Name:		Index Number:		Class:	

CATHOLIC HIGH SCHOOL
Preliminary Examination
Secondary 4 (O-Level Programme)

B

CHEMISTRY

6092/02

Paper 2

15 September 2020
1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Section B
Answer all **three** questions, the last question is in the form either/or.
Answer **all** questions in the spaces provided.

For examiner's use only:

Question	Marks
B9	/12
B10	/8
B11 Either/Or	/10
Total	/30

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **10** printed pages.

[Turn over

Section B

Answer all **three** questions in this section.

The last question is in the form of an either/or and only one of the alternatives should be attempted.

B9 Extraction of metals

The order of steps involved in the extraction of metals from their ores and their subsequent purification are:

1. Crushing
2. Concentration of the ore
3. Roasting of the ore
4. Reduction of metal oxides to metal
5. Purification and refining of metal

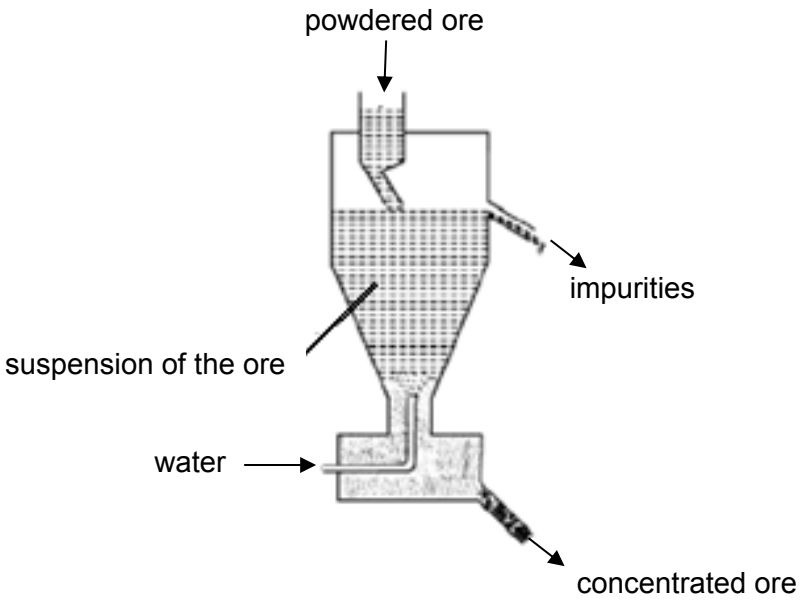
1. Crushing

The ore is generally obtained as big rock pieces. These big rock pieces are crushed to smaller pieces by using jaw crushers and grinders. The crushed pieces are then powdered in a mill.

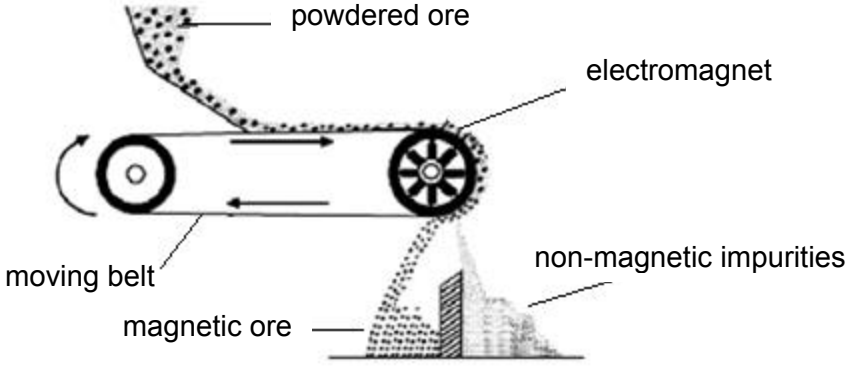
2. Concentration of the ore

At this stage, the powder is a mixture of ore and impurities like sand, clay and limestone. There are several methods for concentrating the ores.

- Gravity separation: In this method, the lighter impurities are removed from heavier metallic ore particles by washing the powdered ore with a strong current of water. The heavier ore particles settle down rapidly and the lighter impurities are washed away.



- Electromagnetic separation: In this method, a moving belt moves the ore across two rollers, one of which is magnetic. Powdered ore is first dropped on the belt above the non-magnetic roller. When the particles arrive at the other end where the magnetic roller is, ore particles that are magnetic remain attracted to the magnetic roller while non-magnetic impurities fall off the belt by gravity. Each portion thus accumulates at a different position underneath the moving belt.



3. Roasting of the ore

Roasting involves the heating of an ore at a temperature that is below its melting point in excess air. This removes water, volatile and non-volatile impurities.

4. Reduction of metal oxides to metal

The roasted ore is mixed with coke and heated to a high temperature above its melting point in a blast furnace. An additional reagent called flux is added to the ore to remove impurities still present in the ore. Flux combines with the impurities to form slag.

5. Purification and refining of metal

The metal obtained after step 4 is usually still impure. The impure metal is subjected to further refining in one of two ways.

