GCSE Chemistry

Trilogy Science Paper 1

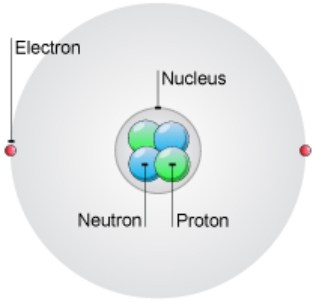
Flashcards

Name: .....

1 - Atomic Structure and the Periodic Table

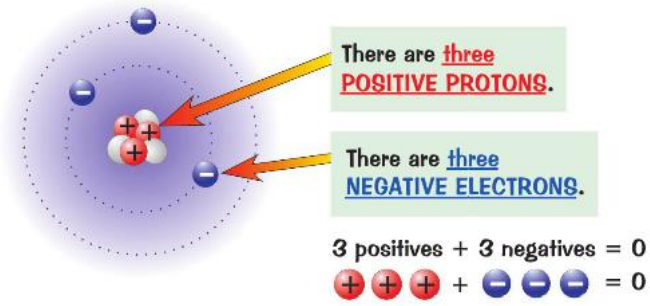
Describe the structure of an atom.

- Atoms contain a nucleus (made of protons and neutrons)
- surrounded by electrons which orbit around in
- shells



Why are atoms neutral? (2 marks)

- The number of protons = the number of electrons
- The charges cancel



Where are elements with similar properties found in the periodic table?

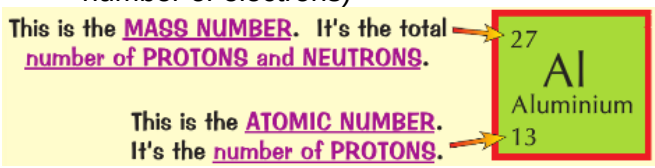
- The same group (vertical column)
- E.g. group 1, group 2…

Which groups are the noble gases, the alkali metals and the halogens found in?

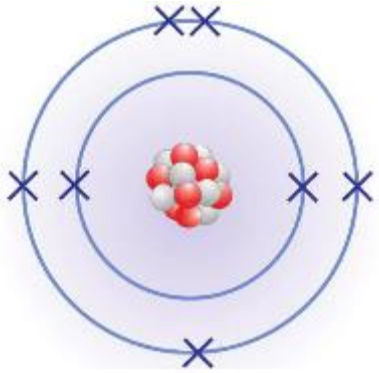
- Noble gases = group 0
- Alkali metals = group 1
- Halogens = group 7

In the periodic table, where are the mass number and atomic number found and what do they tell you about an element?

- Mass number: protons + neutrons
- Atomic number: protons (same as the number of electrons)



Draw an atom of chlorine (1 mark)



Write the electron configuration of sodium (1 mark)

- 2,8,1

(you need to be able to do this for every element up to Ca)

Describe and explain the trend in reactivity down group 1 (4 marks)

- Reactivity increases down group 1
- Atoms get bigger (more shells)
- Outer electron gets further away from the nucleus.
- Attraction between nucleus and outer electron is weaker.
- Electron more easily lost.

Describe and explain the trend in reactivity down group 7 (4 marks)

- Reactivity decreases down group 7
- Atoms get bigger
- Electron being gained is further from the nucleus
- Therefore attraction is weaker
- So electron is harder to gain

Describe and explain the importance of the work of Mendeleev (3 marks)

- He left gaps for undiscovered elements
- He ordered atoms in order of their atomic weight
- He organised elements into groups based on their reactivity

Describe the process of filtration

- Used to separate an insoluble solid from a liquid
  e.g. to separate sand from water

Describe the process of evaporation

- Used to separate a soluble solid from a liquid
  e.g. to separate salt from saltwater

Describe the process of distillation

- Used to separate a soluble solid from a liquid and keep both the liquid and the solid.

Describe the process of chromatography and explain why it is used *(Required Practical 6)*

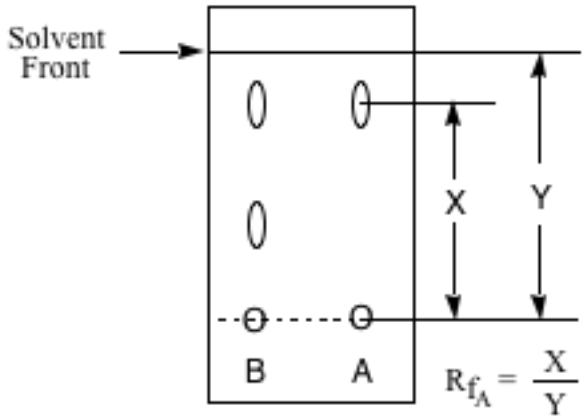
- Used to separate inks.

