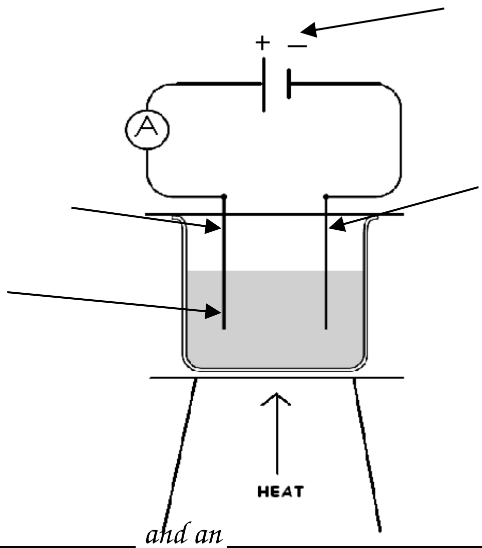
C5b

Electrolysis

Electrolysis of Molten Compounds



- A compound is heated until it ______________ and an _______________________ _________________ is passed through it.
- For the circuit to be complete _________________ must **flow**.
- The __________________ electrode (anode) attracts _______________ ions (anions) and takes electrons away from them.
- These flow through the external circuit to the __________________ electrode.
- The ________________________ electrode (cathode) gives electrons to the ______________________ ions (cations) that it has attracted.
- As ions gain or lose electrons they become _________ or __________________ and are **discharged** from the solution.

Metal ions are always ____

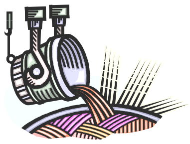
e.g. H^+ Li^+ Na^+ K^+ Rb^+ **what do the last 4 have in common?**

Pb^{2+} Fe^{2+} Mg^{2+} Ca^{2+} Sr^{2+} **what do the last 3 have in common?**

Non-metal ions (except hydrogen, H^+) are _____________________

e.g. F^- Cl^- Br^- I^- **what do these 4 ions have in common?**

O^{2-} S^{2-}

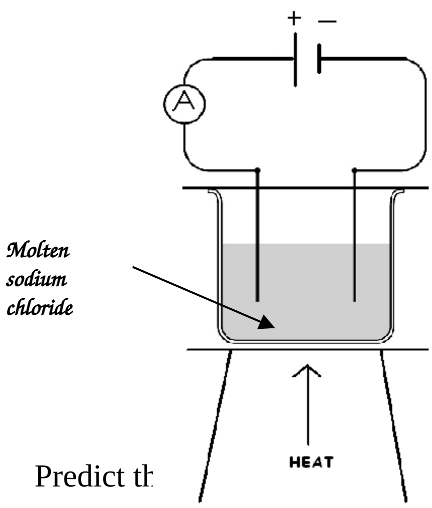


Electrolysing Molten Compounds

What type of compounds electrolyse?

- *Electrolysis is the __________________________ of a liquid by the passing an electric current through it.*
- *This can only happen if the compound decomposes to produce ________ (charged particles) i.e. ionic compounds made from a metal and _____________________ part.*
- *The ions are then attracted to the _____________ (positive electrode) and the __________________ (negative electrode).*
- *Ionic compounds are usually solids. Electrolysis will **ONLY** take place when ionic compounds are molten because the ions must ___________________ to the electrodes.*

Example 1 – Consider Sodium Chloride:



Cathode:

Metal ions ____________ electrons to become metal atoms

Anode:

Non-metal ions _____________ electrons to become atoms or molecules.

We call this type of equation a _________________.

Predict th decomposition of the following molten electrolytes:

Electrolyte		***positive ions (cations)***	***negative ions (anions)***
sodium chloride	*NaCl*	*sodium*	*chloride*
	Al_2O_3		
	$PbBr_2$		
	PbI_2		
	KCl		

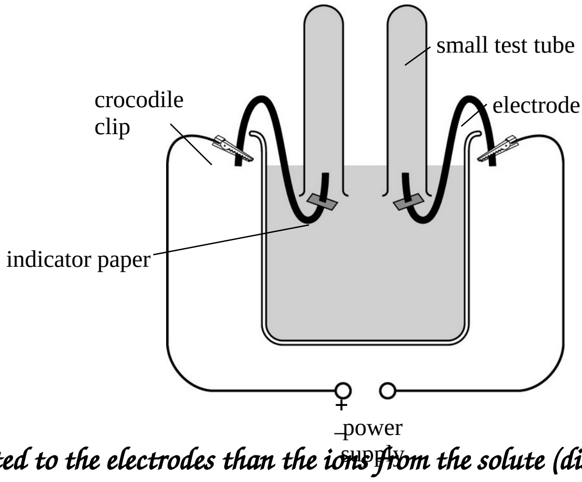
***Half equations**:*

	Cathode	***Anode***
Al_2O_3	Al^{3+} + __e^- ⟶ Al	O^{2-} ⟶ O_2 + __e^-
$PbBr_2$	⟶	⟶
PbI_2	⟶	⟶
KCl	⟶	⟶

Electrolysis of Aqueous Solutions

What difference does dissolving a compound in water make?

