

JUNIOR LYCEUM ANNUAL EXAMINATIONS 2002

Educational Assessment Unit - Education Division

FORM 3

CHEMISTRY

TIME: 1hr 30 mins

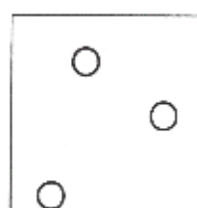
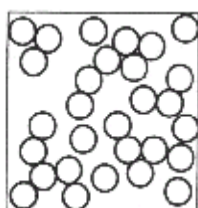
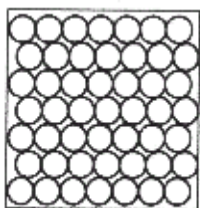
Name: _____

Class: _____

Useful Data: A copy of the Periodic Table is provided with this paper.
Relative atomic masses: Ca = 40, Fe=56, O =16

Section A: Answer All questions in this section, using the spaces provided.
This section carries 60 marks.

1. The diagrams below show the arrangement of particles in the three states of matter.



The kinetic theory of matter states that all substances contain particles that are **moving**.

By referring to the **arrangement** and/or the **movement** of the particles, explain why:

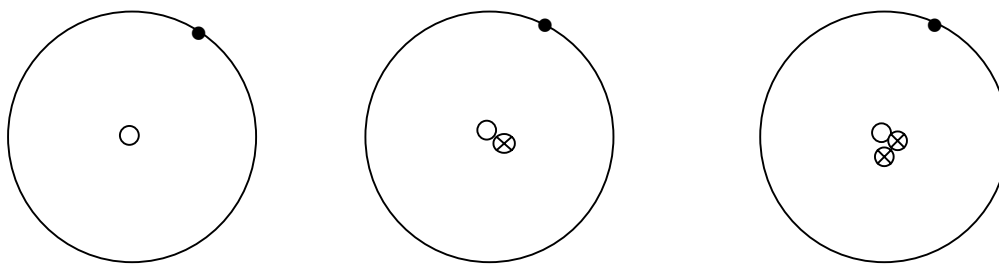
- a) liquids and gases can flow while solids do not flow,

- b) gases can be compressed but solids are usually not compressible,

- c) gases diffuse faster than liquids.

(5 marks)

2. Hydrogen has three **isotopes**: hydrogen ${}^1_1\text{H}$, deuterium, ${}^2_1\text{H}$ and tritium ${}^3_1\text{H}$. Their structures are shown below.



- a) Explain the meaning of the term **isotopes**.

 _____ (2 marks)

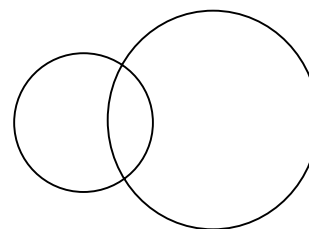
- b) The symbols $\bullet$, $\circ$, and $\otimes$ represent different sub-atomic particles.

Complete: The symbol $\bullet$ represents _____
 The symbol $\circ$ represents _____
 The symbol $\otimes$ represents _____ (3 marks)

- c) The average mass number (relative atomic mass) of naturally occurring hydrogen is 1.008. Tick the isotope which is present in the highest proportion?

${}^1_1\text{H}$ ☐ ${}^2_1\text{H}$ ☐ ${}^3_1\text{H}$ ☐ (1 mark)

- d) Hydrogen combines with chlorine (atomic number 17) to form the covalent compound hydrogen chloride.
 Show the bonding in hydrogen chloride by filling in the outer shell electrons in the diagram opposite.



(2 marks)

- e) Since hydrogen burns in oxygen it can be used as a fuel.

Give one advantage and one disadvantage of using hydrogen as a fuel.

advantage: _____

disadvantage: _____ (2 marks)

3. Magnesium has a **mass number** of 24 and an **atomic number** of 12.

These may be written as $^{24}_{12}\text{Mg}$.

- a) i) What does the term **mass number** stand for?

- ii) What does the term **atomic number** stand for?

(2 marks)

- b) Metal atoms form ions by loss of electrons.

- i) Give the electron configuration for a Magnesium **atom**. _____

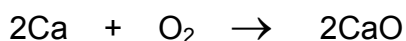
- ii) Draw a diagram to show the electron arrangement of a magnesium **ion**.
Also give the **charge** on the ion.