Method:

- Place a pencil line of a piece of chromatography paper (stationary phase)
- Use pencil so ink doesn't run
- Place dots of known inks and an unknown ink on the link.
- Place in the solvent (mobile phase) in a beaker (below the pencil baseline)
- Leave to develop
- Remove and leave to dry.
- Compare known with unknown to identify what inks are in the unknown sample.
- Calculate Rf values

Calculating Rf values:

- VALUE WILL ALWAYS BE LESS THAN 1



A = pure compound
B = mixture

List the properties of transition metals

- Form coloured compounds
- Conduct electricity
- Conduct heat
- Malleable (can be hammered into shapes)
- Ductile (can be pulled into wires)
- Hard
- Strong
- High melting points

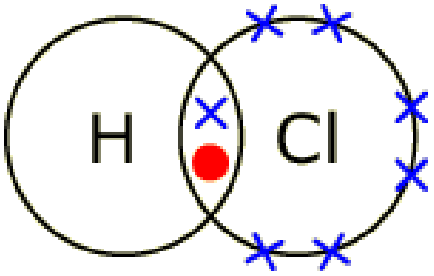
2 - Structure, Bonding and Properties

Describe ionic bonding (4 marks)

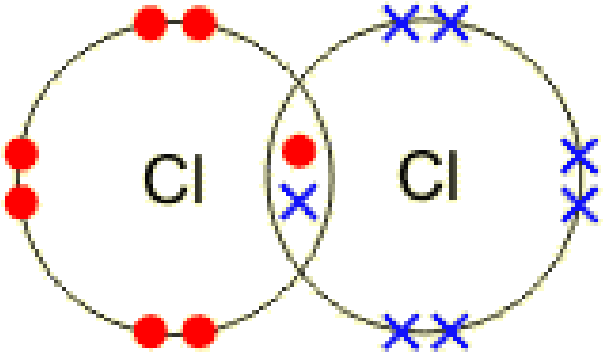
1. Between a metal and a non-metal.
2. Transfer of electrons from the metal to the non-metal.
3. Produces a positive metal ion and a negative non-metal ion.
4. Oppositely charged ions held together by an electrostatic interaction.

e.g. NaCl, $CaCl_2$, MgO, Na_2O… Make sure you use the example in the question
eg: Na transfers one electron to chlorine to form Na^+ and Cl^-. Ions held together by an electrostatic interaction.

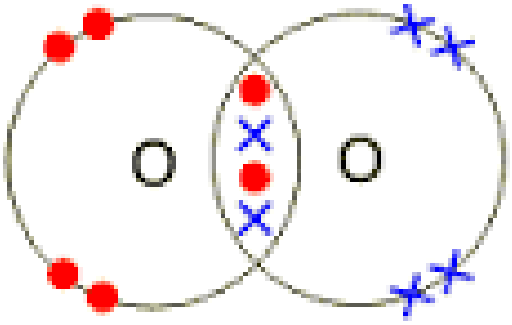
Draw HCl (2 marks)



