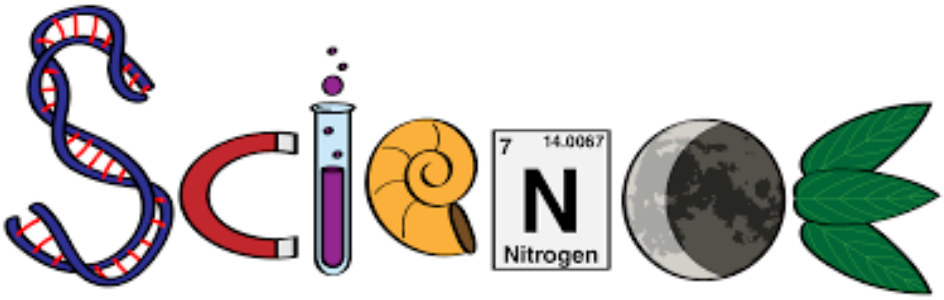
Meopham School



HOMEWORK BOOKLET

C4 Standard

Homework 1

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

Homework 2

A student carried out an investigation into the electrolysis of sodium chloride.

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. Why did this experiment **not** work?

   Tick **one** box.

   Electrolysis is slow and does not start straight away. ☐

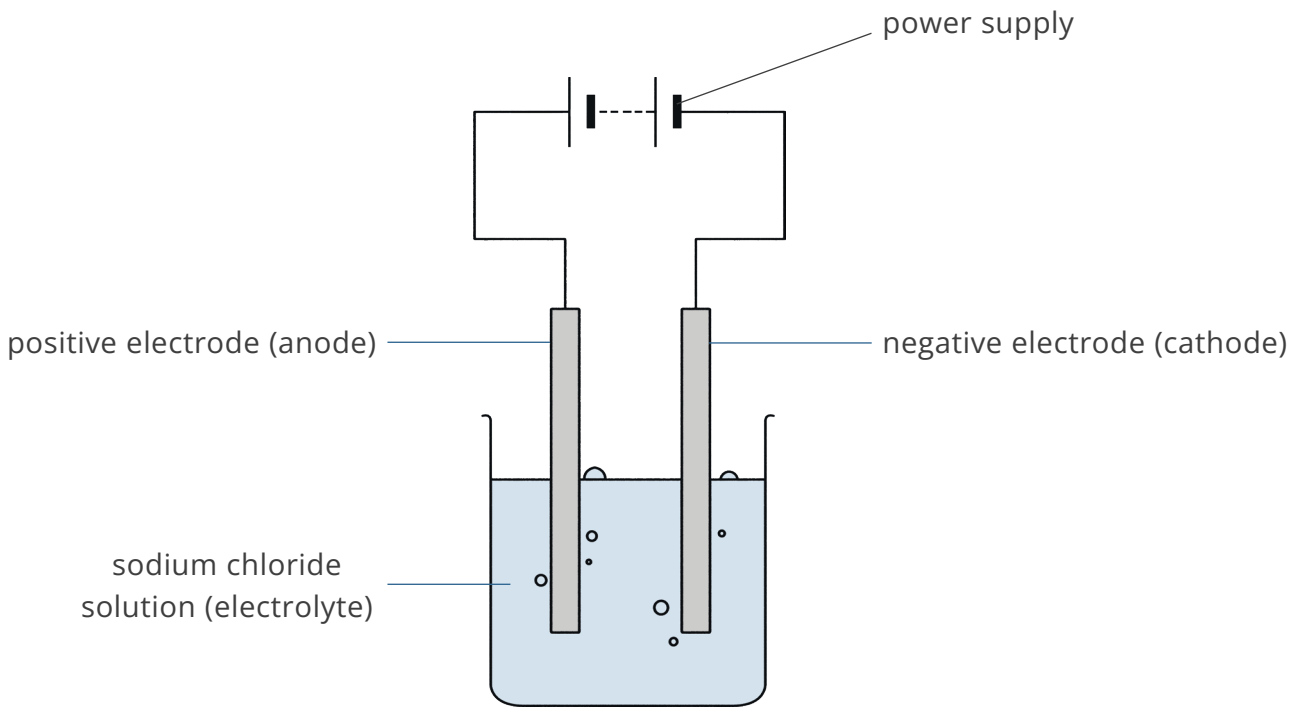
   Solid sodium chloride does not conduct electricity. ☐

   The voltage of the power supply was too high. ☐

The student then dissolved the sodium chloride in water.

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

Figure 1



2. The electrodes are made of graphite. Why is graphite a suitable material for the electrodes?

   Tick **two** boxes.

