HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 11
PAPER 2- Chemistry

DECEMBER 2014
TIME: 3 HRS

Total 150

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (20)
   SECTION B (130)

   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: 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 (1.1 – 1.10) in the ANSWER BOOK.

1.1 Which of the following is a non-polar molecule but contains polar bonds?

A. PH_3

B. CF_4

C. SO_2

D. H_2S

1.2 Which of the following substance(s) is / are amphiprotic?

$H_2PO_4^-$	H_3PO_4	HPO_4^{2-}
(i)	**(ii)**	**(iii)**

A. (i)

B. (iii)

C. (ii) and (iii)

D. (i) and (iii)

1.3 In which one of the following alternatives are the three compounds listed in order of their increasing boiling points?

A. Pentanoic acid, pentane, pentan-1-ol

B. Pentan-1-ol, pentane, pentanoic acid

C. Pentane, pentan-1-ol, pentanoic acid

D. Pentane, pentanoic acid, pentan-1-ol

1.4 A solution whose concentration is known precisely, is referred to as:

A. Concentrated solution

B. Standard solution

C. Homogenous solution

D. Dilute solution

1.5 Consider the following equation:

$$NH_{3(g)} + H_2O \rightarrow NH_4^+ + OH^-$$

The two Bronsted-Lowry bases in the reaction are:

A. NH_3 and H_2O

B. NH_4^+ and OH^-

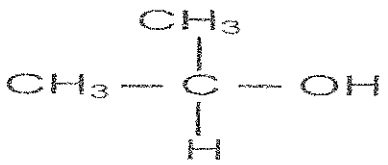
C. H_2O and NH_4^+

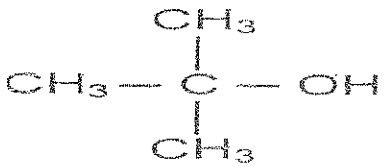
D. NH_3 and OH^-

1.6 Which ONE among the following organic compounds is a secondary alcohol?

A. $CH_3 - OH$

B. $CH_3 - CH_2 - OH$

C.


D


1.7 Which of the following statements regarding a catalyst is **TRUE**?

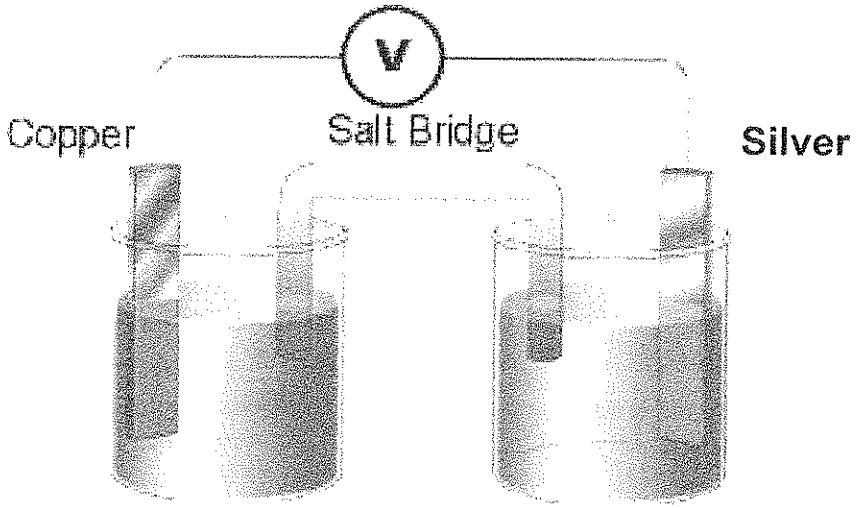
A. It changes the heat of a reaction

B. It reduces the energy of the activated complex

C. It decreases the energy of the reactants

D. It increases the number of moles of products formed

1.8 Look at the electrochemical cell shown below:



Which ONE of the following half-reactions will take place at the anode?