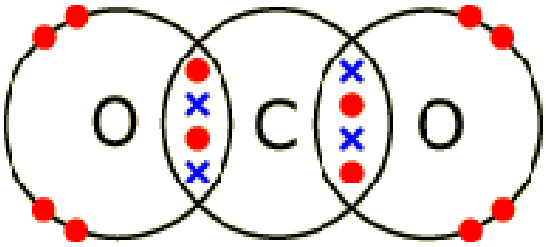
Draw Cl_2



Draw O_2

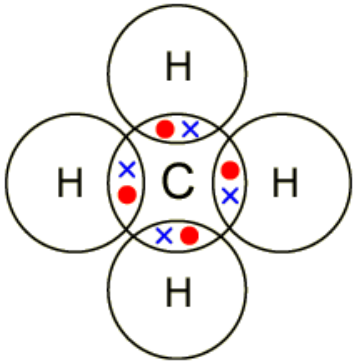


Draw CO_2

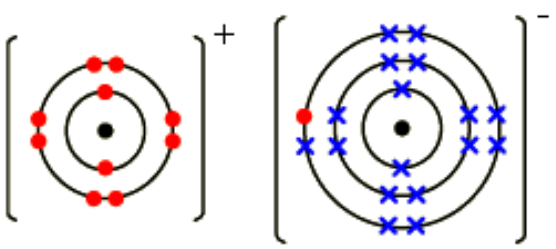


**You have to be able to draw the covalent bond between a variety non-metals*

Draw CH_4



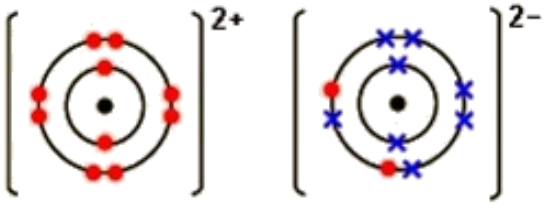
Draw NaCl



sodium ion, Na^+ $[2,8]^+$

chloride ion, Cl^- $[2,8,8]^-$

Draw MgO

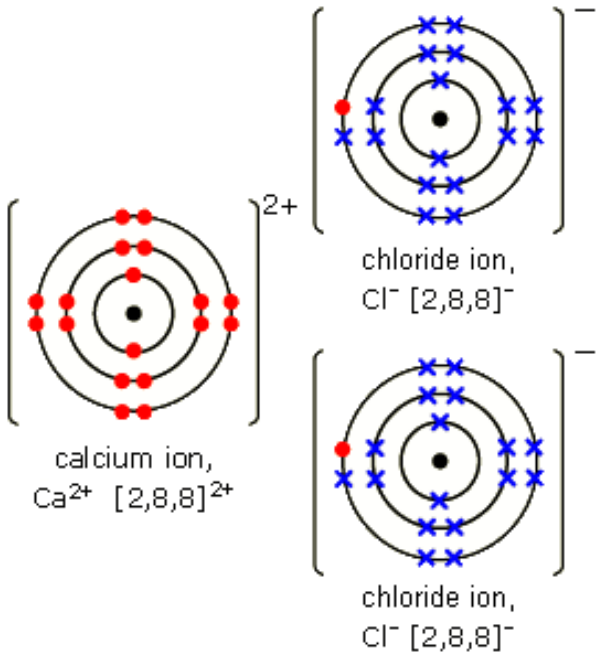


magnesium ion, Mg^{2+} $[2,8]^{2+}$

oxide ion, O^{2-} $[2,8]^{2-}$

**You have to be able to draw the ionic bond between a variety of metals and non-metals*

Draw $CaCl_2$



What is the formula of the ionic compound formed between magnesium and chlorine?

1. Write down the charges on your ions:
   Group 1 = +1
   Group 2 = +2
   Group 3 = +3
   Group 6 = -2
   Group 7 = -1

   Complex ions:
   Nitrate = NO_3^-
   Sulphate = SO_4^{2-}
   hydroxide = OH^-

2. Magnesium = Mg^{2+}
3. Chloride = Cl^-
4. Drop the charge, swap the number:

$Mg^{2+}\ Cl^-$
$Mg^{2}\ Cl$
$= \underline{MgCl_2}$

Describe the structure and bonding in a metal? (2 marks)

- Lattice of positive metal ions
- Surrounded by a sea of delocalised electrons.

What are the different allotropes of carbon? (allotrope = different forms of the same element)

- Diamond
- Graphite
- Graphene (one sheet of graphite)
- Graphane
- Fullerenes (football shaped)
- Carbon nanotubes

Why are atoms neutral? (2 marks)

- Equal number of positive protons and negative electrons
- Cancel.

Why do graphite/grapheme/fullerenes/carbon nanotubes conduct electricity? (3-4 marks)

- Delocalised electrons
- Between the layers
- Free to move
- Carry charge
- Each C has 3 bonds.

Why to atoms react? (1 mark)

- To gain a full outer shell.

Why is graphite slippery? / Why can graphite be used in pencils? *(asking the same thing!)* (3 marks)

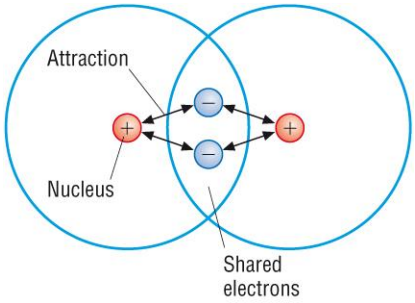
- Weak interactions/forces
- Between the layers
- Easy to break.

What is a covalent bond?
(2-3 marks)

- Shared pair of electrons
- Between 2 non-metals

HT answer:

- Electrostatic attraction between the
- Positive nuclei and the
- Shared pair of negative electrons



Why does silicon dioxide have a high melting point? / Why can silicon dioxide be used to line furnaces?
(asking the same thing!)
(4-5 marks)

- Each Si has 4 bonds and each O has 2 bonds.
- All bonds are covalent.
- Giant covalent structure.
- Many strong covalent bongs need to be broken
- So has a high melting point.

