HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE

GRADE 12
PAPER 2- Chemistry

JUNE 2013
TIME: 2 HRS

Total 100

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (10)
   SECTION B (90)

   Answer SECTIONS A and B in the ANSWER BOOK.
4. Non-programmable calculators may be used.
5. Appropriate mathematical instruments may be used.
6. Number the answers correctly according to the numbering system used in this question paper.
7. Data sheets and a periodic table are attached for your use.
8. Give brief motivations, discussions, et cetera where required.
9. Numbers must be rounded off to **two decimal** places

SECTION A

QUESTION 1: ONE-WORD ITEMS

Give ONE word/term for each of the following descriptions. Write only the word/term next to the question number (1.1 – 1.4) in the ANSWER BOOK.

1.1 The main ore from which aluminium is extracted

1.2 The elimination of H_2O from an alcohol

1.3 A transitional structure in a chemical reaction that results from an effective collision between molecules and exists as a temporary state between reactants and products.

1.4 The only factor that affects the equilibrium constant.

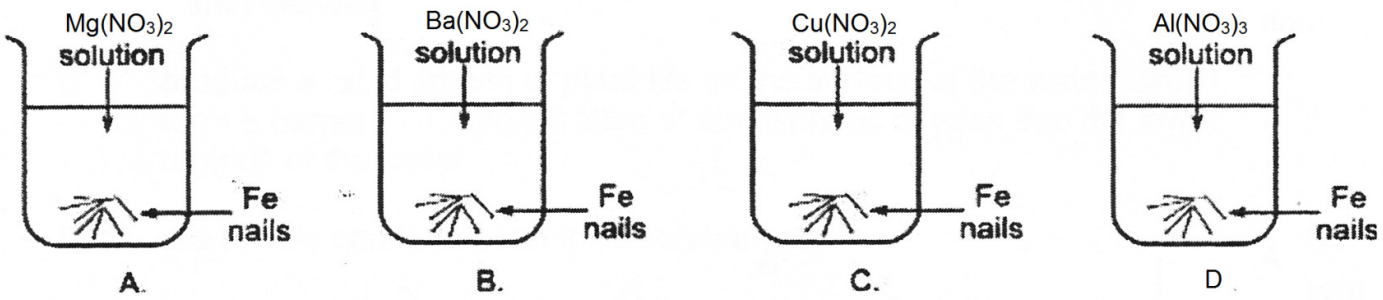
[1 x 4 =4]

QUESTION 2: MULTIPLE-CHOICE QUESTIONS

Four options are provided as possible answers to the following questions. Each question has only ONE correct answer. Write only the letter (A – D) next to the question number (2.1 – 2.3) in the ANSWER BOOK.

2.1

A few small iron nails are placed in each of the solutions shown in the diagram below. In which beaker will there be a spontaneous reaction?



2.2

Which one of the following pairs of compounds contains members of the same homologous series?

A C_2H_4 and C_4H_{10}
B C_3H_6 and C_5H_8
C CH_4O and $C_2H_4O_2$
D $C_2H_4O_2$ and $C_3H_6O_2$

2.3 Consider the following equation

$$NaCl\ (s) \rightleftharpoons Na^+\ (aq) + Cl^-\ (aq)$$

The precipitation of sodium chloride will be promoted by:

A heating the reaction mixture.
B lowering the pressure on the vessel.
C adding a saturated $CuC\ell_2$ solution.
D adding a saturated $AgNO_3$ solution

[2 x 3 = 6]

