

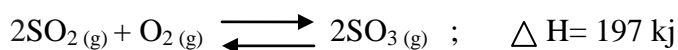
NAME \_\_\_\_\_ INDEX NUMBER \_\_\_\_\_

SCHOOL \_\_\_\_\_ DATE \_\_\_\_\_

## ENERGY CHANGES

1. 1989 Q 2 P1A

The catalytic oxidation of sulphur dioxide is represented by the following equation:



(i) What information about the reaction is given  $\Delta H = 197 \text{ kJ}$ ?

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(ii) Name one catalyst that can be used in this section

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2. 1990 Q 15 P1A

The following experiments were performed and the temperature change in each case was determined. 107g of solid potassium hydroxide was dissolved in 100m<sup>3</sup> of water.

(i) 0.7g of solid potassium hydroxide was dissolved in 100cm<sup>3</sup> of 0.125M hydrochloric acid.

(ii) 50 cm<sup>3</sup> solution containing 0.7 g of potassium hydroxide was mixed with 50cm<sup>3</sup> of 0.25m hydrochloric acid.

(a) In which one of the above three experiments would you expect the highest temperature change? Explain your answer.

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(b) If the heat releases in experiment I is  $\Delta H_I$   $\Delta H_{II}$  and  $\Delta H_{III}$  (1 Mark)

3. 1990 Q 23 P1A

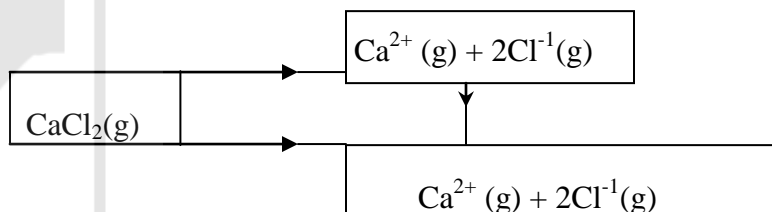
When  $20\text{cm}^3$  of  $0.5\text{ M}$  sulphuric acid was mixed with  $20\text{cm}^3$  of  $1\text{ M}$  sodium hydroxide, the temperature of the solution changed from  $24.2^\circ\text{C}$  to  $31.1^\circ\text{C}$ . Calculate the molar heat of neutralization.  
(Specific heat capacity of the solution is  $4.2\text{ J deg}^{-1}\text{ g}^{-1}$  and its density is  $1\text{ g cm}^3$ )

4. 1990 P1A Q27

(a) In a class experiment  $5.0\text{ g}$  of ethanol  $\text{CH}_3\text{CH}_2\text{OH}$ , were completely burnt and all the heat evolved was used to heat  $500\text{ cm}^3$  of from  $20^\circ\text{C}$  to  $80^\circ\text{C}$ . Given that the specific heat capacity of water =  $4.2\text{ j g}^{-1}\text{ deg}^{-1}$  density of water =  $1\text{ g cm}^3$ ,  $C = 12.0$ ,  $H = 1.0$   
Write a balanced equation to show the reaction that takes place when ethanol burns. (1 mark)

Given out when one mole of ethanol was burned completely. (2 marks).

(c) Use the information in the energy cycle diagram below to



(i) What name is given to the enthalpy change

I  $\Delta H_2$  .....

I  $\Delta H_3$  .....

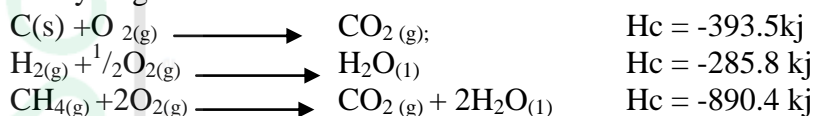
(ii) Given that  $\Delta H_1 = 2237 \text{ kJ}$  and  $\Delta H_2 = 22378 \text{ kJ}$ , calculate the value of  $\Delta H_3$   
(2 marks)

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**5. 1991 Q 5 P1A**

The equation below show the molar enthalpies of combustion for carbon, hydrogen and methane



Use the above information to answer the questions below:

(i) Write the equation for the formation of methane from its elements.