How does the covalent bond between HCl form?
(3 marks)

- H has 1 outer shell electron
- Cl has 7 outer shell electrons
- Each share 1 electron to get a full outer shell.

Why can ionic compounds NOT conduct electricity when solid?
(2 marks)

- Ions
- In fixed position in the ionic lattice
- Cannot carry charge.

Why do simple molecules have low boiling points? / Why is methane a gas a room temperature?
(asking the same thing!)
(3 marks)

- Weak interactions/forces
- Between molecules
- Easy to break.

Why can ionic compounds conduct electricity when molten?
(2 marks)

- Ions
- Free to move and carry charge

Why do simple molecules NOT conduct electricity?
(2 marks)

- No delocalised electrons so
- Cannot carry a charge.

Why does diamond NOT conduct electricity?
(2 marks)

- No delocalised electrons so
- Cannot carry a charge.

Why is diamond hard?
(4-5 marks)

- Each carbon has 4 covalent bonds
- Giant covalent structure
- Strong bonds hard to break.

Why can metals conduct electricity? / Why is copper used in wires?
(asking the same thing!)
(2-3 marks)

- Delocalised electrons
- Free to move and carry charge through the metal structure.

Why does diamond have haigh melting point? (4 marks)

- Each C has 4 bonds
- All bonds are covalent.
- Giant covalent structure.
- Many strong covalent bongs need to be broken
- So has a high melting point.

Explain the difference in boiling point of HCl and NaCl. (6 marks)

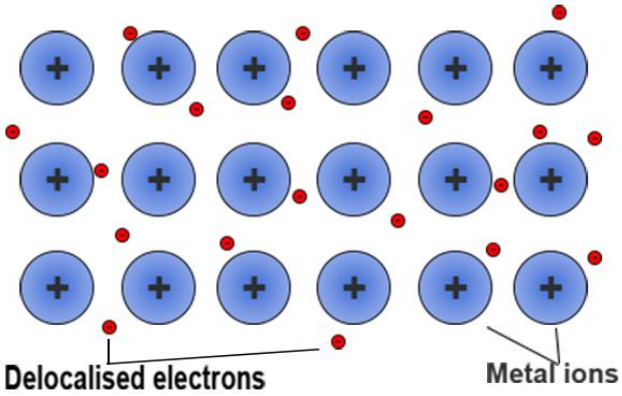
***** you can be asked to compare the boiling point of any two compounds so you need to make sure you can work out what the bonding is!*****

- HCl is simple covalent
- Exists as molecules
- Weak interactions between molecules
- Easy to break

- NaCl is ionic
- Exists in 3D ionic lattice
- Strong electrostatic attraction
- Between Na+ and Cl-/oppositely charged ions
- Need a lot of energy to break

- So NaCl has a higher boiling point than HCl

Draw the structure of a metal (2 marks)



Why can metals be hammered into shapes? (2 marks)

- Layers of metal ions
- Slide over eachother.
- This does not disrupt the structure of the metallic bond.

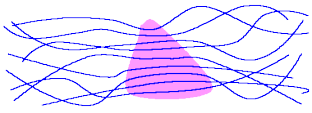
How big are nanoparticles?

One billionth of a metre.
Or
10^{-9}m
Or
Very tiny

What is the difference between thermosetting and thermosoftening polymers?

Thermosetting polymers have cross-linked chains. They are formed by putting them into a mould and heating. The resulting structure cannot be reshaped.

Thermosoftening polymers have weak interactions between polymer chains. They can be reshaped when heated.

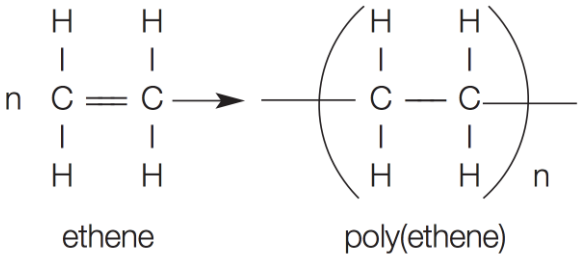


What are the environmental advantages and disadvantages of using nanoparticles?

- Advantages: long-lasting (e.g. using in tennis balls), antibacterial properties (e.g. used in smelly socks).

