

HOMework BOOKLET

C4 Challenge

Metal Reactivity and Extraction Match and Draw

Draw a line to match the keyword with the correct meaning.

Aluminium

Unreactive metal that isn't found as a compound

Gold

Used to reduce less reactive metals from their ores

Carbon

Highly reactive metal that is extracted by electrolysis

Electrolysis

Loss of oxygen from a compound

Displacement

Oxidation and reduction take place at the same time

Reduction

Method of extraction using an electric current

Oxidation

Gain of oxygen in a compound

Redox reaction

A less reactive metal is replaced from its oxide
by another

Electrolysis of Aqueous Solutions

A student carried out an investigation to test the following hypothesis:

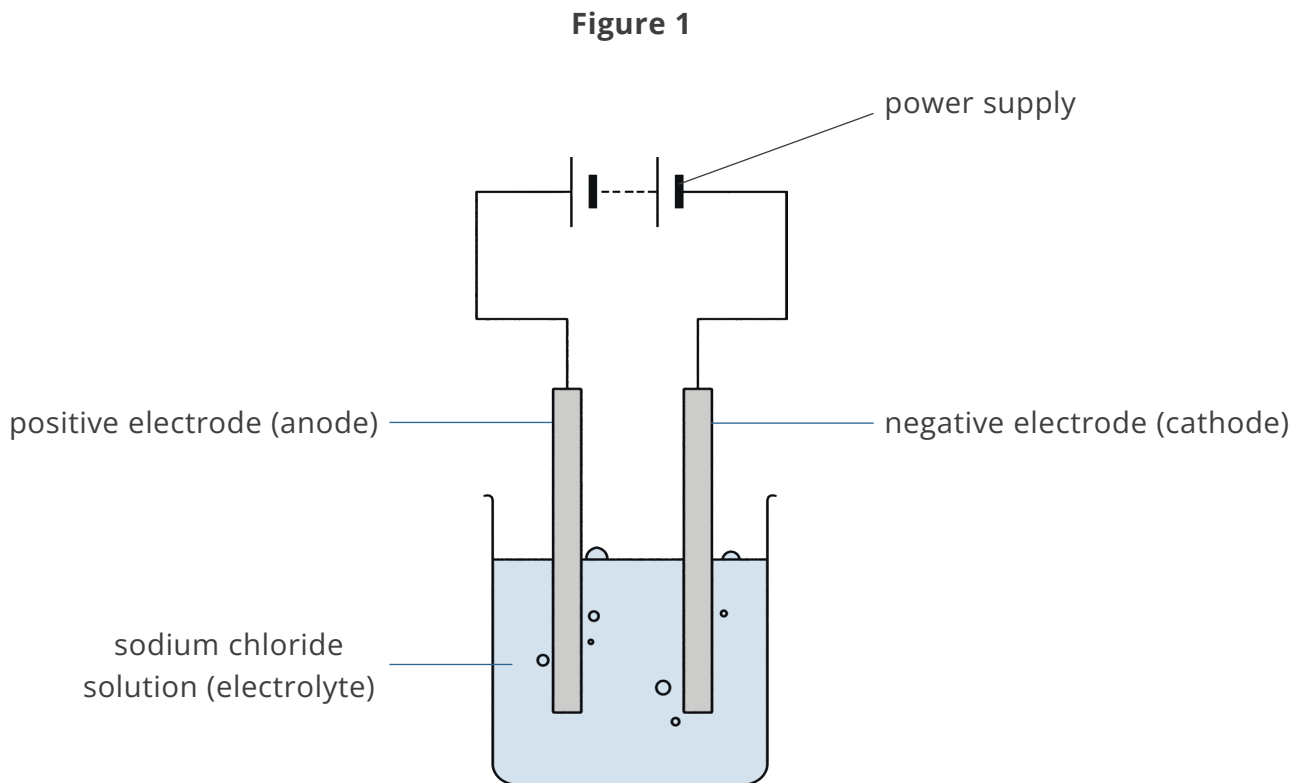
‘In electrolysis, a metal is always produced at the negative electrode.’

First, the student placed solid sodium chloride into a beaker and inserted two graphite electrodes connected to a power supply. When the power supply was switched on, nothing appeared to happen.

1. Explain why this experiment did **not** work.

The student then dissolved the sodium chloride in water.

Figure 1 shows the apparatus used in the electrolysis of sodium chloride solution, NaCl(aq).



2. The electrodes are made of graphite. Give **two** reasons why graphite is a suitable material for the electrodes in the electrolysis of salt solutions.



