NAME: ……..……..

SCHOOL:……

DATE: .....

ENERGY CHANGES IN CHEMICAL REACTIONS

INSTRUCTIONS TO CANDIDATES

*Answer **ALL** questions in this paper in the spaces provided.*

1. Use the information below to answer the questions that follow:

	Equation:	Enthalpy of formation.
(i)	$H_{2(g)} + \frac{1}{2} O_{2(g)} \rightarrow H_2O_{(l)}$	$\Delta H_1 = -286 kJmol^{-1}$
(ii)	$C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$	$\Delta H_2 = -394 kJmol^{-1}$
(iii)	$2C_{(s)} + 3H_{2(g)} + \frac{1}{2} O_{2(g)} \rightarrow C_2H_5OH_{(l)}$	$\Delta H_3 = -277 kJmol^{-1}$

Calculate the molar enthalpy of combustion of ethanol. Given that:

$$C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$$

(3mks)

2. Study the information in the table below and answer the questions that follow

Bond	**Bond energy ($KJmol^{-1}$)**
C – H	414
Cl – Cl	244
C – Cl	326
H - Cl	431

Calculate the enthalpy change of the reaction

$$CH_{4(g)} + 2Cl_{2(g)} \longrightarrow CH_2Cl_{2(g)} + 2HCl_{(g)}$$

(3mks)

3. When 25 $cm^3$of 0.5MHCl is added to 25 cm^3 of 0.5 M NaOH the temperature of the solution rose from 25^0C to 26^0C. Given that the density of the solution is 1g cm^{-3} and its specific heat capacity is 4.2 $jg^{-1}k^{-1}$,

(a) **Determine** the amount of heat evolved that caused the temperature rise. (1mark)

(b) **Work** out the molar enthalpy of neutralization for this reaction. (2marks)

4. Study the following equilibrium equation.

$$2A_{2(g)} + B_{2(g)} \rightleftharpoons 2A_2B_{(g)} \qquad \Delta H = -197KJmol^{-1}$$

a) Suggest two ways of increasing the yield of A_2B. (2mks)

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b) Draw the energy level diagram for the forward reaction.

(1mk)

5. Use the data below to calculate the enthalpy of formation of propane. (3mks)

$C_{(g)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H=-393.5KJmol^{-1}$

$H_{2(g)} + ½\ O_{2(g)} \longrightarrow H_2O_{(l)}$ $\Delta H = -285.9KJmol^{-1}$

$C_3H_{8(g)} + SO_2 \longrightarrow 3CO_{2(g)} + 4H_2O_{2(l)}$ $\Delta H=-2220.0KJmol^{-1}$

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6. Study bond energies shown below and answer the questions that follow.

Bond	Bond Energy KJmol^{-1}
C – C	348
C – H	412
Cl – Cl	242
C – Cl	338
H – Cl	431

a) Calculate the enthalpy change (ΔH) for the reaction given below.

$C_3H_{8(g)} + Cl_{2(g)} \longrightarrow C_3H_7Cl + HCl$ (2mks)

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b) State the condition necessary for the above reaction to occur. (1mk)

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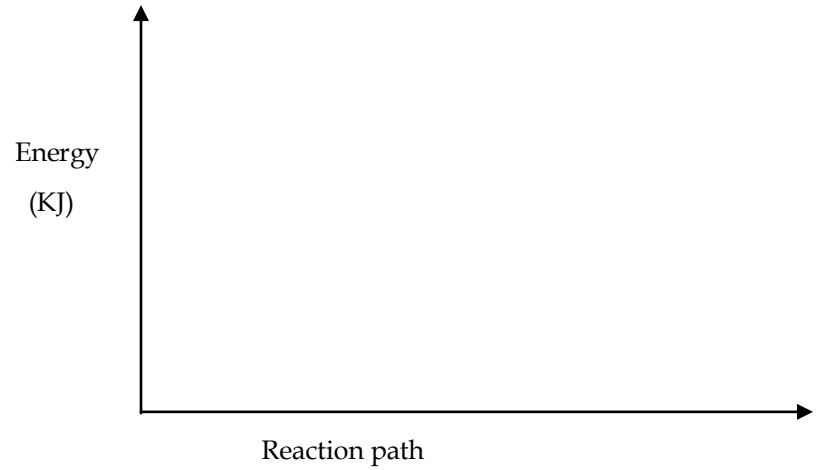
7. 10.0g of ethanol (C_2H_5OH) were completely burnt in air. The heat evolved caused the temperature of 400cm^3 of water to rise from 22^{0}C to 87^{0}C. Calculate the molar heat of combustion of ethanol (H=1, C=12, O=16, specific heat capacity of water = 4.2 kJkg^{-1}k^{-1}; Density of water = 1gcm^{-3})

