7. (a) Copy and complete the following table to show the numbers of protons and electrons in each of the following ions.

Ion	Number of protons	Number of electrons
Ca^{2+}		
Cl^-		
Al^{3+}		
O^{2-}		

(b) Look at the information in the table.

Ion	Number of protons	Number of electrons
zinc	30	28
sulphide	16	18
copper	29	28
tin	50	48

Using the information in the table, show how you would represent

(i) the zinc ion, (ii) the sulphide ion,
(iii) the copper ion, (iv) the tin ion.

8. Hydrogen chloride is made up of molecules but sodium chloride exists as a lattice.

(a) Explain what is meant by a lattice.
(b) Explain why the word "molecule" has no meaning when we are thinking of sodium chloride.

9. Write the ionic formula and formula (without charges on the ions) for each of the following compounds.

(a) sodium bromide (b) potassium oxide
(c) magnesium chloride (d) calcium sulphide
(e) aluminium oxide (f) magnesium nitride
(g) barium oxide (h) caesium bromide

10. Write the ionic formula and formula (without charges on the ions) for each of the following compounds.

(a) lead(II) bromide (b) copper(I) iodide
(c) iron(III) chloride (d) nickel(II) sulphide
(e) silver(I) oxide (f) vanadium(V) oxide

11. Write the ionic formula and formula (without charges on the ions) for each of the following compounds.

(a) lithium hydroxide (b) potassium sulphite
(c) sodium nitrate (d) iron(II) hydroxide
(e) ammonium chloride (f) magnesium carbonate
(g) radium chromate (h) ammonium sulphate
(g) rubidium phosphate (h) barium hydrogencarbonate
(i) potassium permanganate (j) aluminium hydrogensulphate

12. Write the ionic formula and formula (without charges on the ions) for each of the following compounds.

(a) sodium iodide (b) magnesium hydroxide
(c) iron(III) chloride (d) calcium nitrate
(e) ammonium bromide (f) rubidium fluoride
(g) magnesium sulphate (h) ammonium carbonate
(i) copper(II) carbonate (j) sodium sulphide
(k) radium phosphate (l) tin(IV) oxide

Properties of substances

1. (a) Draw a labelled diagram to show how elements can be tested to classify them as conductors or non-conductors.

(b) Which of the following elements conduct electricity?

(i) solid iron (ii) molten copper
(iii) liquid oxygen (iv) liquid sodium
(v) solid sulphur (vi) argon gas
(vii) liquid mercury (viii) solid magnesium
(ix) liquid bromine (x) chlorine gas

2. Consider the following four substances.

sucrose ($C_6H_{12}O_6$), baking powder ($NaHCO_3$)
potash (KCl), acetone (C_2H_6O)

(a) Name the substances that conduct electricity when in aqueous solution.
(b) Explain why the substances you have chosen do **not** conduct when solid.

3. Copy and complete the following table using a √ to show a conductor and an x to show a non-conductor.

Substance	In solid	In solution	As a liquid (molten)
Metal element		insoluble	
Covalent substance (element or compound)			
Ionic compound			

4. The electrical conductivities of substances A, B and C were measured and the results are shown. (0 is no conduction, + is conducts)

Substance	In solid state	Dissolved in water	In molten state
A	0	+	+
B	+	insoluble	+
C	0	0	0

(a) Which substance could be lead?
(b) Which substance could be potassium bromide?
(c) Which substance could be iodine?

5.

	P	Q	R	S
Solubility in water	soluble	insoluble	soluble	soluble
Colour of solution	colourless		blue	colourless
Electrical conductivity in solid state	does not conduct	conducts	does not conduct	does not conduct
Electrical conductivity in liquid (molten) state	does not conduct	conducts	conducts	conducts

The table above refers to the following four substances:

sodium chloride (NaCl), copper(II) bromide ($CuBr_2$),
aluminium (Al), glucose ($C_6H_{12}O_6$)

(a) Use the table to identify the four substances P, Q, R, and S.
(b) State the type of chemical bonding in substances P, R, and S.
(c) Explain why substances R and S do not conduct when solid but do conduct in the molten state.

Ionic bonding

Explain what is meant by
(a) an ion,
(b) an ionic bond.

What is the charge on each of the following ions?

(a) potassium	(b) sulphur
(c) nitrogen	(d) bromine
(e) aluminium	(f) strontium
(g) fluorine	(h) caesium

3. It is often said that metal atoms 'want' to lose electrons to form positive ions.
   (a) To what extent do you agree with this statement?
   (b) Explain your thinking.

4. What is the difference between the information given by the formula for a covalent compound and the formula for an ionic compound?

5. (a) Explain clearly what happens when
   (i) an atom of chlorine forms a chloride ion,
   (ii) an atom of calcium forms a calcium ion.
   (b) What happens during the formation of an ionic bond in calcium chloride?

6. A compound is formed from a Group 1 element and a Group 7 element.
   Choose two elements and show by means of a diagram what happens to the electrons in the outer shell (energy level) of the atoms involved.

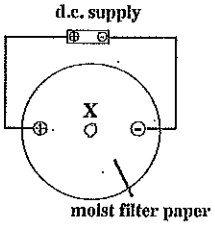
10. Shown below is a list of compounds and their colours.

sodium chloride	white	sodium sulphate	white
sodium selenate	white	copper sulphate	blue
nickel sulphate	green	vanadium sulphate	violet

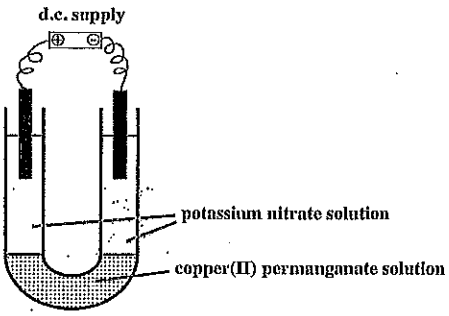
State the colour of
(a) copper selenate,
(b) vanadium chloride,
(c) nickel chloride.

11. A crystal of potassium dichromate was placed on moist filter paper at position X. When a high voltage was applied an orange colour moved towards the positive electrode.

Explain this observation.

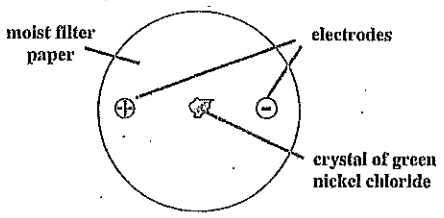


12.



The apparatus shown is used to demonstrate the electrolysis of copper permanganate solution.
(a) Why is potassium nitrate solution used instead of water?
(b) Potassium chloride is white while potassium permanganate is purple.
What is the colour of the permanganate ion?
(c) (i) What will be observed after passing the current in the above apparatus for about 20 minutes?
(ii) Explain your answer.

