

# JUNIOR LYCEUM ANNUAL EXAMINATIONS 2002

Educational Assessment Unit - Education Division

**FORM 4**

**CHEMISTRY**

**TIME: 1hr 30 mins**

Name: \_\_\_\_\_

Class: \_\_\_\_\_

Useful Data: A copy of the Periodic Table is provided with this paper.  
Relative atomic masses : Na = 23  
One Faraday (one mole of electrons) = 96500 coulombs.  
 $Q = It$

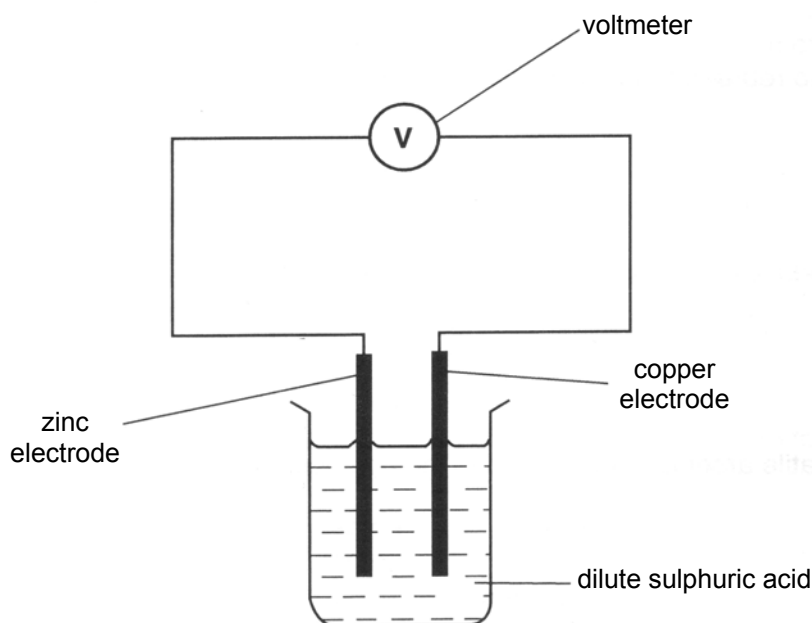
**Section A:** Answer **All** questions in this Section, using the spaces provided.  
This section carries 60 marks.

1. Elements in the same Group of the Periodic Table show a *similarity* in *physical* and *chemical* properties. The elements also show a *trend* in *reactivity*.

Barium is in Group 2 of the Periodic Table. Use your knowledge of the Group 2 metals (e.g. Mg, Ca) to answer the following questions about Barium.

- (a) (i) What is the number of electrons in the outer shell of a barium atom? \_\_\_\_\_  
(ii) Write down the formula for the barium ion. \_\_\_\_\_ (2 marks)
- (b) Predict **one** physical property that you would expect barium to show.  
\_\_\_\_\_ (1 mark)
- (c) How would you expect barium to be extracted from its compounds?  
\_\_\_\_\_ (1 mark)
- (d) (i) State one thing you would expect to **see** when barium is added either to water, or to dilute hydrochloric acid.  
\_\_\_\_\_ (1 mark)
- (ii) Give a balanced equation for the reaction of barium -  
with water,  
\_\_\_\_\_  
with dilute hydrochloric acid.  
\_\_\_\_\_ (4 marks)
- (e) Would you expect barium to be more, or less reactive, than magnesium and calcium? \_\_\_\_\_ (1 mark)

2. A simple cell changes chemical energy into electrical energy.  
The cell contains two metallic electrodes in an electrolyte as shown in the diagram.

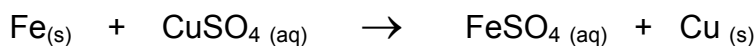


- (a) The more reactive metal reacts with the acid and goes into solution as ions.
- (i) Which is the more reactive metal in the cell? \_\_\_\_\_
- (ii) Give an **ionic half equation** to show the more reactive metal forming ions.  
\_\_\_\_\_  
(3 marks)
- (b) Charged particles move in the outer circuit to the less reactive metal where a gas is formed.
- (i) Name the particles that move through the outer circuit. \_\_\_\_\_
- (ii) Name the gas formed. \_\_\_\_\_ (2 marks)
- (c) A graphite rod could be used instead of the copper electrode.  
Give a reason why this is possible.  
\_\_\_\_\_  
(1 mark)
- (d) State whether the voltage of the cell would increase, decrease, or stay the same if the zinc electrode was replaced by an iron electrode. Give a reason for your answer. \_\_\_\_\_  
\_\_\_\_\_  
(2 marks)

3. In a series of experiments investigating the *displacement* of a metal from a solution of its salt by another metal, the following table of results was obtained.