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(ii) Calculate the molar enthalpy of formation for methane

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**6. 1992 P1A Q 4**

4g of methanol ( $\text{CH}_3\text{OH}$ ) requires 93.5 kJ to vaporize completely. Calculate the heat required to vaporize one mole of methanol completely ( $\text{C}=12.0$ ,  $\text{H}=1.0$ ,  $\text{O}=16.0$ )  
(2 marks)

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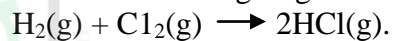
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7. 1992 P1A Q9

Draw an energy diagram for the reaction, on the diagram show clearly the activation energy and enthalpy of reaction.

8. 1992 P1A Q10

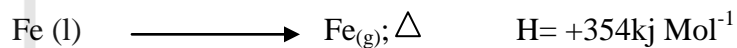
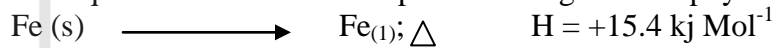
Use the bond energies given below to calculate the heat of reaction for



Bond	Bond energy
H-H	435 KJ Mol <sup>-1</sup>
CL-CL	243 KJ Mol <sup>-1</sup>
H-CL	431 kJ Mol <sup>-1</sup>

9. 1993 P1A Q2

The equations below would represent changes in the physical states for



10. 1993 P1A Q4

Given that the lattice energy of NaCl is  $+771 \text{ kJ Mol}^{-1}$  and hydration energy of  $\text{Na}_{(s)}$  & are  $496 \text{ kJ Mol}^{-1}$  and  $364 \text{ kJ Mol}^{-1}$  respectively.

Calculate the heat of solution for one mole of  $\text{NaCl}_{(s)}$ . (2 marks)

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11. 1993 P1A Q 10

Nitrogen and oxygen react according to the equation



If the reaction was allowed to reach equilibrium, explain the effect on the yield of  $\text{NO}_{(g)}$  if the temperature below was increased. (2 marks)

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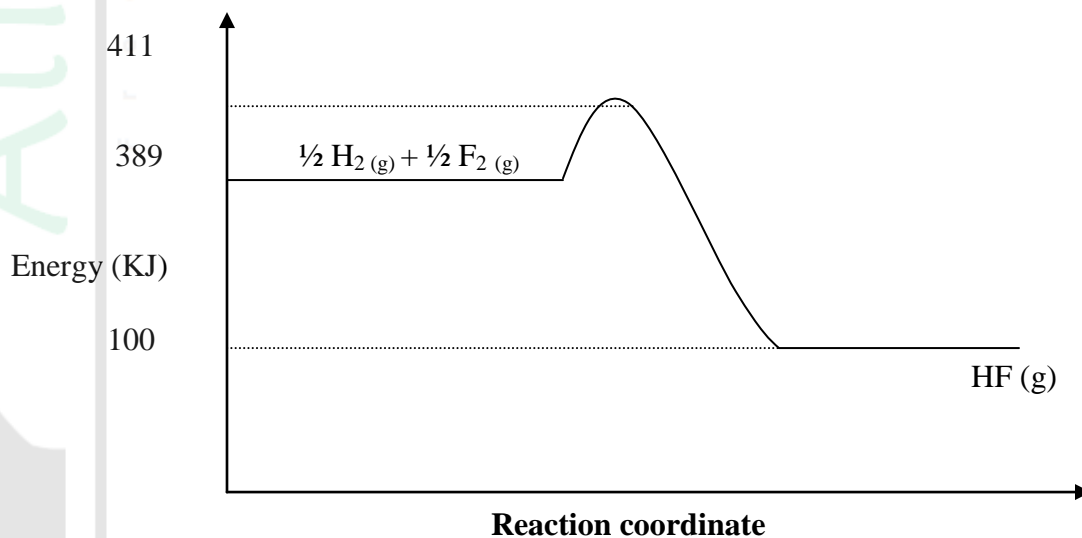
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12. 1994 1A Q 11

