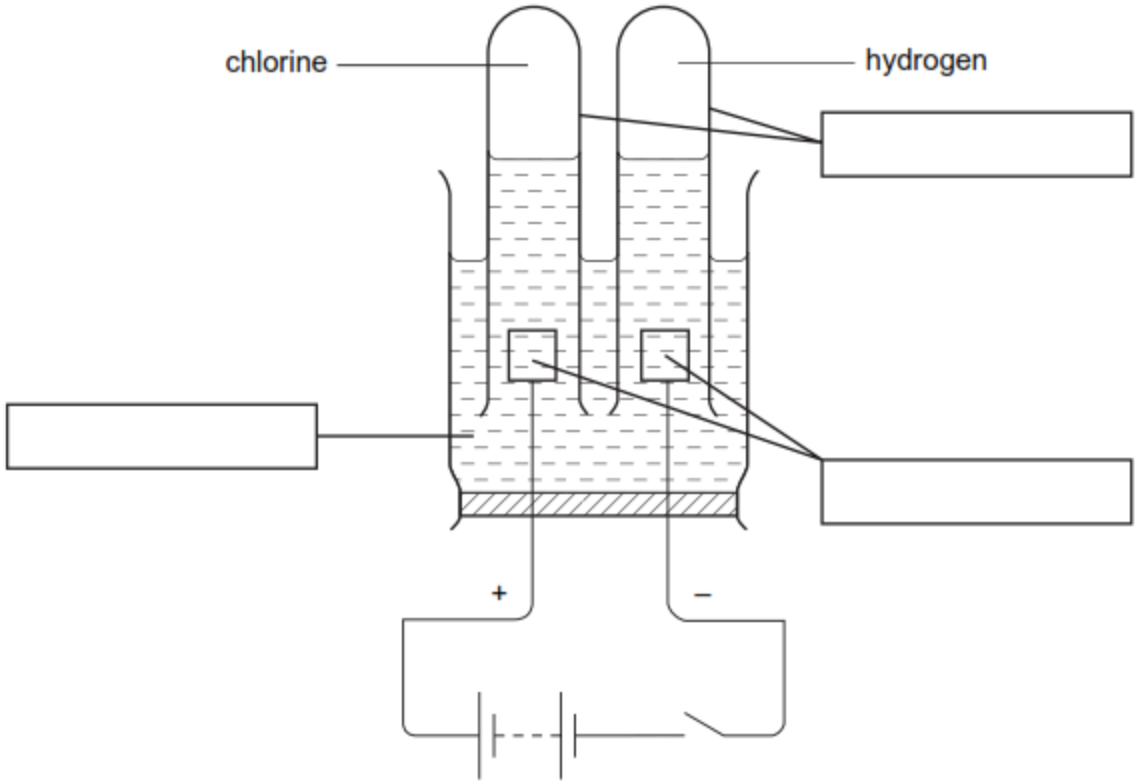
electrode ..... [2]

(d) Why is this experiment carried out in a fume cupboard?

.....

[1]

The diagram shows the effect of passing electricity through concentrated hydrochloric acid.



(a) Label the diagram by completing the boxes. [3]

(b) Name this process.

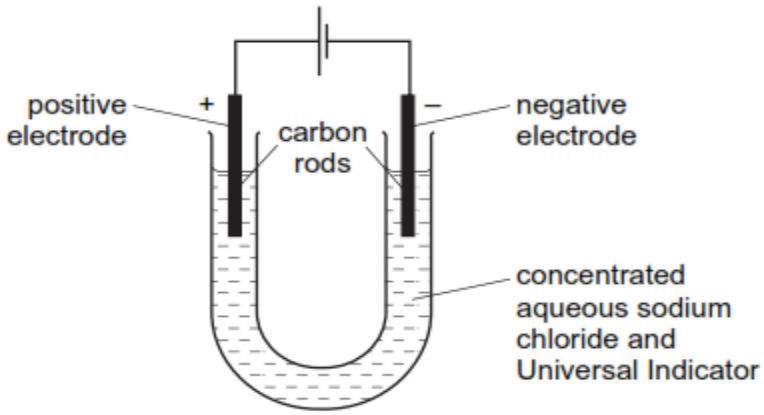
..... [1]

(c) Give a test for chlorine.

test .....

result ..... [2]

Electricity was passed through a concentrated solution of sodium chloride containing Universal Indicator.



(a) Suggest a suitable material for the electrodes.

.....[1]

Three observations were noted:

1 Bubbles of gas seen immediately at the negative electrode.
2 Bubbles of gas formed after some time at the positive electrode.
3 The solution turned blue around the negative electrode and colourless near the positive electrode.

(b) Give a test to show that the gas observed in 1 is hydrogen.

test .....

result .....[2]

(c) Suggest why bubbles of gas were not seen immediately in 2.

.....

.....[1]

(d) What causes the colour change in 3 at

the negative electrode, ...

the positive electrode? .....[2]

The following are examples of redox reactions.

(a) Bromine water was added to aqueous sodium sulfide.

$$Br_2(aq) + S^{2-}(aq) \rightarrow 2Br^-(aq) + S(s)$$

(i) Describe what you would observe when this reaction occurs.

.....

..... [2]

(ii) Write a symbol equation for this reaction.