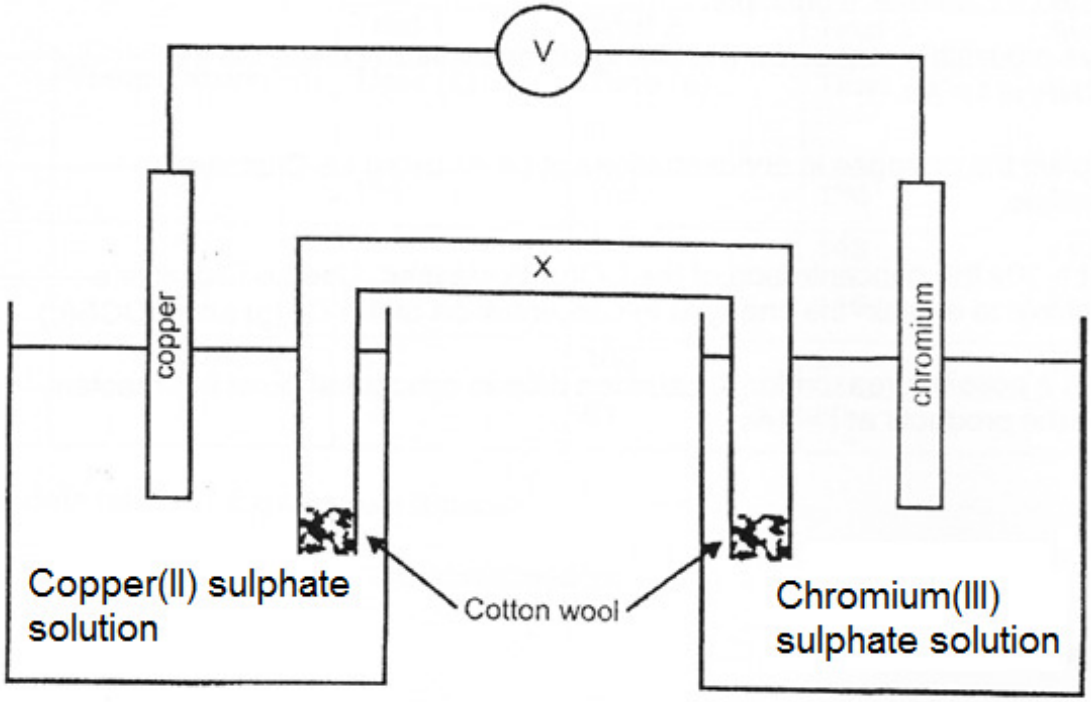
SECTION B

INSTRUCTIONS AND INFORMATION

1. Leave ONE line between two sub questions, for example between QUESTION 3.1 and QUESTION 3.2.
2. Show the formulae and substitutions in ALL calculations.
3. Round off your numerical answers to **TWO** decimal places

Question 3

The diagram below shows a galvanic cell which functions under standard conditions.



3.1 Write down the formula of chromium (III) sulphate. (1)

3.2 Explain why the two electrodes must be placed in solution of their salts. (2)

3.3 Which electrode is the anode? (Write down Cu or Cr) (2)

3.4 Write down the chemical equation for the oxidation half-reaction that occurs in this cell. (2)

3.5 Write down the chemical equation for the reduction half-reaction that occurs in this cell. (2)

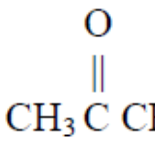
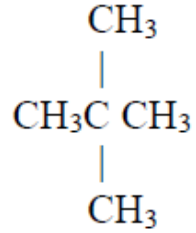
3.6 Write down the net equation for the reaction that occurs in this cell. (2)

3.7 Calculate the initial emf of this cell. (3)

3.8 Consider component X in the diagram:

3.8.1 Give two possible functions of X. (2)
[16]

Question 4

A	C_3H_8		F	CH_3COOCH_3
B	2-pentene		G	$CH_3CH_2CH_2F$
C			H	
D	$CH_3CH_2CH_2OH$		I	$CH_3CH_2CH_2CH_2COOH$
E	$CH_3CH_2CH_2CH_2CH_3$		J	1,2-dibromobutane