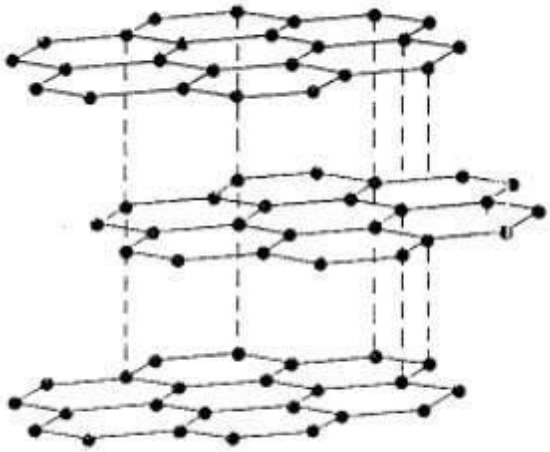
- Disadvantages: Could be toxic if they entered the bloodstream.

Draw and name the polymer formed by ethene (4 marks)



1 – for n before monomer
2 – for breaking double bond and drawing 2 bonds outside of brackets
3 – for brackets
4 – name = poly(ethene)

Sketch the structure of graphite (2 marks)



3 - Quantitative Chemistry: Calculations

What is the relative molecular mass, Mr?

The sum of the mass numbers in a molecule or compound

What is the Mr of LiCl?

3 + 35.5 = 38.8

What is the Mr of $Ca(OH)_2$

40 + (2x16) + (2x1) = 74

What equation links mass, molecular mass and moles?

Mass = molecular mass x moles

m = Mr x n

Rearrange m = Mr x n to calculate n.

n = m / Mr

What equation links moles, concentration and volume?

Moles = concentration (in mol/dm^3) x volume (in dm^3)

n = c x v

What equation links mass, concentration and volume?

Mass (in g) = concentration (in g/dm^3) x volume (in dm^3)

m = c x v

What is the maximum mass of magnesium oxide that can be formed from 5 g of Magnesium? (3 marks)

$2Mg + O_2 \rightarrow 2MgO$

1. Work out the moles of Mg
2. Write down the Mr of Mg and MgO
3. Work out the molar ratio
4. Work out the moles of MgO that would be produced
5. Work out the mass of MgO

$2Mg + O_2 \rightarrow 2MgO$

m = 5g	m = 40 x 0.21 = **<u>8.3g</u>**
Mr = 24	Mr = 24 + 16 = 40
n = 5 / 24 = 0.21	n = 0.21 (as 1:1)

**you have to be able to do this for any equation with any ratio and any quantities given*

What is the maximum mass of magnesium oxide that can be formed from 5 g of Magnesium and 12 g of oxygen? (4 marks) – *Limiting reagent question! (They have given you information about both reactants)*

$2Mg + O_2 \rightarrow 2MgO$

1. Work out the moles of Mg
2. Work out the moles of O_2
3. Work out which moles are in excess and which are limiting – *the limiting you use in your reacting masses calculation.*
4. Write down the Mr of the limiting reagent and MgO
5. Work out the molar ratio
6. Work out the moles of MgO that would be produced
7. Work out the mass of MgO

$2Mg + O_2 \rightarrow 2MgO$

m = 5g	m = 12g
Mr = 24	Mr = 16
n = 5/24 = 0.21	n = 12/16 = 0.75

0.21 moles of Mg needs 0.21/2 = 0.105 moles of O_2
We have 0.75 g of O_2, so O_2 is in excess and Mg is limiting – USE MOLES OF Mg:

m = 40 x 0.21 = **<u>8.3g</u>**
Mr MgO = 24 + 16 = 40
n = 0.21 (as 1:1)

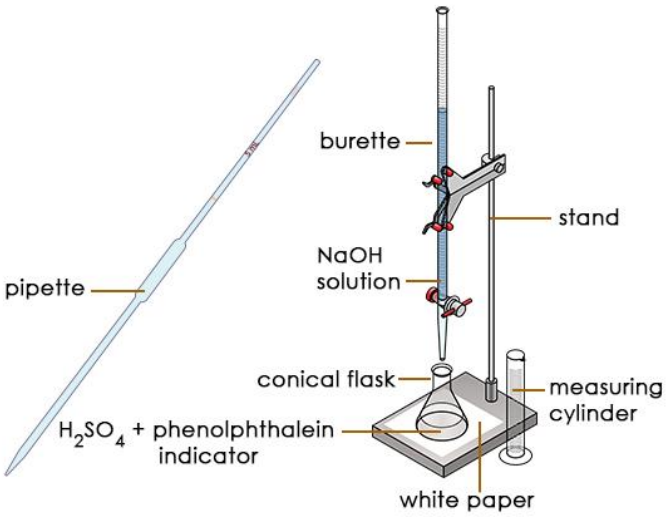
**you have to be able to do this for any equation with any ratio and any quantities given*

What is a titration?