(3 marks)

- iii) Give **two** properties of **ionic** compounds.

(2 marks)

- c) 4.0g of calcium metal reacted with oxygen according to the following equation.



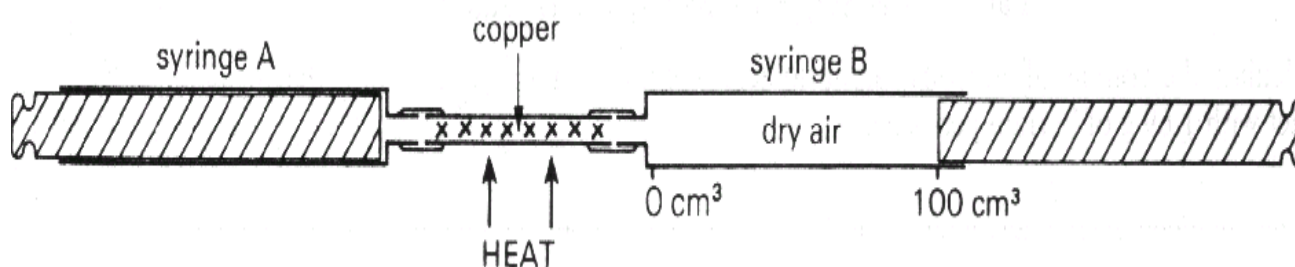
- i) Calculate the number of moles of atoms in 4.0g of calcium.

(1 mark)

- ii) Calculate the mass of calcium oxide that is formed.

(2 marks)

4. Two gas syringes are connected as shown in the diagram below and the copper is heated strongly. By moving the plunger of the syringes in and out, the air is passed over the hot copper until no further change in volume takes place. The apparatus is then allowed to cool to the original temperature before a final reading of the gas volume is taken.



- a) i) Why is the apparatus allowed to cool before the final volume is read?

 ii) What would be the approximate **final** volume of gas in the syringe?
 _____ (2 marks)
- b) i) Which gas is removed from the air by the hot copper?
 _____ (1 mark)
 ii) How would the surface of the copper change in appearance?
 before _____ after _____ (2 marks)
 iii) Write a balanced equation for the reaction that occurs.
 _____ (2 marks)
- c) Name:
 i) the main residual gas in the syringe _____
 ii) any other gas remaining in the syringe _____ (2 marks)

5. Read the following passage, then answer the questions that follow.

Normally nitrogen is not very reactive, however at high temperatures (as in a car engine) nitrogen reacts with oxygen. So the exhaust fumes of vehicles emit oxides of nitrogen, e.g. nitrogen monoxide and nitrogen dioxide which contributes to the formation of acid rain. The hydrocarbons (unburnt petrol) in exhaust fumes, together with nitrogen dioxide, give a harmful form of ozone known as 'photochemical smog'. On the other hand, ozone in the upper atmosphere is important.

- a) i) What **type** of oxide is nitrogen monoxide?
 _____ (1 mark)
 ii) Write a balanced formula equation for the following word equation.
 nitrogen + oxygen $\rightarrow$ nitrogen monoxide
 _____ (2 marks)
- b) i) Suggest why ozone in the lower atmosphere is harmful.
 _____ (1 mark)
 ii) Why is ozone in the upper atmosphere important?
 _____ (1 mark)

- c) i) Give a reason why nitrogen dioxide contributes to the formation of acid rain. _____ (1 mark)
- ii) Give one way to avoid nitrogen dioxide being released in car exhaust fumes.
_____ (1 mark)

- d) Oxygen and ozone are examples of **allotropes**.
- i) Explain the meaning of the term **allotropes**.

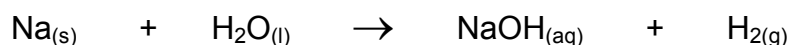
_____ (2 marks)
- ii) Which of these allotropes is more stable?
_____ (1 mark)

6. a) What is seen when soap is added to hard water?
_____ (1 mark)

- b) Give the name and formula of a substance that causes
- i) temporary hardness: name _____
formula _____
- ii) permanent hardness: name _____
formula _____ (4 marks)

- c) State a method which removes
- i) temporary hardness only _____
- ii) both temporary and permanent hardness _____ (2 marks)

- d) The reaction between sodium and water may be represented by the following unbalanced equation.



