

Year 10 revision 2006

Atomic structure

Atoms are made up of 3 types of particle. Complete the table below showing the type of particle, its mass and its location within the atom.

Type of particle and charge			
Mass in atomic units			
Location within the atom			

Write the symbol for phosphorus, showing the atomic number and the mass number.

What determines the mass number?

What determines the atomic number?

Write down the electronic configuration of a phosphorus atom.

Bonding

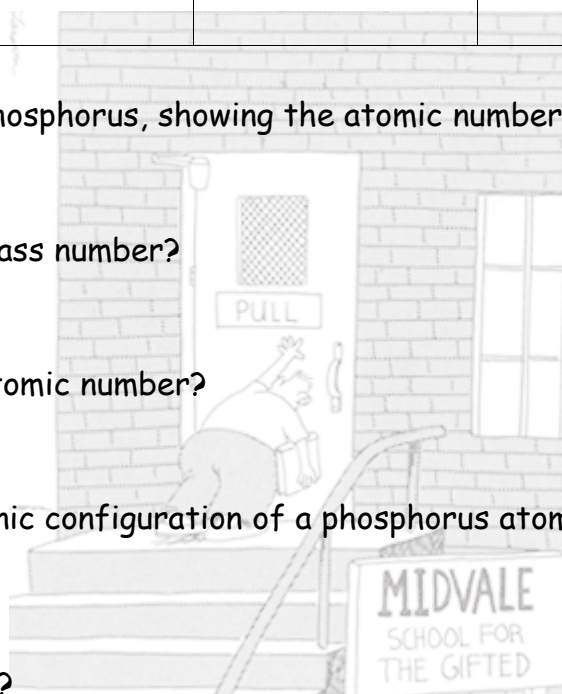
What is a covalent bond?

What types of atoms can be joined together by covalent bonds?

What is an ionic bond?

What types of atoms can be joined together by ionic bonds?

What is metallic bonding?



Methane is a compound of one carbon atom and some hydrogen atoms. What sort of bonding would you expect methane to have?

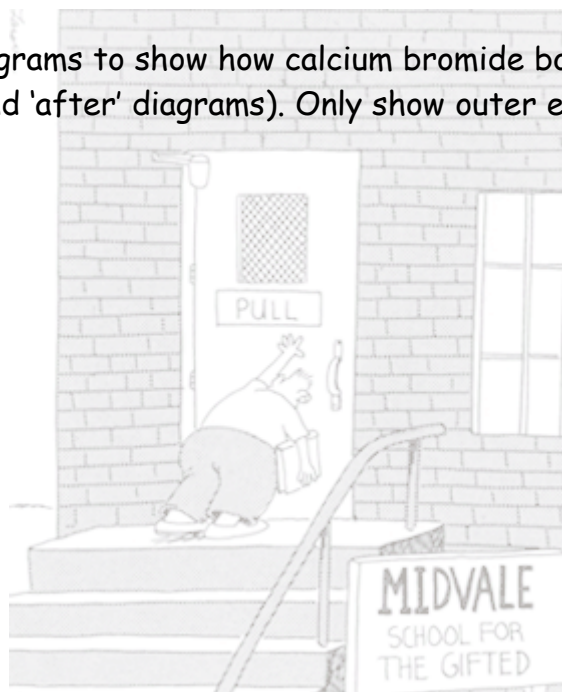
Draw a 'dot and cross' diagram of the bonding in methane.

From your diagram write down the formula for methane.

Calcium bromide is a compound of calcium and bromine only. What sort of bonding would you expect calcium bromide to have?

Draw 'dot and cross' diagrams to show how calcium bromide bonds together (you will need to draw 'before' and 'after' diagrams). Only show outer electrons.

'Before'



'After'

How does the structure of copper metal explain the electrical conductivity of copper?

Structures - pages 21 - 29

Substances come in two types - those with molecular structures and those with giant structures.

Molecules, such as carbon dioxide (formula: CO_2), water (formula: H_2O) and ammonia (formula: NH_3) have definite numbers of atoms in them.

Giant structures do not have definite numbers of atoms in them - they have many millions of each of the constituent particles in them, arranged in a particular way and in definite proportions.