Below is an energy level diagram for the reaction:  $\frac{1}{2} \text{H}_2(\text{g}) + \frac{1}{2} \text{F}_2(\text{g}) \longrightarrow \text{HF}(\text{g})$



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13. 1994 P1A Q18

When excess magnesium powder was added to 100cm<sup>3</sup> of 0.5M iron (II) sulphate solution, the pale green colour of the solution faded and the temperature rose by 6.0 °C.

(a) Write an ionic equation for the reaction that takes place. (1 mark)

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(b) Calculate the molar heat of reaction given that heat change = mass × temperature change × 4.2 jg<sup>-1</sup>°C<sup>-1</sup> and the density of solutions is 1.0gcm<sup>-3</sup> (2 marks)

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14. 1995 1A Q26

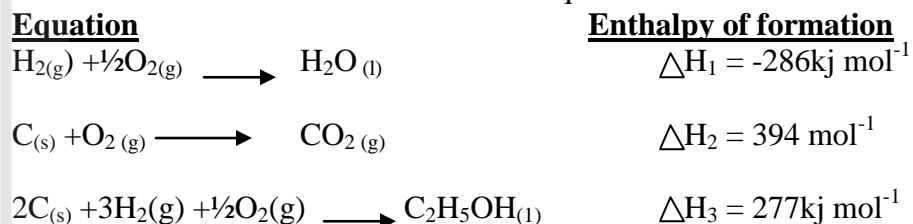
Explain why the enthalpy of neutralization of ethanoic acid with sodium hydroxide is different from that of hydrochloric acid with sodium hydroxide.

(2 marks)

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15. 1996 P1A Q 19

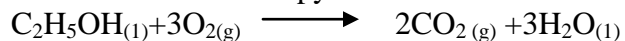
Use the information below to answer the questions that follow:-



(a) Define the term enthalpy of formation of a compound (1 mark)

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(b) Calculate the molar enthalpy of combustion  $\Delta H_c$  of ethanol:



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16. 1997 PP1B Q5

The reaction between bromine and methanoic acid at  $30^\circ\text{C}$  proceeds according to the information given below



Concentration of $\text{Br}_2(\text{aq})$ $\text{Mol dm}^{-3}$	Time minutes
$10.0 \times 10^{-3}$	0
$8.1 \times 10^{-3}$	1
$6.6 \times 10^{-3}$	2
$4.4 \times 10^{-3}$	4
$3.0 \times 10^{-3}$	6
$2.0 \times 10^{-3}$	8
$1.3 \times 10^{-3}$	10

(a) On the grid below, plot a graph of concentration of Bromine (Vertical axis against time)

(b) From the graph determine:

(i) The concentration of bromine at the end of 3 minutes

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(ii) The rate of reaction at time 't' where  $t = 1 \frac{1}{2}$  minutes

(c) Explain how the concentration of bromine affects the rate of reaction

(d) On the same axis sketch the curve that would be obtained if the reaction was carried out at  $20^{\circ}\text{C}$  and label the curve as curve II. Give a reason for your answer.