- i) Balance the equation. (1 mark)
- ii) Write down the meaning of the small symbols in brackets.

(s) _____ (aq) _____

(l) _____ (g) _____ (2 marks)

7. a) The colour of universal indicator can be matched with a pH scale. The colour can match with a pH of **less** than 7 (in acids), a pH of **greater** than 7 (in alkalis) and with a pH of **exactly** 7 (in neutral solution).

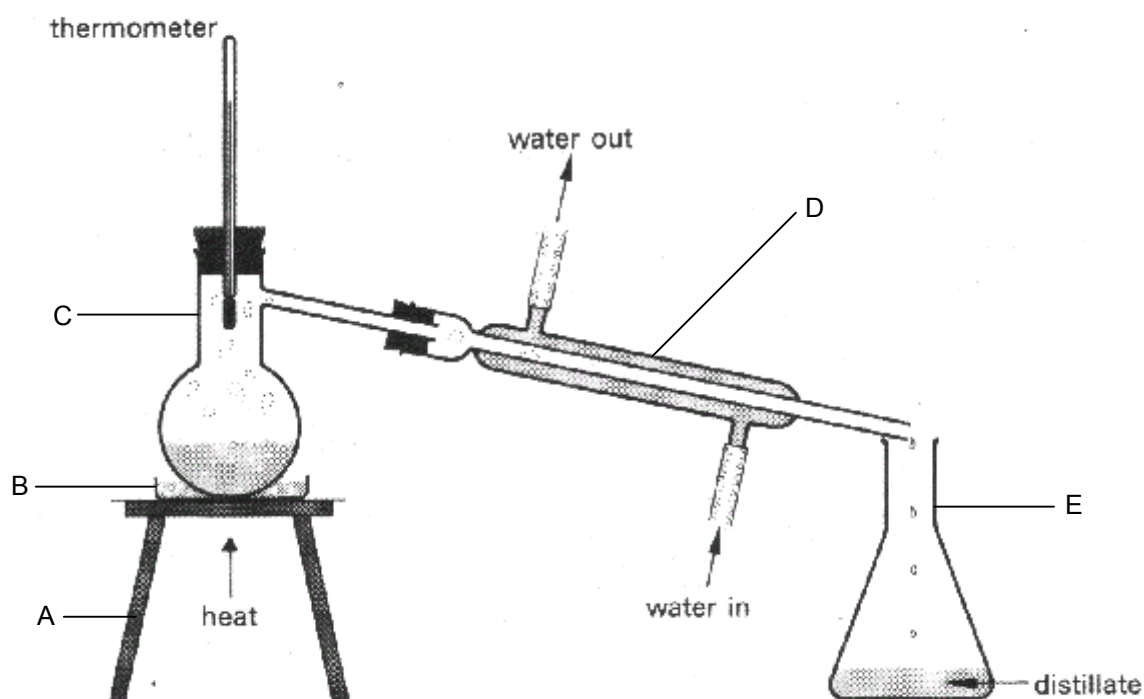
Complete the results for the solutions below.

- i) $\text{NH}_4\text{OH}_{(aq)}$ will give a pH of _____ 7.
- ii) $\text{KCl}_{(aq)}$ will give a pH of _____ 7.
- iii) $\text{HCl}_{(aq)}$ will give a pH of _____ 7. (3 marks)

- b) Give the name of **one** other indicator and state its colour when added to an acidic or alkaline solution.
- name of indicator _____
- colour in acid _____
- colour in alkali _____ (3 marks)