13. A student set up the following experiment.



(a) (i) What will happen when the current is switched on?
(ii) Explain your answer.
(b) What will happen if the current is reversed?

Chemical equations

1. Write the chemical formula for each of the following substances. Add the state symbol to show whether the substance is a solid, liquid, gas or in solution.
   (a) liquid carbon tetrachloride
   (b) carbon dioxide gas
   (c) oxygen gas
   (d) silicon oxide solid
   (e) solid sulphur
   (f) iodine solid
   (g) a solution of sodium chloride in water
   (h) a solution of sulphur dioxide in water

2. Write word equations for each of the following chemical reactions.
   (a) When magnesium metal burns, it reacts with oxygen of the air to form magnesium oxide, a white powder.
   (b) In the Blast furnace, iron is made by reacting iron oxide with carbon monoxide gas. Carbon dioxide gas is also produced.
   (c) In our bodies, starch which we get from food, breaks down to form glucose, which can pass through the walls of our intestines, and water.
   (d) When calcium metal is added to water, a gas is given off and calcium hydroxide solution is formed. When tested with a burning splint, the gas burns with a "pop".
   (e) Copper oxide powder and a gas that turns limewater milky are made when copper carbonate powder is heated.

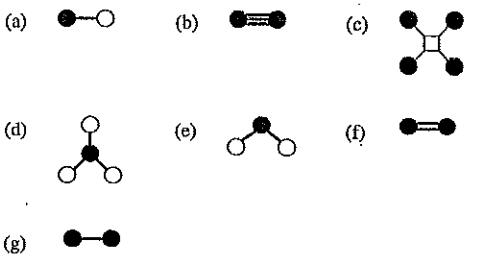
3. Write a sentence to describe the following reactions. The first one is done for you.
   (a) $C(s) + O_2(g) \rightarrow CO_2(g)$
   Carbon solid reacts with oxygen gas to form carbon dioxide gas.
   (b) $CO(g) + O_2(g) \rightarrow CO_2(g)$
   (c) $H_2(g) + F_2(g) \rightarrow HF(g)$
   (d) $SO_2(g) + O_2(g) \rightarrow SO_3(g)$
   (e) $CuO(s) + CO(g) \rightarrow Cu(s) + CO_2(g)$
   (f) $NH_3(g) \rightarrow N_2(g) + H_2(g)$
   (g) $Mg(s) + CO_2(g) \rightarrow MgO(s) + C(s)$
   (h) $HBr(g) \rightarrow H_2(g) + Br_2(l)$

4. Balance each of the following equations.
   (a) $C + O_2 \rightarrow CO_2$
   (b) $P + Cl_2 \rightarrow PCl_3$
   (c) $C + Br_2 \rightarrow CBr_4$
   (d) $C_4H_8 + O_2 \rightarrow CO_2 + H_2O$
   (e) $H_2O_2 \rightarrow H_2O + O_2$
   (f) $SiCl_4 + H_2 \rightarrow Si + HCl$

5. Balance each of the following equations.
   (a) $Ca + O_2 \rightarrow CaO$
   (b) $Mg + AgNO_3 \rightarrow Mg(NO_3)_2 + Ag$
   (c) $NaOH + H_2SO_4 \rightarrow Na_2SO_4 + H_2O$
   (d) $AgNO_3 + BaCl_2 \rightarrow Ba(NO_3)_2 + AgCl$
   (e) $Na + H_2O \rightarrow NaOH + H_2$
   (f) $Al + Cl_2 \rightarrow AlCl_3$
   (g) $Ag + O_2 + H_2S \rightarrow Ag_2S + H_2O$
   (h) $Ag_2S + Al \rightarrow Ag + Al_2S_3$
   (i) $HCl + Na_2S_2O_3 \rightarrow NaCl + S + SO_2 + H_2O$
   (j) $TiCl_4 + H_2O \rightarrow TiO_2 + HCl$

6. Write balanced chemical equations for each of the following reactions. State symbols are **not** necessary.
   (a) carbon monoxide + oxygen → carbon dioxide
   (b) hydrogen + chlorine → hydrogen chloride
   (c) methane (CH_4) + oxygen → carbon dioxide + water
   (d) sulphur dioxide + oxygen → sulphur trioxide
   (e) phosphorus + bromine → phosphorus bromide

4. The molecules below show the way atoms are arranged in different molecules.



Choose a name for each substance from the following list:
chlorine, hydrogen oxide, carbon chloride, nitrogen, oxygen, hydrogen chloride, nitrogen hydride

5. Write the chemical formula for each of the following compounds.
   (a) sulphur trioxide
   (b) carbon dioxide
   (c) carbon monoxide
   (d) silicon tetrafluoride
   (e) phosphorus pentachloride
   (f) uranium hexafluoride

6. (a) Explain what is meant by a diatomic molecule.
   (b) Which of the following elements exist as diatomic molecules?
   (i) calcium (ii) carbon
   (iii) nitrogen (iv) aluminium
   (v) hydrogen (vi) neon
   (vii) chlorine (viii) sulphur
   (ix) magnesium (x) oxygen
   (xi) fluorine (xii) argon
   (c) Which of the following compounds exist as diatomic molecules?
   (i) CH_2O (ii) HCl
   (iii) NH_3 (iv) CO
   (v) CH_2Cl_2 (vi) SO_2

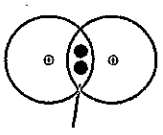
7. Draw diagrams to show how the outer electrons form covalent bonds in each of the following molecules.
   (a) hydrogen
   (b) oxygen
   (c) fluorine
   (d) phosphorus chloride
   (e) hydrogen chloride
   (f) hydrogen oxide
   (g) carbon fluoride
   (h) carbon dioxide
   (i) nitrogen hydride
   (j) sulphur fluoride

8. Write the chemical formula for each of the following compounds.
   (a) hydrogen sulphide
   (b) phosphorus fluoride
   (c) nitrogen chloride
   (d) hydrogen iodide
   (e) sulphur chloride
   (f) silicon oxide

9. Explain what is meant by
   (a) the chemical formula for a covalent substance,
   (b) the full structural formula.

10. (a) Make a drawing to show the shape of each of the following molecules.
   (i) N_2 (ii) CCl_4
   (iii) NH_3 (iv) H_2O
   (b) What name can be used to describe the shape of a CCl_4 molecule?
   (c) Why is the molecule of H_2O **not** linear?