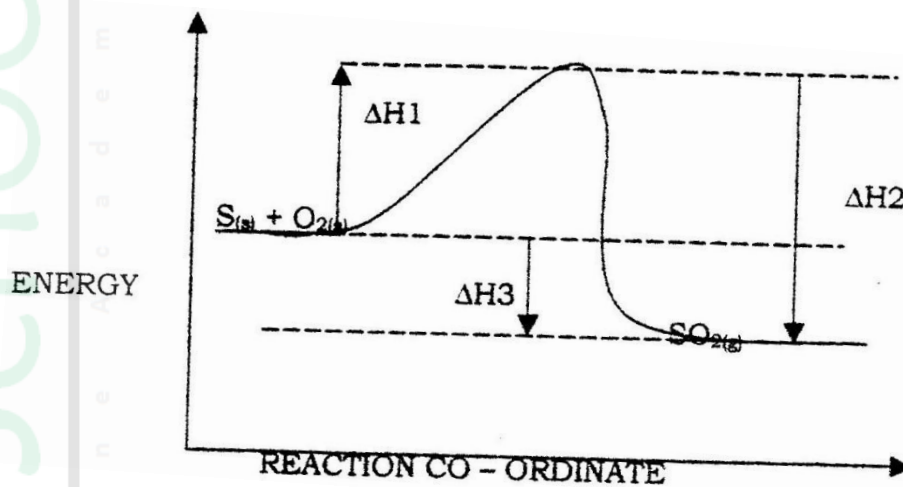
17. 1997 P1A Q 20

When 0.6g of element J were completely burnt in oxygen and all the heat evolved was used to heat  $500\text{cm}^3$  of water, the temperature of the water rose from  $23^{\circ}\text{C}$  to  $32^{\circ}\text{C}$ . Calculate the relative atomic mass of element J given that the specific heat capacity of water =  $4.2\text{KJ}^{-1}\text{g}^{-1}$  density of water =  $1.0\text{g}/\text{cm}^3$  and molar heat of combustion of j is  $380\text{KJmol}^{-1}$ . (3 marks)



18. 1997 P1A Q 13

Sulphur burns in air to form sulphur dioxide. A simple energy level diagram for the reaction is given below. Study the diagram and answer the questions that follow.



a) What do the following represent?

i)  $\Delta H_1$

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ii)  $\Delta H_3$

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b) Write an expression, for  $\Delta H_3$  in terms of  $\Delta H_1$  and  $\Delta H_2$

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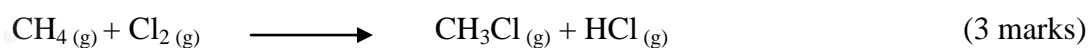
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19. 1998 Q 16 P1

Study the information given in the table below and answer the questions below the table:

Bond	Bond energy (kJmol <sup>-1</sup> )
C — H	414
Cl — Cl	244
C — Cl	326
H — Cl	431

Calculate the enthalpy change for the reaction.



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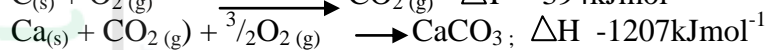
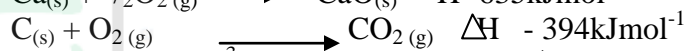
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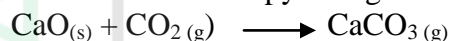
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**20. 1999 P1 Q15**

Use the information below to answer the information that follows



Calculate the enthalpy change for the reaction.



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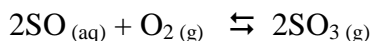
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**21. 1999 Q 6d P2**

The reaction between sulphur dioxide and oxygen to form trioxide in the contact process is exothermic.



Factory manufacturing sulphuric acid by contact process produces 350kg of sulphur trioxide per day (conditions) for the reaction catalyst. 2 atmospheres pressure and temperatures between. (400 – 500 °C)

i) What is meant by an exothermic reaction?

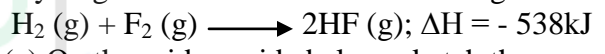
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ii) How would the yield per day of sulphur trioxide be affected  
Temperatures lower than 4000°C are used? Explain.

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22. 2000 Q 24

Hydrogen and fluorine react according to the equation below



(a) On the grid provide below, sketch the energy level diagram for the forward reaction

(b) Calculate the molar enthalpy of formation of HF

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23. 2001 Q 2

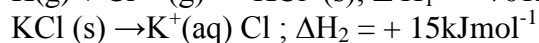
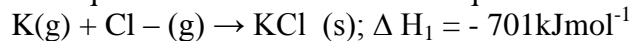
In an experiment, 0.8gm of magnesium of powder were reacted with excess dilute sulphuric acid at 25°C. The time for the reaction to come to completion was recorded.

