HILLCREST HIGH SCHOOL
PHYSICAL SCIENCE
GRADE 12
PAPER 2- Chemistry

JUNE 2016
TIME: 2 HRS

Total 100

Instructions

1. Answer ALL the questions.
2. This question paper consists of TWO sections:
3. SECTION A (6)
   SECTION B (94)

   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

Question 1

1.1 The equilibrium constant, K_c, for the reaction $A(g) \rightleftharpoons B(g)$ is 1×10^{-4}.

Which ONE of the following statements is always CORRECT for this reaction?

The mixture at equilibrium consists of ...

A equal amounts of A(g) and B(g).

B very little of A(g).

C mostly A(g).

D mostly B(g).

1.2 The compound $C_4H_8O_2$ could be

I an alcohol

II a carboxylic acid

III an ester

Which ONE of the above statement(s) is/are CORRECT?

A I only

B I and II only

C I and III only

D II and III only

1.3 Ammonium sulphate is dissolved in water. Which ONE of the following statements regarding the solution which is formed, is CORRECT?

A pH = 7

B $[H_3O^+] \cdot [OH^-] < 1 \times 10^{-14}$

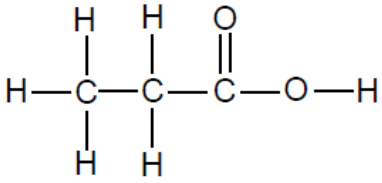
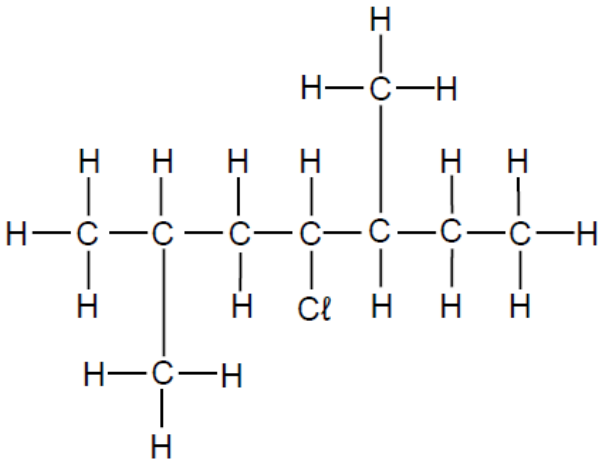
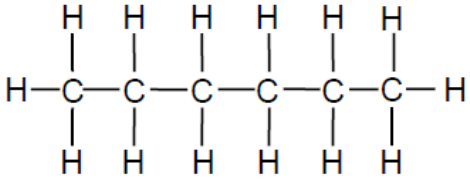
C $[H_3O^+] > [OH^-]$

D $[H_3O^+] < [OH^-]$

[3 X 2 = 6]

Question 2

The letters **A** to **F** in the table below represent six organic compounds.

A		**B**	
C	C_4H_8	**D**	$CH_3CH_2COCH_3$
E	$CH_3CH(CH_3)CH_2OH$	**F**	

Use the information in the table (where applicable) to answer the questions that follow.

2.1 Write down the LETTER that represents a compound that:
(A compound may be used more than once.)

2.1.1 Is a haloalkane (1)

2.1.2 Has a hydroxyl group as functional group (1)

2.1.3 Belongs to the same homologous series as ethanoic acid (1)

2.2 Write down the:

2.2.1 Structural formula of the functional group of compound **D** (1)

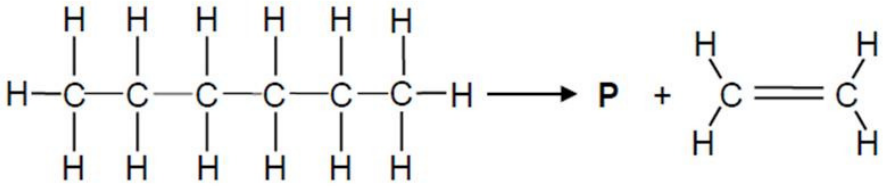
2.3 Compound **C** has CHAIN and POSITIONAL isomers.

