Name : _____( ) **Class : 4E1**

Greenridge Secondary School

Mid-Year Examination 2008

Pure Chemistry 5072

Secondary Four Express

Paper 2

Date : 6 May 2008 **Duration : 1 h 45 min**

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class in the spaces at the top of this page and on all separate answer paper used.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions in the spaces provided.

Section B
Answer **all three** questions.
Write your answers on foolscap papers provided.

At the end of the examination, hand up the foolscap papers separately from the question paper.

The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page **11**.

Parent's Signature & Date

_____

FOR EXAMINER'S USE	
Section A	/50
Section B	/30
Total	/80

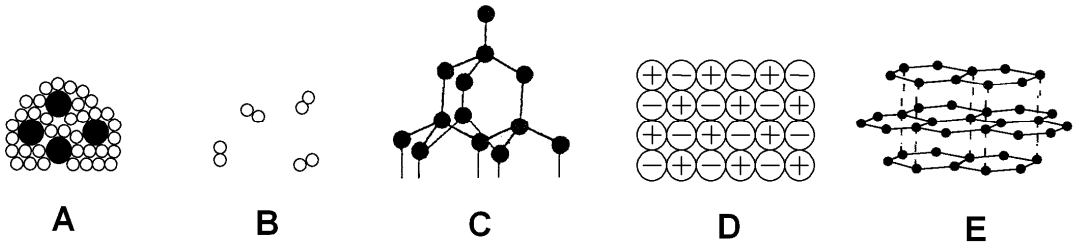
Setter : Mr Victor Lee

This paper consists 11 printed pages, including this cover page.

Section A (50 marks)

*Answer **ALL** questions from this Section.*

1. The diagram below shows the structure of three solids **A**, **B**, **C**, **D** and **E**.



(a) Name a substance, which has the same structure as

A: _____

C: _____

D: _____

E: _____ [4]

(b) Name the type of particles present in each of the following:

B: _____

C: _____

D: _____

E: _____ [4]

2. (a) Butane (C_4H_{10}) is commonly used as a fuel for portable cookers during outdoor camping activities. If the cooker were used in a closed tent, **incomplete** combustion occurs and carbon monoxide is produced.

(i) What causes **incomplete** combustion? [1]

_____

(ii) Construct an equation to show that **incomplete** combustion of butane produces carbon monoxide and water only. [1]

_____

(iii) State why carbon monoxide is hazardous. [1]

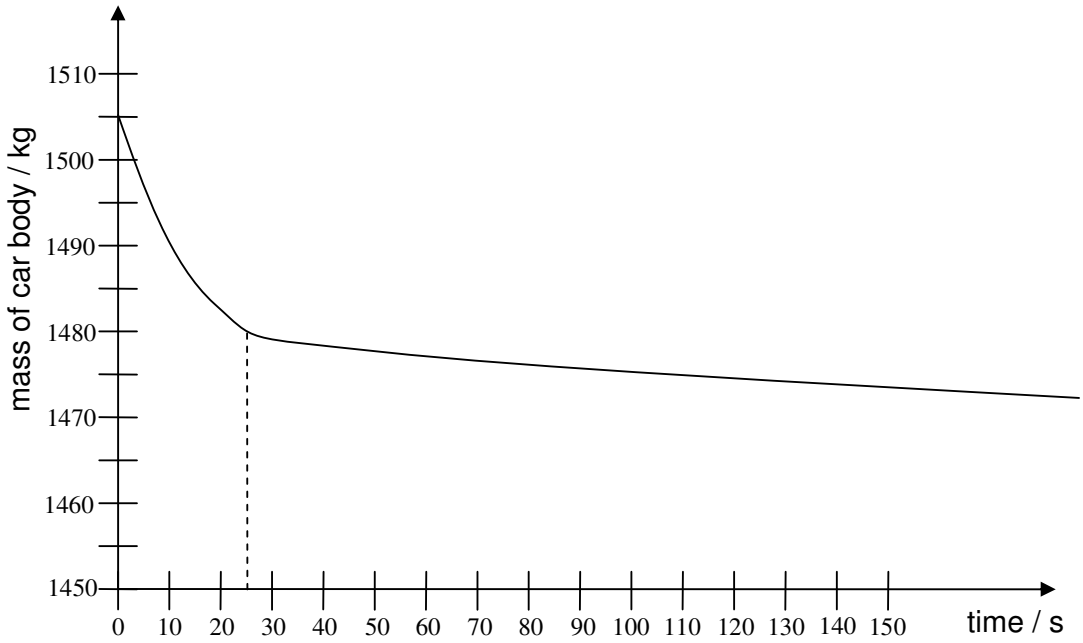
_____

_____

(b) Combustion of fuel in power stations also produces pollutants.
Name two acidic pollutants produced in power stations. [2]

_____

3. Car bodies are made of steel contains mainly iron. The car body is dipped in dilute sulphuric acid to remove rust (iron (III) oxide) before being painted. The graph below shows how the mass of a car body varies with time when completely immersed in dilute sulphuric acid.