The experiment was repeated at 40°C. In which experiment was the time taken shorter?  
Explain your answer.

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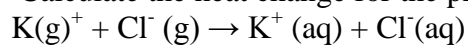
24. 2002 Q 13

Use the equations below to answer the questions that follow



(a) What is the name of  $\Delta H_1$ ? .....

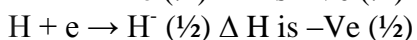
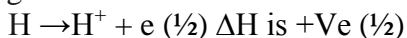
(b) Calculate the heat change for the process



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25. 2003 Q 5

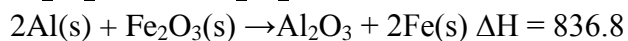
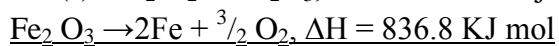
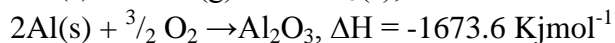
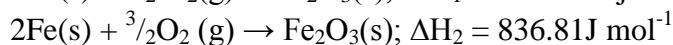
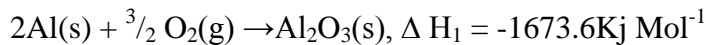
An atom of hydrogen can form two ions. Write two equations to show how a neutral atom of hydrogen can form two ions. In each case show the sign of the energy change involved.



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26. 2003 Q 3

Use the following equations to determine the heat evolved when aluminum metal is reacted with iron (III) oxide (3 marks)



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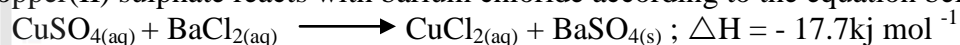
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27. 2004 Q 5

Copper(II) sulphate reacts with barium chloride according to the equation below.



Calculate the temperature change when 900cm<sup>3</sup> of m copper (II) sulphate were added to 600cm<sup>3</sup> of 1M Barium (II) chloride.

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28. 2004 Q 9

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

Alcohol	Heat of combustion on KJ mol <sup>-1</sup>
Methanol	715
Ethanol	1371
Propanol	2010
Butanol	2673

Give a reason why the difference in the molar heats of combustion between successive alcohols are close.

(3 marks)

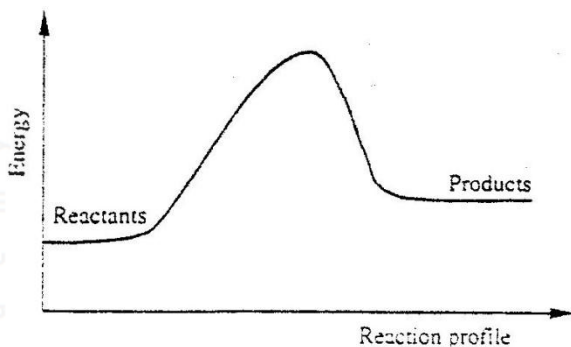
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29. 2004 Q 25

Below is a sketch of a reaction profile.



- a) On the diagram, show the heat of reaction,  $\Delta H$ . (1 mark)
- b) State and explain the type of reaction represented by the profile (2 marks)

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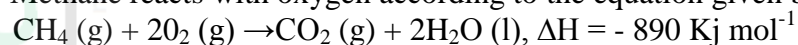
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30. 2005 Q 13

Methane reacts with oxygen according to the equation given below.