2.3.1 Define the term *positional isomer*. (2)

2.3.2 Write down the IUPAC name of each of the TWO positional isomers of compound **C**. (4)

2.3.3 Write down the structural formula of a chain isomer of compound **C**. (2)

2.4 Compound **F** reacts at high pressure and high temperature to form compounds **P** and **Q** as given below.



Compound **F** Compound **Q**

Write down the:

2.4.1 Type of reaction that takes place (1)

2.4.2 IUPAC name of compound **Q** (1)

2.4.3 Molecular formula of compound **P** (1)

Compound **Q** is the monomer of a polymer used to make plastic bags.

2.4.4 Write down the NAME and CONDENSED FORMULA of this polymer. (3)

[18]

Question 3

Compounds **A** to **E**, shown in the table below, are used during two investigations to determine factors which influence boiling point. The compounds are of similar molecular mass and therefore it is considered as a controlled variable.

Investigation	Compound		Relative molecular mass	Boiling point (°C)
I	A	2-methylbutane	72	27
	B	2,2-dimethylpropane	72	9
	C	Pentane	72	36
II	D	$CH_3CH_2CH_2CH_2OH$	74	117
	E	$CH_3CH_2CH_2CHO$	72	75

3.1 Consider the boiling points of the compounds in investigation **I**.

3.1.1 Write down the independent variable for this investigation. (1)

3.1.2 Fully explain why the boiling point of compound C is higher than the boiling point of compound A. (3)

3.2 Write down the type of intermolecular forces between molecules of each of the following compounds:

3.2.1 Compound **C** (1)

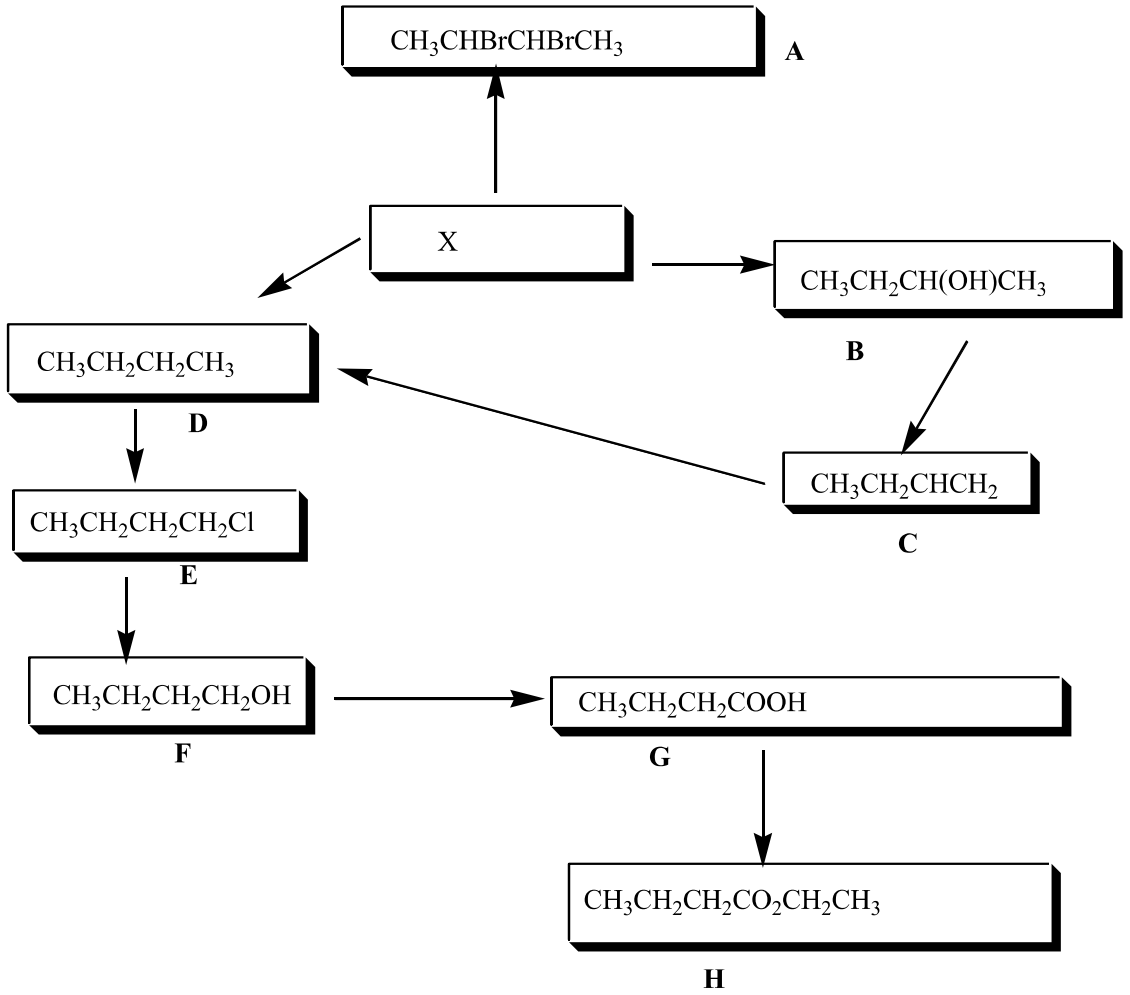
3.2.2 Compound **D** (2)