(a) Write a balanced chemical equation for the reaction between the rust and the sulphuric acid. [2]

(b) (i) Explain why the mass of the car body decreases rapidly in the first 25s and then slows down to a constant but more gradual decrease as it reacts with the acid? *Assuming that the concentration of the excess acid does not change significantly during the 150s reaction with the car body.* [2]

(ii) Use the graph to explain why it is important that the car body is only left in the acid for less than 30s. [1]

(c) After the reaction, any excess acid on the car body is removed by dipping the car body in dilute aqueous sodium hydroxide.

(i) What is the name given to this type of reaction. [1]

(ii) Write a chemical equation, with state symbols, for the reaction that happens between sulphuric acid and sodium hydroxide. [1]

(iii) Write an ionic equation for the reaction in c(ii). [1]

4. The table below shows some bond energies, measured in kilojoules per mole. Bond energy is the energy (ΔH, +ve) required to break the bonds between pairs of atoms.

Bond	**Bond energy in kJ/mol**	**Bond**	**Bond energy in kJ/mol**
H–H	436	O=O	496
H–Cl	421	C–H	410
C=C	610	H–O	460
N=N	410	N–N	160
C=O	740	O–O	150

(a) Use the information given to calculate

(i) total energy required to break 1 mole of methane(CH_4) into atoms. [2]

(ii) total energy required to break 1 mole of oxygen (O_2) into atoms. [1]

(iii) total energy released when 1 mole of carbon dioxide is formed. [1]

(iv) total energy released when 1 mole of water is formed. [1]

(b) Methane burns in oxygen to produce carbon dioxide and water. Write a chemical equation for the combustion reaction. [1]

(c) Calculate the enthalpy change for the reaction in (b). [3]

(d) Define exothermic reaction. [1]

(e) Explain, in terms of bond breaking and bond formation, why combustion of methane is an exothermic reaction. [2]

5. Manganese, atomic number 25, is one of the transition elements.

(a) What is the oxidation state of manganese in each of the following compounds of manganese? [3]

(i) $\underline{Mn}Cl_2$

(ii) $K\underline{Mn}O_4$

(iii) $\underline{Mn}O_2$

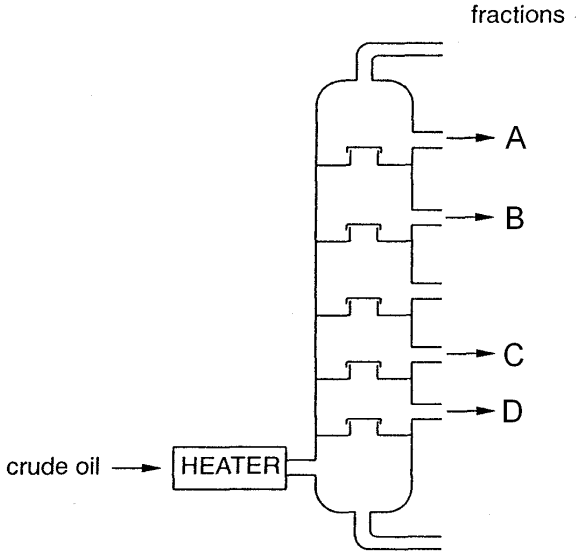
(b) Aqueous iron(II) ions react with acidified potassium manganate(VII) according to the equation below.

$$\_\_\_Fe^{2+}_{(aq)} + \_\_\_MnO_4^-{}_{(aq)} + \_\_\_H^+_{(aq)} \rightarrow \_\_\_Fe^{3+}_{(aq)} + \_\_\_H_2O_{(l)} + \_\_\_Mn^{2+}_{(aq)}$$

(i) Balance the above equation. [2]

(ii) Explain, in terms of change in oxidation state, why the above reaction is a redox reaction. [3]

6. This diagram shows a fractionating column for the separation of crude oil.



(a) Name the fractions that leave the column at each of the points **A**, **B**, **C** and **D**? [4]

A : _____

B : _____

C : _____

D : _____

(b) Octane, C_8H_{18}, is a hydrocarbon in petrol. Hexadecane, $C_{16}H_{34}$, is one of the hydrocarbons in ship fuel.