Metals have giant metallic structures. Mixing two types of metal makes an alloy, which changes the physical properties of the original metal. Make some notes on the properties of metals and their structure here:

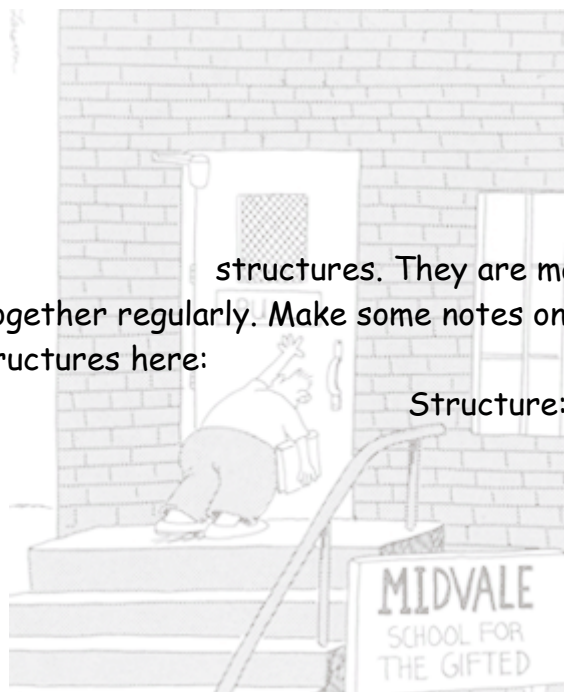
Properties:

Structure:

Ionic substances have giant ionic structures. They are made of huge lattices of ions which are packed together regularly. Make some notes on the properties of ionic substances and their structures here:

Properties:

Structure:



Diamond, graphite and silicon dioxide have giant covalent structures, even though they are held together by strong covalent bonds. Describe the physical properties of diamond and graphite. Use their structures to explain these physical properties

Properties:

Structure:

Simple molecular structures contain small numbers of atoms. These are joined together by covalent bonds which are strong / weak. The forces between the molecules are weak, and so molecular compounds generally have low melting points.

Common Ions

You should, by now, have an idea what atoms form what ions. Most of the ones you meet will be dictated by their position in the periodic table - metals and non-metals will try to get a full outer shell of electrons.

Metals form _____ ions because they _____ electrons.

Non-metals form _____ ions because they _____ electrons.

Complete this table:

Group (column) of periodic table	Charge on ion
1	+1
2	
3	
6	
7	

Some compounds will tell you the charge on the ion in the name of the compound. For instance, what ions do copper (II) oxide and iron (III) chloride contain?

Some ions need to be learnt. You will not get a data sheet with common ions on, so be prepared to learn and use these now.

Positive ions	zinc	
	silver	
	hydrogen	
	ammonium	
Negative ions	nitrate	
	hydroxide	
	hydrogencarbonate	
	carbonate	
	sulphate	

Methane reacts with oxygen to form carbon dioxide and water. Write a balanced symbol equation for this reaction.

If we burn 16g of methane, can we work out how much oxygen is needed for the combustion? Yes...

The relative formula mass of methane is $12 + (4 \times 1) = 16$

This means that one mole of methane weighs 16g

We are therefore starting with one mole of methane

Our equation shows us that two moles of oxygen, O_2 , are required for each mole of methane (there is a 1:2 ratio)

Each mole of oxygen, O_2 , weighs $2 \times 16 = 32g$

We need two lots of O_2 , and this will weigh $2 \times 32 = 64g$

If we burn 8g of methane, how much oxygen is needed for the combustion?

Each mole of methane weighs 16g

8g of methane is how many moles of methane?

