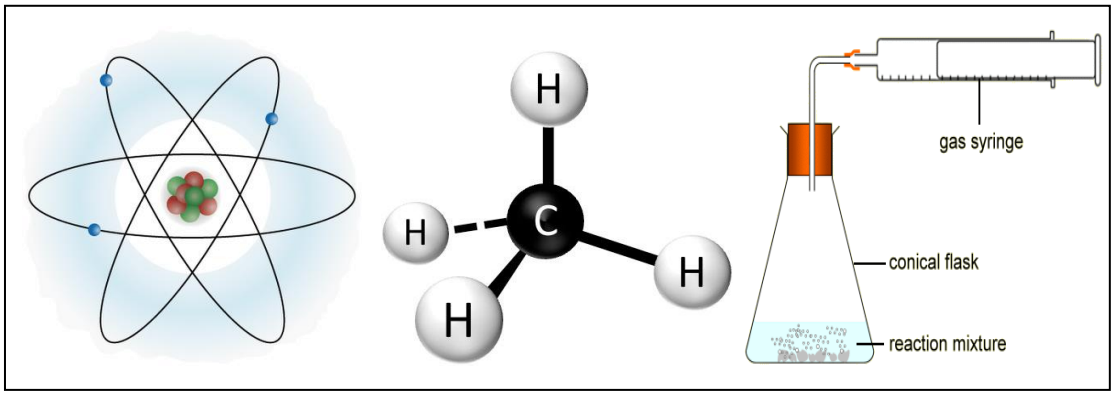
St. Ninian's High School
National 4 and 5
Chemistry



Unit 1
Chemical Changes and Structure
Homework Booklet

Chemistry Department

Standards Expected of Homework

- All homework must be recorded in your homework diary.
- All homework must be **dated** and have a **heading** which is **underlined.**
- A **ruler** must be used for all underlining and for diagrams.
- Diagrams must be properly **labelled.**
- Graphs should be drawn on graph paper.
- You must **attempt every question,** using your notes to help you and ask for help if it is required.
- **Answer in sentences** when appropriate.
- **Care** and **attention** must be given to your written work at all times.
- In every report you receive, your teacher will give you a rating for your homework. This rating is based on the criteria outlined below. You should be aware of this when completing each piece of homework:

Homework grade

1	Excellent	2	Good	3	Needs improvement	4	Significant concern

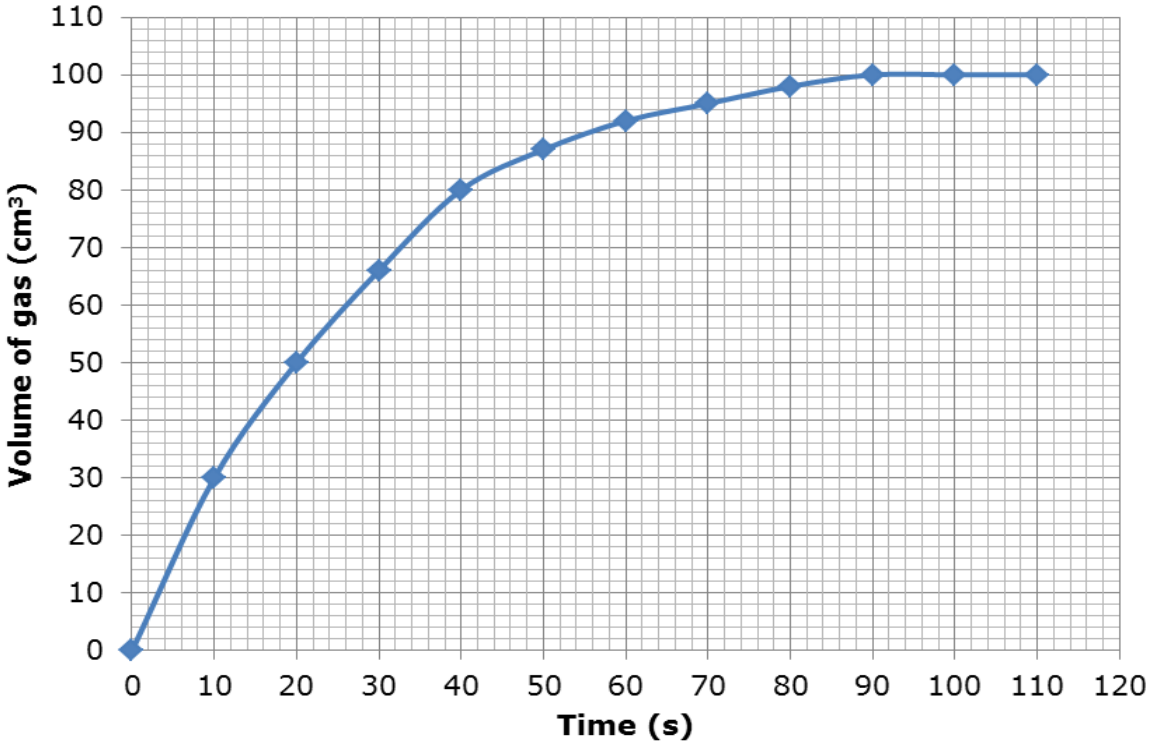
Following the course of a reaction (collect graph paper) 1

1. A pupil obtained the following results when marble chips were reacted with dilute sulfuric acid solution.

Time (seconds)	Mass of Flask (g)
0	1.00
10	0.80
20	0.50
30	0.40
40	0.30
50	0.20
60	0.20
70	0.20

(a) Draw a labelled diagram of the equipment that could be used to accurately measure the rate of reaction.
(b) Draw a graph of the results.

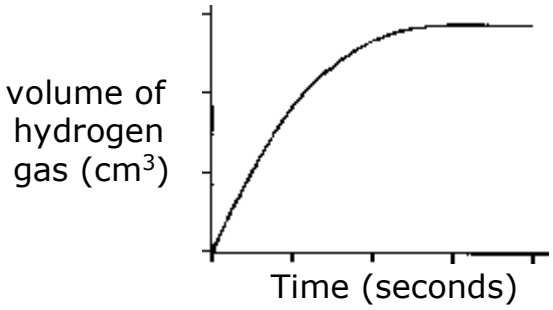
2. The graph below shows the volume of hydrogen gas given off against time when large lumps of magnesium are reacted with dilute hydrochloric acid solution



(a) Draw a labelled diagram of the equipment that could be used to accurately measure the rate of reaction.
(b) How long does it take to produce 30 cm^3 of hydrogen gas?
(c) What volume of gas was formed after 40 seconds?
(d) What was the total volume of gas given off in the reaction?
(e) How long did it take to complete the reaction?

Factors affecting rate 2

1. Excess magnesium powder was added to 50 cm^3 of 1 mol l^{-1} hydrochloric acid at room temperature.
The volume of hydrogen produced was measured against time.



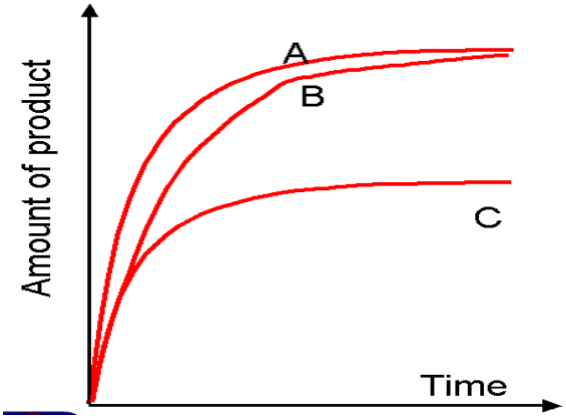
Copy the graph and add corresponding curves (to the ***same*** graph) which would be obtained if the reaction is repeated
(a) At a higher temperature
(b) Using magnesium ribbon
The curves that you add to the graphs must have labels.