3.3 Consider investigation **II**. Refer to the type of forces in each of the compounds to give a reason why the boiling point of compound **D** is higher than that of compound **E**. (2)

[9]

QUESTION 4

Carefully study the following reaction scheme and then answer the questions that follow:



4.1 Organic compounds are classified in homologous series:

4.1.1 Write down the letters of two compounds from the reaction scheme above that belong to the same homologous series. (2)

4.2 Compound X is an isomer of compound **C**. X reacts with Br_2 to produce compound **A** as the only product.

4.2.1 State the type of isomerism shown by compounds X and **C**. (1)

4.2.2 Deduce the structure of compound X and give its full STRUCTURAL formula. (3)

4.3 Write down the (IUPAC) names of:

4.3.1 **X**

4.3.3 **B**

4.3.4 **H** (4)

4.4. There are different reaction types that occur in organic chemistry and these occur under different conditions.

4.4.1 Write down the types of reaction in the reactions from:

a) X $\longrightarrow$ **A**

b) **B** $\longrightarrow$ **C**

c) **E** $\longrightarrow$ **F** (3)

4.4.2 Write a chemical equation using condensed structural formulae for the reaction from G to H.

(2)

4.5 Compound **D** is often used as a fuel.

4.5.1 With the aid of an equation suggest why **D** is used as fuel. (3)

[18]

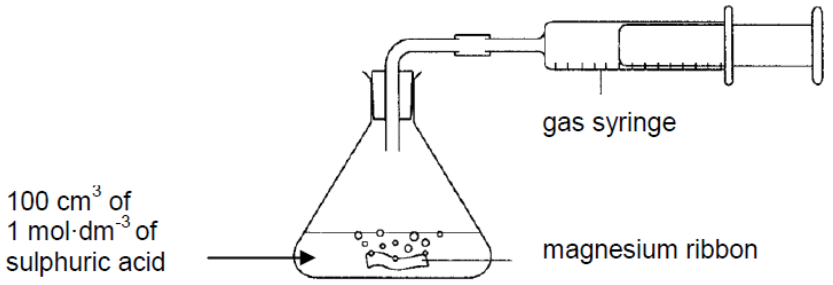
Question 5

The following apparatus was used by a group of learners in an investigation to find out how surface area affects the rate of reaction between solid magnesium metal and 100 cm^3 dilute sulphuric acid with a concentration of 1 $mol \cdot dm^{-3}$.