<b>metal \ solution</b>	copper (II) sulphate $\text{CuSO}_4$	nitrate of (X) $\text{XNO}_3$	magnesium sulphate $\text{MgSO}_4$	nitrate of (Y) $\text{Y(NO}_3)_2$
copper Cu		shiny grey precipitate formed	no reaction	no reaction
metal (X)	no reaction		no reaction	no reaction
magnesium Mg	brown precipitate formed	shiny grey precipitate formed		grey precipitate formed
metal (Y)	brown precipitate formed	shiny grey precipitate formed	no reaction	

- (a) From these experiments list the metals copper, metal (X), magnesium and metal (Y) in order of *decreasing* chemical reactivity.  
\_\_\_\_\_ (2 marks)
- (b) Suggest the **name** of **either** metal (X), **or** metal (Y).  
\_\_\_\_\_ (1 mark)
- (c) Predict if a reaction would take place or not when -  
 (i) metal (X) is added to dilute hydrochloric acid \_\_\_\_\_,  
 (ii) metal (Y) is heated with steam \_\_\_\_\_. (2 marks)
- (d) Displacement reactions are also redox reactions. The equation for the reaction of iron with copper(II) sulphate solution is:



- (i) write an **ionic** equation for this reaction (omitting spectator ions);  
\_\_\_\_\_ (2 marks)
- (ii) write the **ionic half equations** for this reaction and use them to explain why this is a redox reaction.  
\_\_\_\_\_  
\_\_\_\_\_ (3 marks)

4. The questions below refer to the action of heat on the elements copper and sulphur, as well as on the compounds copper (II) carbonate and anhydrous sodium carbonate.
- (a) A piece of copper foil is heated directly in a Bunsen flame.
- (i) Describe the *change* that is *seen*.  
 \_\_\_\_\_ (1 mark)
- (ii) Give a balanced equation for the reaction.  
 \_\_\_\_\_ (2 marks)
- (b) A combustion spoon containing a little solid sulphur is *strongly* heated over a Bunsen flame in a fume cupboard.
- (i) Why was the sulphur heated in a fume cupboard?  
 \_\_\_\_\_ (1 mark)
- (ii) Describe one change that is *seen* on heating the sulphur strongly.  
 \_\_\_\_\_ (1 mark)
- (iii) Write an equation for the reaction.  
 \_\_\_\_\_ (1 mark)
- (c) When a sample of anhydrous sodium carbonate is heated, it remains unchanged and no gas is liberated. On the other hand on heating copper (II) carbonate it changes from green to black and liberates carbon dioxide.
- (i) What term is used to describe solids like anhydrous sodium carbonate which is not affected by heating? \_\_\_\_\_ (1 mark)
- (ii) Why does copper (II) carbonate change from green to black?  
 \_\_\_\_\_ (1 mark)
- (iii) Give an equation for the decomposition of copper (II) carbonate.  
 \_\_\_\_\_ (2 marks)
5. Complete the following table to give a chemical test to show the presence of each ion and the result obtained.

Ion	Test / Reagent(s) used	Result / Observation (showing positive test)
$\text{NH}_4^+$		
$\text{CO}_3^{2-}$		
$\text{Fe}^{3+}$		
$\text{Br}^-$		