2. James, Lizzie and Edward measured the rate at which an indigestion tablet dissolved. Graphs of three reactions are shown below. State which graphs **A, B**, and **C** best match the descriptions for the experimental conditions for James (1), Edward (2) and Lizzie (3).

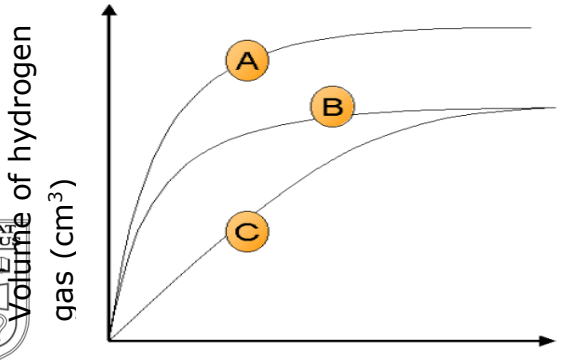
1. James broke the tablet in 4 pieces and added it to cold water.

2. Edward only put half of the tablet into cold water.

3. Lizzie added the tablet to cold water.



3. The graphs below show three reactions between marble chips and hydrochloric acid. State which graphs; **A, B** and **C** best describe the experimental conditions for reactions **1, 2** and **3** below.



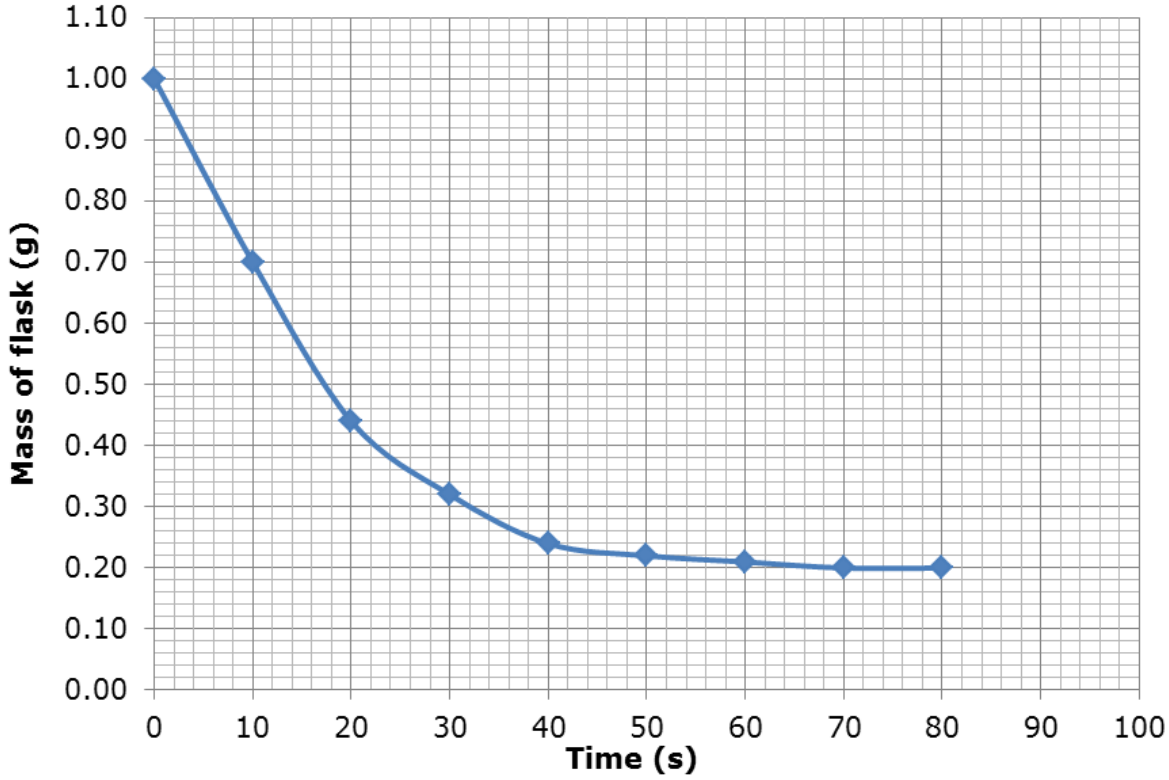
1. Marble chips (10g) were reacted with acid (125cm^3) at 20°C.

2. Marble chips (10g) were reacted with (125cm^3) at 30°C.

3. Marble chips (15g) were reacted with acid (125cm^3) at 30°C.

Average rates of reaction calculations 3

1. Jean was investigating the reaction between magnesium and sulfuric acid. She added 1.0 g of magnesium ribbon to excess sulfuric acid in a beaker and measured the mass lost as hydrogen escaped from the beaker. Her results are shown in the graph below.



(a) Use data from the graph to calculate the rate of reaction:
(i) From 10 to 20 seconds.
(ii) From 20 to 30 seconds.

(b) Copy the graph into your jotter and add a curve to show the results which would be obtained if 1.0 g of magnesium powder was added to excess sulfuric acid in the same beaker.

2. Ethyne (C_2H_2)is the first member of the alkyne family. It can be produced by the reaction of calcium carbide with water.
The equation for this reaction is:

$$CaC_2(s) + 2H_2O(\ell) \rightarrow C_2H_2(g) + Ca(OH)_2(aq)$$

The table below shows the results obtained in an experiment carried out to measure the volume of ethyne gas produced.

Time (s)	0	30	60	90	120	150	180	210
Volume of ethyne (cm^3)	0	60	96	120	140	148	152	152

Calculate the average rate of reaction between 60 and 90 seconds.
Your answer must include the appropriate unit.

Periodic Table 4

1. Name
   (a) three metals whose name begin with the letter C.
   (b) three elements which are gases.
   (c) two elements which are liquids.
   (d) a liquid metal which will conduct electricity.
   (e) two man made elements.
   (f) the gas which is necessary for animal life.
   (g) the lightest gas.
   (h) a liquid non-metal.
   (i) a non-metal in group 3 of the periodic table.
   (j) a metal in group 6 of the periodic table.

2. From the elements:

argon	lithium	potassium	fluorine	oxygen	silver
bromine	magnesium	neon	hydrogen	iron	

   Identify
   (a) Two alkali metals
   (b) A Group II element.
   (c) Two halogens
   (d) Two noble gases
   (e) Two elements stored under oil
   (f) The least dense noble gas
   (g) An element from period one
   (h) The element in period four, group one
   (i) Two transition metals
   (j) A non-metal in period four

3. Which of the elements below exist at diatomic molecules?

   (a) neon
   (b) chlorine
   (c) fluorine
   (d) potassium
   (e) sulfur
   (f) iodine
   (g) oxygen
   (h) nitrogen

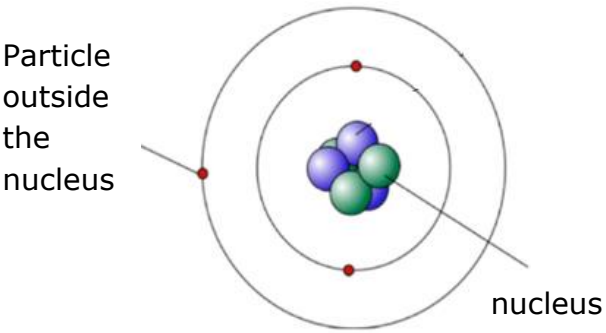
4. (a) Copy and complete the table below. The table refers to the group seven elements.