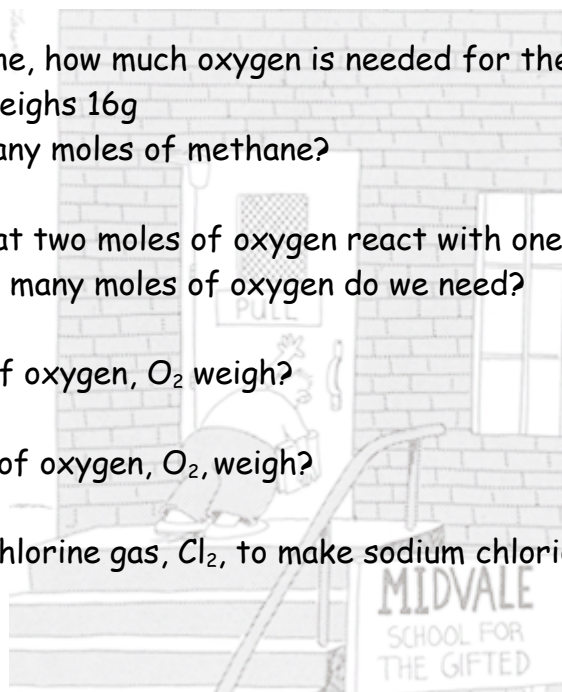
The equation tells us that two moles of oxygen react with one of methane. When we have 8g of methane how many moles of oxygen do we need?

How much does a mole of oxygen, O_2 weigh?

How much do our moles of oxygen, O_2 , weigh?

Sodium can react with chlorine gas, Cl_2 , to make sodium chloride. Write an equation for this reaction.

If we start with 23g of sodium, what mass of sodium chloride can we make at the end?



Reactivity series

The reactivity series is worth learning! It will not be in the exam. Use p 53 of the text book to complete this list:

potassium
sodium

magnesium

zinc

iron

tin

()

copper

gold
platinum

Label the most reactive metal and the least reactive metal on the list.

The thermit reaction involves the reaction of aluminium powder with iron (III) oxide powder. Iron and aluminium oxide are the products. It is useful because the iron produced is in molten form. Write a balanced symbol equation for the reaction between aluminium and iron (III) oxide.

Why does the aluminium displace the iron from the iron (III) oxide?

Rewrite the equation in terms of the ions involved - leave out any ions which are not taking place in the reaction.

What are ions which do not take part in the reaction called?

This is a redox reaction. Identify the species which has been reduced.

Identify the species which has been oxidised.

You should also make yourself familiar with the reaction between copper (II) oxide and magnesium metal. This is in your notes.

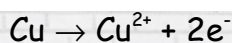
Displacement reactions can also happen in solution. If a copper wire is dipped in silver nitrate solution, silver metal is seen to form around the copper wire.

Write an equation for the reaction between copper and silver nitrate solution (silver forms an Ag^+ ion and nitrate is NO_3^-).

Why does copper displace silver from a solution of its ions?

What type of reaction is this?

The equation for the formation of copper ions from copper metal is



Write a similar equation for the formation of silver from silver ions

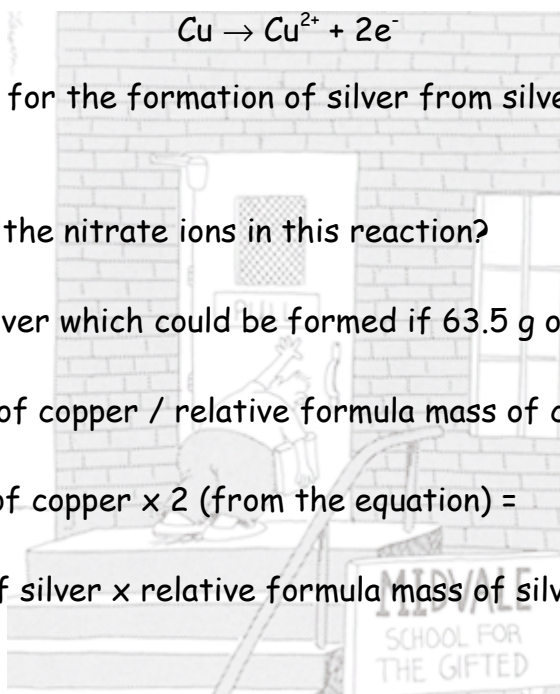
How would you describe the nitrate ions in this reaction?

Calculate the mass of silver which could be formed if 63.5 g of copper were used.