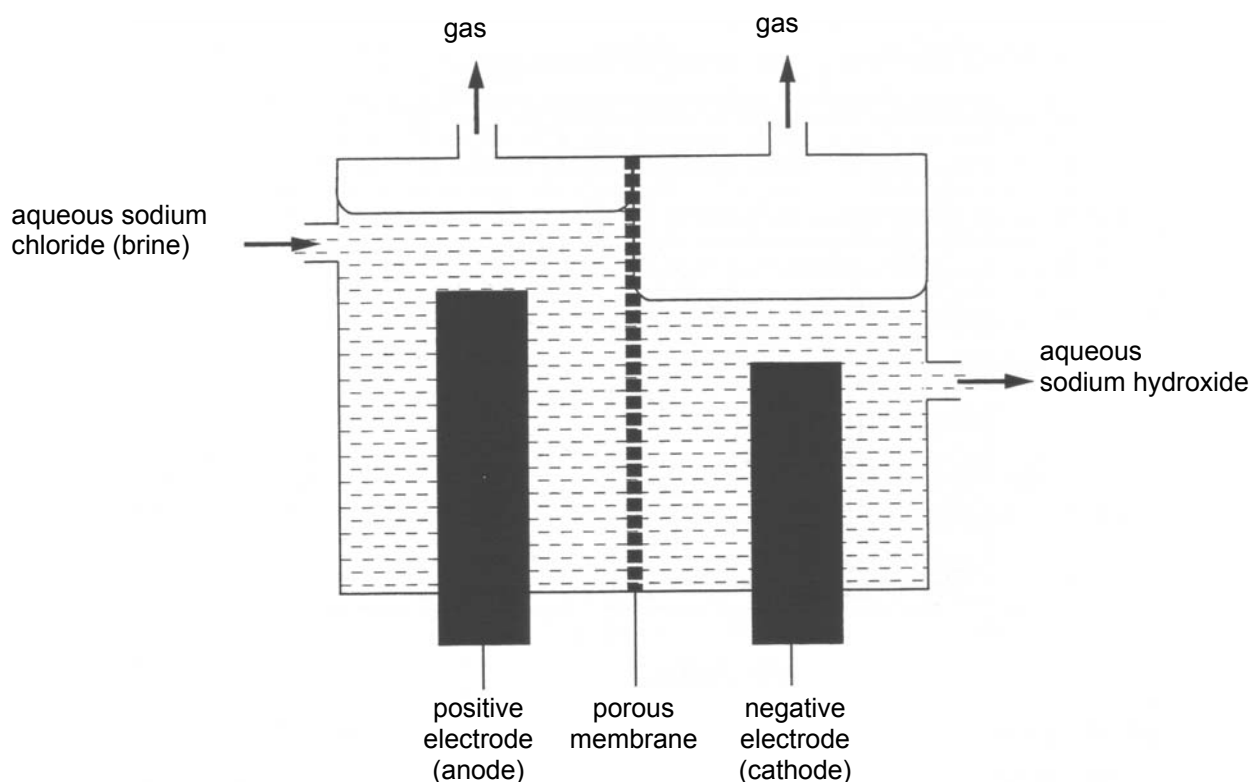
(8 marks)

6. Sulphuric acid is manufactured by the Contact Process.  
In this process sulphur trioxide is formed by passing sulphur dioxide and oxygen over a heated catalyst.
- (a) Give the **names** of the *raw materials* which are used as a source of:  
(i) sulphur dioxide \_\_\_\_\_ (ii) oxygen \_\_\_\_\_ (2 marks)
- (b) What is meant by the term 'catalyst'?  
\_\_\_\_\_  
\_\_\_\_\_ (2 marks)
- (c) Write an equation for the reaction of sulphur dioxide with oxygen.  
\_\_\_\_\_ (2 marks)
- (d) The sulphur trioxide cannot be converted to sulphuric acid by dissolving it directly in water.  
(i) Give a reason why this cannot be done.  
\_\_\_\_\_  
(ii) What is the sulphur trioxide actually dissolved in?  
\_\_\_\_\_ (2 marks)
- (e) Give *two large scale* uses of sulphuric acid.  
\_\_\_\_\_ (2 marks)
7. (a) Use the simple kinetic particle theory to explain:  
(i) what causes the pressure inside a car tyre;  
\_\_\_\_\_  
(ii) why there is an increased pressure if the tyre becomes warmer.  
\_\_\_\_\_ (2 marks)
- (b) If a gas occupies  $11.2\text{dm}^3$  at  $0^\circ\text{C}$  and 2 atm. pressure, what volume would it occupy at s.t.p?