A neutralisation reaction used to find the unknown concentration of the acid or alkali using a known concentration of the other.

(required practical 2)

Name the apparatus used in a titration.



Calculate the concentration of sodium hydroxide if 25 cm^3 needed 23.25 cm^3 of 0.1 mol/dm^3 hydrochloric acid for neutralisation (3 marks) (HT only)

$HCl + NaOH \rightarrow NaCl + H_2O$

1. Write down the volumes in dm^3 (cm^3 /1000) of HCl and NaOH
2. Write down the concentration of HCl
3. Calculate the moles of HCl
4. Calculate the molar ratio
5. Calculate the concentration of NaOH

$HCl + NaOH \rightarrow NaCl + H_2O$

n = 0.1 x 0.02325 = 0.002325	n = 0.002325
c = 0.1 mol/dm^3	c = 0.002325/0.025 = **0.093 mol/dm^3**
v = 0.02325 dm^3	v = 0.025 dm^3

**you have to be able to do this for any equation with any ratio and any quantities given*

4 - Chemical Changes: Salts and Electrolysis

What is oxidation in terms of oxygen? (1 mark)

Gain of oxygen

What is reduction in terms of oxygen? (1 mark)

Loss of oxygen

What are oxidation and reduction in terms of electrons? (2 marks)

Oxidation **i**s **l**oss of electrons

Reduction **i**s **g**ain of electrons

Think OILRIG!

Are the following oxidation or a reduction?

1. **$Na^+ + e^- \rightarrow Na$**
   Reduction
2. **$2Cl^- \rightarrow Cl_2 + 2e^-$**
   (Can also be written $2Cl^- - 2e^- \rightarrow Cl_2$)
   Oxidation

Examples of acids:

- Hydrochloric acid (HCl)
- Sulphuric acid (H_2SO_4)
- Nitric acid (HNO_3)

Examples of alkalis:

- Metal hydroxide (e.g. sodium hydroxide, NaOH))
- Metal oxide (e.g. sodium oxide, Na_2O)

Naming salts

The salt produced is named from the acid used:

Acid used	Metal salt produced
Hydrochloric acid	Chloride
Sulphuric acid	Sulphate
Nitric acid	nitrate

What is the ionic equation for neutralisation? (1 mark)

- **$H^+ + OH^- \rightarrow H_2O$**

Acid + alkali → salt + water

e.g. hydrochloric acid + sodium hydroxide → sodium chloride + water

- **Neutralisation reaction**

Acid + carbonate → salt + water + carbon dioxide

e.g. nitric acid + lithium carbonate → lithium nitrate + water + carbon dioxide

Acid + metal → salt + hydrogen

e.g. sulfuric acid + potassium → potassium sulfate + hydrogen

What is a strong acid? (2 marks)

- Fully dissociates
- In solution

e.g. $HCl \rightarrow H^+ + Cl^-$

What is a weak acid? (2 marks)

- Partially dissociates
- In solution

e.g. $CH_3OOH \rightleftharpoons H^+ + CH_3COO^-$

What is the pH of a strong acid and a weak acid?

Strong acid = pH 0-2 (red in universal indicator)
Weak acid = pH 3-5 (orange/yellow in universal indicator)

How can you test to see whether a solution is neutral?

Universal indicator turns green

Or

pH meter gives a reading of 7.0 (most accurate)

What is electrolysis? (1 mark)

- Splitting up ionic compounds using electricity

Why does the electrolyte need to be molten or in solution for electrolysis to work? (2 marks)

- So the ions
- Can move

Describe and explain how crystals of copper sulfate can be produced (6 marks)
(Required practical 1)

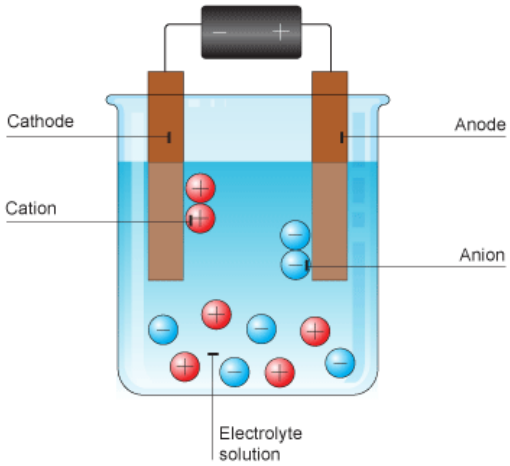
1. Add an excess of copper oxide to sulphuric acid to react via the following equation:

Copper oxide + sulphuric acid → copper sulfate + water
$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