- Fractional crystallisation: The impure metal is melted and then left to cool. The pure metal crystallises out while the impurities remain in the melt. Extremely pure metals can be obtained in this way.

- Reduction: Freshly cut tree trunks are added to the molten impure metal. The heat from the molten metal causes the tree trunks to liberate methane which reduces metal oxide to pure metal.

(a) Suggest why crushing the ore into powder is essential in the extraction of a metal from its ore.

_____

_____ [1]

(b) The table below gives some properties of some metal ores.

	density/ g/cm^3	magnetic?	element, compound or mixture?
haematite	5.3	no	
magnetite	5.2	yes	
pyrolusite	5.0	yes	

(i) Fill the blanks in the table above. [1]

(ii) Give the chemical formula of the iron compound in haematite.

..... [1]

(iii) Suggest why there is a need for more than one method to concentrate various ores in step 2.

.....

..... [2]

(c) **(i)** Give a balanced chemical equation to show how roasting produces an oxide of iron from an ore containing $Fe_2O_3 \cdot xH_2O$.

..... [1]

(ii) During roasting, sulfide ores are also roasted to the metal oxides as metal oxides can be reduced to metal more easily than sulfides.

$$2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$$

$$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$$

Describe one harmful effect of roasting on the environment.

.....

..... [1]

(d) The selection of flux depends upon the nature of impurities found in the ore.
If impurities are acidic, a basic flux is used. If impurities are basic, an acidic flux is used.

(i) Common impurities found in haematite are phosphorus(V) oxide, P_4O_{10} and silicon dioxide, SiO_2.

Name a suitable substance that can be used as flux to remove these two impurities.

---- [1]

(ii) Write a chemical equation to show how the substance named in **(d)(i)** can be combined with phosphorus(V) oxide, P_4O_{10} to form a slag that contains a phosphate salt.

---- [1]

(e) Fractional crystallisation is used to obtain a metal while crystallisation is used to obtain the salt of a metal such as copper(II) sulfate.

Give a similarity and another difference between fractional crystallisation and crystallisation.

similarity:

difference:

[2]

(f) Methane can be used to refine copper containing copper(I) oxide impurities.

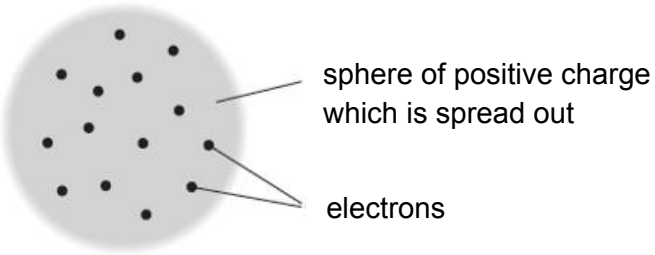
$$3Cu_2O + CH_4 \rightarrow 6Cu + 2H_2O + CO$$

Suggest a disadvantage of using methane over hydrogen in this reduction process.

[1]

[Total: 12]

B10 In 1904, J. J. Thomson suggested a model of the atom. He called this the 'plum pudding' model. This model of an atom, containing 14 electrons, is shown below.



(a) Describe how Thomson's model of the atom differs from our present structure of an atom.

difference 1: _____

_____

difference 2: _____

_____

difference 3: _____

_____ [3]

(b) Potassium has two naturally-occurring isotopes. These can be written as:

$^{39}_{19}K$ and $^{41}_{19}K$

Describe the difference between these isotopes.

_____

_____ [1]

(c) Potassium is in Group I of the Periodic Table.

(i) State a physical property unique to Group I metals.

_____ [1]

(ii) State the trend of melting point and atomic radius down Group I.

melting point: _____

atomic radius: _____ [1]

(iii) Potassium reacts with water. An alkaline solution and a colourless gas are formed.

Estimate the pH of the alkaline solution and write the chemical equation for this reaction.

pH of alkaline solution: _____

chemical equation: _____ [2]

[Total: 8]

EITHER

B11 This question is about making salts.

(a) For each salt, suggest the name of the missing reagent and briefly describe how to obtain a pure sample of the salt from the reaction mixture.

(i) Salt to be made: lithium chloride

reagent 1: dilute hydrochloric acid

reagent 2: .....

I could obtain solid lithium chloride by: .....

..... [2]