Moles of copper = mass of copper / relative formula mass of copper =

Moles of silver = moles of copper \times 2 (from the equation) =

Mass of silver = moles of silver \times relative formula mass of silver =



Acids

Complete the table

Name of acid	Formula
Sulphuric acid	
	HCl
Nitric acid	

What do all these acids have in common?

How could you tell that these substances were acidic?

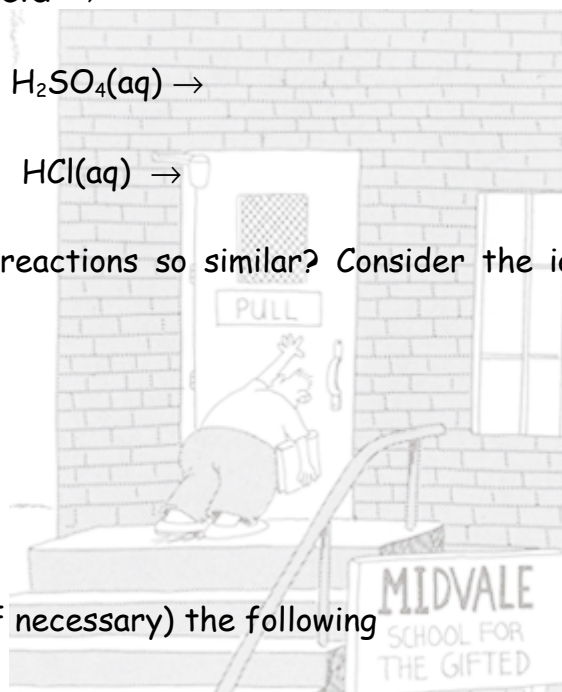
Complete (and balance if necessary) the following

Metal + Acid \rightarrow

e.g. $\text{Mg(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow$

or $\text{Mg(s)} + \text{HCl(aq)} \rightarrow$

Why are the last two reactions so similar? Consider the ionic equations for these reactions.



Complete (and balance if necessary) the following

Metal oxide + Acid \rightarrow

e.g. $\text{CuO(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow$

What ions are important in the above reaction? Re-write the equation as an ionic equation.

Complete (and balance if necessary) the following

Metal hydroxide + Acid \rightarrow

e.g. $\text{NaOH(aq)} + \text{HCl(aq)} \rightarrow$

or $\text{Ca(OH)}_2\text{(aq)} + \text{H}_2\text{SO}_4\text{(aq)} \rightarrow$

Rewrite the equations between sodium hydroxide and hydrochloric acid, and calcium hydroxide and sulphuric acid, as ionic equations.

What is the similarity between these reactions?

Complete (and balance if necessary) the following

Metal carbonate + Acid \rightarrow

e.g. $\text{CuCO}_3 + \text{H}_2\text{SO}_4 \rightarrow$

Rewrite the equation as an ionic equation.

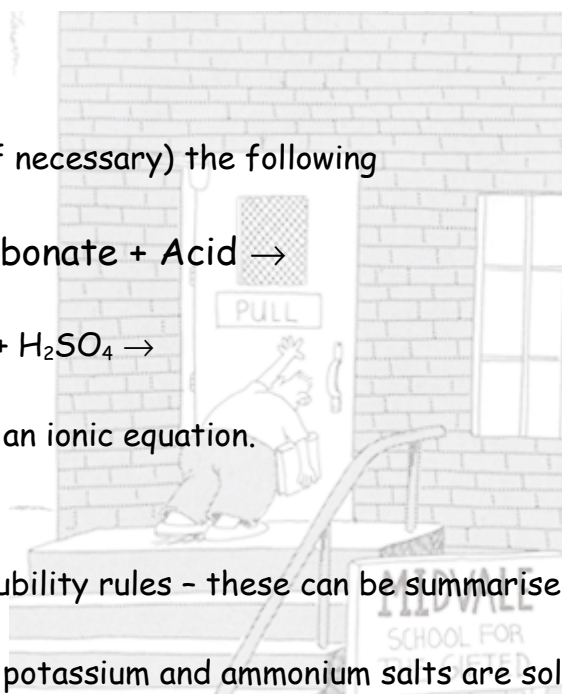
Salts

You should learn the solubility rules - these can be summarised as:

All sodium, potassium and ammonium salts are soluble

Most of the others are soluble apart from carbonates and hydroxides

- Soluble salts can be made by reacting excess metal or metal compound with acid. The resulting mixture is then filtered and the salt crystallised. An example of this is preparation of copper (II) sulphate by reaction between copper (II) oxide and sulphuric acid.
- Sodium, potassium and ammonium salts should be prepared by titration.
- Insoluble salts are prepared by precipitation reactions - two solutions are mixed to produce a solid.
- Direct combination involves directly combining the components of a salt - sodium chloride can be made by reaction between sodium and chlorine.



Periodic table

The periodic table is made up of groups and periods.

Groups run vertically / horizontally (delete one)

Periods run vertically / horizontally (delete one)

- Group 0 contains the elements He, , Ar, , Xe, . These are called the _____.

They have electronic structures in which the outer shell is _____.

This makes them very reactive / unreactive.

Helium is used in

Neon is used in

- Group 1 contains the metallic elements

These all have ____ outer electron.

This outer electron is lost easily, so they form ions with the general formula M^+ .

Caesium is more / less reactive than lithium.

This is because it is easier / harder to remove the outer electron of caesium than it is to remove the outer electron of lithium.

Would Fr be more or less reactive than caesium?

What ions would Fr form?

- Group 7 contains the elements

These all have ____ space for an electron in their outer shells.

This space for an electron can be filled easily, so they form ions with the general formula X^- .

They form homonuclear diatomics, with the general formula X_2 .

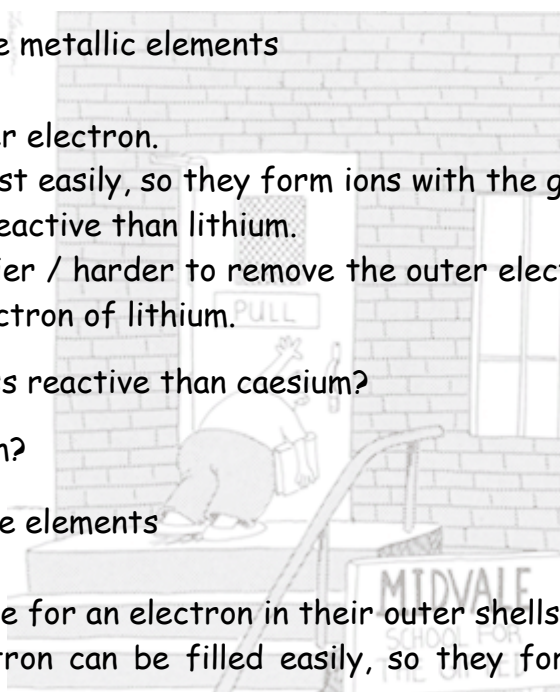
Fluoride compounds are found in

Chlorine is used in

- The transition metals are found

They are useful as

Their compounds are often



Electrolysis

Electricity is the flow of _____. Metals contain positive metal ions in a 'sea' of delocalised electrons. The electrons are free to move, so the metal will conduct electricity.

Graphite also contains delocalised electrons. These are between sheets of carbon atoms. The electrons between the layers of carbon allow graphite to conduct electricity.

Ionic solids do not contain free electrons.

They do not conduct electricity because the ions which contain the electrons are held in a rigid lattice.

If the solid is melted the ions become free to move, and the molten ionic substance will conduct electricity - it is called an electrolyte.