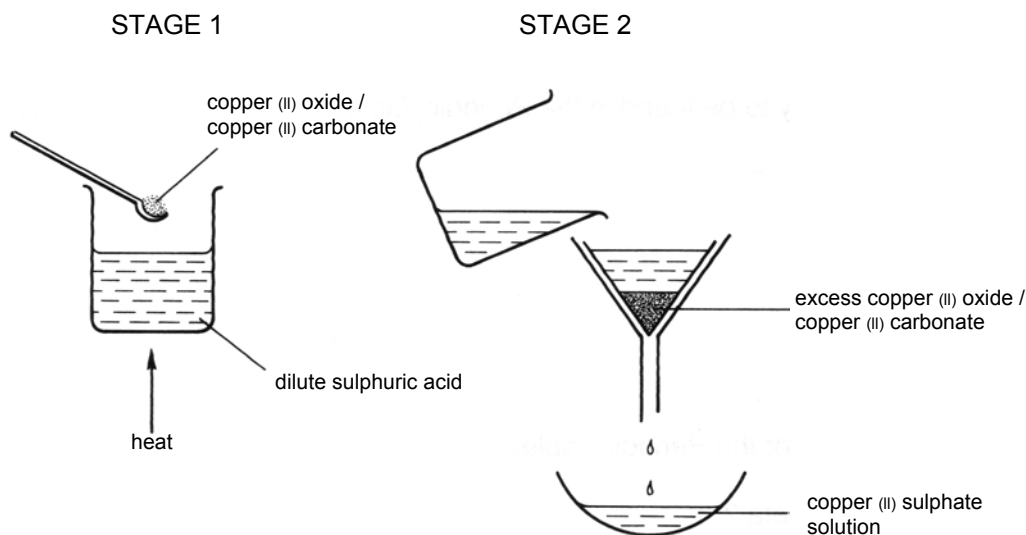
Section B: Answer any TWO questions from this section on the separate sheets provided. Each question carries 20 marks.

8. a) In the laboratory it is sometimes necessary to separate a mixture of two immiscible liquids, for example oil and water.
- What does the term 'immiscible' mean?
 - Draw a clear, well labelled diagram of the apparatus and briefly describe the practical steps involved in this separation. (8 marks)
- b) In the laboratory, you can obtain a sample of pure water from some impure water using the apparatus shown below.



- Write the names of the parts of the apparatus labelled A to E.
 - Explain what happens in the apparatus labelled C and D. (9 marks)
- c) i) How would you use anhydrous copper sulphate to show the presence of water in the impure water.
- How would you prove that the distillate obtained in (b) is pure water. (3 marks)

9. This question is about the preparation of a salt.
The diagrams below show the stages in preparing a sample of copper (II) sulphate **solution** by reacting an excess of an insoluble base, or a carbonate with dilute sulphuric acid.



- a) Write a description of the **practical steps** involved in carrying out stage 1 and stage 2 shown above. Include the **names of the apparatus** and any **general terms** that are used to describe the substances shown in the diagrams. (11 marks)
- b) In order to obtain pure, dry, blue crystals of hydrated copper (II) sulphate ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$) it will be necessary to carry out stage 3 – crystallisation. Draw a clear, well labelled diagram of the apparatus required for stage 3. (5 marks)
- c) Give balanced equations for the reactions of :
i) copper (II) oxide with sulphuric acid,
ii) copper (II) carbonate with sulphuric acid. (4 marks)

10. The passage below describes one method of finding the empirical formula of a metal oxide.

An oxide of iron was weighed in a porcelain boat and placed in a combustion tube. The iron oxide was then heated in a stream of dry hydrogen gas to obtain iron. The boat with the iron in it was allowed to cool **with the hydrogen still passing over it** and it was then weighed. The boat and metal was **reheated in hydrogen**, cooled and **reweighed**.

- a) i) Name a metal and an acid that would be suitable for preparing the stream of hydrogen gas. Give a balanced equation for the reaction.
ii) Name a suitable drying agent for hydrogen gas and give the name of the apparatus in which the drying agent is placed. (6 marks)
- b) Suggest reasons why;
i) hydrogen was still passed over the boat + metal while it was cooling.
ii) the boat + iron was reheated in hydrogen and reweighed. (4 marks)
- c) The results obtained were as follows.
mass of porcelain boat = 5.4g
mass of boat + iron oxide = 7.0g
mass of boat + iron = 6.52g
- i) Find the mass of iron left and use it to calculate the number of moles of iron atoms present in the iron oxide. (3 marks)
ii) Find the mass of oxygen that was combined with iron and use it to calculate the number of moles of oxygen atoms present. (3 marks)
iii) Use your answers to (i) and (ii) to find the empirical formula of the oxide of iron. (2 marks)
iv) What is an empirical formula? (2 marks)

END