(i) Show by calculation that hexadecane contains a higher percentage of carbon by mass than octane. [2]

This is the equation for the complete combustion of octane.

$$2C_8H_{18(l)} + 25O_{2(g)} \rightarrow 16CO_{2(g)} + 18H_2O_{(g)}$$

(ii) Write an equation for the complete combustion of hexadecane. [1]

(iii) Use the equations to explain why hexadecane burns with a smokier flame than octane. [2]

Section B (30 marks)

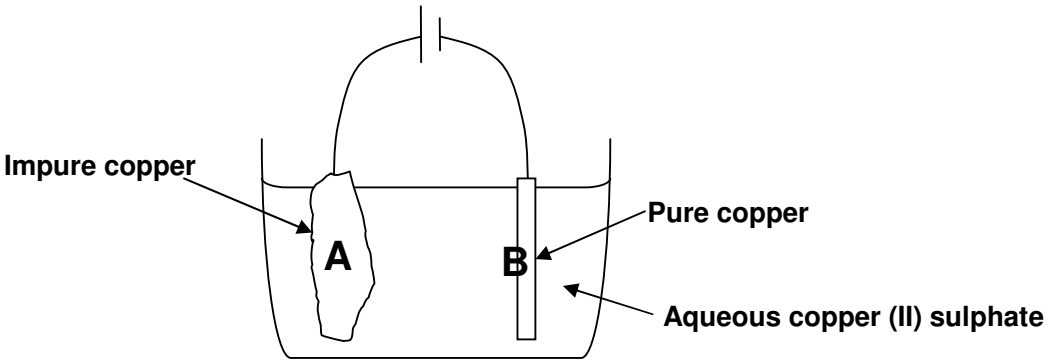
*Answer ALL **THREE** questions from this Section.*

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

7. Two naturally occurring ores of copper are cuprite, Cu_2O, and tenorite, CuO. Copper can be extracted from tenorite by heating the ore with a reducing agent. When copper is extracted from its ore, it contains carbon impurities.

(a) Suggest how the carbon impurities get into the copper. [1]

(b) Pure copper is made by electrolysis, using aqueous copper(II) sulphate as an electrolyte.

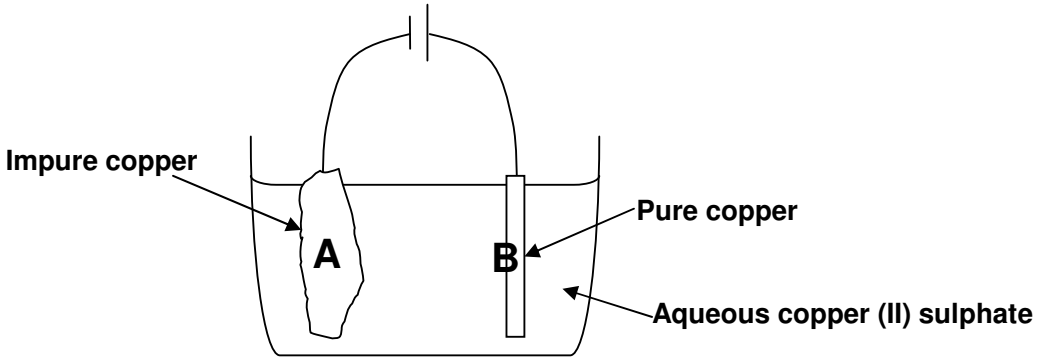


(i) Give the formula of the ions present in aqueous copper (II) sulphate. [1]

(ii) Write ionic equations, including state symbols, for the reactions at the electrodes **A** and **B**. [2]

(iii) What happens to the concentration of the aqueous copper(II) sulphate during the electrolysis? Explain your reasoning. [2]

(c) A student made a small mistake while setting up the apparatus to purify copper. He accidentally connected the battery in the wrong direction. The figure below shows how he sets up the experiment.



(i) Write ionic equations, including state symbols, for the reactions at the electrodes **A** and **B**. [2]

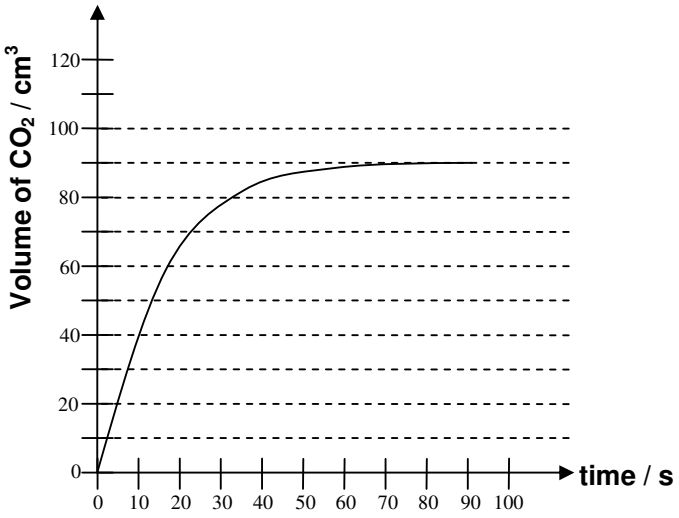
(ii) Would the student be able to obtain pure copper metal at the end of the experiment? Explain your reasoning. [2]

8. Copper (II) carbonate reacts with dilute hydrochloric acid according to the following equation.

$$CuCO_{3(s)} + 2HCl_{(aq)} \rightarrow CuCl_{2(aq)} + CO_{2(g)} + H_2O(l)$$

The speed of this reaction can be followed by adding excess dilute hydrochloric acid to powdered copper (II) carbonate and measuring the total volume of gas given off at certain intervals.