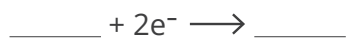
The student observed that bubbles of gas were produced at both the positive and the negative electrodes. The student concluded that these observations did **not** support the hypothesis.

3. Name the gas produced at the negative electrode in **Figure 1**.

4. Explain why this gas was produced at the negative electrode and **not** sodium metal.

5. Name the gas produced at the positive electrode in **Figure 1**.

6. Complete the half equation to show what happens at the positive electrode during the electrolysis of sodium chloride solution.



The apparatus shown in **Figure 1** can be used in the electrolysis of other salt solutions.

7. Complete the table below by naming the product that would form at each electrode during the electrolysis of each salt solution.

| Salt Solution | Product Formed at the Positive Electrode (Anode) | Product Formed at the Negative Electrode (Cathode) |
|----------------|--|--|
| copper sulfate | | |
| silver nitrate | | |
| zinc chloride | | |



Making Soluble Salts Sequencing

Homework 2

Each of the statements describes a stage in a method used to prepare a pure, dry sample of copper sulfate crystals. Add the numbers 1-7 in the box next to each statement to sequence the method in the correct order.

Continue adding copper oxide or copper carbonate powder and stir until no more dissolves. This means that the copper oxide or copper carbonate is in excess and the solution is saturated. Carefully remove the glass beaker from the heat.

Pour the filtrate into an evaporating basin. Gently warm the solution using a Bunsen burner. Do not allow it to boil. Continue heating the solution until half of it has evaporated.

Pour the solution through a funnel lined with filter paper to remove the undissolved copper oxide or copper carbonate powder. Collect the solution in a conical flask.

Use a measuring cylinder to pour dilute sulfuric acid into a beaker. Gently warm the sulfuric acid using a Bunsen burner. Do not allow the acid to boil.

Carefully pat the crystals dry using filter paper or paper towels to remove excess moisture.

Add one spatula of copper oxide or copper carbonate powder to the warmed sulfuric acid. Use a glass rod to stir the powder until it dissolves. Continue heating the solution. Do not allow it to boil.

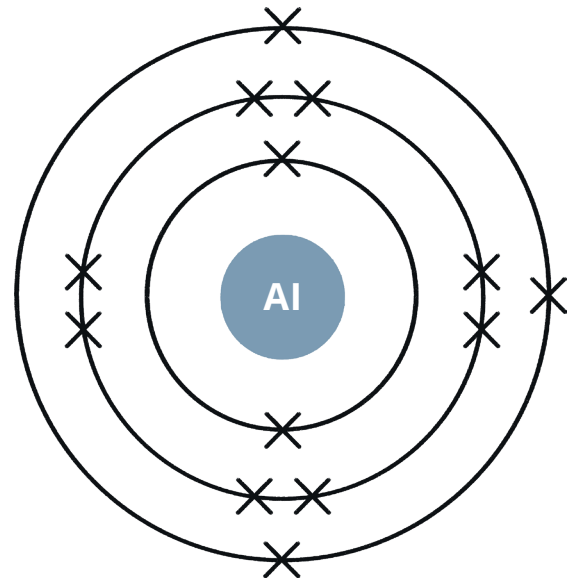
Leave the evaporating basin in a warm room overnight to allow it to crystallise. You could use an electric heater or a water bath to keep the solution warm.

The Properties and Extraction of Aluminium

Properties of Aluminium

Aluminium is a silver-coloured, low density metal that is solid at room temperature. It has an atomic number of 13 and an atomic mass of 27. Aluminium is found in Group 3 of the periodic table and has three electrons in its outer shell. It is also in the third period, so its thirteen electrons occupy three shells in total, with the configuration [2, 8, 3].

Aluminium is a malleable metal. This means that it can be shaped without breaking or cracking. Being a metal, it is a good electrical conductor and has a high thermal conductivity. Like most metals, aluminium is not magnetic. Pure aluminium is not very strong, so aluminium is often alloyed with other elements, such as copper or silicon, to increase its strength.