Write a definition of electrolysis here (see p119)

Positive ions are called

A positive electrode is called the

Negative ions are called

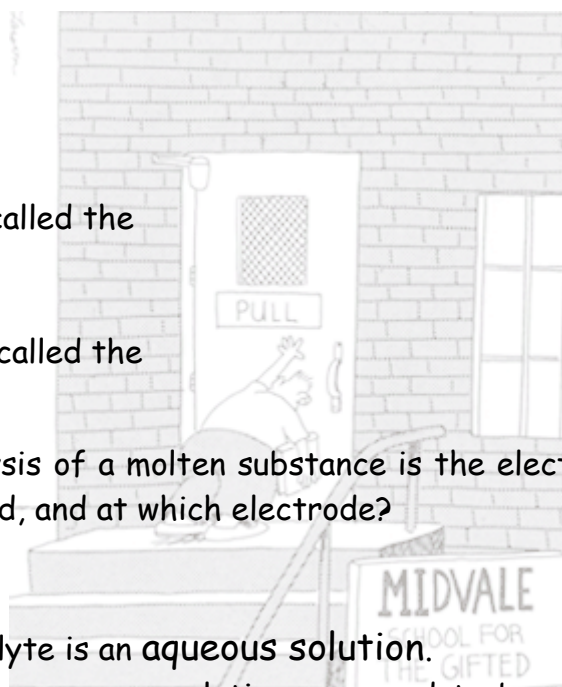
A negative electrode is called the

An example of electrolysis of a molten substance is the electrolysis of molten sodium chloride. What is formed, and at which electrode?

Another sort of electrolyte is an aqueous solution.

In the electrolysis of an aqueous solution you need to be more careful than with a molten substance - there are other possible products.

- If the metal is highly reactive (above H in the reactivity series) what is produced?
- If the metal is below hydrogen in the reactivity series what is produced?
- If the solution is a concentrated halide (chloride, bromide or iodide) what is produced?
- What is produced with other common negative ions such as sulphate or nitrate?



Purification of copper

Copper purification involves the electrolysis of copper (II) sulphate.

The anode is made of pure / impure copper

The cathode is made of pure / impure copper

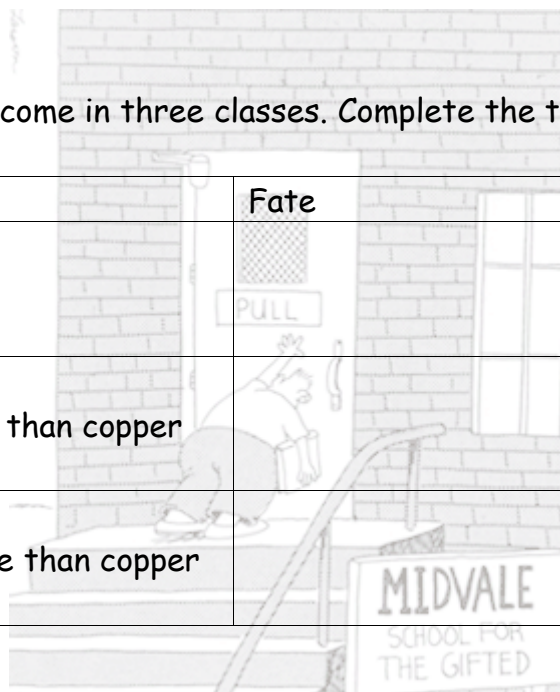
Copper ions from the impure anode go into solution. Write a half equation for the reaction, showing how copper ions are formed from copper metal.

Copper ions from the solution deposit on the cathode. Write a half equation for the formation of copper metal from copper ions in solution.

(When you did this experiment you measured a drop in mass of the anode and a rise in mass of the cathode.)

Impurities in the anode come in three classes. Complete the table.

Impurity	Fate
Unreactive material	
Metals less reactive than copper	
Metals more reactive than copper	

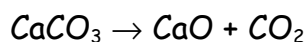


Calculations from equations

Sometimes chemists want to know how much product they can get from a certain amount of starting material.

When calcium carbonate is heated, carbon dioxide and calcium oxide are produced. Below we work out how to calculate the mass of calcium oxide produced when 25g of calcium carbonate are heated.