4.1 Which of the above are isomers of each other? (1)

4.2 If D and I react with each other, give the name of the product(s) formed. (2)

4.3 To which group does C belong? Name compound C. (2)

4.4 Consider compound **F**

4.4.1 Write down the IUPAC name of this compound. (2)

4.4.2 Write down the names of the **two** organic compounds that were used to prepare this compound (F) . (2)

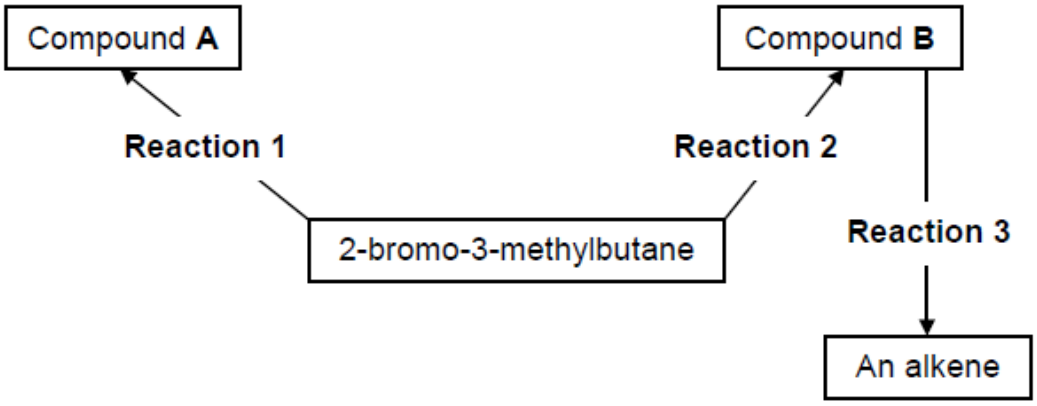
4.4.3 Write down the structural formula **and IUPAC** name of one isomer of this compound. (2)

4.4.4 Name the catalyst required for this reaction. (1)

[12]

QUESTION 5

The flow diagram below shows how three organic compounds can be prepared from 2-bromo-3-methylbutane.



5.1 Write down the:

5.1.1 Homologous series to which 2-bromo-3-methylbutane belongs (1)

5.1.2 Structural formula of 2-bromo-3-methylbutane (2)

5.2 **Reaction 2** takes place in the presence of a dilute sodium hydroxide solution.

Write down the:

5.2.1 Name of the type of reaction which takes place (1)

5.2.2 Structural formula of compound **B** (2)

5.3 **Reaction 1** takes place in the presence of concentrated sodium hydroxide.

Write down:

5.3.1 Another reaction condition needed for this reaction (1)

5.3.2 The name of the type of reaction which takes place (1)

5.3.3 The structural formula of compound **A**, the major product formed (2)

5.4 **Reaction 3** takes place when compound **B** is heated in the presence of concentrated sulphuric acid. Write down the IUPAC name of the major product formed. (2)

[12]

Question 6

A group of learners were asked to investigate the reactivity of alkanes and alkenes. They chose cyclohexane and cyclohexene as examples. Both compounds are liquids at normal temperature and pressure. They poured equal amounts of cyclohexane and cyclohexene into two separate test tubes and then added a few drops of bromine to the contents of each test tube. They firstly performed the investigation in the darkened room and then repeated it in sunlight .

6.1 Write down TWO safety precautions that the learners took during the experiment. (2)

6.2 The learners then use the table format to record their observations. Copy the table into your answer book and write down what the learner's observations will be.

Compound	Action of liquid bromine in the dark room	Action of liquid bromine in sunlight
Cyclohexane		
Cyclohexene		

(4)