   Graphite has a high melting point. ☐

   Graphite is a good conductor of electricity. ☐

   Graphite is slippery. ☐

   Graphite is unreactive. ☐

The student observed that bubbles of gas were produced at both the positive and the negative electrodes.

The gas produced at the negative electrode is hydrogen.

3. Why are hydrogen ions present in sodium chloride solution, NaCl(aq)?

   Tick **one** box.

   Chloride ions are turned into hydrogen ions during electrolysis. ☐

   Hydrogen from the air dissolves in the sodium chloride solution. ☐

   Water molecules are split into hydrogen ions and hydroxide ions. ☐

4. Explain why hydrogen gas is produced at the negative electrode and **not** sodium metal.

The students carried out another investigation to test the following hypothesis.

'In the electrolysis of salt solutions, oxygen is always produced at the positive electrode unless a halogen is present.'

5. Complete the table below to predict the name of the product that will form at each electrode during the electrolysis of the salt solutions named.

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. One has been done for you.

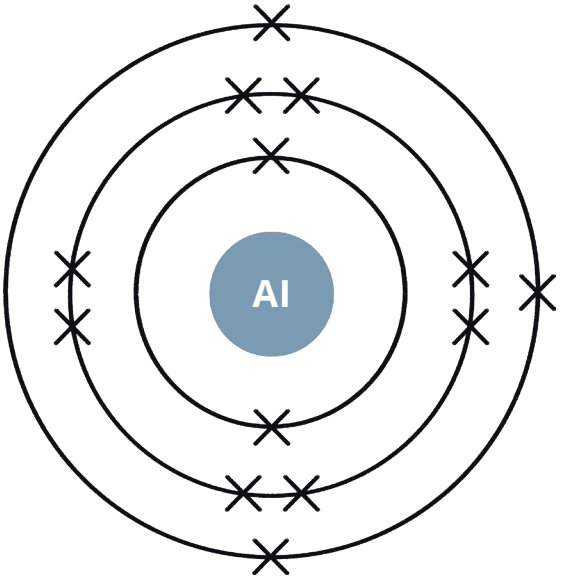
Continue adding copper oxide or copper carbonate powder and stir until no more dissolves. This means that the copper oxide or copper carbonate is in excess and the solution is saturated. Carefully remove the glass beaker from the heat.	3
Pour the filtrate into an evaporating basin. Gently warm the solution 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.	

Homework 3

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].



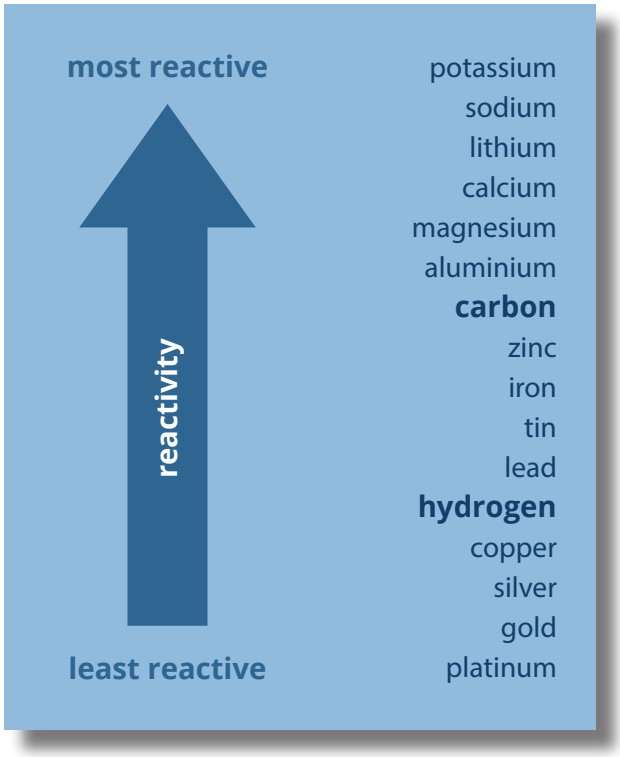
Aluminium is a malleable metal. This means that it can be shaped without breaking or cracking. Being a metal, it is a good electrical conductor and has a high thermal conductivity. Like most metals, aluminium is not magnetic. Pure aluminium is not very strong, so aluminium is often alloyed with other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