Calculate the volume of methane which would produce 111.25 KJ when completely burnt. (Molar volume of a gas = 24 litres.) (2 marks)

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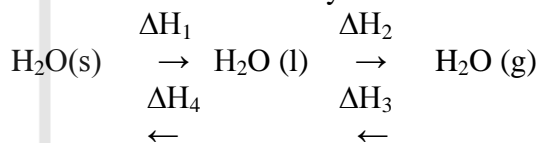
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31. 2005 Q 19

The scheme below shows the energy changes that are involved between ice, water and steam. Study it and answer the questions that follow



- (a) What name is given to the energy change,  $\Delta H_4$ ? (1 mark)

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- (b) What is the sign of  $\Delta H_3$ ? Give a reason (2 marks)

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32. 2006 Q 9

At 200C,  $\text{NO}_2$  and  $\text{N}_2\text{O}_4$  gases exist in equilibrium as shown in the equation



copper, 0.15g of magnesium powder were added to 25.0cm<sup>3</sup> of 2.0M copper (II) chloride solution. The temperature of copper (II) chloride solution was 25°C. While that of the mixture was 43°C.

i) Other than increase in temperature, state and explain the observations which were made during the reaction. (3 marks)

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ii) Calculate the heat change during the reaction (specific heat capacity of the solution = 4.2Jg<sup>-1</sup>K<sup>-1</sup> and the density of the solution = 1g/cm<sup>3</sup>) (2 marks)

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iii) Determine the molar heat of displacement of copper by magnesium. (Mg=24.0).

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iv) Write the ionic equation for the reaction. (1 mark)

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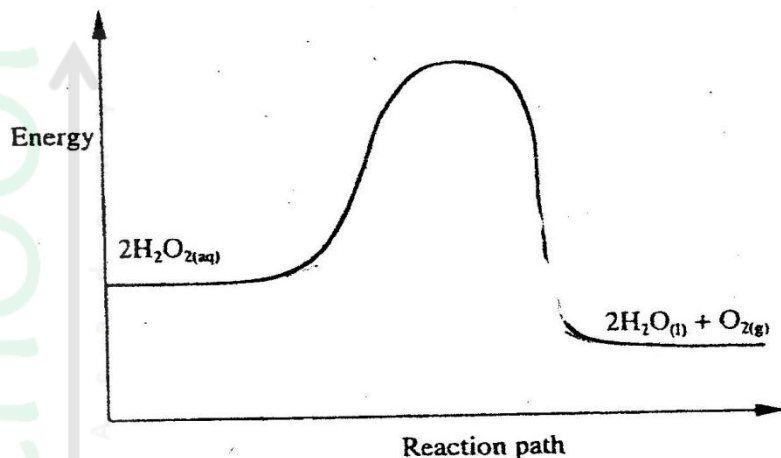
v) Sketch an energy level diagram for the reaction. (2 marks)

35. 2007 Q 27

The diagram below is a sketch of the graph of the non-catalysed decomposition of hydrogen peroxide.

(1 mark)





On the same axis, sketch the graph for the decomposition of hydrogen peroxide when manganese (IV) oxide is added. (2 marks)

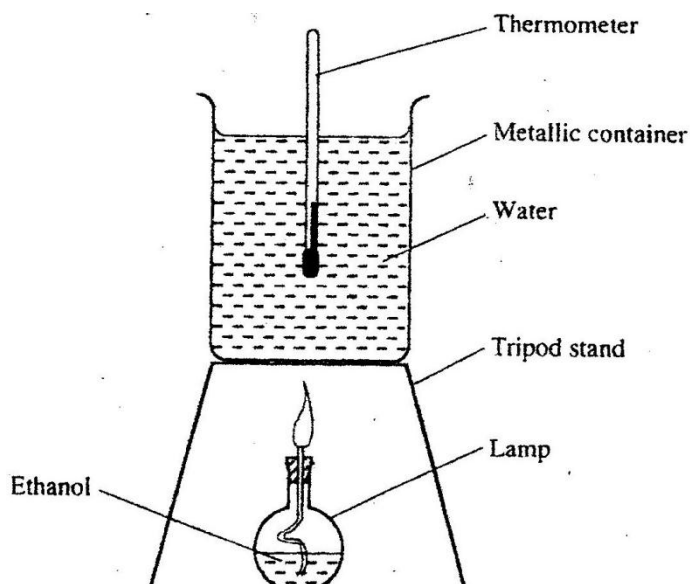
36. 2007 Q 1 P2

(a) State two factors that should be considered when choosing fuel for cooking (2 marks)