During the reaction, the gas that forms is collected in the gas syringe which measures the volume of gas produced.

The equation for the reaction is:

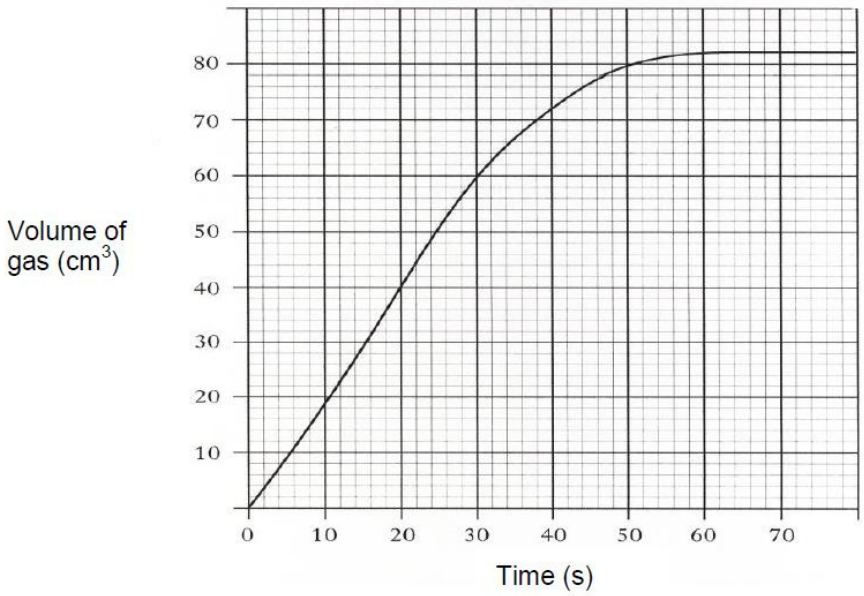
$$Mg\ (s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2\ (g)$$



In EXPERIMENT **I**, 20 g of magnesium, in the form of 5 small pieces, was used.

In EXPERIMENT **II**, 20 g of magnesium, in the form of one big piece was used.

The learners performed the experiments and plotted a graph of their results for experiment one, which is represented below.



5.1 Besides the mass and the volume of the reactants, give ONE other variable that must be kept constant in this investigation (1)

5.2 Name the dependent variable for EXPERIMENT **I**. (1)

5.3 **Use the graph** to calculate the average rate of the reaction (in $cm^3 \cdot s^{-1}$) for the first 30 seconds. (3)

5.4 Will the rate of the reaction at 50s be GREATER THAN, LESS THAN or EQUAL TO that rate calculated in QUESTION 5.3? (1)

5.5 Give a reason for your answer in QUESTION 5.4 (1)

5.6 Predict how the gradient of EXPERIMENT **II** results would compare to EXPERIMENT **I** plotted above.

Write only INCREASE, DECREASE or NO CHANGE. (1)

5.7 Use the collision theory to explain how the increase in surface area of the magnesium metal affects the rate of the reaction. (3)

5.8 Calculate the mass of magnesium metal that remains after the reaction has stopped. (5)

[16]

Question 6

6.1 Solid potassium chromate (K_2CrO_4) is dissolved in water. In solution, the chromate ions (CrO_4^{2-}) reach equilibrium with the dichromate ions ($Cr_2O_7^{2-}$) according to the following balanced equation.

$$2CrO_4^{2-}(aq) + 2H^+(aq) \rightleftharpoons Cr_2O_7^{2-}(aq) + H_2O(\ell)$$

Yellow Orange

Concentrated nitric acid is now added to the equilibrium mixture.

6.1.1 Predict the change in colour (if any) that will be observed as the nitric acid is added to the solution. ONLY Write down "Orange to Yellow", "Yellow to Orange" or "No Change". (1)

6.1.2 Which ONE of the two ions (CrO_4^{2-} or $Cr_2O_7^{2-}$) is more stable in a solution with a low pH? (1)

When the temperature is increased gradually, it is observed that the colour of the solution changes to yellow.