Element	F	Cl	Br	I	At
Atomic number					
Boiling Point / °C					

   (b) Use the table to predict the boiling point of Astatine (At).
   (c) What is the relationship between atomic number and boiling point for the group seven elements?

Atomic Structure 5

1. Elements are made up of atoms.



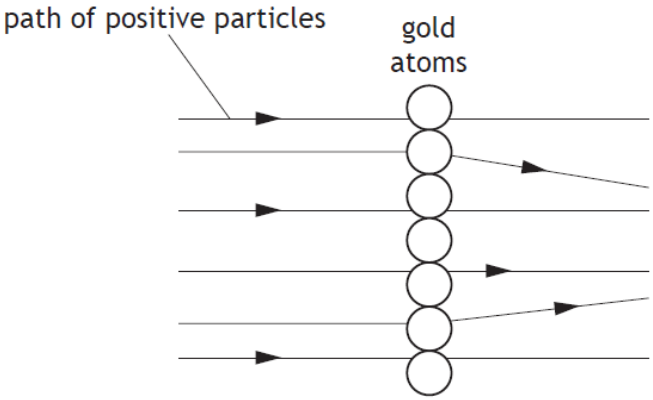
Use a ruler to copy the following table into your jotter and supply the missing pieces of information.

Particle	Proton	Neutron	Electron
Mass (amu)			
Charge			
Location in atom			

2. Calculate the mass and charge of the following particles:

(a) 3p, 4n, 3e
(b) 6p, 6n, 6e
(c) 11p, 12n, 11e
(d) 1p, 1n, 1e
(e) 26p, 30n, 26e
(f) 12p, 12n, 12e

3. In 1911, Ernest Rutherford carried out an experiment to confirm the structure of the atom. In this experiment, he fired positive particles at a very thin layer of gold foil. Most of the particles passed straight through but a small number of the positively charged particles were deflected.



What caused some of the positive particles to be deflected in this experiment?

Atomic Number/Mass Number/Nuclide Notation 6

1. Give the number of protons, neutrons and electrons for the following atoms:

   (a) $^{28}_{14}Si$ (b) $^{20}_{10}Ne$ (c) $^{24}_{12}Mg$ (d) $^{40}_{20}Ca$ (e) $^{56}_{26}Fe$

2. Copy and complete the table below, using a ruler:

Name of Element	Atomic Number	Mass Number	Number of		
			protons	neutrons	electrons
Phosphorus				16	
Silver		108			
Chlorine				18	
Lithium		7			

3. Write the nuclide notation for the following atoms.
   (p = protons, n= neutrons, e=electrons)

   (a) 1p, 2n, 1e
   (b) 30p, 35n, 30e
   (c) 8p, 9n, 8e
   (d) 5p, 6n, 5e
   (e) 60p, 64n, 60e
   (f) 47p 51n, 47e

Electron Arrangement 7

1. Use information in the data booklet to find the missing term in the table below.

Element	Symbol	Atomic Number	Electron arrangement
Lithium	Li	3	2,1
Boron	(a)	(b)	(c)
(d)	Si	(e)	(f)
(g)	(h)	20	(i)

2. Give the electron arrangement of the following atoms.

(a) ${}^{12}_{6}C$ (b) ${}^{14}_{7}N$ (c) ${}^{40}_{18}Ar$ (d) ${}^{19}_{9}F$ (e) ${}^{32}_{16}S$

3. An atom of sodium with 12 neutrons can be written as ^{23}Na.
Represent each of the following atoms in a similar way.

(a) An atom of carbon with 7 neutrons.
(b) An atom of hydrogen with a mass number of 2
(c) An atom with 4 protons, 5 neutrons, and 4 electrons

4. Name the elements A and B from the following information.

(a) Element A has an equal number of protons and neutrons and has a mass number of 16
(b) Element B has 3 protons in the nucleus of its atoms

5 Lithium and sodium are reactive metals with similar chemical properties.

(a) Give the electron arrangements for these two elements.
(b) What feature of their electron arrangement is responsible for lithium and sodium having similar chemical properties.

Isotopes/Relative Atomic Mass 8

1. Atom **A** has an atomic number of 93 and a mass number of 239. Atom **B** has an atomic number of 94 and a mass number of 239. Are A and B isotopes? Explain your answer.

2. Two types of neon atom exist, one has a mass number of 20, the other has a mass number of 22.

   (a) Write the symbol for each atom showing the atomic and mass numbers.
   (b) Calculate the number of protons, neutrons, and electrons for the neon atom with a mass of 22.
   (c) Give the electron arrangement of a neon atom.
   (d) What name is given to atoms like the neon atoms described above.
   (e) Explain why you cannot calculate the relative atomic mass of neon from the above information.

3. A sample of nitrogen was found to contain equal amounts of two isotopes. One isotope has mass number 14 and the other has mass number 15. What is the relative atomic mass of this sample of nitrogen?

4. Calculate the formula and formula mass of each of the following compounds.

(a)	NaF	(b)	Cl_2O
(c)	CaO	(d)	P_2O_3
(e)	sodium oxide	(f)	magnesium sulfate
(g)	carbon chloride	(h)	sodium nitrate
(i)	potassium oxide	(j)	nitrogen fluoride

5. Calculate the formula and formula mass of each of the following compounds.

(a)	aluminium nitrate	(b)	potassium sulfate
(c)	aluminium sulfate	(d)	magnesium carbonate
(e)	copper(II) nitrate	(f)	sodium carbonate
(g)	iron(III) sulfate	(h)	silver(I) nitrate

1. The symbol for the sodium ion is Na^+. The symbol for the copper (II) ion is Cu^{2+}. What are the symbols for the following ions:

   (a) calcium ion (b) chloride ion (c) oxide ion

   (d) copper(II) ion (e) potassium ion (f) aluminium ion

2. A sodium atom has the symbol Na and an electron arrangement of 2,8,1. When sodium forms an ion it loses one electron to form the ion Na^+, which has an electron arrangement of 2,8. Give the symbol and electron arrangement of the following:

   (a) a lithium atom (b) a chloride atom

   (c) a lithium ion (d) a sulfide ion

3. For the following ions give:
   i) the number of protons
   ii) the number of neutrons,
   iii) the number of electrons,
   iv) the electron arrangement

   (a) $^{24}_{12}Mg^{2+}$ (b) $^{31}_{15}P^{3-}$ (c) $^{16}_{8}O^{2-}$ (d) $^{23}_{11}Na^{+}$ (e) $^{27}_{13}Al^{3+}$

4. Fluoride ions are effective in preventing tooth decay. A fluoride ion contains 9 protons, 10 neutrons, and 10 electrons. The symbol for a fluoride ion is $^{19}F^-$.

   Write the symbols for the following ions:

   (a) A chloride ion which contains 17 protons, 20 neutrons, and 18 electrons.
   (b) A calcium ion which contains 20 protons, 20 neutrons, and 18 electrons.
   (c) A potassium ion which contains 19 protons, 20 neutrons, and 18 electrons.

Naming Compounds/ Chemical Formulae 10

1. Name the elements which are present in the following compounds.

   (a) hydrogen sulfide
   (b) magnesium oxide
   (c) potassium chloride
   (d) sulfur chloride

2. Name the elements which are present in the following compounds.

   (a) aluminium nitrate
   (b) potassium sulfate
   (c) sodium carbonate
   (d) silver nitrate

3. What is the formula of the following compounds?

   (a) carbon monoxide
   (b) dintrogen monoxide
   (c) nitrogen monoxide
   (d) carbon tetrachloride

4. What is the chemical formulae of the following compounds?

   (a) hydrogen chloride
   (b) lithium oxide
   (c) sodium oxide
   (d) sodium chloride

Complex Ion Formulae 11

1. Calculate the chemical formulae of the following compounds:

   (a) silver(I) oxide
   (b) iron(III) chloride
   (c) iron(II) oxide
   (d) zinc(II) bromide

2. Calculate the chemical formulae of the following compounds:

   (a) potassium carbonate
   (b) copper(II) hydroxide
   (c) sodium nitrate
   (d) copper (II) carbonate

3. The ionic formula of magnesium chloride is $Mg^{2+}(Cl^{-})_2$. What are the ionic formulae of the following compounds?