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(b) The diagram below represents a set – up that was used to determine the molar heat of combustion of ethanol



During the experiment, the data given below was recorded

Volume of water 450cm<sup>3</sup>

Initial temperature of water	25 <sup>0</sup> C
Final temperature of water	46.5 <sup>0</sup> C
Mass of ethanol + Lamp before burning	125.5g
Mass of ethanol + lamp after burning	124.0g

Calculate the:

- (i) Heat evolved during the experiment (density of water = 1g/cm<sup>3</sup>  
Specific heat capacity of water = 4.2 Jg<sup>-1</sup>K<sup>-1</sup>) (3 marks)

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- (ii) Molar heat of combustion of ethanol (C = 12.0, O = 16.0, H=1.0) (2 marks)

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- (c) Write the equation for the complete combustion of ethanol (1 mark)

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- (d) The value of the molar heat of combustion of ethanol obtained in (b) (ii) above is lower than the theoretical value. State two sources of error in the experiment. (2 marks)

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**37. 2008 Q 7 P2**

- (a) Define the standard enthalpy of formation of a substance (1 mark)

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- (b) Use the thermo chemical equations below to answer the questions that follow.

- $C_2H_6(g) + \frac{7}{2} O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l); \quad \Delta H_1 = -1560kJmol^{-1}$
- $C_{(graphite)} + O_2(g) \rightarrow CO_2(g); \quad \Delta H_2 = -394kJmol^{-1}$
- $H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(g) \quad \Delta H_3 = -286kJmol^{-1}$

- (i) Name two types of heat changes represented by  $\Delta H_3$  (2 marks)

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(ii) Draw an energy level diagram for the reaction represented by equation 1

(iii) Calculate the standard enthalpy of formation of ethane (2 marks)

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(iv) When a sample of ethane was burnt, the heat produced raised the temperature of 500g of water by 21.5 K, (specific heat capacity of water =  $4.2\text{Jg}^{-1}\text{K}^{-1}$ ).

Calculate the:

I. Heat change for the reaction (2 marks)

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II. Mass of ethane was burnt. ( relative formula mass of ethane= 30) (2 marks)

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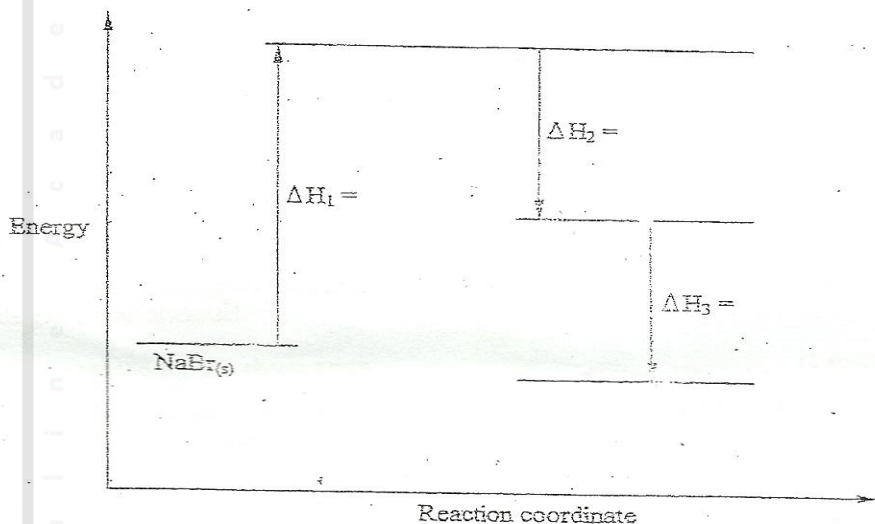
38.