A. $Ag^+ + e^- \rightarrow Ag$

B. $Cu \rightarrow Cu^{2+} + 2e^-$

C. $Cu^{2+} + 2e^- \rightarrow Cu$

D. $Ag \rightarrow Ag^+ + e^-$

1.9 Which one of the following molecules will have the strongest intermolecular forces?.

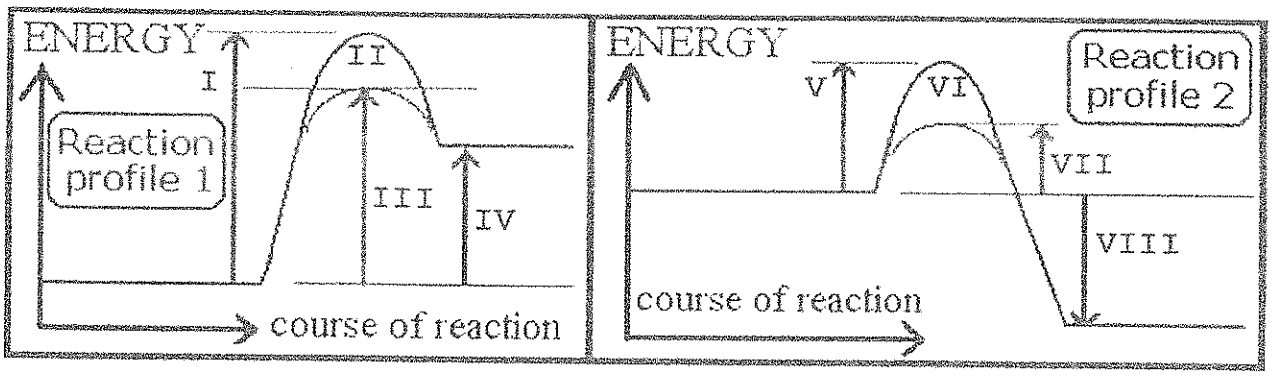
A. H_2

B. HBr

C. F_2

D. HF

1.10 In the diagram below the activation energy of the forward reaction is indicated by which labels?



A. I and V

B. II and VI

C. III and VII

D. IV and VIII **[2 x 10 = 20]**

SECTION B

INSTRUCTIONS AND INFORMATION

1. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
2. Show the formulae and substitutions in ALL calculations.
3. Round off your numerical answers to **TWO** decimal places.

Question 2

2.1 In a chemical reaction 31.2g of NH_4NO_3 is allowed to react with 32.8g of Na_3PO_4. The balanced equation is given below:

$$3NH_4NO_{3(aq)} + Na_3PO_{4(aq)} \rightarrow (NH_4)_3PO_{4(g)} + 3NaNO_{3(g)}$$

2.1.1 What is meant by the term limiting reagent? (1)

2.1.2 Identify the limiting reagent. Show **ALL** calculations (8)

2.1.3 How many moles of the limiting reactant is in excess? (2)

2.2 A compound having a molar mass (or sample mass) of 106.0 g.mol^{-1} consists of 43.4% Na, 11.3% C and 45.3% O.

2.2.1 Distinguish between empirical formula and molecular formula. (4)

2.2.2 Calculate the empirical formula of the compound. Show **ALL** working out. (6)

2.2.3 Calculate the molecular formula (true formula). (2)

2.3 A sample of $AlCl_3 \cdot xH_2O$ having a mass of 1.746g is heated in a a crucible until all the steam has disappeared. Once cooled it is weighed and found the anhydrous $AlCl_3$ solid to be 1.375g. Determine the number of moles of water of crystallisation in the salt. (6)