Consider a sodium chloride solution (salty water)



- ***Sometimes the ions from water are more attracted to the electrodes than the ions from the solute (dissolved compound)***
- *In the solution above, the ______________ ions are attracted to the anode (+), _______________ electrons and become __________________________________*
- *The ___________________ ions from water are attracted to the cathode (-) and form ________________________ molecules, H_2.*

  Cathode: $\longrightarrow$

  Anode: $\longrightarrow$

Example 2 Potassium sulfate, *$K_2SO_{4(aq)}$*

Cathode: $\longrightarrow$

Anode: $\longrightarrow$

Example 3 *$KNO_{3(aq)}$*

Cathode: $\longrightarrow$

Anode: $\longrightarrow$

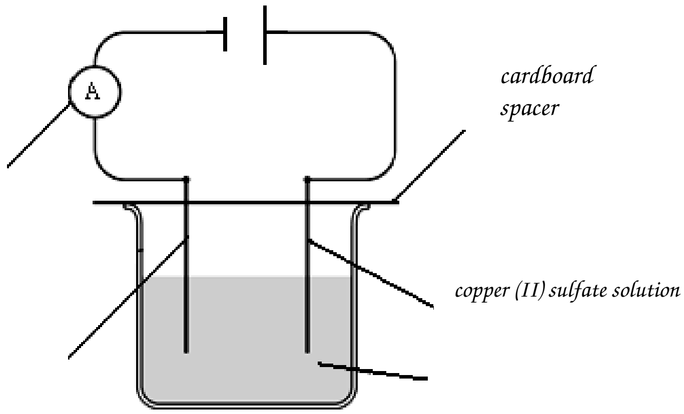
Summary

The following 3 solutions all produce hydrogen and oxygen when electrolysed:

$NaCl_{(aq)}$ sodium chloride *$K_2SO_{4(aq)}$potassium sulfate* *$KNO_{3(aq)}$ potassium nitrate*	$\left.\right\}$ *oxygen + hydrogen*

<u>*Purifying Copper using Electrolysis*</u>

<u>*Summary:*</u>



<u>*Describe the changes in mass of the copper electrodes*</u>

- *The cathode (negative electrode)* ___________ *mass*
- *The positive electrode (anode)* ____________ *mass*
- *The gain in mass of the negative electrode is* ________________ *the loss in mass of the positive electrode.*

Positive electrode (anode):

Negative electrode (cathode):

<u>*What factors affect the amount of copper produced during electrolysis?*</u>

- *The amount of product made depends on the number of* ________________ *transferred*
- *So the* ________________ *the current the more electrons there are. Also, the* ________ *the time the greater the number of electrons transferred.*

more time and higher current = _________________ *mass of pure copper*

<u>***The relationship between charge transfer, current and time***</u>*:*

		<u>*Units*</u>
$Q = I\,t$	*Q =*	*C (coulombs)*
	I =	*A (amps)*
	t =	*s (seconds)*

<u>*Example 1*</u>

0.96g of copper is deposited by a 0.5A current running for 100 minutes

a) What is the total charge used up?

b) How much charge would used in 200 minutes?

c) How much charge would be used if we increased the current to 1.0A for 100mins?

<u>*Example 2*</u>

0.48g of copper is deposited by a 0.25A current running for 100 minutes

a) How much copper is deposited by 1 coulomb of charge?

(hint: work out the total charge first and then divide the mass by the total number of coulombs)

b) If a current of 0.25A ran for 5 hours how much copper would be deposited?

A couple of harder challenges *(you wont get these in a GCSE exam!)*

c) If a current of 0.25A is used, how long would be needed to deposit 9.6g of copper? Give your answer in ***hours and minutes*** *(not just minutes)*

Example 3

A current of 5A was used for 60 minutes to produce 19.5g of lead from molten lead bromide.

a) which electrode will produce the lead?

b) give the chemical formula of the substance produced at the other electrode.

c) Calculate the total charge used in the electrolysis

d) Calculate how much lead 1 coulomb of charge could produce

f) What mass of lead would be produced if a current of 30 amps was used for 10 minutes?

e) Suggest two different ways that you could exactly double the amount of lead being produced? (see if you can prove it mathematically)