11. The atoms in a hydrogen molecule are held together by a covalent bond. A covalent bond is a shared pair of electrons. Explain how this holds the atoms together.



shared pair of electrons

Covalent bonding

1. Explain what is meant by
   (a) a molecule,
   (b) a covalent bond.

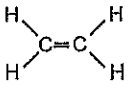
2. (a) Atoms of what kind of elements form covalent bonds?
   (b) Which of the following are covalent compounds?

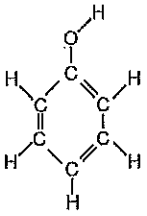
(i) sodium chloride	(ii) hydrogen chloride
(iii) carbon sulphide	(iv) aluminium nitrate
(v) iron oxide	(vi) phosphorus oxide
(vii) copper sulphate	(viii) CH_3Cl
(ix) MgO	(x) NO_2
(xi) $FeCl_2$	(xii) C_2H_5OH
(xiii) Na_2CO_3	(xiv) $C_6H_{12}O_6$

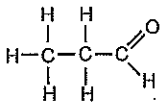
3. Write the chemical formula for each of the following substances.

(a) 

(b) 

(c) 

(d) 

(e) 

Calculations

1. Calculate the formula mass of each of the following substances.

(a) H_2O	(b) CH_4
(c) $CaCO_3$	(d) Na_2SO_4
(e) $Mg(NO_3)_2$	(f) nitrogen hydride
(g) carbon dioxide	(h) potassium carbonate
(i) aluminium oxide	(j) ammonium chloride

2. Calculate the mass of one mole of each of the following substances.

(a) C_3H_6	(b) MgO
(c) K_2CO_3	(d) $C_6H_{12}O_6$
(e) $(NH_4)_3SO_4$	(f) magnesium chloride
(g) calcium oxide	(h) potassium hydroxide
(i) magnesium sulphate	(j) sodium nitrate

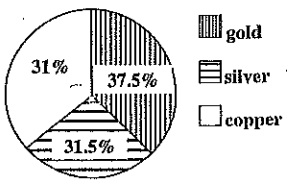
3. Calculate the mass of each of the following substances.

(a) 2 mol of sodium	(b) 0.1 mol of $CaSO_4$
(c) 0.25 mol of $Mg(NO_3)_2$	(d) 5 mol of sulphur dioxide
(e) 0.2 mol of magnesium iodide	(f) 0.5 mol of ammonium carbonate

4. Calculate the number of moles in each of the following substances.

(a) 36 g of carbon	(b) 5.6 g of CO
(c) 5.6 g of KOH	(d) 2.2 g of lithium sulphate
(e) 8.2 g of calcium nitrate	(f) 5.3 kg of sodium carbonate

5. The composition by mass of a gold ring is shown in the pie chart.
   The gold ring weighs 7.88 g.
   Calculate the number of moles of gold in the ring.



9. An alpha particle is a positive particle that can gain two electrons to become a neutral atom.
An alpha particle has a mass number of 4 and an atomic number of 2.
Calculate the number of protons, neutrons and electrons in an alpha particle.

10. Atom A has mass number 239 and atomic number 93.
Atom B has a mass number 239 and atomic number 94.
   (a) How many protons has A?
   (b) How many neutrons has B?
   (c) (i) Are atoms A and B of the same element?
       (ii) Explain your answer.

11. In the reactions occurring in the sun, some atoms collide with such force that their nuclei join together to make one new nucleus.
   (a) Why must a new element be formed in reactions of this kind?
   (b) Helium is formed in solar reactions.
   Nuclei of which element join together to make helium?

12. Normal hydrogen atoms, ${}^{1}_{1}H$, are known as protium atoms.
   (a) (i) How many protons are there in a protium nucleus?
       (ii) How many neutrons are there in a protium nucleus?
       (iii) What name is given to the total number of protons and neutrons in the nucleus of an atom?
   (b) Deuterium, ${}^{2}_{1}H$, is another type of hydrogen atom.
       (i) How many protons are there in a deuterium nucleus?
       (ii) How many neutrons are there in a deuterium nucleus?
       (iii) Suggest why deuterium is sometimes referred to as "heavy" hydrogen.
   (c) Tritium is a third type of hydrogen atom with a mass number of 3.
   How many protons and neutrons are there in a tritium nucleus?

Relative atomic mass (atomic weight)

1. Bromine has a relative atomic mass of 80. Analysis of a sample of bromine shows that it contains two isotopes, one with a relative mass of 79 and the other with a relative mass of 81.
   (a) Explain what is meant by isotopes.
   (b) What can be said about the proportions of the isotopes in the sample?

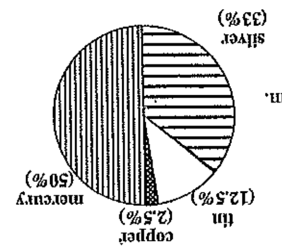
2. ${}^{20}_{10}Ne$ and ${}^{22}_{10}Ne$ are two different kinds of neon atom.
   (a) In what ways are the kinds of neon atom different?
   (b) Explain why the atoms can be regarded as atoms of the same element.
   (c) What further information is needed to calculate the relative atomic mass (atomic weight) of neon?

3. Two types of chlorine atom are ${}^{35}_{17}Cl$ and ${}^{37}_{17}Cl$.
Chlorine has a relative atomic mass of 35.5.
   (a) What term is used to describe the different types of chlorine atom?
   (b) What can be said about the proportions of each type of atom in chlorine?

4. Copper has a relative atomic mass (atomic weight) of 63.5.
It contains two different kinds of atom: ${}^{63}Cu$ and ${}^{65}Cu$.
   (a) How many neutrons are present in each kind of atom?
   (b) Which kind of atom is more common in copper?

6. Heavy water is made up of molecules in which each of the hydrogen atoms has one neutron in its nucleus.
Calculate the number of moles of heavy water molecules in 500 g of heavy water.

7. The filling for a tooth is often made of dental amalgam.
The pie chart shows the composition of a typical dental amalgam.
   (a) Calculate the number of moles of mercury in 2.0 g of dental amalgam.
   (b) Calculate the number of moles of tin in 5.0 g of dental amalgam.