2. An excess of copper oxide is added to ensure all of the sulphuric acid reacts.
3. Filter off any unreacted CuO(s) ← insoluble.
4. Pour the copper sulfate solution (blue) into an evaporating dish.
5. Heat using a Bunsen burner to remove half the water and start crystallisation.
6. Leave to evaporate, leaving crystals of pure copper sulfate ($CuSO_4$)

Label a diagram showing the set-up of equipment used in electrolysis

(Required practical 4)



Describe and explain how crystals of copper lead iodide using the following equation (4 marks)
$Pb(NO_3)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + 2KNO_3(aq)$

1. Add lead nitrate to potassium iodide solution in a 1:2 ratio.
2. Solid lead iodide (yellow) is produced.
3. Filter off the solid, insoluble lead iodide from the unreacted lead nitrate and potassium iodide and potassium nitrate solution products.
4. Wash with distilled water.
5. Leave to dry.

Describe the electrolysis of brine/sodium chloride solution/ $NaOH_{(aq)}$ and explain why three products are made (6 marks)

- Ions in solution = Na^+, Cl^-, H^+ and OH^-
- Na^+ and Cl^- from sodium chloride
- H^+ and OH^- from the water (solution)
- H^+ moves to negative electrode to produce hydrogen gas (H_2)
  - Half equation: $2H^+ + 2e^- \rightarrow H_2$
- Cl^- moves to positive electrode to produce chlorine gas (Cl_2)
  - Half equation: $2Cl^- \rightarrow Cl_2 + 2e^-$
- Na+ and OH- left in solution form sodium hydroxide (NaOH).

****THE MOST REACTIVE POSITIVE ION STAYS IN SOLUTION**

Describe the process of electrolysis of aluminium oxide (Al_2O_3), stating the products and explaining how they are formed (6 marks)

- Heated until molten (melted)
- Cryolite added to lower melting point
- Ions = Al^{3+} and O^{2-}
- Al^{3+} moves to negative electrode to produce aluminium (Al)
  - Half equation = $Al^{3+} + 3e^- \rightarrow Al$
- O^{2-} moves to positive electrode to produce oxygen (O_2)
  - Half equation = $2O^{2-} \rightarrow O_2 + 4e^-$
- O_2 reacts with carbon electrodes to form carbon dioxide (CO_2)
  - $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$
- Carbon electrodes therefore need to be replaced frequently as they ware away.

State the chemical tests for the products of electrolysis of $NaOH_{(aq)}$ and describe their uses (6 marks)

Test for products:

- Cl_2 – bleaches litmus paper
- H_2 – lit splint pops
- NaOH (pH 14) – turns universal indicator paper blue

Uses of products:

- Cl_2 – bleach
- H_2 – making margarine
- NaOH - making soap

2 types of electrolysis:

1. **Molten** — **Look at the state symbol!**
   e.g. $PbBr_2$ (l)

Ions present: Pb^{2+} Br^-

2. **Aqueous**
   e.g. $CaCl_2$(aq)

Ions present: Ca^{2+} Cl^- H^+ OH^-

**In aqueous electrolysis, THE MOST REACTIVE + ION STAYS IN SOLUTION and the LEAST REACTIVE FORMS THE PRODUCT at the cathode.

At the anode, if NO_3^-, OH^- or SO_4^{2-} are present, oxygen is produced.

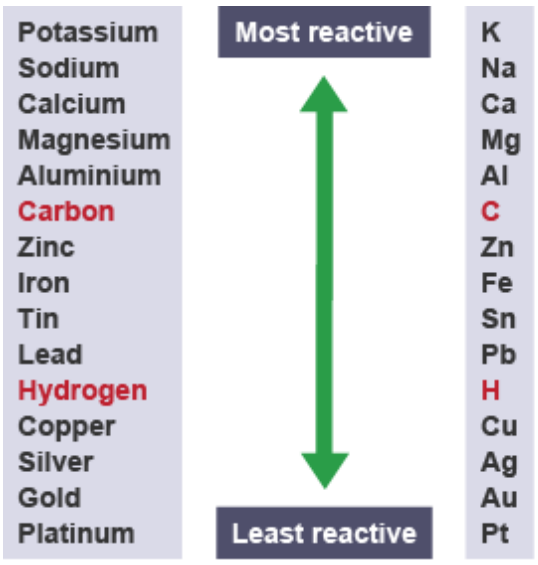
Writing half-equations:

1. **Look at the charge on the ion**
2. **Swap it around to write the number of electrons**

e.g. Ca^{2+} $+2e^-$ → Ca

e.g. $2O^{2-}$ $-4e^-$ → O_2

The Reactivity Series (*learn*!)