(3mks)

8. (a) Consider the following reaction: $A_{2(g)} + B_{2(g)} \rightleftharpoons 2AB_{(g)} \quad DH = 75KJ$

Sketch an energy level diagram showing the relative activation energies for the catalysed and uncatalysed reactions using the axes below. (2 marks)



(b)

$Given \quad \Delta H_f(Al_2O_3) = -1590\,KJ\,mol^{-1}$

$\Delta H_f(Cr_2O_3) = -1134KJ\,mol^{-1}$

Calculate the heat of reaction for

$2Al_{(s)} + Cr_2O_{3(s)} \longrightarrow Al_2O_3 + 2Cr_{(s)}$ (2marks)

(c) The following data was obtained during an experiment

Mass of ethanol burnt	=	0.2g
Mass of water in the calorimeter	=	200g
Specific heat capacity of water	=	4.2 j $g^{-1}k^{-1}$
Initial temperature of water	=	23.5 ^{0}C
Final temperature of water	=	28.0 ^{0}C

(i) **How** was the mass of ethanol that burnt determined? (1mark)

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(ii) **How** much heat was required to raise the temperature of water from 23.5 ^{0}C to 28.0^{0}C? (2marks)

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(iii) Two assumptions were made in calculating the enthalpy of combustion for ethanol. **State them**. (1mark)

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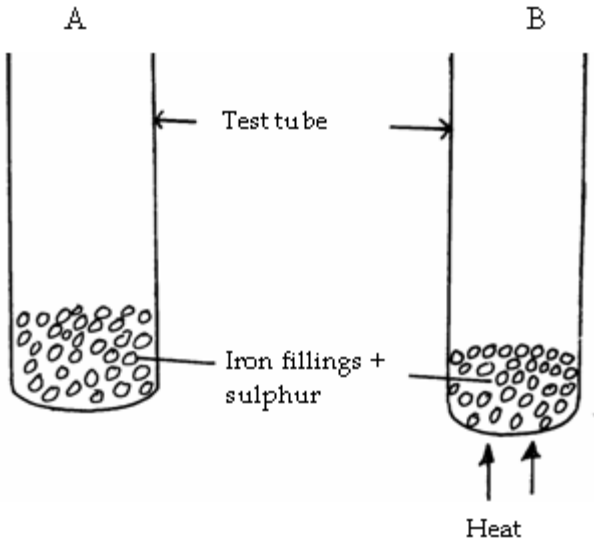
(iv) **Determine** the molar enthalpy of combustion of ethanol
(2marks)
(C= 12, H=1, O= 16)

(v) **Write** a thermochemical equation for the combustion of ethanol given the accurate value for enthalpy of combustion is -1368 Kj mol^{-1}.

(1mark)

9. Iron fillings were thoroughly mixed with sulphur then placed in two test tubes as shown below.



Both test tubes were cooled to room temperature then $3cm^3$ of 2M Hydrochloric acid was added.

a) What is the general name given to the substance in. (2mks)

(i) Test tube A

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(ii) Test tube B

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b) Identify the gas produced when 2M Hydrochloric acid was added to test tube A. Explain your answer. (2mks)

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c) Write an equation for the reaction that takes place when 2M Hydrochloric acid is added to test tube B. (1mk)

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d) In another experiment excess iron powder was added to 25.0cm^3 of 0.2M copper II sulphate solution in a plastic cup wrapped in tissue paper. The temperature of this solution rose from 21.5^{0}C to 31.5^{0}C.

(i) What was the main reason for using a plastic cup wrapped in tissue paper? (1mk)

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(ii) Give reason for using excess iron powder. (1mk)

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(iii) State two other observations made in the above experiment. (2mks)

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(iv) Calculate the molar enthalpy of displacement of copper II ions by iron powder. (3mks) (Density of solution =1.0gcm^{-3} heat capacity of soln 4.2J/g/k.)

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v) Write a Thermo chemical equation for the reaction that took place. (1mk)

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