8. Calculate the number of moles of potassium hydroxide that must be dissolved to make each of the following solutions.
   (a) 500 cm^3 of 1 mol l^{-1}
   (b) 200 cm^3 of 0. 5 mol l^{-1}
   (c) 100 cm^3 of 0. 1 mol l^{-1}
   (d) 2 litres of 0.25 mol l^{-1}
   (e) 200 cm^3 of 2 mol l^{-1}

9. Calculate the concentration of each of the following solutions of hydrochloric acid.
   (a) 1 mol of hydrogen chloride dissolved to make 100 cm^3 of solution
   (b) 2.5 mol of hydrogen chloride dissolved to make 1 litre of solution
   (c) 0.1 mol of hydrogen chloride dissolved to make 500 cm^3 of solution
   (d) 0.2 mol of hydrogen chloride dissolved to make 250 cm^3 of solution
   (e) 0.4 mol of hydrogen chloride dissolved to make 200 cm^3 of solution

10. Calculate the volume of each of the following solutions of sodium hydroxide.
   (a) 1 mol l^{-1} solution containing 0.2 mol of solute
   (b) 0.5 mol l^{-1} solution containing 1 mol of solute
   (c) 2 mol l^{-1} solution containing 0.1 mol of solute
   (d) 0.1 mol l^{-1} solution containing 0.5 mol of solute
   (e) 0.4 mol l^{-1} solution containing 0.1 mol of solute.

11. Calculate the number of grams of substance required to make each of the following solutions.
   (a) 50 cm^3 of NaOH (aq), concentration 2 mol l^{-1}
   (b) 100 cm^3 of KOH (aq), concentration 0.5 mol l^{-1}
   (c) 1 litre of Na_2CO_3 (aq), concentration 0.1 mol l^{-1}
   (d) 25 cm^3 of lithium nitrate solution, concentration 0.2 mol l^{-1}
   (e) 250 cm^3 of ammonium sulphate solution, concentration 1 mol l^{-1}
   (f) 200 cm^3 of calcium nitrate solution, concentration 0.25 mol l^{-1}

12. Calculate the concentration of each of the following solutions.
   (a) 5.85 g of NaCl dissolved to make 1 litre of solution
   (b) 1.38 g of K_2CO_3 dissolved to make 100 cm^3 of solution
   (c) 8 g of NaOH dissolved to make 250 cm^3 of solution
   (d) 2.02 g of potassium nitrate dissolved to make 50 cm^3 of solution
   (e) 0.22 g of lithium sulphate dissolved to make 100 cm^3 of solution
   (f) 1.27 g of iron(II) chloride dissolved to make 2 litres of solution

Atomic structure

1. (a) (i) What name is given to the "core" at the centre of the atom?
   (ii) What charge has the 'core'?
   (iii) Name the two subatomic particles found in the 'core'.
   (b) (i) Name the particles that move around the outside of the atom.
   (ii) What charge do these particles have?
   (c) Explain why an atom is neutral.

2. Copy and complete the following table.

Subatomic particle	Mass	Charge	Location in atom
electron			
proton			
neutron			

3. (a) Name the elements with each of the following electron arrangements.
   (i) 2,8,1 (ii) 2,8 (iii) 2,8,3
   (iv) 2,4 (v) 2,7 (vi) 2,8,4
   (b) Which **two** of the above elements will have similar chemical properties?

4. (a) Which element has atoms with 17 protons in the nucleus?
   (b) Which element has 11 electrons in each of its atoms?
   (c) Which element has atoms with an electron arrangement of 2,6?

5. (a) For an atom of an element, explain what is meant by
   (i) the atomic number,
   (ii) the mass number.
   (b) An atom of potassium can be written as ${}^{x}_{y}K$.
   State the information that is given by **x** and **y**.

6. (a) Copy and complete the following table.

Element	Atomic number	Mass number	Number of protons	Number of neutrons	Number of electrons
Ne		22			
N				7	
Ca		40			
A	4	9			
B		14			6
C		80	36		
D			10	10	
E				17	15

   (b) Identify elements **A**, **B**, **C**, **D** and **E**.

7. Calculate the number of protons, neutrons and electrons in each of the following atoms of elements.
   (a) ${}^{23}_{11}Na$ (b) ${}^{16}_{8}O$ (c) ${}^{3}_{1}H$
   (d) ${}^{35}_{17}Cl$ (e) ${}^{1}_{1}H$ (f) ${}^{40}_{20}Ca$
   (g) ${}^{39}_{19}K$ (h) ${}^{7}_{3}Li$ (i) ${}^{32}_{16}S$

8. An atom of sodium can be written as ${}^{23}_{11}Na$.
   Write each of the atoms below in a similar way.
   (a) An oxygen atom with 10 neutrons.
   (b) An atom, atomic number 6, with 7 neutrons.
   (c) An atom with 17 protons and 20 neutrons.
   (d) An atom of hydrogen, mass number 3.

Acids and bases

1. (a) (i) Name **three** laboratory acids.
   (ii) Name **three** 'everyday' solutions that are acidic.
   (b) (i) Name **three** laboratory alkalis.
   (ii) Name **three** household products that contain an alkali.

2 (a) What is meant by the pH of a solution?
   (b) Name the indicator used to measure the pH of aqueous solutions.
   (c) State the colour changes that can be seen when pH paper is added to
   (i) acids,
   (ii) alkalis.
   (d) State the range of pH values that can be shown by
   (i) acids,
   (ii) alkalis.
   (e) (i) What colour do neutral solutions turn pH paper?
   (ii) What is the pH of water (and neutral solutions)?

3. Decide whether or not each of the following statements is **TRUE** or **FALSE**.
   (a) An acid can have a pH of 3.7
   (b) An alkali can have a pH of 14.2
   (c) An acid can have a pH of 0.
   (d) Solutions with a pH between 6 and 8 are neutral.
   (e) An acid can have a pH of -1.
   (f) A solution with a pH of 4 is less acidic than a solution with a pH of 6.
   (g) A solution with a pH of 11 is less alkaline than a solution with a pH of 9.

4. Explain why crystals of citric acid have no effect on dry pH paper but turn Universal indicator red.

5. Many pollution problems are linked to acid rain.
   (a) (i) What is meant by acid rain?
   (ii) How is it formed?
   (b) Describe the damaging effects of acid rain on
   (i) the natural environment,
   (ii) structures and buildings,
   (iii) humans.
   (c) Describe **two** ways of reducing the problems caused by acid rain pollution.

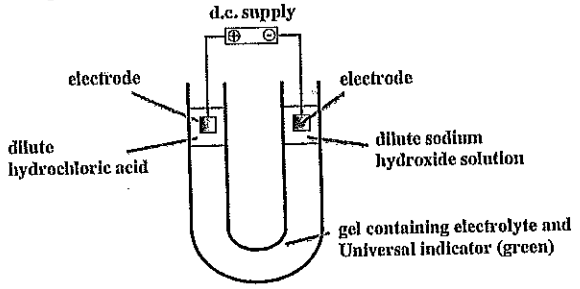
6. Consider the following list of oxides:

iron(III) oxide,	*sodium oxide,*	*carbon dioxide,*
calcium oxide;	*nitrogen dioxide,*	*copper(II) oxide,*
barium oxide,	*nickel oxide,*	*phosphorus oxide*

   (a) Name the **three** oxides that dissolve to produce a solution with a pH below 7.
   (b) Name the **three** oxides that dissolve to produce a solution with a pH above 7.
   (c) Name the **three** oxides that do **not** change the pH of water.