You will need the equation:



This means that 1 particle of calcium carbonate produces 1 particle of calcium oxide. The relative atomic masses are $\text{Ca} = 40$, $\text{C} = 12$, $\text{O} = 16$

The relative formula mass of calcium carbonate is $40 + 12 + (16 \times 3) = 100\text{g}$

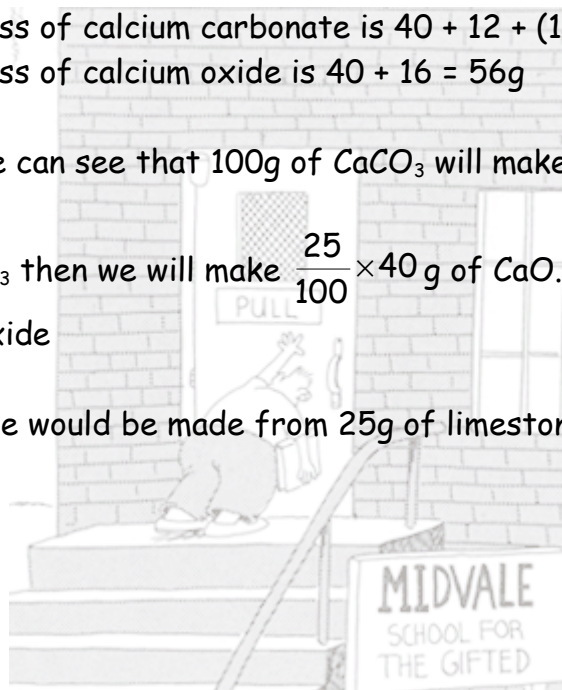
The relative formula mass of calcium oxide is $40 + 16 = 56\text{g}$

So from the equation we can see that 100g of CaCO_3 will make 56g of CaO .

If we have 25g of CaCO_3 then we will make $\frac{25}{100} \times 56\text{g}$ of CaO .

This is 14g of calcium oxide

How much carbon dioxide would be made from 25g of limestone (calcium carbonate)?



You should try to answer the questions on p279, nos 1 - 6.

Answers:

1. 1.92 tonnes
2. 8.61 g
3. a) 0.56 tonnes b) 0.18 tonnes c) 0.74 tonnes
4. 12.50 g
5. a) 0.35 tonnes b) 0.68 tonnes
6. a) 2/3 tonne b) 0.53 tonnes

Empirical formulae

An empirical formula for a compound gives the simplest ratios of the atoms in it. For example, the empirical formula of butane (C_4H_{10}) is C_2H_5 .

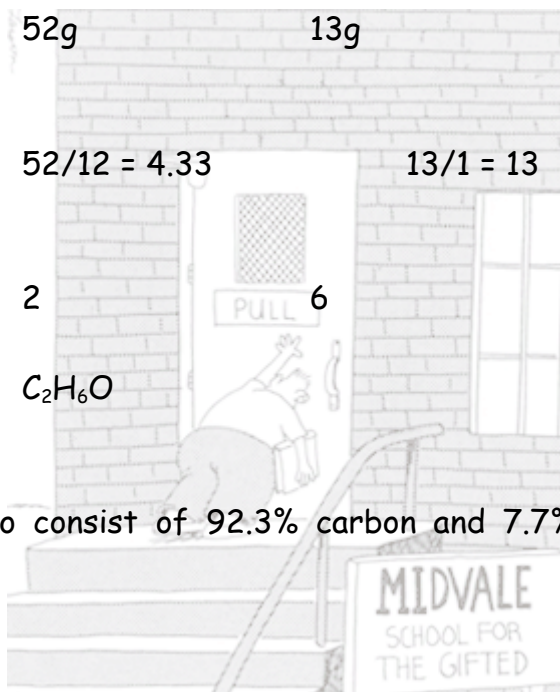
What are the empirical formulae of:

- Hydrazine, N_2H_4
- Hydrogen peroxide, H_2O_2
- Diborane, B_2H_6

A compound of carbon hydrogen and oxygen has the following make-up: 52% carbon, 13% hydrogen, 35% oxygen. What is its empirical formula?

	C	H	O
Convert % to g	52g	13g	35g
Divide by the RAMs of the atoms	$52/12 = 4.33$	$13/1 = 13$	$35/16 = 2.19$
Simplify the ratios (\div smallest no.)	2	6	1
Empirical formula is	C_2H_6O		

A compound is found to consist of 92.3% carbon and 7.7% hydrogen. What is its empirical formula?



This compound actually has a relative formula mass of 78. What is the formula of the molecule?