A more reactive element can displace a less reactive element within a compound.

e.g. $CuSO_4 + Mg \rightarrow MgSO_4 + Cu$

List the metals that can be extracted using carbon (reduction).

Zinc
Iron
Tin
Lead
Copper

Which metals do not need to be extracted and why?

Gold
Platinum

Are unreactive and so exist native. They exist as pure elements and do not need to be extracted from compounds.

Which elements need to be extracted by electrolysis and why?

Potassium
Sodium
Calcium
Magnesium
Aluminium

They are too reactive and therefore cannot be displaced by carbon from their compounds

5 - Energy Changes

Define exothermic (2 marks)

- Gives out heat energy
- To the surroundings

ΔH is negative

Define endothermic (2 marks)

- Take in heat energy
- From the surroundings

ΔH is positive

Describe a simple experiment you could do to find out whether a reaction is exothermic or endothermic.

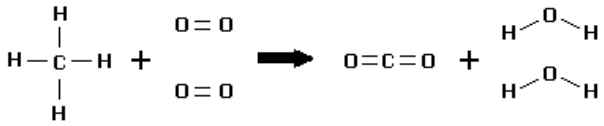
- Measure the change in temperature.
- If the temperature increases (gets hotter) = exothermic
- If the temperature decreases (gets colder) = endothermic

Enthalpy change (ΔH) using bond enthalpies:

ΔH = Sum of bonds broken – sum of bonds made

Calculate the enthalpy change of the following reaction using the following bond enthalpies:

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$



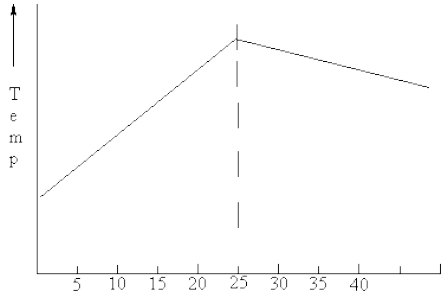
Bond	Mean bond enthalpy (kJ/mol)
C-H	412
O=O	498
C=O	743
O-H	463

ΔH = [(4x412) + (2x498)] - [(2x743) + (4x463)
= [1648 + 996] - [1486 + 1852)
= 2644 – 3338
= **-694 kJ/mol**

** *you have to be able to do this for any equation*

Describe how you could determine the point of neutralisation in an acid-base reaction by measuring the temperature.
(Required practical 4)

- Add 25 cm^3 of acid to a polystyrene cup (for insulation)
- Record the start temperature
- Add 5 cm^3 of alkali and record the temperature
- Add 5 cm^3 of alkali until you have added 40 cm^3 in total, recording the temperature each time.
- Plot a graph of volume of alkali added (x axis) against temperature (y axis)
- Draw two lines of best fit.
- Find the intersect of the two lines and read the value off the x-axis: This is the volume of alkali needed to neutralise the 25cm^3 of acid.



***Use the values in the question (the values here are just an example)*
Acid/alkali may be the other way around – read the question!

What equation can be used to calculate the heat energy released by a reaction?

$$q = m \times c \times \Delta T$$

heat energy (J) = mass of water x specific heat capacity of water (4.2) x change in temperature

What equation allows us to calculate the enthalpy change of a reaction in kJ/g?

ΔH = q / mass of fuel burned (g)

What equation allows us to calculate the enthalpy change of a reaction in kJ/mol?

ΔH = q / moles of fuel burned (moles)

***Remember moles = mass / Mr!!*

1.5 g of ethanol (C_2H_5OH) was burned. This caused the temperature of 50 cm^3 of water to rise by 14 ^oC. Calculate the enthalpy change for the reaction in kJ/mol.

q = mcΔT
= 50 x 4.2 x 14
= 2940 J

n = m/Mr
= 1.5/((12x2)+16+6)
= 1.5 / 46
= 0.0326 moles of ethanol

Δ□ = q/n
= 2.940 KJ / 0.0326 ← don't forget to convert q to kJ
= **- 90.18 kJ/mol** ← add – sign as reaction gets hotter so is exothermic

1.2 g of ethanol (C_2H_5OH) was burned. This caused the temperature of 100 cm^3 of water to rise by 8 ^oC. Calculate the enthalpy change for the reaction in kJ/g.

q = mcΔT
= 100 x 4.2 x 8
= 3360 J

Δ□ = q/m
= 3.360 KJ / 1.2 ← don't forget to convert q to kJ
= **- 2.8 kJ/mol** ← add – sign as reaction gets hotter so is exothermic