   (a) sodium chloride
   (b) copper (II) chloride
   (c) calcium iodide
   (d) iron (II) bromide

4. Calculate the chemical formulae of the following compounds:

   (a) lithium carbonate
   (b) copper(II) hydroxide
   (c) calcium nitrate
   (d) magnesium (II) carbonate

NEED H/W ON
FORMULA MASS (PROVIDE FORMULA)
AND MOLE TRIANGLE CALCS
MOVE MOLE CALCS

Calculations involving the mole and balanced equations 12

1. A new air bag is being developed for use in cars. In the reaction, butane reacts with an oxide of nitrogen. Balance the following equation.

$$C_4H_{10} + N_2O \rightarrow CO_2 + H_2O + N_2$$

2. When a rocket booster is firing, the aluminium reacts to produce aluminium oxide. Balance the following equation.

$$Al + O_2 \rightarrow Al_2O_3$$

3. Dinitrogen monoxide can be used to boost the performance of racing car engines. When dinitrogen monoxide decomposes it forms a mixture of nitrogen and oxygen.

$$2N_2O(g) \rightarrow 2N_2(g) + O_2(g)$$

How many moles of oxygen will be produced when four moles of dinitrogen monoxide are decomposed.

4. Calculate the masses of the following:

(a) 4 moles of NaCl
(b) 0.125 moles of CuO
(c) 0.2 moles of $Ca(OH)_2$
(d) 2 moles of SiO_2

5. Calculate the number of moles in each of the following:

(a) 28g of sodium hydroxide
(b) 83.25g of calcium chloride
(c) 32g of iron (III) oxide
(d) 82g of sodium phosphate

6. During a reaction 4·9 g of magnesium reacted with oxygen to form 8·1 g of magnesium oxide.

(a) How many moles of magnesium were used in the reaction?
(b) What is the formula of magnesium oxide?
(c) What is the mass of 1 mole of magnesium oxide?
(d) How many moles of magnesium oxide were made in the reaction?

Calculations involving the mole and balanced equations12(cont)

7. A bag of sugar contains 1 kilogram of sugar. The molecular formula of sugar is $C_{12}H_{22}O_{11}$

   (a) What is the mass of 1 mole of sugar?
   (b) How many moles of sugar are in a bag of sugar?

8. When calcium carbonate is heated it breaks down (decomposes) to produce calcium oxide and carbon dioxide, according to the equation

$$CaCO_3 \rightarrow CaO + CO_2$$

   What mass of carbon dioxide will be produced when 10g of calcium carbonate is decomposed by heating?

9. Sodium nitrate is decomposed by gentle heating to give sodium nitrate and oxygen gas according to the equation

$$NaNO_3 \rightarrow NaNO_2 + \tfrac{1}{2}O_2$$

   What mass of oxygen will be produced when 0.5 mol of sodium nitrate is decomposed?

10. When magnesium is heated in oxygen it forms magnesium oxide according to the equation

$$Mg + \tfrac{1}{2}O_2 \rightarrow MgO$$

   What mass of magnesium oxide is produced when 0.2 mol of magnesium is heated in excess oxygen?

Percentage composition 13

Show your working clearly when answering the following questions.

1. Calculate the percentage by mass of aluminium in aluminium sulfate, $Al_2(SO_4)_3$.

2. Iron can be extracted from its ore haematite, Fe_2O_3, in a blast furnace. Calculate the percentage by mass of iron in haematite.

3. Calculate the percentage mass of silicon in andalusite, Al_2SiO_3.

4. Calculate the percentage mass of sodium in sodium phosphate, Na_3PO_4

Revision Mole calculations

5. When sulfur is burned in air it forms sulfur dioxide according to the equation

$$S + O_2 \rightarrow SO_2$$

What mass of sulfur will be needed to produce 6.4g of sulfur dioxide?

6. Methane burns in oxygen to produce carbon dioxide and water according to the equation

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

What mass of water will be produced by the combustion of 0.4 mol of methane?

Covalent compounds 14

1. Which of the following does **not** contain covalent bonds?
   A Sulfur
   B Copper
   C Oxygen
   D Hydrogen

2. The atoms in nitrogen trifluoride are held together by covalent bonds.
   Rewrite the following sentence by selecting the correct underlined words:

   A covalent bond forms when two **positive/negative/neutral** nuclei are held together by their common attraction for a shared pair of **protons/neutrons/electrons**.

3. Look at the list of compounds below:

sodium chloride	hydrogen oxide	carbon sulfide
aluminium bromide	iron oxide	phosphorus chloride

   (a) Name the elements which are present in each compound.
   (b) Which of the compounds is made up from molecules?

4. Look at the compounds below:

hydrogen chloride	iron (II) nitride	sodium carbonate
hydrogen oxide	phosphorous iodide	magnesium sulfide

   (a) Which of the above are covalent compounds?
   (b) Use valency rules to work out the formulae of each of the above compounds.

Bonding Diagrams/ Shapes of Molecules 15

1. Hydrogen gas exists as molecules which contain two hydrogen atoms. The diagram below shows a molecule of hydrogen.

(a) What name is given to a molecule which contains two atoms?
(b) Name **three** other elements which are made up from molecules which contain only two atoms.
(c) What is the molecular formula for hydrogen?
(d) Why do the hydrogen atoms share electrons?
(e) What charge do the nuclei have?
(f) What charge do the electrons have?
(g) Explain how the shared pair of electrons help hold the molecule together.

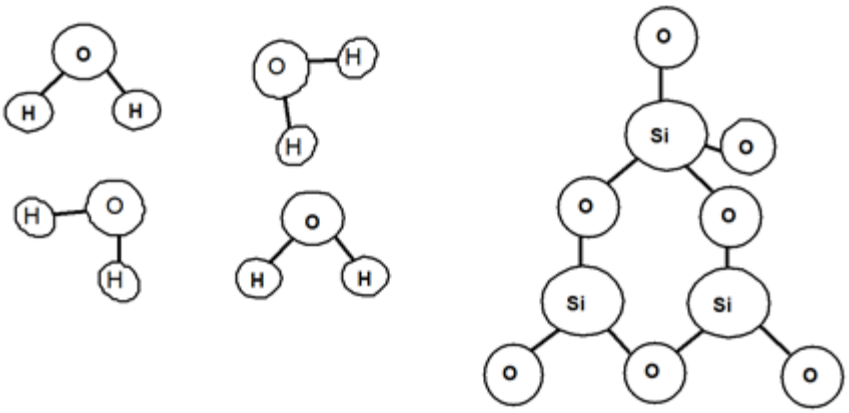
2. Each pair of elements below can form a compound. For each of the compounds below:

(i) Calculate the formula of the compound.
(ii) Draw diagram showing all outer electrons.
(iii) Draw a diagram showing the shape of the molecule.