7. Two unknown elements **A** and **B** form oxides. The oxide of **A** gives an aqueous solution of pH 5 while the oxide of **B** gives a solution of pH 10.
   State what this indicates about
   (a) the oxides of **A** and **B**,
   (b) the elements **A** and **B**.

13. The migration of ions was studied using the apparatus below.



Explain, in terms of movement of ions, the colour changes that would have been observed.

14. (a) What is meant by a base?
(b) Which of the following bases do **not** form an alkali when added to water?

(i) sodium carbonate	(ii) nickel hydroxide
(iii) lithium oxide	(iv) tin(II) hydroxide
(v) barium oxide	(vi) copper(II) carbonate

(c) Why can potassium hydroxide solution be described as '**BOTH** a base and an alkali' and yet copper(II) oxide can be described as 'a base but **NOT** an alkali'?

15. Water, H_2O, can be expected to be made up of molecules with atoms joined by covalent bonds.
(a) Why does water conduct electricity?
(b) Why is the conductivity very poor?

16. Pure water is added to a solution with a pH of 12.
(a) Which **two** ions are present in pure water?
(b) Which contains more hydroxide ions, the solution or the pure water?
(c) What happens to the concentration of hydroxide ions in the solution as the water is added?

17. Acid solutions contain $H^+(aq)$ ions; so does pure water.
(a) Explain why pure water is **not** an acid.
(b) When water is added to an acid solution the pH rises.
(i) Explain why this happens.
(ii) What is the highest value to which the pH can rise?
(iii) Explain your answer to (ii).

Elements and compounds

1. (a) Approximately how many elements are listed in the Periodic Table?
(b) Name **two** naturally occurring elements that are
(i) metallic,
(ii) non-metallic.
(c) Name **two** elements that are
(i) solid at room temperature,
(ii) liquid at room temperature,
(iii) gas at room temperature,
(iv) made by scientists.

2. Find the name and symbol for an element that is

(a) stored under oil,	(b) stored under water,
(c) used as 'lead' in pencils,	(d) once used to fill airships
(e) used as the metal in domestic lightbulbs,	(f) used as the gas in domestic lightbulbs,
(g) used to kill germs in swimming baths,	(h) now used in lighter than air balloons,
(i) called after a planet,	(j) called after Dimitri Mendeleev,
(k) called after an American state,	(l) called after Albert Einstein,
(m) called after a continent,	(n) called after a village in Scotland,
(o) called after the man who discovered dynamite,	(p) called after the woman who discovered radium.

3. The elements are arranged in the Periodic Table.
Explain what is meant by
(a) a group,
(b) a period.

4. (a) Name the elements with each of the following atomic numbers.
(i) 23 (ii) 3 (iii) 18 (iv) 28
(b) Give the atomic number of each of the following elements.
(i) chlorine (ii) helium (iii) uranium (iv) iron

5. There is a special scale to measure the mass of something as light as an atom.
(a) (i) Name this scale.
(ii) Why does the scale **not** have units?
(b) Give the mass on this scale for an atom of

(i) oxygen	(ii) carbon
(iii) sulphur	(iv) magnesium.

6. Look at the following list of elements:

sodium,	*iron,*	*argon,*	*chlorine,*	*magnesium*
copper,	*bromine,*	*helium,*	*potassium,*	*sulphur,*
rubidium,	*iodine,*	*xenon,*	*nickel,*	*carbon*

(a) Name the elements that are members of each of the following families.

(i) the halogens	(ii) the alkali metals
(iii) the transition metals	(iv) the noble gases

(b) State a chemical property of

(i) the alkali metals,	(ii) the noble gases.

7. Germanium is so similar to silicon that it was once called "eka silicon".
Why are germanium and silicon similar to each other?

8. Dimitri Mendeleev used the properties of the elements to help arrange them in his Periodic Table. He left gaps in the table if no known element fitted and then made predictions about the properties of the elements that should occupy these gaps.
(a) Predict whether astatine (atomic number 85) is likely to be a solid, a liquid or a gas at room temperature.
(b) Predict a chemical property of caesium (atomic number 55).

Reactions of acids

1. (a) Explain what is meant by a neutralisation reaction.
   (b) What happens to the pH of an acid as it is neutralised?
   (c) What happens to the pH of an alkali as it is neutralised?

2. (a) Explain why gardeners add lime to soil that is acidic.
   (b) Explain why Milk of Magnesia is taken to relieve acid indigestion.

3. In certain hard-water areas, scale can build up on the inside of kettles. When tested with Universal indicator, the scale shows a pH above 7.
   (a) Explain why vinegar could be used to descale kettles.
   (b) Name the kind of reaction that would occur.

4. During manned flights in space rockets, carbon dioxide builds up in the air inside the cabin.
   Explain why the rockets also carry a supply of lithium hydroxide.

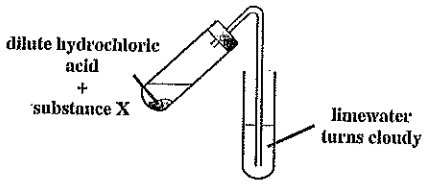
5. Name the salt that would be formed in the reaction between each of the following solutions.
   (a) potassium hydroxide and nitric acid
   (b) sodium hydroxide and sulphuric acid
   (c) lithium hydroxide and hydrochloric acid

6. Name the acid and the alkali that could be used to prepare solutions of each of the following salts.
   (a) sodium chloride
   (b) potassium sulphate
   (c) barium nitrate

7. (a) (i) Which gas is produced when a metal carbonate reacts with a dilute acid?
   (ii) Describe the test for this gas.
   (b) Name the products of each of the following reactions.
   (i) calcium carbonate and dilute sulphuric acid
   (ii) sodium carbonate and dilute nitric acid

8. Crystals of magnesium sulphate can be made by adding excess magnesium oxide to dilute sulphuric acid.
   (a) Name the kind of reaction which takes place.
   (b) What happens to the pH of the dilute acid as the crystals are added?
   (c) Describe how the excess magnesium oxide can be removed from the solution.
   (d) Write a balanced equation for the reaction taking place.

9. An experiment was carried out on a substance **X**.



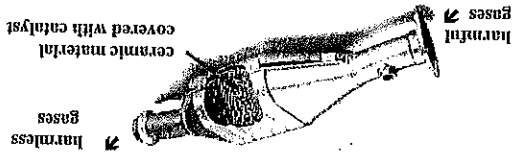
   (a) Which gas turns limewater cloudy?
   (b) From this experiment, what can be learned about **X**?