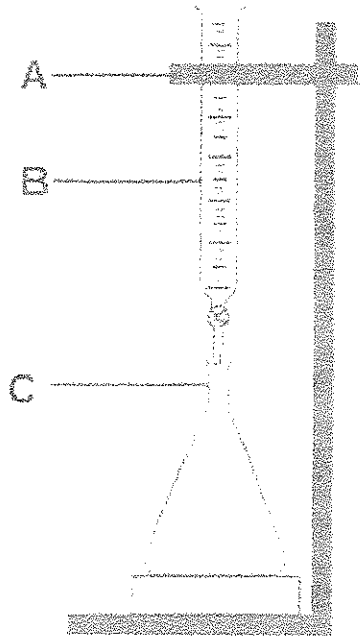
[29]

Question 3

Commercial vinegar contains a small percentage of ethanoic acid. A laboratory technician wishes to determine the concentration of ethanoic acid in vinegar. He titrates a solution of ethanoic acid against a standard solution of sodium hydroxide of concentration 0.009mol.dm^{-3}. The equation for the reaction is:

$$CH_3COOH_{(aq)} + NaOH_{(aq)} \rightarrow CH_3COONa_{(aq)} + H_2O_{(\ell)}$$

The apparatus shown alongside was used during the titration.



25cm^3 of vinegar was diluted with distilled water and made up to a volume of 250cm^3. Some of the diluted solution was added to apparatus B. 25cm^3 of sodium hydroxide solution was added to apparatus C and a few drops of an indicator added.

3.1 What is the name of apparatus B? (1)

3.2 Ethanoic acid is a considered a weak acid. What does the term weak acid mean? (2)

A titration was carried out and the results tabulated as shown below:

EXPERIMENT	VOLUME OF CH_3COOH (cm^3)
1	21.1
2	21.1
3	20.9

3.3 Why would the learners carry out the experiment 3 times and calculate the average volume of CH_3COOH for the experiment? (1)

3.4 What observation is made to identify the end point for the acid-base titration? (1)

3.5 Which one of the indicators listed in the table below is suitable to be used for the above titration? Give a reason for your answer. (3)

INDICATOR	pH RANGE
Methyl Orange	2.9 – 4.0
Bromothymol Blue	6.0 – 7.6
Phenolphthalein	8.3 – 10.0

3.6 Calculate the concentration of dilute ethanoic acid. (5)

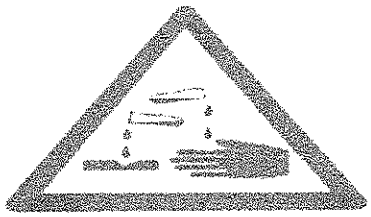
3.7 Calculate the concentration of ethanoic acid in vinegar. (4)

[17]

Question 4

A grade 11 learner finds a $250cm^3$ sulphuric acid (H_2SO_4) solution bottle with the following information and hazard symbol.

pH = 2,2



4.1 Is sulphuric acid **MONOPROTIC, DIPROTIC** or **TRIPROTIC**? Write down only the correct word. (1)

4.2 Write a balanced reaction for the ionization of sulphuric acid in water. (2)

4.3 Calculate the concentration of the sulphuric acid solution in the bottle. (5)

[8]

Question 5

An important decomposition reaction used in industry is the roasting of calcium carbonate or limestone in a lime kiln. The balanced reaction is shown below:

$$CaCO_{3(s)} \xrightarrow[\Delta]{} CaO_{(s)} + CO_{2(g)}$$

5.1 Is the reaction **ENDOTHERMIC** or **EXOTHERMIC**? Give a reason for your answer. (2)

5.2 Draw a sketch graph of the energy profile for this reaction shown above. Make sure to include the following labels:

- Energy of the products
- Energy of the reactants
- Change in enthalpy for the forward reaction
- Activation energy for the forward reaction
- Activated complex

(7)

[9]

Question 6

During a practical John and Mary investigate one of the facts that affect the rate of a reaction.