(a) phosphorus and hydrogen
(b) hydrogen and sulfur
(c) nitrogen and chlorine
(d) hydrogen and oxygen

Properties of covalent molecules/ compounds 16

1. The diagram below shows the structure of water and of silicon dioxide.



(a) What is the molecular formula of water?
(b) Although the covalent bonds in water are strong, water has a low boiling point. Explain this apparent contradiction.
(c) Use your data booklet to find the melting point of silicon dioxide.
(d) Use the diagram to explain why silicon dioxide has a high melting point.

2. Methoxyethane is a covalent molecular substance. It has a low boiling point and is a gas at room temperature.

Copy and complete the sentence selecting the correct underlined words.

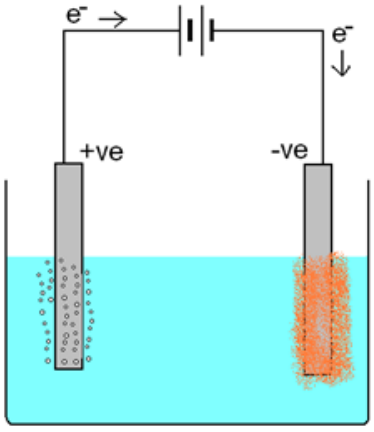
The bonds between the molecules are **weak/strong** and the bonds within the molecule are **weak/strong**.

Ionic Compounds/ Ion-electron equations 17

1. Give the formula of the following compound and state whether the bonding is ionic or covalent.

   (a) sodium chloride (b) copper (II) oxide (c) sulfur dioxide
   (d) hydrogen oxide (e) nitrogen chloride (f) magnesium nitrate

2. The apparatus on the right is used to pass electricity through a solution of nickel (II) chloride. A grey solid is produced at one electrode and a gas at the other.



   (a) What name is given to the process which occurs when electricity is passed through a solution of nickel(II) chloride?
   (b) For the grey solid which is produced:
      (i) Name the solid.
      (ii) Which electrode is the solid produced at, explain your answer.
      (iii) Give an ion electron equation for the reaction which produces this solid.
   (c) Name the gas produced and give an ion electron equation for its formation.

3. The following substances are melted and an electric current is passed through them.

      (i) Calculate the ionic formulae of the compound.
      (ii) Give the ion-electron equations for the reaction.
      (iii) Name the products obtained at the positive and negative electrodes.

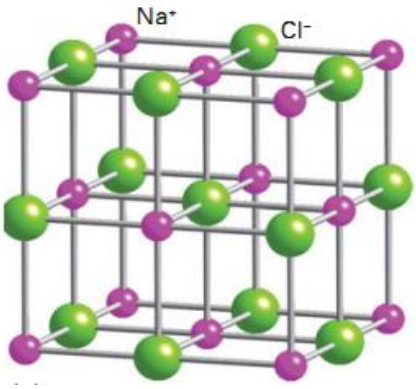
   (a) potassium bromide (b) aluminium bromide (c) magnesium iodide

4. Some pupils electrolysed molten lithium bromide.

   (a) Explain why the lithium bromide cannot be electrolysed when it is solid.
   (b) Give an ion electron equation for the production of bromine from bromide ions.
   (c) What is the ionic formula of lithium bromide?

Properties of Ionic Compounds 18

1. The structure of a crystal of sodium chloride is shown on the right.



   (a) What name is given to this arrangement of ions?
   (b) Give the ionic formula of sodium chloride.
   (c) Use your data book to find the melting point of sodium chloride.
   (d) Explain, with reference to the diagram, the high melting point of sodium chloride.

2. Hydrogen iodide exists as molecules whilst sodium iodide exists as a lattice of oppositely charged ions.

   (a) Which substance, HI or NaI, has the highest melting point?
   (b) Solid sodium iodide does not conduct, whilst an aqueous solution does. Explain why this is so.

3. The compounds **A**, **B**, **C**, **D** and **E** all contain oxygen. Use the information in the table below to answer the questions which follow.

Oxide	**A**	**B**	**C**	**D**	**E**
Melting point (^{o}C)	-199	2803	2318	264	1700
Boiling point (^{o}C)	-192	4173	3253	295	2230
Electrical conductivity of molten substance	Nil	Good	Good	Nil	Nil

   (a) Identify the oxide(s) which consists of a lattice of oppositely charged ions.
   (b) Identify the oxide(s) which consist of simple molecules.
   (c) Identify the oxide(s) which consist of a covalent network.

4. Which of the following will conduct electricity?

   (a) Solid copper (II) chloride
   (b) solid sodium
   (c) liquid bromine
   (d) liquid hydrogen oxide
   (e) solid iodine
   (f) liquid mercury
   (g) sucrose ($C_6H_{12}O_6$) solution
   (h) molten sodium chloride
   (i) liquid sodium
   (j) iron(II) chloride solution

5. Covalent and ionic compounds have different physical properties. Copy and complete the table below by circling the words which correctly describe the properties of the two compounds.

Compound	**Melting point**	**Conductor of electricity**
Chloromethane gas	High / low	Yes / no
Solid sodium chloride	High / low	Yes / no

The pH scale (collect graph paper) 19

1. (a) What is meant by the pH of a solution?
   (b) Name 3 methods of testing the pH of a solution.
   (c) Using one of these methods, describe in detail how the pH of a solution can be measured.

2. (a) What colour do acids turn pH paper?
   (b) What colour do alkalis turn pH paper?
   (c) What colour do neutral solutions turn pH paper?
   (d) What are the pH values of an acidic solution?
   (e) What are the pH values of an alkaline solution?
   (f) What is the pH value of a neutral solution?

3. Jim measured the pH of various concentrations of hydrochloric acid. His results are shown in the table below.

Acid concentration (mol l^{-1})	0.2	0.4	0.6	0.8	1.0
pH	0.69	0.4	0.22	0.1	0.0

   (a) Draw a graph of these results.
   (b) What is the relationship between acid concentration and pH?

4. One solution has a pH value of 2 and another has a pH value of 5. Which is the more acidic?

5. One solution has a pH value of 12 and another has a pH value of 9. Which is the more alkaline?

Lab/Household Acids and Alkalis 20

1. Some pupils tested some solutions with universal indicator. They wrote down their pH results:

3, 7, 9, 12,

However, the pupils forgot to write the names of the solutions next to their results. Can you help them by matching the pH values to the correct solution?

Solution tested	pH
distilled water	
bleach	
vinegar	
soap	

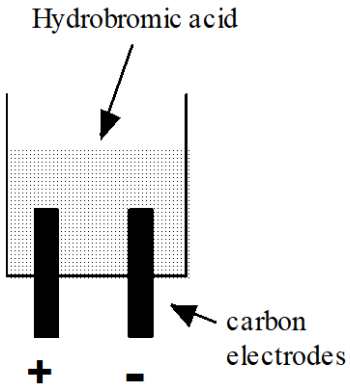
2. Here are the formulae of various acids and alkalis

(a) H_2SO_4 (b) NaOH
(c) $Ca(OH)_2$ (d) CH_3COOH
(e) HNO_3 (f) KOH

(i) Name each of the acids and alkalis shown above.
(ii) Calculate the mass of 1 mole of each of the acids and alkalis

Producing Acids and Alkalis 21

1. Electricity is passed through a solution of hydrobromic acid (H^+Br^-). A gas is produced at one electrode and a brown coloured liquid at the other electrode.



(a) For the gas:
   (i) Name the gas, give its formula and the mass of 1 mole.
   (ii) What is the test for this gas?

(b) For the brown liquid:
   (i) Name the liquid.
   (ii) Which electrode would the liquid be produced at? Explain your answer.

2. From the following list:

potassium oxide,	phosphorous oxide,	iron(II) oxide,
lithium oxide,	sulfur dioxide,	lead(II) oxide

(a) Name **two** oxides which dissolve in water to produce acidic solutions.
(b) Name **two** metal oxides which are insoluble in water.
(c) Name **two** oxides which dissolve in water to produce an alkaline solution.

