Seb Academy
Chemistry Homework
Topics: Energy of Reactions
Time allowed: 40 min

Date: _____

Name: _____

Energy of Reactions Homework 1

- State whether the following observations are exothermic or endothermic reaction?

Chemical reactions	Exothermic or endothermic reaction
Br_2 2Br	
CCl_4 (g) C (g) + 4Cl (g)	
2H + 2O H_2O	
2Ca + O_2 2CaO	
NaOH + HCl NaCl + H_2O	
$CuCO_3$ (s) CuO (s) + CO_2 (g)	

- Explain why CCl_4 (g) C (g) + 4H (g) is endothermic in part (b).

[2]

- (2010/O/GCSE/10) Car manufacturers are developing fuel cells for use in cars

  Fuel cells produce electrical energy from the reaction between a fuel and oxygen.
  Two possible turns for use in fuel cells are hydrogen and methanol.
  The table gives some date about these two fuels.

Fuel	Melting point ° C	Boiling point ° C	Energy charge of combustion kJ/mol
Hydrogen	-259	-252	256
Methanol	-97.7	54.5	715

- The table gives values for the change of combustion for each fuel in kJ/mol

- Calculate the energy output for 1g of each fuel

[2]

(2013/RP/S3IP/5) ΔH Calculation: Methane

- (2013/RP/S3IP/5) The table below shows some bond energies, measured in kilojoules per mole.

bond	Bond energy in kJ mol^{-1}
C-C	347
C-H	414
C-O	351
C=O	745
O-H	460
O-O	142

Complete the statements below to calculate the energy change expected from the reaction of methane and oxygen

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g) \qquad \Delta H = ? \text{ kJ}$$

(a) Energy change in breaking the bonds in one mole of CH_4 = ……..kJ

[1]

(b) Energy change in breaking the bonds in two moles of O_2 = ……..kJ

[1]

(c) Energy change in making the bonds in one mole of CO_2 = ……kJ

[1]

(d) Energy change in making the bonds in two moles of H_2O = ……kJ

[1]

(e) Hence ΔH for this reaction = …….kJ

[1]

[Total: 5 marks]

(2007/RP/S4/IP) ΔH Calculation: Ethane

- (2007/RP/S4/IP) The combustion of ethane can be represented by the following equation:

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O \quad \Delta H=?$$

The bond energy data of some chemicals are given in the table below.

Bond	C - H	O = O	C = O	C - O	O - H	C - C
Bond energy (kJ/mol)	432	497	803	323	464	347

(a) Calculate the enthalpy change, ΔH, for the combustion of ethane.

[3]

(b) Using your answer in **(a)**, calculate the energy liberated when 60.0 g of ethane is combusted.

[1]

(c) Draw an energy profile diagram to represent the combustion process. On your diagram, label activation energy and enthalpy change clearly.

[2]

(d) Explain why the reaction is exothermic in terms of bond breaking and bond forming.

Bonding breaking is an _____ process.

Bonding forming is an _____ process.

There is _____ energy _____ in bond forming than energy _____ in bond breaking. As such, the overall reaction is exothermic

[2]

[Total: 8 marks]

(2012/RP/S3IP/6) hydrogen peroxide and enthalpy change and moles

- (2012/RP/S3IP/6) Aqueous hydrogen peroxide decomposes rapidly to give oxygen and water when manganese(IV) oxide is added. The reaction can be represented by the following equation:

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g); \quad \Delta H = -196 \text{ kJ}$$

(a) Explain what is meant by $\Delta H = -196$ kJ.

[2]

(b) In terms of bond breaking and bond making, explain how this energy change occurs.

[1]

(c) Calculate the change in enthalpy, ΔH, when 1.00 g of hydrogen peroxide decomposes.

[2]

(d) Predict the oxidation state of manganese in manganese(IV) oxide after the reaction completes.

[1]

[Total: 6 marks]

(2015/S4/RP/MYCT/5) ΔH Calculation Hydrogen Fuel Cell

- (2015/S4/RP/MYCT/5) Fuel cells may be used to power cars. One type of fuel cell produces electricity from the reaction of hydrogen with oxygen to produce water.

(a) Suggest a reason why using this type of fuel cell is less polluting than using petrol.

[1]

(b) Write the balanced equation for this reaction.

[1]

(c) Using the bond energies given below, calculate the overall enthalpy change for this reaction.