In **Experiment 1,** 5g of Zinc granules are added to $50cm^3$ of $0.3mol.dm^{-3}$ hydrochloric acid
In **Experiment 2,** 5g of Zinc powder are added to $50cm^3$ of $0.3mol.dm^{-3}$ hydrochloric acid

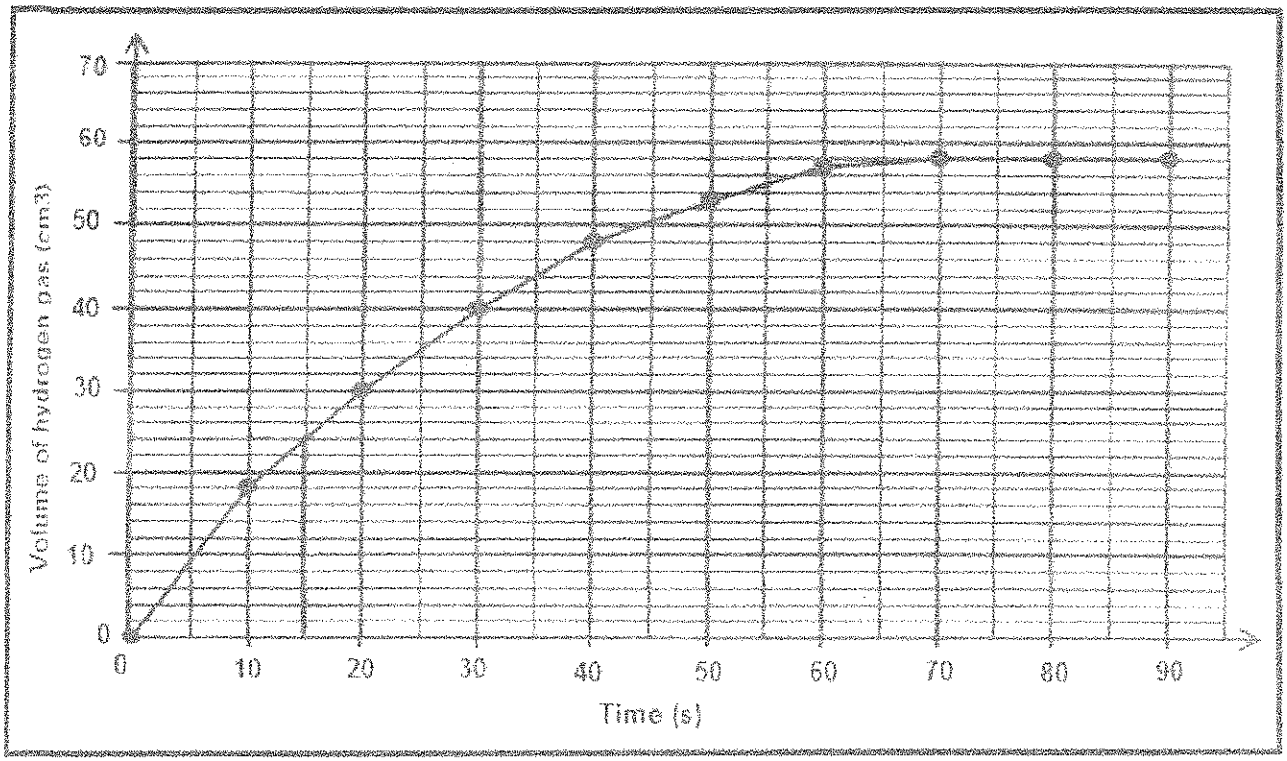
For both experiments the volume of hydrogen gas produced is measured every 10 seconds.