3. When sodium oxide is added to water the pH of the water rises.

(a) What new substance is produced when sodium oxide dissolves in water?
(b) Give an equation for the reaction which occurs when sodium oxide reacts with water.

4. Ammonia gas dissolves in water easily to form an alkaline solution.

(a) What is the formula of ammonia?
(b) Write an equation for the reaction of ammonia gas with water.
(c) Which ion is present in all alkaline solutions?

Ionisation of water/Diluting Acids and Alkalis 22

1. Distilled water has a very low conductivity.

   (a) What type of bonding is found in water?
   (b) Explain why you would not expect distilled water to conduct electricity.
   (c) Explain why distilled water conducts electricity to some extent.

2. Here are a series of statements

   A It contains ions
   B It contains more $OH^-_{(aq)}$ ions than pure water
   C It has a pH of more than 7
   D It has a pH equal to 7
   E It contains more $H^+_{(aq)}$ ions than pure water
   F It has a pH of less than 7

   (a) Which statement is true for both acids and alkalis?
   (b) Which TWO statements are true for alkaline solutions?
   (c) Which TWO statements are true for acidic solutions?
   (d) Which TWO statements are true for distilled water?

3. Look at the following statements:

   A the pH rises
   B the pH falls
   C the electrical conductivity rises
   D the electrical conductivity falls

   Which statement(s) is/are true when

   (a) an alkali is added to water
   (b) water is added to an alkali
   (c) an acid is added to water
   (d) water is added to an acid

4. Pure water is added to a solution of pH 12.

   (a) Which contains more hydroxide ions, the solution or pure water?
   (b) What happens to the concentration of hydroxide ions as water is added?

Reactions of acids: Metal oxide 23

1. Excess iron (II) oxide is added to hydrochloric acid. A reaction occurs in which one of the products is iron (II) chloride.

   (a) Write an equation for the reaction.
   (b) Write an ionic equation for the reaction.
   (c) Identify the **two** spectator ions in the reaction.
   (d) What name is given to substances like iron (II) oxide which can neutralise acids?

2. Excess powdered copper (II) oxide is added to nitric acid and the reaction mixture is heated. At the end of the reaction the remaining copper (II) oxide is removed and a blue solution is obtained.

   (a) What type of reaction had occurred?
   (b) How could the excess copper (II) oxide be removed from the reaction mixture?
   (c) Name the blue solution produced. Which ion gives the solution this colour?
   (d) Write a balanced equation for the reaction.
   (e) Write an ionic equation for the reaction.
   (f) Identify the **two** spectator ions in the reaction.

3. Jim decided to make magnesium sulfate by reacting magnesium oxide with an acid.

   (a) Which acid did Jim use in the reaction?
   (b) Write a balanced equation for the above reaction.
   (c) Write an ionic equation for the above reaction.
   (d) Identify the **two** spectator ions in the above reaction.

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Reactions of acids: Metal Hydroxide 24

1. Sodium hydroxide solution is added to nitric acid to produce a neutral solution. At the end of the reaction the solution is heated to evaporate the water and a white solid remains.

   (a) What type of reaction had occurred?
   (b) What name is given to substances like sodium hydroxide?
   (c) What is the likely pH of a solution of nitric acid?
   (d) Name the white solid produced.
   (e) Write an equation for the reaction.
   (f) Write an ionic equation for the reaction.
   (g) Identify the **two** spectator ions in the reaction.

2. Fiona decided to make sodium methanoate by reacting sodium hydroxide with an acid. She added sodium hydroxide to the acid until the reaction mixture was neutral.

   (a) Which acid did Fiona use in the reaction?
   (b) Write a word equation for the above reaction.
   (c) How could Fiona have obtained a sample of the sodium methanoate from the reaction mixture?
   (d) How would Fiona have known when the sodium hydroxide had exactly neutralised the acid?

3. Potassium hydroxide is added to ethanoic acid. The temperature of the solution is found to rise.

   (a) Give two words could be used to describe the reaction which had occurred.
   (b) Write an equation for the reaction.
   (c) Write an ionic equation for the reaction.
   (d) Identify the spectator ion in the reaction.

4. Crystals of sodium sulfate can be made by reacting sulfuric acid with an alkali.

   (a) Name the alkali used in the above reaction.
   (b) Write a balanced equation for the above reaction.
   (c) Write an ionic equation for the above reaction.
   (d) Identify the **two** spectator ions in the above reaction.

Reactions of acids: Metal Carbonate 25

1. Chalk is calcium carbonate. Excess chalk is added to an acid. A reaction occurs in which one of the products is calcium nitrate.

   (a) Name the acid used in the reaction.
   (b) Write a balanced equation for the reaction.
   (c) Write an ionic equation for the reaction.
   (d) Identify the **two** spectator ions in the reaction.

2. Crystals of sodium sulfate can be made by reacting an acid with a carbonate.

   (a) Name the type of reaction which occurs between a carbonate and an acid.
   (b) Name the acid used in the above reaction.
   (c) Name the carbonate used in the above reaction.
   (d) Write an equation for the above reaction.
   (e) Write a balanced equation for the above reaction.

3. Fred decided to make sodium chloride by reacting sodium carbonate with an acid. He added sodium carbonate to the acid until the mixture was neutral.

   (a) Which acid did Fred use in the reaction?
   (b) Write an equation for the above reaction.
   (c) Write a balanced equation for the above reaction.
   (d) What is the test for the gas produced in the above reaction?

4**.** Solid sodium carbonate is added to nitric acid. The reaction mixture fizzes vigorously. At the end of the reaction the solution is heated to evaporate the water and a white crystalline solid remains.

   (a) What type of reaction had occurred?
   (b) What is the likely pH of a solution of nitric acid?
   (c) Why does the reaction mixture fizz?
   (d) Name the white crystalline solid produced.
   (e) Write a balanced equation for the reaction.
   (f) Write an ionic equation for the reaction.
   (g) Identify the **two** spectator ions in the reaction.

1. What is the concentration of the following solutions?

(a) 0.1 mole of substance dissolved in 200 cm^3 of solution

(b) 0.2 mole of substance dissolved in 200 cm^3 of solution

(c) 0.15 mole of substance dissolved in 75 cm^3 of solution

2. How many moles of substance are dissolved in the following solutions?

(a) 250 cm^3 of 2 mol l^{-1} (b) 300 cm^3 of 1 mol l^{-1}

(c) 500 cm^3 of 0.5 mol l^{-1} (d) 400 cm^3 of 2 mol l^{-1}

3. Nitric acid reacts with potassium hydroxide according to the equation:

$$HNO_3 + KOH \rightarrow KNO_3 + H_2O$$

12·5 cm^3 of nitric acid is neutralised by 20 cm^3 of a 0·1 mol l^{-1} solution of potassium hydroxide.
What was the concentration of the nitric acid?

4. Sodium hydroxide reacts with hydrochloric acid according to the equation:

$$NaOH + HCl \rightarrow NaCl + 2H_2O$$

40 cm^3 of a solution of sodium hydroxide was neutralised by 100 cm^3 of a 0·5 mol l^{-1} solution of hydrochloric acid.
What was the concentration of the sodium hydroxide?

5. Calcium hydroxide reacts with sulfuric acid according to the equation:

$$Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$$

20 cm^3 of a solution of sulfuric acid is neutralised by 25 cm^3 of a 0·5 mol l^{-1} solution of calcium hydroxide.
What was the concentration of the sulfuric acid?