Catalysts

1. (a) What is meant by a catalyst?
   (b) (i) Does a catalyst take part in a reaction?
   (ii) Is the catalyst chemically changed in the reaction?
   (iii) Can the catalyst be recovered at the end of the reaction?

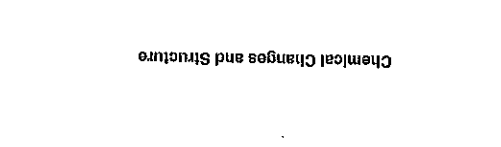
2. (a) What is meant by an enzyme?
   (b) Give an example of the use of an enzyme in everyday life.

3. Catalytic converters are fitted to the exhaust systems of cars.



   (a) Why do manufacturers fit a catalytic converter to car exhaust systems?
   (b) Suggest why the catalyst is spread over a large surface area.

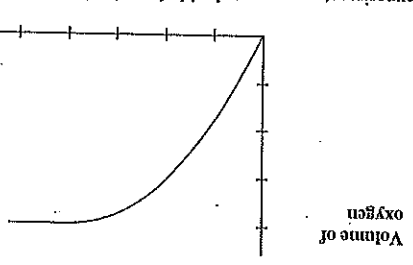
4. Reactions take place on the surface of a catalyst.
   A catalyst can be produced in pellets of different shapes.



   Explain which of the shapes **A**, **B**, **C** or **D** would be best for use as a catalyst.

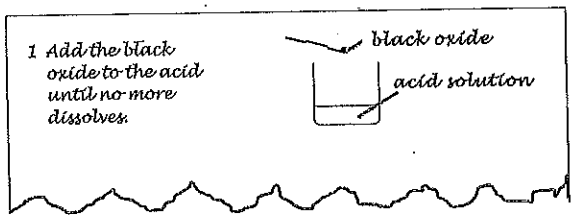
5. Catalysts are used in many industrial reactions.
   (a) Explain why catalysts are used in many industrial reactions.
   (b) In the chemical industry, give an example of the use of a catalyst.

6. Hydrogen peroxide solution decomposes to produce oxygen. The graph shows the volume of oxygen produced with time in one experiment.



   The experiment was repeated with the only change being the addition of 1 g of manganese dioxide, a catalyst for the reaction.
   (a) What mass of manganese dioxide will be left at the end of the second experiment?
   (b) Copy the graph and add a second curve to show the results that you would expect in the second experiment (label **X**).

17. The first step in the procedure to prepare crystals of copper(II) sulphate is shown.



(a) Name the black oxide and the acid solution.
(b) Name the type of chemical reaction that took place in the beaker.
(c) Write a balanced equation for the reaction.

18. A student used the instructions on a workcard.

Preparation of copper chloride crystals

Step 1 Add 25 cm^3 of dilute hydrochloric acid to a beaker.
Step 2 Add a spatulaful of copper carbonate powder to the acid and stir.
Step 3 Continue adding copper carbonate until some of the solid remains.
Step 4
Step 5

(a) Why did the student continue to add copper carbonate until some of solid remained?
(b) Name the **two** techniques that the student carried out in steps 4 and 5 to prepare a sample of copper chloride crystals.
(c) Write a balanced equation for the reaction.

19. Identify the two spectator ions in each of the following reactions.
(a) $Na^+(aq) + OH^-(aq) + H^+(aq) + Cl^-(aq) \rightarrow Na^+(aq) + Cl^-(aq) + H_2O(l)$
(b) $2K^+(aq) + CO_3^{2-}(aq) + 2H^+(aq) + 2NO_3^-(aq) \rightarrow 2K^+(aq) + 2NO_3^-(aq) + H_2O(l) + CO_2(g)$

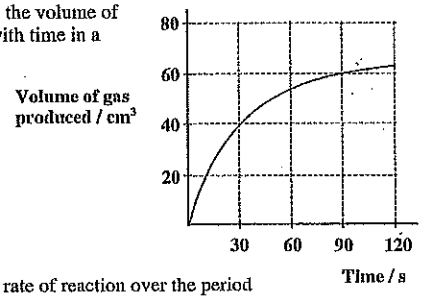
20. For each of the following reactions:
* identify the two spectator ions,
* remove the spectator ions to write the ion equation.
(a) $2KOH(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$
(b) $Na_2CO_3(aq) + 2HNO_3(aq) \rightarrow 2NaNO_3(aq) + CO_2(g) + H_2O(l)$

4. The table shows how the total mass of reactants varies with time in a chemical reaction.

Time /min	Mass of reactants /g
0	246.24
2	245.98
4	245.82
6	245.72
8	245.64
10	245.64
12	245.51

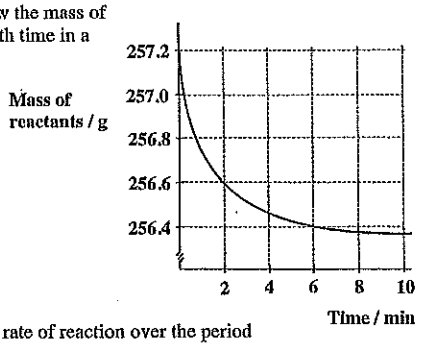
Calculate the average rate of reaction over the period
(a) 0 to 6 min,
(b) 6 to 12 min.

5. The graph shows how the volume of gas produced varies with time in a chemical reaction.



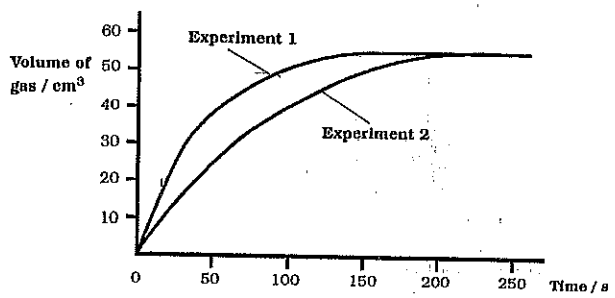
Calculate the average rate of reaction over the period
(a) 0 to 30 s,
(b) 30 s to 60 s.

6. The graph shows how the mass of reactants changes with time in a chemical reaction.



Calculate the average rate of reaction over the period
(a) 0 to 2 minutes,
(b) 2 to 6 minutes.

9. Mary was investigating the reaction of marble chips with excess dilute hydrochloric acid. Her results for two experiments are shown below.



(a) What volume of gas was produced in Experiment 1 during the first 90 s?