(ii) Salt to be made: zinc sulfate

reagent 1: dilute sulfuric acid

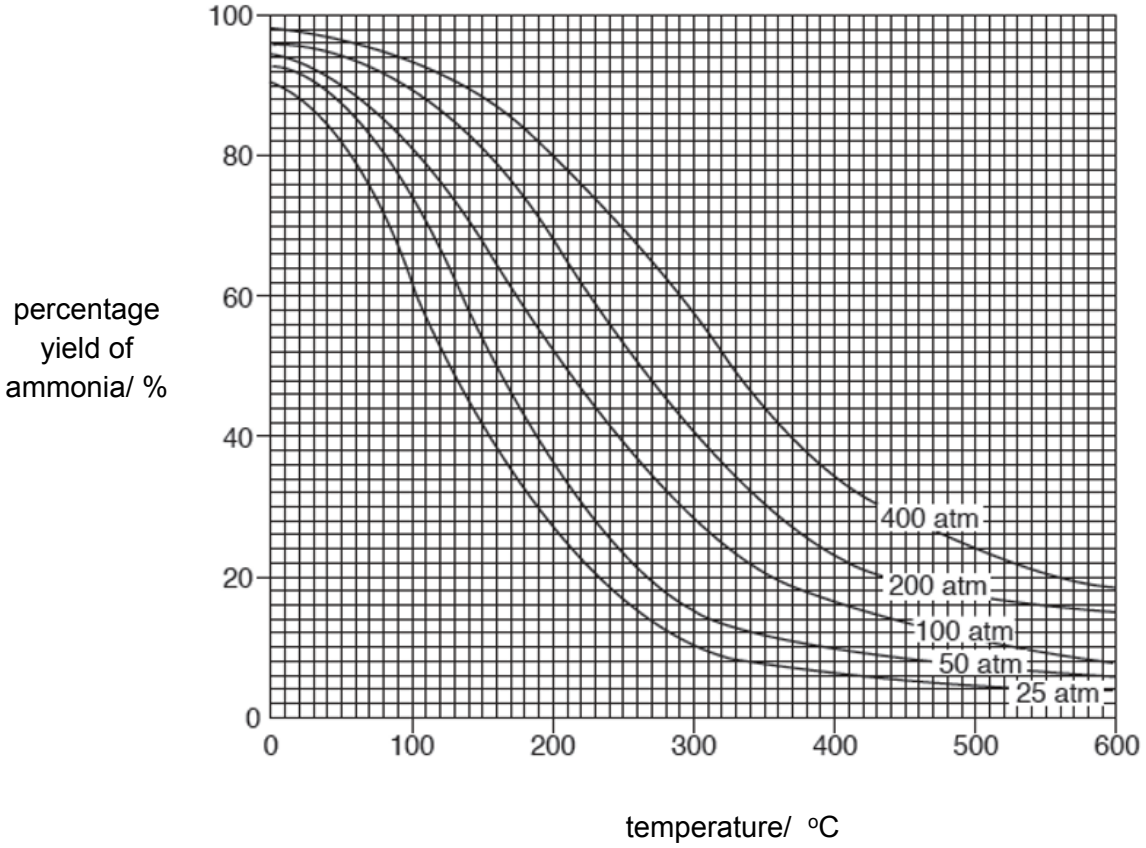
reagent 2: .....

I could obtain solid zinc sulfate by: .....

..... [2]

(b) Ammonia is manufactured by the Haber process.

The graph below gives information about the percentage yield of ammonia at different temperatures and pressures.



(i) Determine the percentage yield of ammonia at the normal working temperature and pressure used in the Haber process.

---------- [1]

(ii) A student claimed that increasing the pressure beyond 400 atm at 0 °C will give a 100% yield of ammonia.

Do you agree with the student's claim? Explain.

---------- [2]

(c) Ammonia is used to manufacture nitrogenous fertilisers such as ammonium sulfate.

Ammonium sulfate can be made by reacting aqueous ammonia with dilute sulfuric acid.

$$2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$$

Calculate the mass of ammonium sulfate that can be made from 72 dm^3 of ammonia gas at room temperature and pressure.

[3]

[Total: 10]

OR

B11 Nickel is a transition metal which exhibits oxidation states of −1, 0, +1, +2, +3 and +4 in its compounds.

(a) State the chemical formula of the substance in which nickel exhibits oxidation state of 0.

_____ [1]

(b) Other than exhibiting variable oxidation states, give **two other** characteristics of transition metals.

characteristic 1: _____

characteristic 2: _____ [2]

(c) **(i)** Write an ionic equation for the reaction of nickel(II) chloride and sodium hydroxide.

_____ [1]

(ii) Two bottle labels for nickel(I) chloride and nickel(II) chloride were mixed up. A student wanted to identify the bottles. He did an experiment on one of the bottles.

He dissolved 3.51 g of the nickel chloride sample in distilled water. The solution is then added to excess aqueous sodium hydroxide. He stirred and filtered the mixture to obtain the precipitate. The precipitate was washed, dried and weighed. The mass of the precipitate was recorded.

Assuming yield of the precipitate was 100 %, calculate the mass of precipitate he would obtained if it was 3.51 g of nickel(II) chloride that was used in his experiment.

[3]

(iii) Explain why the volume of distilled water used to dissolve nickel chloride is **not** essential in the experiment.

_____

_____ [1]

(d) An element G is found in the second period of the Periodic Table. (G is not the actual symbol of the element.)

It burns in air to form GO_2 which dissolves in water to form an acidic solution.
This solution reacts with sodium hydroxide to form the salt Na_2GO_3.

(i) Identify G.

.....[1]

(ii) An oxide of nickel undergoes a similar reaction as GO_2 with sodium hydroxide.
Suggest why.

.....[1]

[Total: 10]