6. 1 mole of oxalic acid neutralises 2 moles of sodium hydroxide.
What volume of a 0·5 mol l^{-1} solution of oxalic acid neutralises 100 cm^3 of a 2 mol l^{-1} solution of sodium hydroxide?

1. Give the formula and mass of 1 mole of each of the following substances.

(a) sodium hydroxide
(b) potassium nitrate
(c) carbon dioxide
(d) magnesium chloride
(e) calcium carbonate
(f) sodium sulfate
(g) water
(h) iron (II) sulfate

2. Calculate the mass of the following (**show all your working**)

(a) 0·1 moles of potassium oxide
(b) 0·25 moles of water
(c) 0·5 moles of sulfuric acid
(d) 0·2 moles of sodium hydroxide
(e) 0·75 moles of calcium hydroxide
(f) 0·1 moles of sodium chloride

3. How many moles of substance are present in the following **(show all your working)**

(a) 10g of sodium hydroxide
(b) 14·8g of calcium hydroxide
(c) 36g of iron (II) oxide
(d) 90g of water
(e) 2g of methane (CH_4)
(f) 8·8g of carbon dioxide

4. What is the concentration of the following solutions?

(a) 0.1 mole of substance dissolved in 250 cm^3 of solution
(b) 0.02 mole of substance dissolved in 20 cm^3 of solution
(c) 0.14 mole of substance dissolved in 70 cm^3 of solution
(d) 0.05 mole of substance dissolved in 25 cm^3 of solution

5. How many moles of substance are dissolved in the following solutions?

(a) 1000 cm^3 of 2 mol l^{-1}
(b) 250 cm^3 of 0.5 mol l^{-1}
(c) 50 cm^3 of 0.5 mol l^{-1}
(d) 40 cm^3 of 2 mol l^{-1}
(e) 60 cm^3 of 0.1 mol l^{-1}
(f) 50 cm^3 of 4 mol l^{-1}

Extra calculations **27 (cont.)**

6. For each of the following solutions calculate:

   (i) the number of moles of substance dissolved
   (ii) the mass of substance dissolved in grams

   (a) 50 cm^3 of a 2 mol l^{-1} solution of potassium hydroxide (KOH)
   (b) 25 cm^3 of 0.1mol l^{-1} solution of sulfuric acid (H_2SO_4)
   (c) 100 cm^3 of 0.5mol l^{-1} solution of nitric acid (HNO_3)

7. Calculate the mass of solute in each of the following solutions:

   (a) 25 cm^3 of sodium hydroxide (NaOH), concentration 4 mol l^{-1}
   (b) 10 cm^3 of sulfuric acid (H_2SO_4), concentration 5 mol l^{-1}
   (c) 0.1 litre of hydochloric acid, (HCl), concentration 0.4 mol l^{-1}

8. Calculate the concentration of the following solutions:

   (a) 5.85g of sodium chloride (NaCl) dissolved in 0.2 litre of solution
   (b) 0.25 g of calcium carbonate ($CaCO_3$) dissolved in 25 cm^3 of solution
   (c) 1g of sodium hydroxide (NaOH) dissolved in 50 cm^3 of solution

9. A solution contains 2 g of sodium hydroxide in 100 cm^3 of solution.
   (a) What is the formula and mass of 1 mole of sodium hydroxide?
   (b) How many moles of substance are present in 2g of sodium hydroxide?
   (c) What is the concentration of the sodium hydroxide solution?

10. 30.4g of iron(II) sulfate ($FeSO_4$)is used to make a 0.5 mol l^{-1} solution.
   (a) What is the mass of 1 mole of iron(II) sulfate?
   (b) How many moles of substance are present in 30.4g of iron(II) sulfate?
   (c) What volume of a 0.5 mol l^{-1} solution can be made from 30.4g of iron(II) sulfate?

11. Calum prepares 250 cm^3 of an 0·2 mol l^{-1} solution of calcium hydroxide, $Ca(OH)_2$.
    (a) What is the mass of 1 mole of calcium hydroxide?
    (b) How many moles of calcium hydroxide are present in the solution?
    (c) What mass of calcium hydroxide is present in the solution?

12. A beaker contains 50 cm^3 of a 0·6 mol l^{-1} solution of sodium carbonate.
    (a) What is the formula and mass of one mole of sodium carbonate?
    (b) How many moles of sodium carbonate is present in the solution?
    (c) What mass of sodium carbonate is present in the solution?

13. A bottle of sodium hydroxide solution is found in a lab. The bottle is labelled as "sodium hydroxide; 8 grams per litre solution".
    (a) What is the formula and mass of 1 mole of sodium hydroxide?
    (b) How many moles of substance are present in 8 grams of sodium hydroxide?
    (c) What is the concentration in moles per litre of a 8 grams per litre solution of sodium hydroxide?

14. In an experiment 4.9 g of magnesium reacted with excess dilute hydrochloric acid.

$$Mg(s) + 2HCl(aq) \text{ --> } MgCl_2(\ ) + H_2(g)$$

    (a) What is the state symbol for magnesium?
    (b) Calculate the mass of hydrogen produced in this reaction.

15. Another student reacted aluminium with dilute nitric acid.

$$2Al(s) + 6HNO_3(aq) \rightarrow 2Al(NO_3)_3(aq) + 3H_2(g)$$

    1 mole of hydrogen gas has a volume of 24 litres.
    Calculate the volume of hydrogen gas, in litres, produced when 0·01 moles of aluminium react with dilute nitric acid.
    Show your working clearly.

16. Urea, H_2NCONH_2, can be used as a fertiliser.
    Calculate the percentage of hydrogen in urea.

Open Ended Questions 28

1. A student wanted to investigate whether copper could be used as a catalyst

for the reaction between zinc and sulfuric acid.

$$Zn(s) + H_2SO_4(aq) \; ZnSO_4(aq) + H_2(g)$$

Using your knowledge of chemistry, suggest how the student could investigate this.

2. A student reacted acidified potassium permanganate solution with oxalic acid, $C_2H_2O_4$.

$$2MnO^{4-}(aq) + 5C_2H_2O_4(aq) + 6H^+(aq) \; 2Mn^{2+}(aq) + 10CO_2(g) + 8H_2O(\ell)$$

Using your knowledge of chemistry, comment on how the student could have determined the rate of the reaction.

3. The element strontium was discovered in 1790 in the village of Strontian in Scotland.

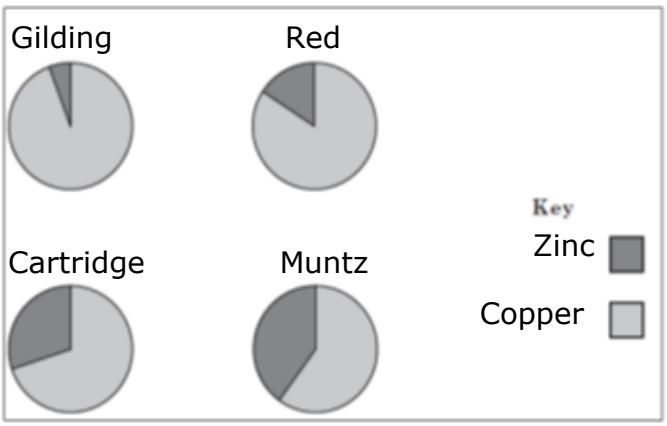
Using your knowledge of chemistry, comment on the chemistry of strontium.

4. Carbonated water, also known as sparkling water, is water into which carbon dioxide gas has been dissolved. This process is called carbonating.

A group of students are given two brands of carbonated water and asked to determine which brand contains more dissolved carbon dioxide.