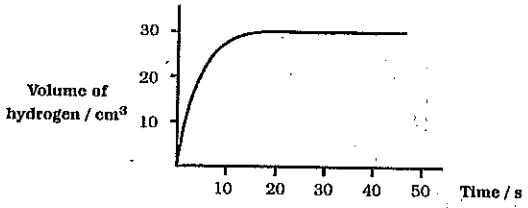
(b) In the initial stages, the reaction in Experiment 2 was slower than in Experiment 1.

(i) How can this be concluded from the graph?

(ii) Suggest two changes in conditions which could have resulted in the slower reaction.

(c) Mary used the same mass of marble chips in each experiment. How can this be concluded from the graph?

10. The graph shows the volume of hydrogen produced in the reaction of magnesium ribbon with excess dilute hydrochloric acid.



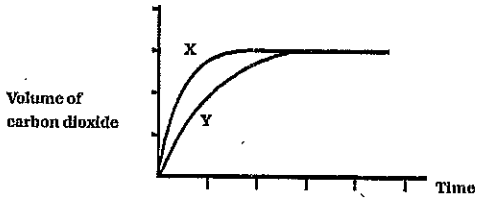
(a) State the volume of hydrogen which was produced after 10 s.

(b) State the time required to produce 20 cm^3 of hydrogen.

(c) State the total volume of hydrogen produced.

(d) Copy the graph and add a second curve to show the results that you would expect to obtain if the same mass of magnesium reacted with excess of more concentrated hydrochloric acid.

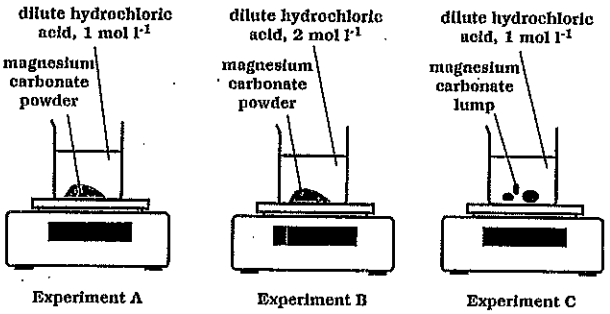
11. The graph shows the volume of carbon dioxide produced in the reaction of calcium carbonate powder and calcium carbonate lumps with excess dilute hydrochloric acid.



(a) Which curve, **X** or **Y**, shows the results using calcium carbonate powder?

(b) State **three** variables which must be kept the same when comparing the reactions.

12. Pauline was studying rates of reaction. She set up three experiments in which magnesium carbonate was added to equal volumes of dilute hydrochloric acid. In each experiment, some magnesium carbonate remained unreacted.



(a) Place the experiments in order of increasing reaction rate.

(b) Pauline noted the balance readings and found that, at the end of all the experiments, the readings showed a decrease in mass.

Why was the decrease in mass twice as much in Experiment **B** as in Experiment **A**?

Volumetric titrations

1. In an investigation to find the concentration of alkali in a water sample, a student carried out three titrations.

The following results were obtained.

Titration	Volume of acid used / cm^3
1	27.7
2	26.8
3	27.0

One of the titrations can be described as a **rough** titration.

(a) What is meant by the underlined word?

(b) How would the student know when to stop adding acid from the burette?

(c) What volume of acid would be used in the calculation to find the concentration of alkali?

2. The equation for the reaction between sodium hydroxide solution and dilute hydrochloric acid is:

$$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$$

In one titration, 25 cm^3 of sodium hydroxide solution (concentration 0.1 mol l^{-1}) was neutralised by 37.4 cm^3 of a dilute acid.

(a) Calculate the number of moles of sodium hydroxide used in the titration.

(b) Calculate the concentration of the dilute hydrochloric acid.

3. Vinegar is a dilute solution of ethanoic acid in water. A student carried out a titration, using 0.1 mol l^{-1} sodium hydroxide solution, to find out the concentration of ethanoic acid in some vinegar.
The average volume of sodium hydroxide solution that was used to neutralise 25 cm^3 of vinegar was 20 cm^3.
   (a) Calculate the number of moles of sodium hydroxide in this average volume.
   (b) **One** mole of ethanoic acid reacts with **one** mole of sodium hydroxide.
   Calculate the concentration of ethanoic acid, in mol l^{-1}, in the vinegar.

4. (a) $HCl\,(aq) + NaOH\,(aq) \rightarrow NaCl\,(aq) + H_2O\,(l)$
   What volume of hydrochloric acid (concentration 0.1 mol l^{-1}) is required to neutralise 50 cm^3 of sodium hydroxide solution (concentration 0.2 mol l^{-1})?
   (b) $H_2SO_4\,(aq) + 2KOH\,(aq) \rightarrow K_2SO_4\,(aq) + 2H_2O\,(l)$
   What is the concentration of sulphuric acid if 50 cm^3 neutralises 25 cm^3 of potassium hydroxide solution (concentration 1 mol l^{-1})?

5. (a) What is the concentration of hydrochloric acid if 12.6 cm^3 neutralises 20 cm^3 of potassium hydroxide solution (concentration 0.1 mol l^{-1})?
   (b) What volume of nitric acid (concentration 2 mol l^{-1}) is required to neutralise 20 cm^3 of sodium hydroxide solution (concentration 0.5 mol l^{-1})?
   (c) What is the concentration of sulphuric acid if 17.3 cm^3 neutralises 25 cm^3 of sodium hydroxide solution (concentration 0.5 mol l^{-1})?

6. A student wanted to prepare ammonium sulphate.
   0.5 mol l^{-1} sulphuric acid was added from a burette to 20 cm^3 of 0.5 mol l^{-1} ammonia solution in a conical flask with pH indicator.
   The equation for the reaction is:
   $2NH_3\,(aq) + H_2SO_4\,(aq) \rightarrow (NH_4)_2SO_4\,(aq)$
   (a) Calculate the volume of sulphuric acid that was used to neutralise the ammonia solution.
   (b) The indicator was removed from the ammonium sulphate solution by filtering the solution through charcoal.
   How would the student then obtain a sample of solid ammonium sulphate from the solution?

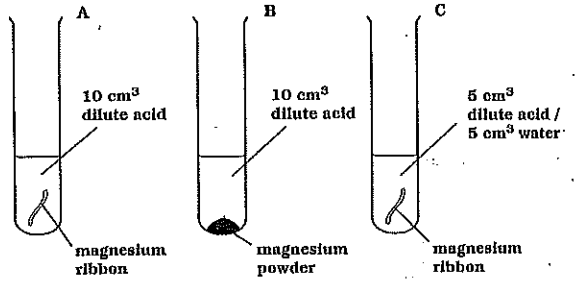
7. The concentration of dissolved calcium ions in hard water can be found by titration with an acid called EDTA, using a suitable indicator.
   One mole of calcium ions reacts with **one** mole of EDTA.
   In one titration 18.6 cm^3 of 0.12 mol l^{-1} EDTA reacted with 25.0 cm^3 of a water sample.
   Calculate the concentration of calcium ions, in mol l^{-1}, in the sample.