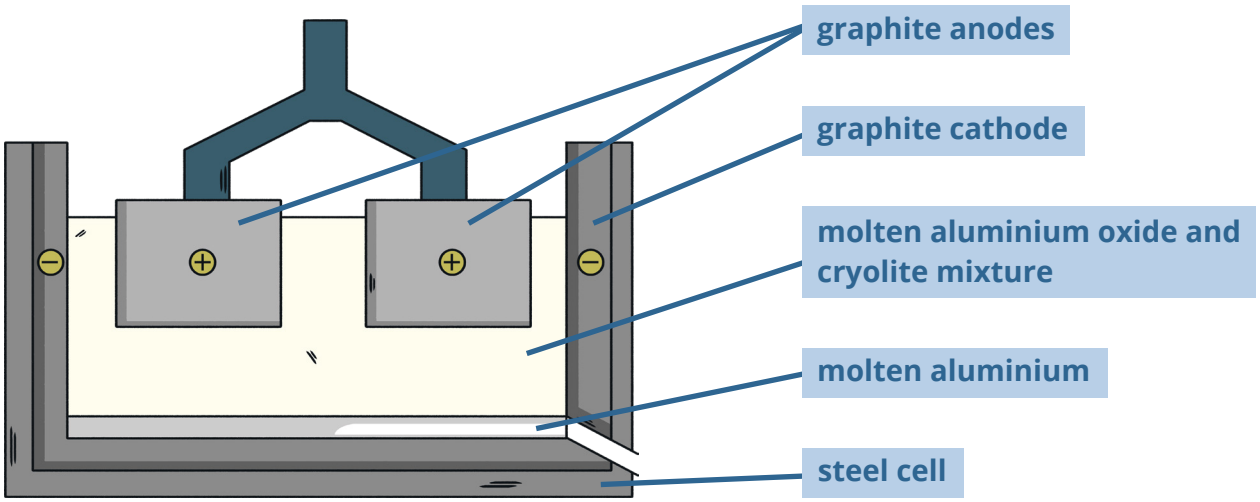
aluminium oxide → aluminium + oxygen

Homework 3

Electrolysis of Aluminium

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.

$$Al^{3+} + 3e^- \rightarrow Al$$

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.

$$2O^{2-} \rightarrow O_2 + 4e^-$$

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.

$$C + O_2 \rightarrow CO_2$$

Homework 3

The Properties and Extraction of Aluminium

1. State the number of electrons in the outer shell of an aluminium atom.

_____

2. Which of the following is **not** a property of aluminium?

- ☐ high thermal conductivity
- ☐ low density
- ☐ magnetic
- ☐ malleable

3. Give the names of **two** metals that are more reactive than aluminium.

1. _____
2. _____

4. Draw **one** line from each use of aluminium to the property that makes it most suitable for that use.

overhead power cables	high electrical conductivity
aeroplane fuselages	shiny appearance
telescope mirrors	lightweight and malleable

5. Explain why aluminium is often combined with other elements to form alloys.

_____

_____

6. Give the name of an ore that naturally contains aluminium.

_____

Homework 3

7. Each of the statements below describes a stage in the extraction of aluminium. Number the statements 1 – 4 to correctly sequence the stages.

Electrolysis is used to separate aluminium metal from aluminium oxide.	
Impurities like iron oxide are removed from the bauxite.	
Molten aluminium metal is removed from the bottom of the cell.	
Bauxite is mined from the surface of the Earth.	

8. Describe why electrolysis is used to extract aluminium from aluminium oxide.

_____

_____

9. Calculate the difference between the melting point of aluminium oxide on its own and the melting point of aluminium oxide mixed with cryolite.

_____ °C

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

_____

_____

11. State the product formed at each electrode in the electrolysis of aluminium oxide.

positive electrode (anode): _____

negative electrode (cathode): _____

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

_____

_____

_____

_____

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.

   c __ __ __ __ n

2. The loss of oxygen from a substance.

   r __ __ __ __ __ __ __ n

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

   d __ __ __ __ __ __ __ __ __ __ t

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

   c __ __ __ __ __ __ e

5. A negatively charged ion found in alkaline solutions.

   h __ __ __ __ __ __ __ e

6. The gain of oxygen by a substance.

   o __ __ __ __ __ __ __ n

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

   a __ __ __ e

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

   h __ __ __ __ __ __ n

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

   i __ __ __ __ __ __ __ r

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

    z __ __ c s __ __ __ __ __ e

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

    m __ __ __ __ __ __ __ m c __ __ __ __ __ __ e

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

    c __ __ __ __ __ __ __ __ __ __ __ __ __ n

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

    e __ __ __ __ __ __ __ __ __ __ s

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

    c __ __ __ __ __ e

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

    o __ __ __ __ n

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

    a __ __ __ __ i