6.1 Write down the balanced equation for the reaction taking place. (3)

6.2 Name the factor affecting the rate of the reaction that is investigated here. (1)

6.3 Why should John and Mary ensure that equal masses of zinc are used in both experiments? (1)

The graph below represents the results obtained for **Experiment 1.**



6.4 Calculate the average rate of the reaction between the 20th and 40th second. (3)

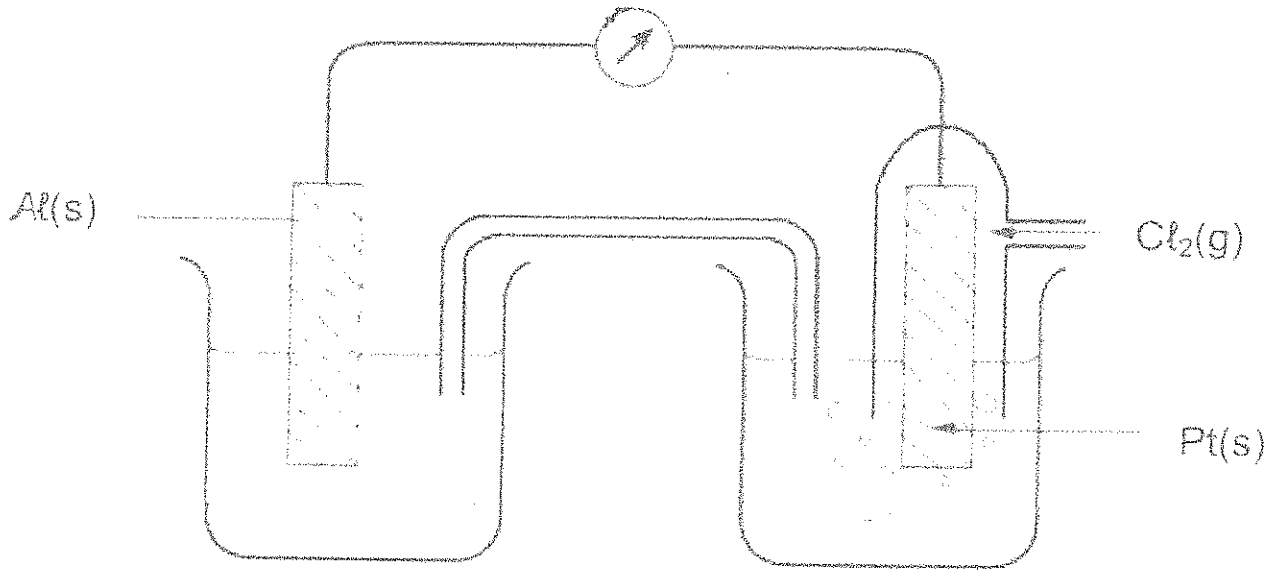
6.5 How will the average rate of the reaction between the 20th and the 40th second in **Experiment 2** compare with that in **Experiment 1**? Write down only **GREATER THAN, LESS THAN** or **EQUAL TO.** (1)

6.6 Use the collision theory to explain your answer in question 6.5. (2)

[11]

Question 7

A galvanic cell is set up with Al / $Al^{3+}_{(aq)}$ and Pt / Cl_2 /$Cl^-_{(aq)}$ half cells under standard conditions as shown below. As the Cl_2 is a gas the reaction must be carried out on the surface of an electrochemically inert conductor. This is why Platinum (Pt) is used, as it does not take part in the reaction but allows the reaction to occur between Al and Cl_2



7.1 State the standard conditions for that apply to this cell. (3)

7.2 Is Al the anode or the cathode? Give a reason for your answer. (2)

7.3 How will the mass of aluminium electrode change while the cell is in operation? Write only **INCREASES, DECREASES** or **STAYS THE SAME** (1)

7.4 Write the half reaction to support the answer in 7.3 above. (2)

7.5 Write down the formula for the oxidizing agent in this cell. (1)

7.6 Write down the reduction half reaction (2)

7.7 Write down the overall nett cell reaction (3)

7.8 Calculate the initial emf of the cell. (4)

[18]

Question 8

Learners want to investigate the relationship between evaporation and the strength of intermolecular forces.

Learners conduct the investigation by measuring the evaporation times of four solvents (A – D), at room temperature.