Exercise 1.4 Factors affecting reaction rate

1. List the following in order of rate of reaction, fastest first:
   milk turning sour, an egg frying, a motor car rusting, a match igniting

2. The speed of a reaction depends on the reaction conditions.
   Describe how each of the following affects the speed of a reaction.
   (a) particle size of the reactants
   (b) concentration of the reactants
   (c) temperature of the reactants
   (d) using a catalyst

3. Three experiments are set up as shown. Each experiment is carried out at room temperature and the mass of magnesium is the same in each case.

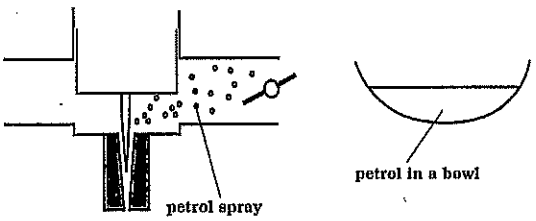


   (a) Explain any difference that would be observed between
      (i) A and B,
      (ii) A and C.
   (b) Explain any difference that would be observed if experiment A was repeated at 50 °C.

4. Natural gas will burn in a bunsen burner.
   (a) What happens to the temperature of the flame when the air hole is opened.
   (b) Explain your answer.

5. Different chemical reactions happen at different speeds.
   Give an example of an everyday reaction which
   (a) is finished after a few seconds,
   (b) takes between a few minutes and a few hours to be finished,
   (c) goes on for many years.

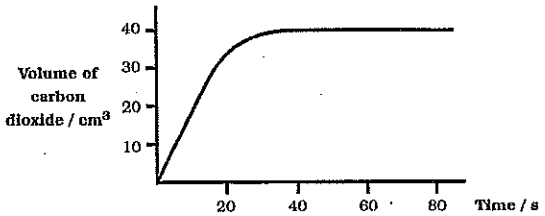
6. A jet of petrol is sprayed into the carburettor of a car.



   Explain why the spray of petrol burns faster than the petrol in the bowl.

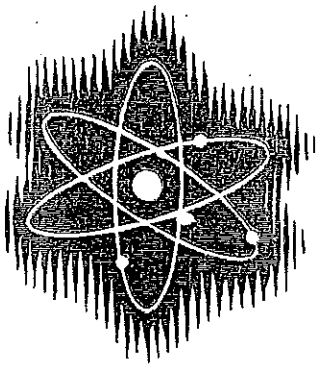
7. Explain each of the following.
   (a) Small sticks of wood burn faster than logs.
   (b) When bellows are used to blow air on to a fire, the fire burns brighter.
   (c) Food is preserved longer when stored in a fridge.
   (d) Plants grow faster in a green-house than in the open-air.
   (e) Large potatoes take longer to cook than small potatoes.
   (f) An oxy-acetylene flame is hot enough to cut through metal.
   The flame obtained by burning acetylene in air is not.

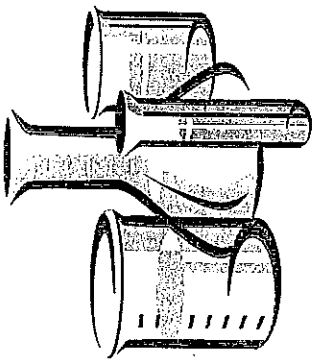
8. The graph shows the volume of carbon dioxide produced in the reaction of calcium carbonate powder with dilute hydrochloric acid.



   The experiment was repeated under two different conditions. For both reactions, the volume and concentration of the hydrochloric acid remained the same.
   (a) What would have happened to the volume of gas produced in the first 20 s when the temperature was increased?
   (b) What would have been the final volume of gas produced when the same mass of calcium carbonate lumps was used?

Chemical Changes and Structure Homework



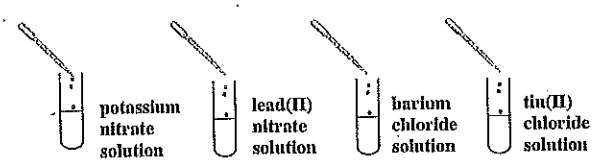


Precipitation

1. An insoluble product can be formed in the reaction between solutions.
   (a) Name this kind of reaction.
   (b) Identify the insoluble product in each of the following reactions.
      (i) potassium sulphate solution and barium nitrate solution
      (ii) calcium chloride solution and sodium carbonate solution
      (iii) potassium hydroxide solution and iron(III) nitrate solution
      (iv) lithium bromide solution and silver nitrate solution

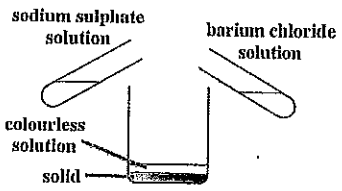
2. Barium carbonate has a solubility of less than 1 gl^{-1}.
   (a) From the following list of substances, select **two** that together could be use to make barium carbonate:
   barium, barium nitrate, magnesium carbonate, carbon, barium oxide, sodium carbonate
   (b) Describe in detail how you would use these two substances to prepare a dry sample of barium carbonate.

3. A class investigated the formation of precipitates.
   A few drops of sodium hydroxide solution were added to four other solutions.



   (a) What is meant by a precipitate?
   (b) Identify the solutions that will form a precipitate with sodium hydroxide solution.

4. Sodium sulphate solution and barium chloride solution were mixed as shown.



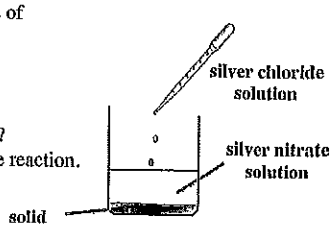
   (a) Name the white solid.
   (b) Name the technique which could be used to remove the white solid from the solution.

5. Magnesium ions can be removed from magnesium sulphate solution by adding sodium hydroxide solution.

$$Mg^{2+}(aq) + SO_4^{2-}(aq) + 2Na^+(aq) + 2OH^-(aq) \rightarrow Mg^{2+}(OH^-)_2(s) + 2Na^+(aq) + SO_4^{2-}(aq)$$

   (a) Name the type of reaction taking place between the magnesium sulphate solution and the sodium hydroxide solution.
   (b) Identify the spectator ions in the reaction.

6. When a student added a few drops of sodium chloride solution to silver nitrate solution, a solid formed at the bottom of the beaker.



   (a) What is the name of the solid?
   (b) Name the spectator ions in the reaction.