(2 marks)

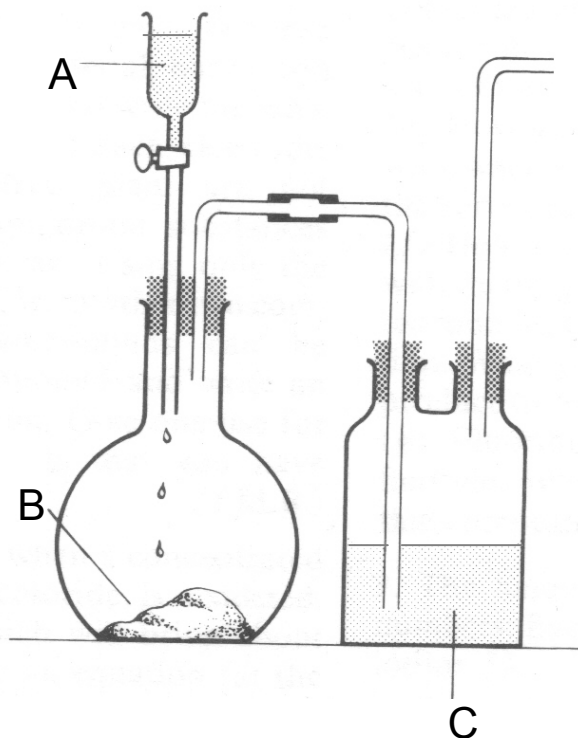
**Section B:** Answer any TWO questions from this section on the separate sheets provided. Each question carries 20 marks.

8. Sodium hydroxide is manufactured by the electrolysis of brine (a concentrated solution of sodium chloride). Two gases are also obtained as by-products. The diagram below shows the cell used in one of the processes to manufacture sodium hydroxide.



- (a) Describe the principle of the process. Your answer should include.
- (i) the formulae of **all** the ions present in solution; (2 marks)
  - (ii) the **name** of the **ions** discharged at the anode and cathode, and the reasons for their preferential discharge; (4 marks)
  - (iii) the ionic half equations for the reactions at the electrodes. (4 marks)
- (b) Suggest a reason for the porous membrane. (1 mark)
- (c) Give **one** use for sodium hydroxide and **one** use for **each** of the by-products. (3 marks)
- (d) Molten sodium chloride can also be electrolysed using inert electrodes in an inert atmosphere. This is used to extract sodium.
- (i) If a current of 5 amperes flows for 10 minutes, calculate the electrical charge in coulombs and convert the answer into Faradays.
  - (ii) Write the ionic half equation for the discharge of sodium ions and use it to calculate the mass of sodium that would be deposited. (6 marks)

9. A sample of pure, **dry** hydrogen chloride gas can be prepared in the laboratory by the reaction of an acid with a metal chloride.  
The diagram below shows part the apparatus set up.



- (a) (i) Give the **names** of the reagents labelled A and B, and the name of the drying agent labelled C. (3 marks)
- (ii) State what is **seen** when the reagents are mixed and write an equation for the reaction. (2 marks)
- (b) (i) Draw a diagram to show how the gas would be collected **in a gas jar**. (3 marks)
- (ii) What name is given to this method of collection? (1 mark)
- (iii) What makes it possible to collect the gas in this way? (1 mark)
- (c) Describe what change you would see (if any) and explain the result when:
- (i) **dry** hydrogen chloride is tested with **dry** blue litmus; (2 marks)
- (ii) hydrogen chloride gas is mixed with ammonia gas. (2 marks)
- (d) (i) Hydrogen chloride gas is very soluble in water. Draw a labelled diagram to show how hydrogen chloride gas could be safely dissolved in water. (No description is required.) (4 marks)
- (ii) Describe and explain what would be seen if a sample of the solution formed in (d)(i) is added to blue litmus. (2 marks)

10. A solution of hydrochloric acid was titrated against a standard solution of sodium carbonate of molar concentration  $0.1 \text{ mol dm}^{-3}$  (0.1M) using a suitable indicator.

- (a) For this titration procedure, give:
- (i) a labelled diagram of the titration set up; (3 marks)
  - (ii) the names of the **three main** items of apparatus; (3 marks)
  - (iii) the name of a suitable indicator and its colour change at the end point; (3 marks)
  - (iv) three precautions or practical steps which must be taken to obtain accurate titre values. (3 marks)

- (b) It was found that  $25\text{cm}^3$  of the standard sodium carbonate solution was exactly neutralised by  $30\text{cm}^3$  of the hydrochloric acid solution.

The equation for the reaction is:



- (i) Calculate the number of moles in  $25\text{cm}^3$  of the sodium carbonate solution. (3 marks)
- (ii) Use the acid : carbonate **mole ratio** of the equation to find the number of moles of hydrochloric acid that must have reacted. (2 marks)
- (iii) Use your answer to part (ii) to find the Molarity of the hydrochloric acid solution. (3 marks)

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End