Learners' use a stop watch to measure the evaporation time of a fixed volume of each solvent placed onto a watch glass, the results are recorded in the table below

	SOLVENT	EVAPORATION TIMES (s)
A	Water	700
B	Ethanol	105
C	Methylated spirits	105
D	Nail polish remover	45

8.1 Write down a possible hypothesis for this investigation. (2)

8.2 Name the:

8.2.1 Independent variable (1)
8.2.2 Dependent variable (1)

8.3 Which solvent evaporates the fastest? Use the data in the table to give a reason for you answer. (2)

8.4 Explain the trend in the evaporation times above by referring to intermolecular forces and energy. (4)

[10]

Question 9

Give the name of the intermolecular forces that exist between the particles in:

9.1 Hydrogen fluoride (HF) (2)

9.2 Carbon tetrachloride (CCl_4) (2)

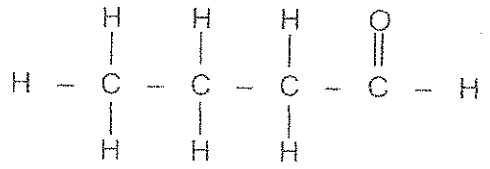
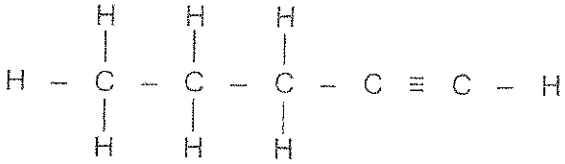
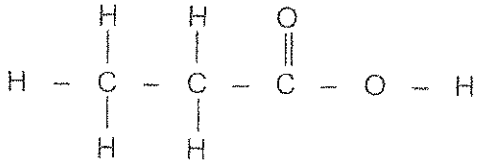
9.3 $HCl_{(g)}$ (2)

9.4 HCl in liquid ammonia (2)

[8]

Question 10

Look at the table below with six organic compounds A – F

A. 2,5-dimethylhexane	B. 
C. 	D. 1-bromo-3-chloro-4-methylpentane
E. CH_3COCH_3	F. 

10.1 Write down the letter(s) that represent(s) the following:

10.1.1 Aldehyde (1)

10.1.2 A compound with a general formula C_nH_{2n-2} (1)

10.2 Write down the homologous series to which each of the following compounds belong

10.2.1 D (1)

10.2.2 E (1)

10.3 Write down the IUAPC name of each of the following compounds

10.3.1 B (1)

10.3.2 F (1)

10.4 Give the:

10.4.1 Molecular formula of compound A (1)

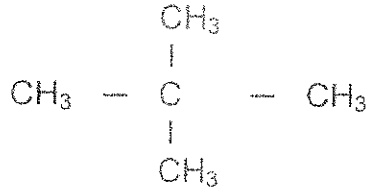
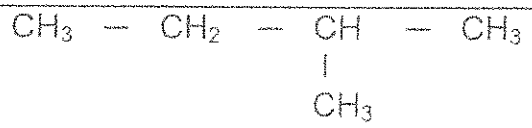
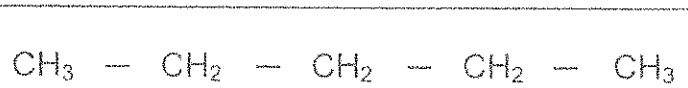
10.4.2 Structural formula of compound D (2)

10.4.3 IUPAC name and the structural formula for an isomer of compound B (4)

[13]

Question 11

The table below shows the boiling points for some hydrocarbons

	COMPOUND	BOILING POINT(^{0}C)
A		9
B		28
C		36

11.1 What are hydrocarbons? (1)

11.2 Consider the boiling point of the compounds in the above table.

11.2.1 Describe the trend in the boiling points. (2)

11.2.2 Explain this trend in terms of the strength of intermolecular forces and energy. (3)

11.3 Which compound, A, B, C will have the highest vapour pressure? (1)

[7]

TOTAL 150