The following graph was obtained from such an experiment carried out at room temperature and pressure.



(a) (i) Draw a diagram of the experimental setup you would use to follow the speed of the reaction by this method. [2]

(ii) Suggest one other method by which the speed of this reaction might be followed. [1]

(b) (i) Using the results from the graph, calculate the mass of copper (II) carbonate used. [3]

(ii) Deduce the volume of carbon dioxide given off if the same mass of powdered copper (II) carbonate had been used while the acid is changed into sulphuric acid of the same temperature, concentration and volume as dilute hydrochloric acid in (a). [1]

(c) A fresh sample of the hydrochloric acid was heated to 70℃ and the experiment was repeated using the same mass of powdered copper (II) carbonate as before.

(i) Explain, in terms of particle theory, why the reaction is faster at this temperature. [2]

(ii) Explain why the final volume of carbon dioxide collected (measured at r.t.p.) is greater in this experiment. [1]

9. Either

Zinc can be extracted from calamine, $ZnCO_3$, in a two-stage process.

Stage 1 $ZnCO_3 \rightarrow ZnO + CO_2$

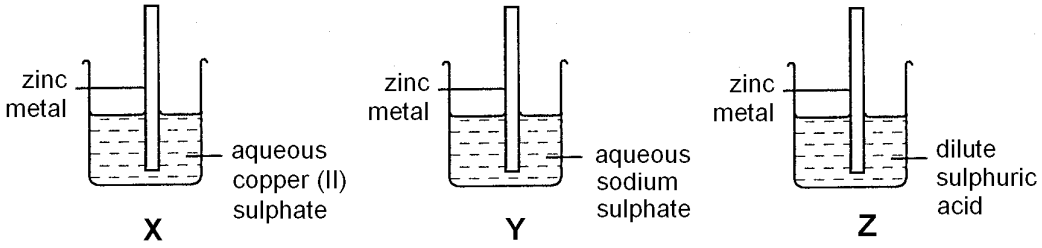
Stage 2 $ZnO + C \rightarrow Zn + CO$

(a) The gas produced in **stage 2** must be removed immediately as it is harmful to the workers. Explain its effect on the health of the workers. [1]

(b) (i) A student tried to extract calcium from calcium carbonate using the two-stage process similar to the extraction of zinc. He managed to carry out **stage 1** and obtained calcium oxide and carbon dioxide. Write a chemical equation for the decomposition of calcium carbonate into calcium oxide and carbon dioxide. [1]

(ii) However, he has problem carrying out **stage 2**. Explain why **stage 2** process **cannot** be used to extract calcium from calcium oxide, CaO. [2]

(c) In the laboratory, three experiments were set up using zinc metal.



For each experiment, describe what you would ***observe*** and how you would test any gases evolved. Write an equation for the reaction you observe in each beaker. [6]

9. Or

25.0g of impure sodium hydrogen carbonate powder ($NaHCO_3$) was dissolved in pure distilled water and the volume made up to $1000cm^3$. $25.0cm^3$ of this solution was titrated with 0.100 mol/dm^3 dilute sulphuric acid. $30cm^3$ of dilute sulphuric acid was needed to completely neutralize the $25.0cm^3$ of aqueous sodium hydrogen carbonate. *(show all your workings clearly)*

(a) Write a balanced chemical equation for the reaction between aqueous sodium hydrogen carbonate and dilute sulphuric acid. [2]

(b) Calculate the number of moles of sulphuric acid used. [2]

(c) Find the number of moles of aqueous sodium hydrogen carbonate used. [1]

(d) Calculate the number of moles of sodium hydrogen carbonate in $1000cm^3$ of the solution. [1]

(e) Calculate the mass of pure sodium hydrogen carbonate powder dissolved in $1000cm^3$ of the solution. [2]

(f) What is the percentage purity of the sodium hydrogen carbonate? [2]

~ The End ~

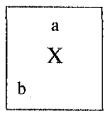
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 27	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yitrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 47	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 +															

* 58 – 71 Lanthanoid series
\+ 90 – 103 Actinoid series

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

Key



a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)