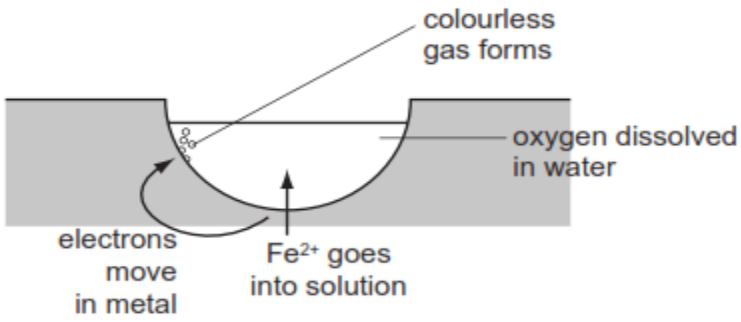
..... [1]

(iii) Explain, in terms of electron transfer, why bromine is the oxidant (oxidising agent) in this reaction.

.....

..... [2]

(b) Iron and steel in the presence of water and oxygen form rust.



The reactions involved are:

reaction 1

$Fe \rightarrow Fe^{2+} + 2e^-$

The electrons move through the iron on to the surface where a colourless gas forms.

reaction 2

$Fe^{2+} + 2OH^- \rightarrow Fe(OH)_2$

from water

reaction 3

.....$Fe(OH)_2$ + O_2 + ...H_2O → .....$Fe(OH)_3$

The water evaporates to leave rust.

(i) What type of reaction is **reaction 1**? ..... [1]

(ii) Deduce the name of the colourless gas mentioned in **reaction 1**.

..... [1]

(iii) What is the name of the iron compound formed in **reaction 2**?

..... [1]

(iv) Balance the equation for **reaction 3**.

.....$Fe(OH)_2$ + O_2 + ...H_2O → .....$Fe(OH)_3$

[1]

(v) Explain why the change $Fe(OH)_2$ to $Fe(OH)_3$ is oxidation.

.....

..... [1]

(vi) Explain why iron in electrical contact with a piece of zinc does not rust.

.....

.....

..... [3]

[Total: 13]

The results of experiments on electrolysis using inert electrodes are given in the table.

Complete the table; the first line has been completed as an example.

electrolyte	change at negative electrode	change at positive electrode	change to electrolyte
molten lead(II) bromide	lead formed	bromine formed	used up
....	potassium formed	iodine formed	used up
dilute aqueous sodium chloride	.....	.....	....
dilute aqueous sodium chloride	.....	.....	....
aqueous copper(II) sulfate	.....	.....	....
....	hydrogen formed	bromine formed	potassium hydroxide formed

[Total: 8]

(c) Concentrated aqueous potassium bromide is an electrolyte.

(i) What is meant by the term *electrolyte*?

.....

..... [2]

(ii) Describe the electrolysis of concentrated aqueous potassium bromide.

Include:
- an ionic half-equation for the reaction at the cathode
- the name of the product at the anode
- the name of the potassium compound formed.

.....

.....

.....

..... [4]

(iii) When molten potassium bromide is electrolysed, the product at the cathode is different.

Name the product at the cathode when molten potassium bromide is electrolysed.

..... [1]

(f) When chlorine gas is passed through aqueous potassium bromide, a redox reaction occurs. The ionic equation is shown.

$$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$$

(i) Write an ionic half-equation showing what happens to the chlorine molecules, Cl_2, in this reaction.

..... [1]

(ii) Explain why the bromide ions, Br^-, act as reducing agents in this reaction.

..... [1]

(a) When magnesium is added to aqueous copper(II) sulfate a reaction occurs.
The ionic equation for the reaction is shown.

$$Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$$

(i) Give **one** change you would observe during this reaction.

..... [1]

(ii) Explain why this is a redox reaction.

.....

..... [1]

(iii) Identify the oxidising agent in this reaction. Give a reason for your answer.

.....

..... [2]

(iv) A redox reaction occurs when magnesium is heated with iron(III) oxide.

Write a chemical equation for the reaction between magnesium and iron(III) oxide.

..... [2]

(b) The metal iron and the alloy steel are commonly used materials. A problem with them is that they rust.

(i) How does painting iron and steel prevent rusting?

.....

..... [1]

(ii) Magnesium blocks can be attached to the bottom of steel boats.

Explain how the magnesium blocks prevent the whole of the bottom of the boat from rusting.

.....

.....

.....

..... [2]

(iii) Replacing the magnesium blocks with copper blocks does not prevent rusting.

Explain why the copper blocks do **not** prevent rusting.

.....

..... [1]

(e) Aqueous sodium hydroxide, aqueous potassium iodide and aqueous acidified potassium manganate(VII) are added to aqueous solutions of iron(II) sulfate and iron(III) sulfate.

- Iron(II) ions, Fe^{2+}, are reducing agents in aqueous solution.
- Iron(III) ions, Fe^{3+}, are oxidising agents in aqueous solution.

Complete the table.

reagent	observations with aqueous iron(II) sulfate	observations with aqueous iron(III) sulfate
aqueous sodium hydroxide	green precipitate	
aqueous potassium iodide		
aqueous acidified potassium manganate(VII)		no change

[4]

This question is about electrolysis.

(a) (i) What is meant by the term *electrolysis*?

.....

..... [2]

(ii) Name the type of particle responsible for the conduction of electricity during electrolysis in:

the metal wires .....

the electrolyte .....

[2]

(b) The table gives information about the products of the electrolysis of two electrolytes. Platinum electrodes are used in each case.

(i) Give **two** reasons why platinum is suitable to use as an electrode.

1 .....

2 .....

[2]

(ii) Complete the table.

electrolyte	observation at the anode (+)	name of product at the anode (+)	observation at the cathode (–)	name of product at the cathode (–)
concentrated aqueous potassium chloride			bubbles of colourless gas	
aqueous copper(II) sulfate	bubbles of colourless gas			

[6]