6.3 What conclusion should the learners reach about the reactivity of the above compounds? (2)

6.4 Write down the balanced equation using structural formula for the reaction between cyclohexene and bromine. (3)

6.5 What kind of addition reaction does the reaction mentioned in 6.4 above undergo? (2)

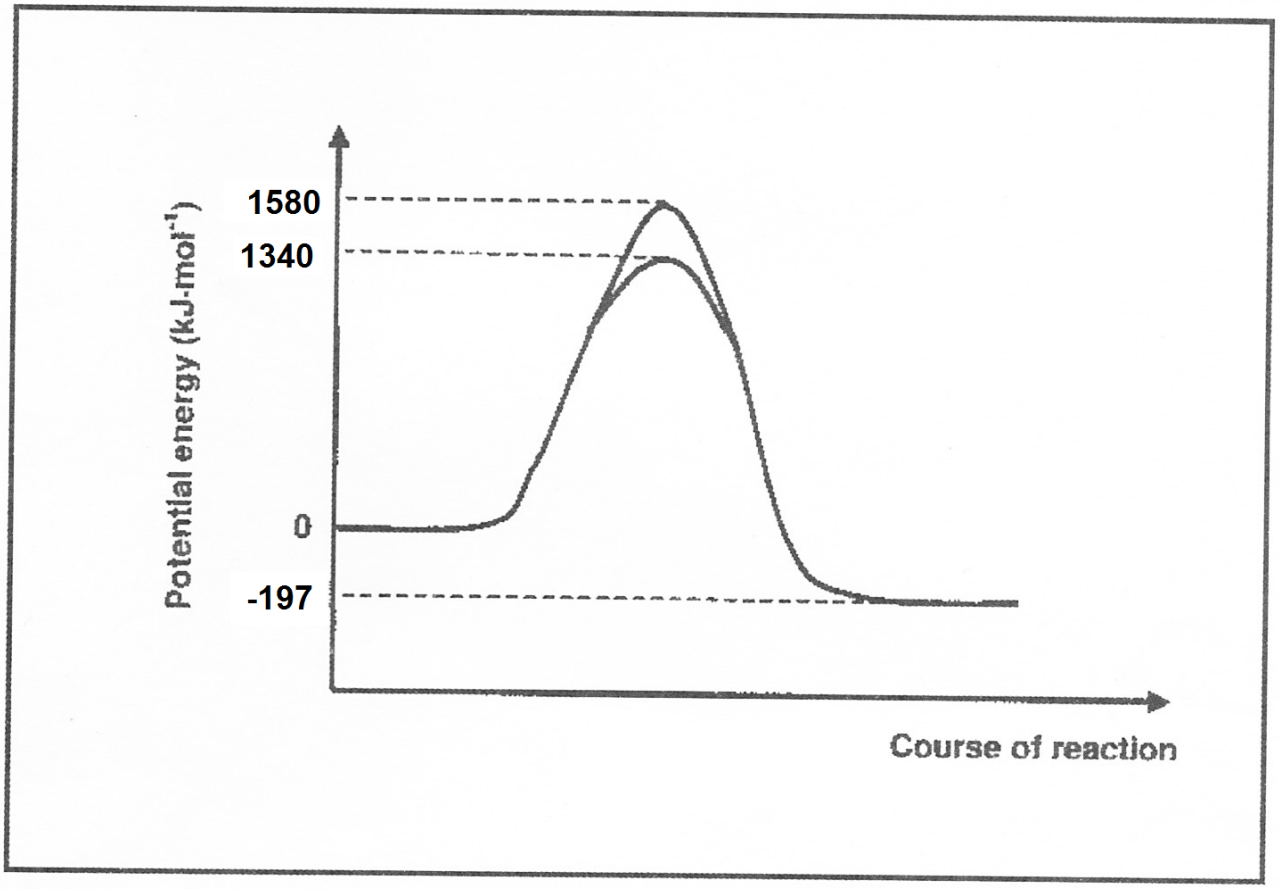
(13)

Question 7

The contact process is used to prepare sulphuric acid in high concentrations needed for industrial purposes. The process involves the oxidation of sulphur dioxide in the presence of vanadium(V) oxide as a catalyst:

$2SO_2(g) + O_2(g) \leftrightarrows 2SO_3(g)$

Consider the following graph (not drawn to scale) that represents the change in chemical potential energy for the above reaction:



Use the reaction and the graph, where applicable, to answer the questions that follow.

7.1 Is the forward reaction exothermic or endothermic? Prove your answer by writing down the value of ΔH for this reaction. (2)

7.2 Write down the activation energy for the forward reaction in the absence of the vanadium(V) oxide catalyst. (1)

7.3 If we assume that 1580 $kJ.mol^{-1}$ is involved to break the bonds in the $SO_2(g)$ and $O_2(g)$ molecules, how much energy is released when the new bonds in the $SO_3(g)$ molecules form? (2)

7.4 Determine the activation energy for the reverse reaction in the presence of the vanadium(V) oxide catalyst. (2)

7.5 In the contact process, the catalysed reaction reached equilibrium in a closed container. Chemical engineers devise ways to shift the above equilibrium to the right, so that a higher yield of $SO_3(g)$ can be obtained.