6.1.3 Is the forward reaction represented above exothermic or endothermic? (1)

6.1.4 Explain the answer in QUESTION 6.1.3 by referring to Le Chatelier's principle. (3)

6.2 Five (5) moles of hydrogen gas and 5 moles of iodine vapour are sealed in a 2 dm^3 vessel at a temperature of 600 K. The reaction reaches equilibrium according to the following balanced chemical equation:

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

6.2.1 Calculate the concentration of the hydrogen iodide (HI) at equilibrium if the equilibrium constant, K_c, at 600 K is 0,36. (8)

[14]

Question 7

A student is asked to make 200 cm^3 of sodium hydroxide solution of concentration 0,5mol.dm^{-3}.

7.1 Determine the mass of sodium hydroxide pellets he needs to use to do this. (4)

300 cm^3 of a 0,1 mol.dm^{-3} solution of ethanoic acid is added to the 200 cm^3 of a 0,5 mol.dm^{-3} solution of sodium hydroxide that was prepared above.

7.2 Is ethanoic acid monoprotic or polyprotic? (1)

7.3 Write an equation to show how ethanoic acid ionises (CH_3COOH) in water. (2)

7.4 The balanced equation for the above reaction is :

$$NaOH + CH_3COOH \rightarrow CH_3COONa + H_2O$$

7.4.1 Calculate the number of moles of ethanoic acid which were added to the sodium hydroxide solution. (3)

7.4.2 Is the number of moles of ethanoic acid calculated in 7.4.1 sufficient to fully neutralise the NaOH solution?
Support your answer by showing the relevant calculation. (5)

7.5 State whether the salt formed would have a pH of 7, BELOW 7 OR ABOVE 7. (Write the hydrolysis reaction to support your answer). **Then** state which colour phenolphthalein would turn in the final solution. (4)

[19]

Total 100

TABLE 1: PHYSICAL CONSTANTS/*TABEL 1: FISIESE KONSTANTES*

NAME/*NAAM*	SYMBOL/*SIMBOOL*	VALUE/*WAARDE*
Standard pressure *Standaarddruk*	p^{θ}	$1{,}013 \times 10^{5}$ Pa
Molar gas volume at STP *Molêre gasvolume by STD*	V_m	22,4 $dm^3 \cdot mol^{-1}$
Standard temperature *Standaardtemperatuur*	T^{θ}	273 K
Charge on electron *Lading op elektron*	e	$-1{,}6 \times 10^{-19}$ C
Avogadro's constant *Avogadro-konstante*	N_A	$6{,}02 \times 10^{23}$ mol^{-1}

TABLE 2: FORMULAE/*TABEL 2: FORMULES*

$n = \frac{m}{M}$	$n = \frac{N}{N_A}$
$c = \frac{n}{V}$ or/*of* $c = \frac{m}{MV}$	$n = \frac{V}{V_m}$
$\frac{c_a V_a}{c_b V_b} = \frac{n_a}{n_b}$	$pH = -\log[H_3O^+]$
$K_w = [H_3O^+][OH^-] = 1 \times 10^{-14}$ at/*by* 298 K	
$E^{\theta}_{cell} = E^{\theta}_{cathode} - E^{\theta}_{anode}$ / $E^{\theta}_{sel} = E^{\theta}_{katode} - E^{\theta}_{anode}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{reduction} - E^{\theta}_{oxidation}$ / $E^{\theta}_{sel} = E^{\theta}_{reduksie} - E^{\theta}_{oksidasie}$ or/*of* $E^{\theta}_{cell} = E^{\theta}_{oxidising\ agent} - E^{\theta}_{reducing\ agent}$ / $E^{\theta}_{sel} = E^{\theta}_{oksideermiddel} - E^{\theta}_{reduseermiddel}$	

TABLE 3: THE PERIODIC TABLE OF ELEMENTS
TABEL 3: DIE PERIODIEKE TABEL VAN ELEMENTE