Uses of Aluminium

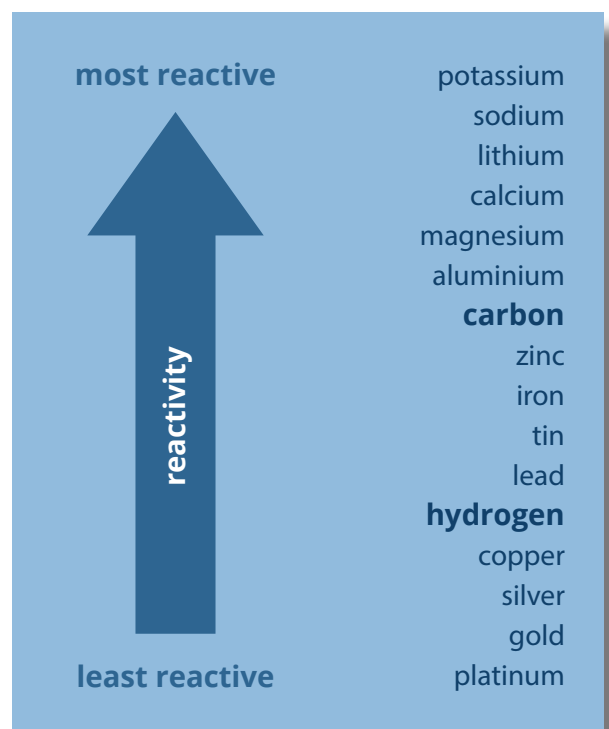
Aluminium metal and its alloys have a wide range of uses in everyday life. Its high electrical conductivity and light weight make it useful in overhead power cables. Its shiny appearance and resistance to corrosion are useful when making reflective surfaces, such as telescope mirrors and wrapping paper. The malleability and low density of aluminium are especially useful in the construction of bicycles, cars and aeroplane fuselages. Because aluminium is very easy to recycle, it is also commonly found in household items, including drinks cans and aluminium foil.

Reactivity of Aluminium

Aluminium is a relatively reactive metal. It is more reactive than transition metals, such as silver, zinc and iron. However, it is less reactive than Group 1 and Group 2 metals, such as sodium, calcium and magnesium. Aluminium can be oxidised to form Al^{3+} ions and readily reacts with oxygen. This means that almost all the naturally available aluminium is found as aluminium oxide, Al_2O_3 .

Aluminium oxide is most commonly found in an ore called bauxite, which is mined from the Earth's surface. Bauxite also contains impurities such as iron oxide which must be removed before aluminium can be extracted.

Aluminium is then extracted from aluminium oxide by electrolysis. The overall reaction is:

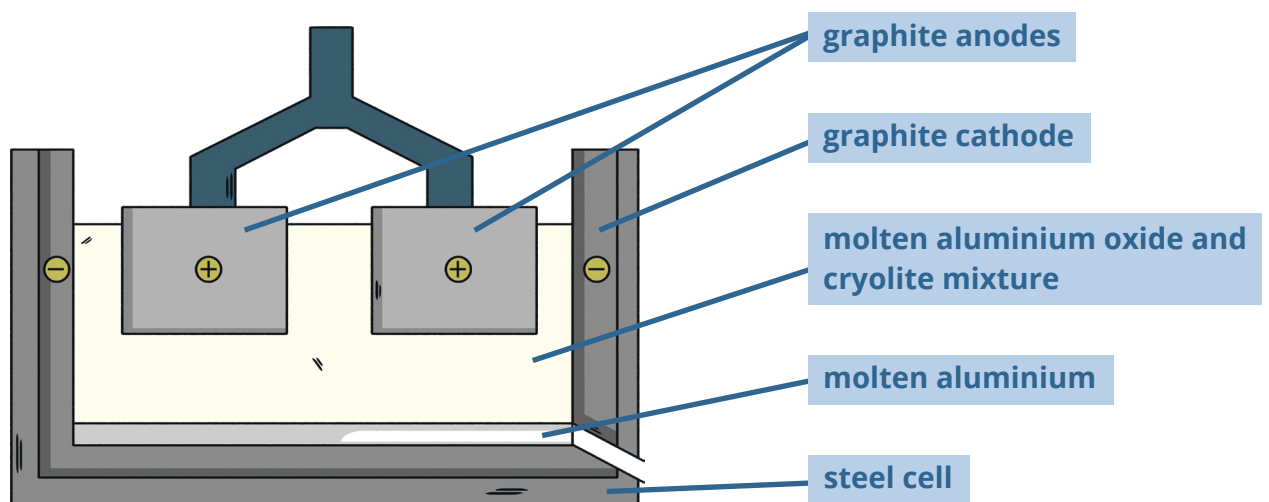


Electrolysis of Aluminium

Homework 3

Electrolysis is used to extract aluminium because it is more reactive than carbon. This means that carbon is not reactive enough to displace aluminium from aluminium oxide. For electrolysis to work, the aluminium oxide needs to be made molten. This requires large amounts of energy because aluminium oxide is an ionic compound, and therefore has a very high melting point of around 2070 °C. To reduce the amount of energy required to melt the aluminium oxide, it is mixed with a compound called cryolite. The melting point of the aluminium oxide and cryolite mixture is significantly lower at around 950 °C.