7.5.1 What effect does the addition of vanadium(V) oxide have on the amount of $SO_3(g)$ at equilibrium? Only answer INCREASES, DECREASES OR NO EFFECT. (1)

[8]

QUESTION 8

The active ingredient in a certain antacid tablet is the carbonate ion ($CO_3^{2-}(aq)$). This ion reacts with the hydrochloric acid in your stomach according to the following reaction:

$$CO_3^{2-}(aq) + 2\,HC\ell(aq) \rightarrow 2\,C\ell^-(aq) + H_2O(\ell) + CO_2(g)$$

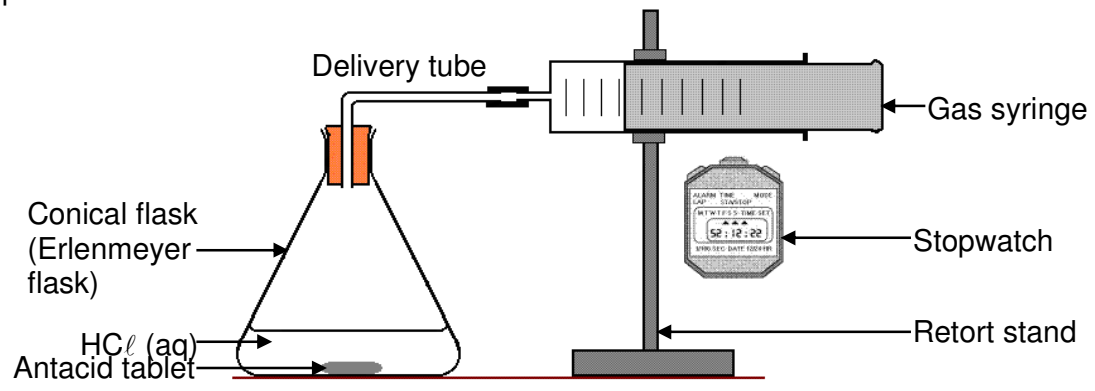
The formation of CO_2 gas is an indication that some of the acid has been neutralised and this brings relief from indigestion.

A group of learners use two of these antacid tablets to investigate **one of the factors that influence the reaction rate**. They follow the method and use the apparatus given below, to conduct the investigation.

Method:

1. Place one antacid tablet in a conical (Erlenmeyer) flask and add 20 cm^3 $HC\ell$ (aq).
2. Simultaneously start the stopwatch and close the flask with the rubber stopper that is at the end of the delivery tube attached to the gas syringe.
3. Measure the volume of the CO_2 gas formed in intervals of 30 seconds.
4. Repeat 1 to 3 above, but grind the second antacid tablet to a fine powder prior to the reaction.

Apparatus



8.1 Define the term *reaction rate*. (2)

8.2 Write down an investigative question for this investigation. (2)

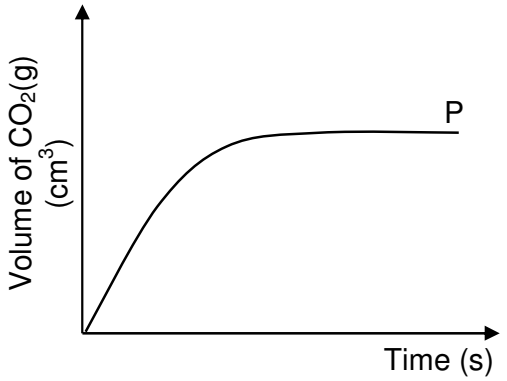
8.3 State THREE variables that must be controlled during this investigation. (3)

8.4 Apart from the apparatus illustrated, the learners need at least **one** other pieces of apparatus to conduct the investigation.