Using your knowledge of chemistry, describe how the students could determine which brand of carbonated water contains more dissolved carbon dioxide.

1. Brass is a mixture of copper and zinc. The pie charts below show the composition of different types of brass.



The table below shows some of the properties of the different types of brass.

Type of brass	Tensile strength (MPa)	Hardness (units)
Gilding	245	52
Red	280	64
Cartridge	357	72
Muntz	378	80

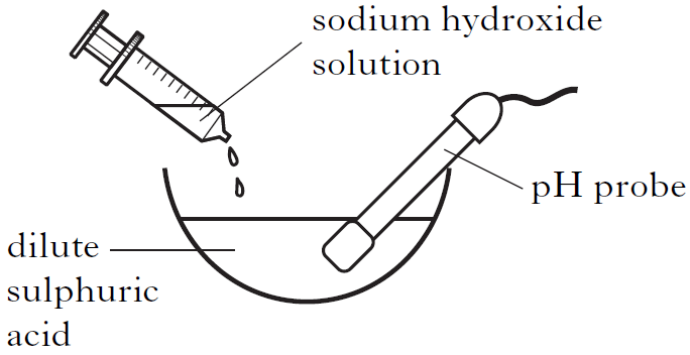
(a) What conclusion can be drawn about the composition of brass and its hardness?
(b) Predict the tensile strength of brass which contains 75% copper.

2. In 1987 many countries agreed to ban, completely, the production and use of CFCs (chlorofluorocarbons) from the year 2000. CFCs are chemicals used in spray cans. Every time the button on a spray can is pressed, CFCs are released into the air. The CFCs rise into the stratosphere, which is a layer of the atmosphere 11 km to 48 km above the Earth's surface. Once in the stratosphere, the CFCs change ozone into oxygen and so create a "hole" in the ozone layer which surrounds the Earth. With less ozone in the stratosphere, more ultra violet radiation reaches the surface of the Earth. This reduces the germination rate of plant seeds. Ultra violet radiation also causes health problems such as cataracts and skin cancer in humans.

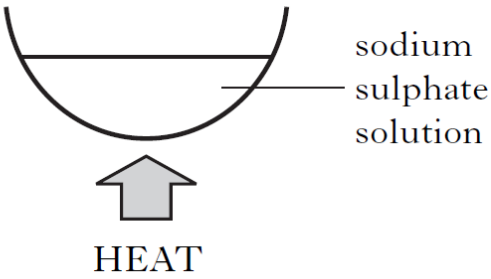
(a) What do the initials CFC stand for?
(b) Where is the stratosphere?
(c) How do CFCs bring about an increase in the ultra violet radiation reaching the Earth's surface?
(d) Give one example of how an increase in ultra violet radiation affects humans.

1. Sodium sulfate crystals can be made from sodium hydroxide solution and dilute sulfuric acid as shown in the procedure below.

Step 1



Step 2



Step 2
Evaporate until half of the solution remains.

Step 3

Step 3
Leave until the remaining water evaporates.

Step 4

Step 4
Sodium sulfate crystals are formed.

(a) Copy and complete the instructions for Step 1.

(b) The equation for the reaction is:

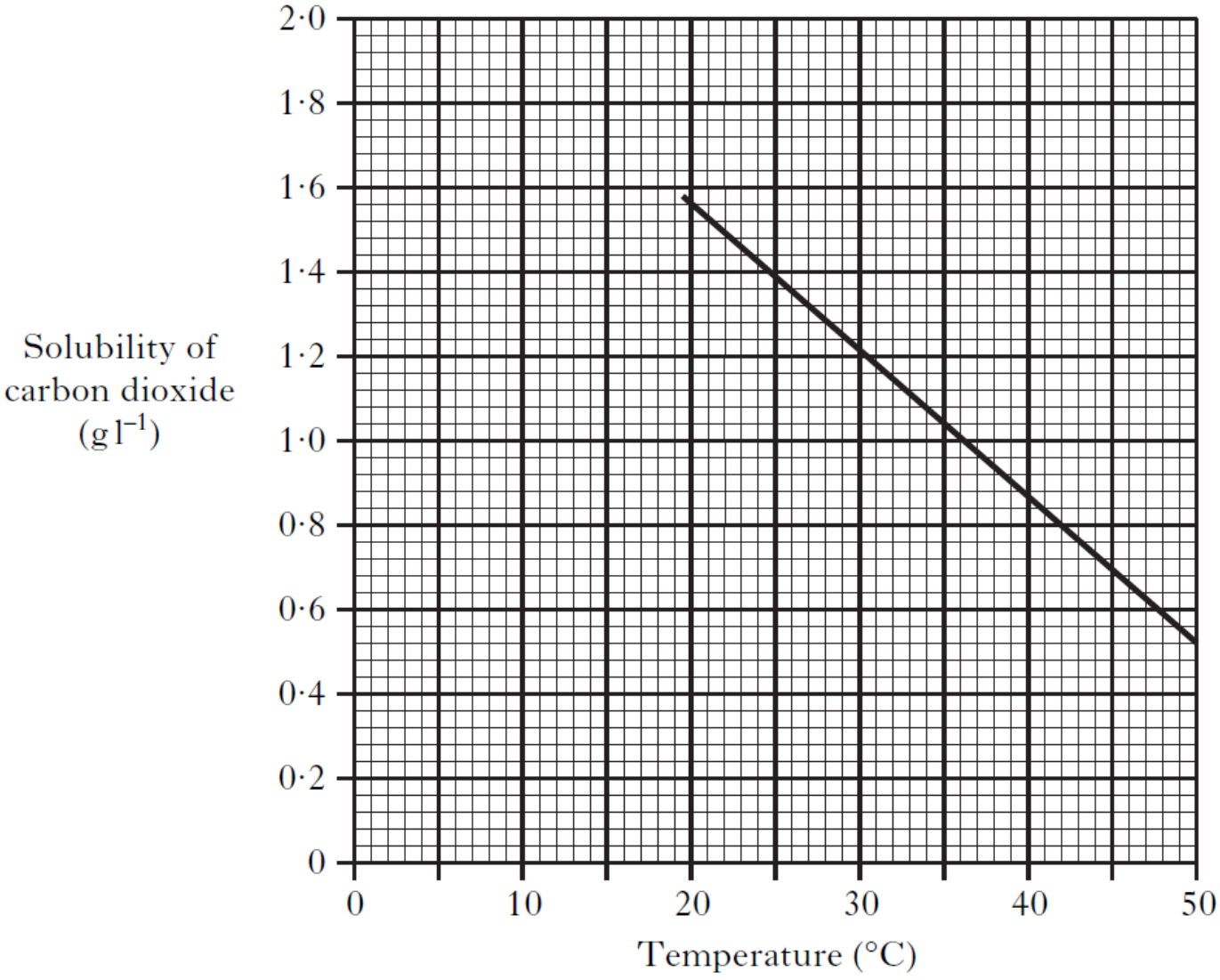
$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

In the experiment 50cm^3 of sodium hydroxide solution reacted with 20cm^3 0·1 mol l^{-1} dilute sulfuric acid.
Calculate the concentration of the sodium hydroxide solution.

2. People often drink lemonade to quench their thirst.

(a) Lemonade contains citric acid. Suggest a pH value for lemonade.

(b) To make the drink fizzy, carbon dioxide gas is added to the lemonade. The solubility of carbon dioxide gas depends on the temperature of the lemonade.
The graph below shows how the solubility of carbon dioxide gas changes with temperature.



(i) Write a general statement describing the effect of temperature on the solubility of carbon dioxide gas.

(ii) Use the graph to predict the solubility, in g l^{-1}, of carbon dioxide at 10 °C.