The electrolysis of aluminium happens inside a steel case called a cell. This specific type of cell is known as a Hall-Héroult cell. It is named after Charles Martin Hall and Paul Héroult, two scientists who separately realised aluminium could be extracted in this way at around the same time in the 1880s. The inside of the cell is lined with carbon in the form of graphite; this acts as the cathode. The cell is filled with the molten aluminium oxide and cryolite mixture. An electric current is passed through graphite anodes suspended within this mixture.



When aluminium oxide is in its molten state, aluminium and oxygen ions are free to move about within the liquid. The positive aluminium ions are attracted to the cathode, where they are reduced. Each aluminium ion gains three electrons to form an aluminium atom.



The aluminium metal formed is molten due to the high temperature inside the cell. It is removed and collected through a tap at the bottom of the cell.

The negative oxide ions are attracted to the anodes, where they are oxidised. Each oxygen ion loses two electrons to form oxygen gas.



Because the graphite anodes get hot when an electric current is passed through them, they react easily with the oxygen gas produced there. This creates carbon dioxide gas, which is released at the anodes. The result of this is that, over time, the graphite anodes need to be replaced.





The Properties and Extraction of Aluminium

1. Calculate the number of neutrons in the nucleus of an aluminium atom.

_____ neutrons

2. Describe how aluminium metal is found naturally.

3. Explain why being malleable makes aluminium suitable for making drinks cans.

4. Describe the role of cryolite in the electrolysis of aluminium oxide.

5. Describe the advantage of alloying aluminium with other elements.

6. Iron can be extracted from its ore by heating it with carbon. Explain why aluminium cannot be extracted in the same way.

7. Explain why the anodes in the electrolysis of aluminium oxide need to be replaced.



8. Explain why aluminium forms positive ions but oxygen forms negative ions.

9. Name the type of reaction that occurs at the cathode.

10. Complete and balance the half equation describing the reaction at the cathode.



11. Name the type of reaction that occurs at the anode.

12. Complete and balance the half equation describing the reaction at the anode.



A student is researching the energy required to extract aluminium from aluminium oxide by electrolysis. They suggest that the process would require less energy if solid aluminium oxide were used.

13. Evaluate this statement.



Chemical Changes Word Search

Homework 4

Each of the words in the grid below relates to chemical changes. Work out the answer to each clue, then find the answers in the grid. They can be found horizontally, vertically and diagonally.

d o a c u c g e w b f m v t f d a y r t
c i q k z i n c s u l f a t e f i m e o
t l d m a g n e s i u m c h l o r i d e
o j v o x x u i l n u d g v o w o u u h
e x v s c w v a r e h o b d r k x f c w
h i d m r f l p k c c t x m f b y t t v
y g q i y a l k a l i t q q o z g x i k
d u a e s u a e v c b x r v r q e d o t
r r n l t p d n m d r f j o x z n i n o
o m m i a v l k o t m y m p l l t e u x
x a m c l v g a z d z i o x r y y j m i
i e h c l e k j c r e w t l b u s d q d
d b y x i j a m o e s t f e i s d i w a
e n d n s d c t f a m x e x s t b a s t
c t r h a u a n v e n e h o o g e u g i
n l o p t u r m z w y z n z c y z w b o
h x g b i x b r c b i g u t l y q f u n
x b e d o u o x n r c a t h o d e r u k
q t n v n f n g c i a z v k c h w i f o
e i v u o z z d r i i s x z y s h o w a

Clues

1. A non-metal element that can be used to extract less reactive metals, such as zinc or iron, from their ores in reduction reactions.

2. The loss of oxygen from a substance.



3. A reaction in which a more reactive element takes the place of a less reactive element in a compound.

4. A substance that is mixed with aluminium oxide to lower its melting temperature in the extraction of aluminium from its ore.

5. A negatively charged ion found in alkaline solutions.

6. The gain of oxygen by a substance.

7. A positive electrode. Negatively charged ions (anions) move towards this electrode.

8. The gas produced when a metal reacts with an acid.

9. A substance that changes colour when added to acidic or alkaline solutions.

10. The salt produced when zinc carbonate reacts with sulfuric acid.

11. The salt produced when magnesium oxide reacts with hydrochloric acid.

12. A technique used to obtain a pure, dry sample of a salt from a salt solution.

13. The process of breaking down a substance by passing an electric current through it.

14. A negative electrode. Positively charged ions (cations) move towards this electrode.

15. The gas formed at the positive electrode during the electrolysis of an aqueous solution that does not contain halide ions.

16. A substance that produces hydroxide ions in aqueous solutions and has a pH greater than 7.