Write down the NAME of the one piece of apparatus, as well as its PURPOSE, in your ANSWER BOOK. (2)

8.5 The learners measure the volume of CO_2 gas formed at 30-second intervals in Step 3 of the method. Write down the NAME of the apparatus that they used for measuring the volume of the CO_2. (1)

8.6 Consider the sketch graph below for the reaction of hydrochloric acid with the SOLID antacid tablet.



Redraw the above sketch graph in your ANSWER BOOK. On the **same set of axes**, sketch the curve Q that was obtained for the reaction of the POWDERED antacid tablet with hydrochloric acid.

Clearly **label** the curves P and Q on the re-drawn sketch graph. (3)

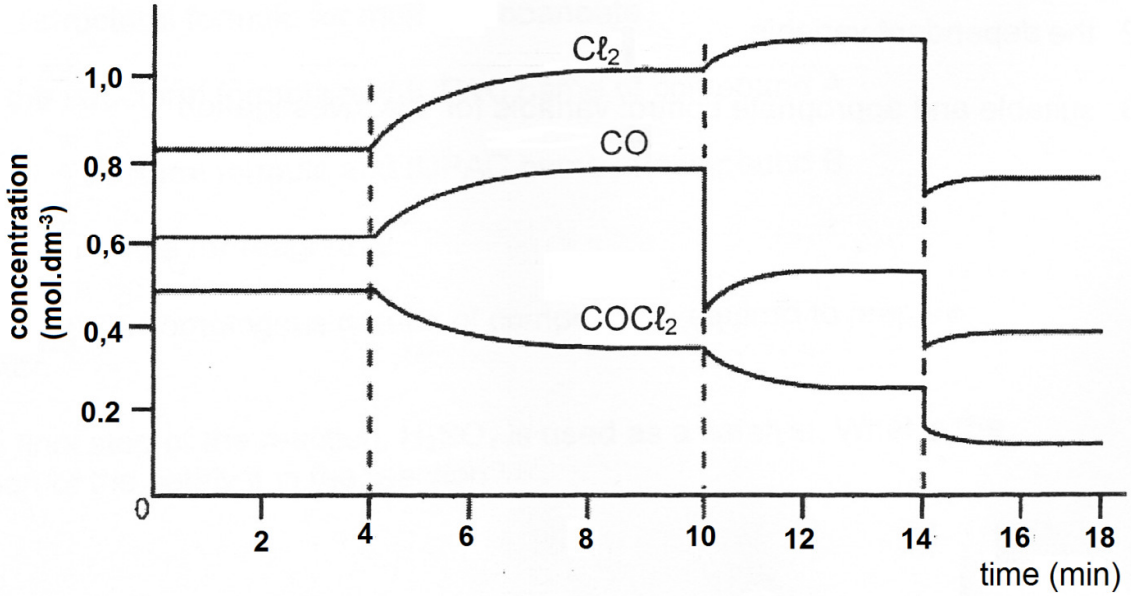
8.7 The instruction on an antacid packet recommends that antacid tablets must be chewed for faster relief. Explain how chewing the tablets bring about faster relief. (2)

[15]

Question 9

The following graph shows the variation in concentration of reactant and products as a function of time for the following equilibrium system:

$$COCl_2\,(g) \rightleftharpoons Cl_2(g) + CO(g) \quad \Delta H = 108kJ.mol\text{-}1$$



9.1 This is a reversible reaction and a dynamic equilibrium is reached. Explain the underlined terms. (2)

9.2 Why is the equilibrium described as "dynamic"? (2)

9.3 State Le Chatelier's principle. (2)

9.4 Give a possible reason for the change in equilibrium conditions that occurs at t = 4s. (1)

9.5 Explain the changes in concentrations at t = 4s using Le Chatelier's principle. (3)

9.6 At t = 10s the concentration of the CO(g) decreased. Use Le Chatelier's principle to explain the changes in concentration of the $Cl_2(g)$ and $COCl_2(g)$. (3)

9.7 Give a possible reason for the sudden drop in concentration of the reactant and the products at t = 14s. (1)

[14]

Total 100