Chemical bond	Bond energy / kJ mol^{-1}
O – O	146
O = O	496
O – H	463
H – H	436

		[3]
	(d)	Represent the above reaction on a labeled energy profile diagram. Indicate on your diagram the activation energy (E_a) and overall enthalpy change (ΔH) of the reaction.
		[4]

Answers				
1	State whether the following observations are exothermic or endothermic reaction?			
		Chemical reactions	**Exo or endo**	
(a)	**(i)**	Br_2 2Br	Endothermic	Energy is absorbed to break the bond between Br-Br molecule.
	(ii)	CCl_4 (g) C (g) + 4Cl (g)	Endothermic	Energy is absorbed to break the bonds between 4 C-Cl molecule in CH_4.
	(iii)	2H + 2O H_2O	Exothermic	Energy is released to form the bonds between 2 O-H molecule in H_2O.
	(iv)	2Ca + O_2 2CaO	Exothermic	Combustion (reaction with oxygen) is always exothermic.
	(v)	NaOH + HCl NaCl + H_2O	Exothermic	Neutrlalization is always exothermic.
	(vi)	$CuCO_3$ (s) CuO (s) + CO_2 (g)	Endothermic	Decomposition is always endothermic. Heat energy is absorbed to break bonds.

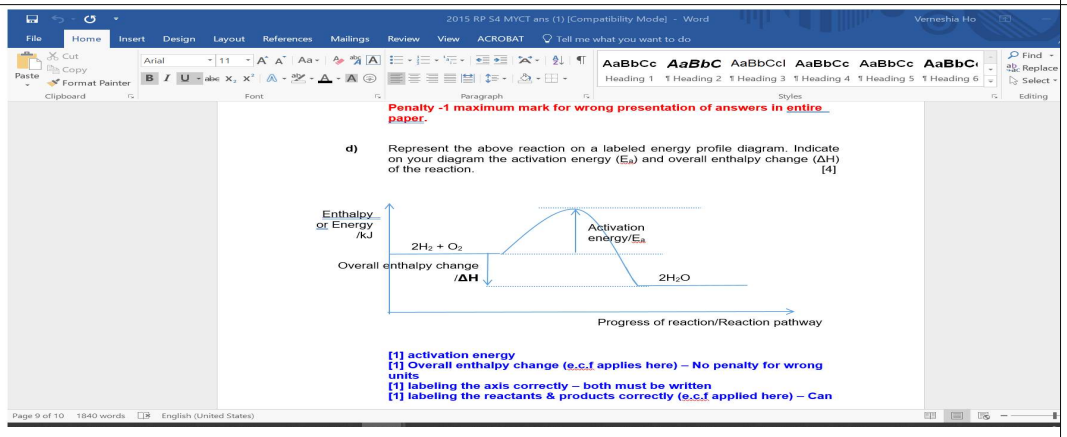
2		**(i)**	Energy output for 1g of hydrogen = 256 / 2 = 128 kJ Energy output for 1g of methanol = 715 / 32 = 22.34 kJ	2

Answers			
3	**(a)**	+1656 kJ	1
	(b)	+1656 kJ	1
	(c)	-1490 kJ	1
	(d)	-1840 kJ	1
	(e)	-676 kJ [-1] no sign / wrong sign (parts i to iv) [-1] no sign (part v)	1

Answers			
4	**(a)**	$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ Energy absorbed to break 6 C-H and 1 C-C and 7 O=O = (2X6X432) + 347 + (7X497) = 9010 KJ Energy given out to form 8 C=O and 12 O-H = (8X803) + (12X464) = 11 992 KJ ΔH = (+9010) + (-11,992) = - 2982 KJ/mol	1 1 1
	(b)	M_r of ethane = 30 60 g of ethane is two moles Therefore, 2982 KJ of energy is liberated with 60 g of ethane.	1

	(c)		2

Answers			
5	**(a)**	The reaction is exothermic / 196 kJ of heat energy is released [1] when two moles of hydrogen peroxide reacts [1] (to give two moles of water and a mole of oxygen).	2
	(b)	The difference between the energy absorbed to break the bonds of hydrogen peroxide and the energy released by formation of bonds in water and oxygen is the energy change.	1
	(c)	Amount of H_2O_2 = 1.00 / 34 = 0.02941 mol ΔH = 0.02941 x (196 / 2) = 2.88 kJ (reject if without negative sign)	2
	(d)	+4	1

Answers			
6	**(a)**	Does not produce soot or other carbon products or SO_2 or oxides of nitrogen/ produces water as the only product	1
	(b)	$2H_2$ (g) + O_2 (g) $2H_2O$ (l)	1
	(c)	Overall enthalpy change = (436 x 2 + 496) - (463 x 2 x 2) = -484 kJ or kJ/mol	3
	(d)		4