2009 Q 9

(a) What is meant by molar heat of solution?

(1 mark)

(b) The lattice energy of sodium bromide and hydration energies of sodium and bromide ions are: 733,406 and 335 kJ mol<sup>-1</sup> respectively

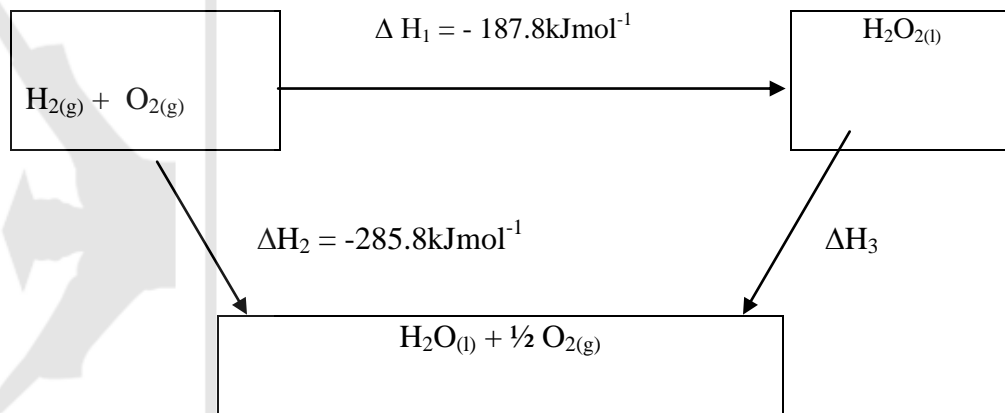


(i) Complete the energy cycle diagram above by inserting the values of  $\Delta H_1$ ,  $\Delta H_2$  and  $\Delta H_3$

(ii) Determine the molar heat of solution of solid sodium bromide ( 1/2 )

39. 2010 Q 10

The figure below shows an energy cycle.



a) Give the name of the enthalpy change  $\Delta H_1$ .

(1 mark)

b) Determine the value of  $\Delta H_3$ . (2 marks)

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40. 2010 Q 12

A beaker contained  $75.0\text{cm}^3$  of aqueous copper (II) sulphate at  $23.7^\circ\text{C}$  when scrap iron metal was added to the solution, the temperature rose to  $29.3^\circ\text{C}$ .

a) Write an ionic equation for the reaction that took place. (1 mark)

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b) Given that the mass of copper deposited was 5.83g, calculate the molar enthalpy change in  $\text{kJmol}^{-1}$ . (Specific heat capacity of solution =  $4.2\text{Jg}^{-1}\text{K}^{-1}$ , density of solution  $1.0\text{gcm}^{-3}$ , Cu = 63.5) (2 marks)

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41. 2010 Q 4b

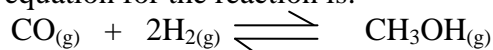
a) The standard enthalpy change of formation of methanol is  $-239\text{kJmol}^{-1}$ .

i) Write the thermal chemical equation for the standard enthalpy change of formation of methanol. (1 mark)

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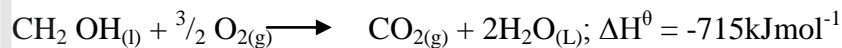
ii) Methanol is manufactured by reacting carbon(II)oxide with hydrogen at  $300^\circ\text{C}$  and a pressure of 250 atmospheres.

The equation for the reaction is:



(I) How would the yield of methanol be affected if the manufacturing process above is carried out at  $300^\circ\text{C}$  and a pressure of 400 atmosphere? Explain (2 marks)

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(II) Use the following data to calculate the enthalpy change for the manufacture of methanol from carbon(II)oxide and hydrogen (3 marks)



ii) The calculate enthalpy change in part B(ii) (II) above differ from the standard enthalpy change of formation of methanol. Give a reason. (1 mark)

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42. 2011 Q 23

The thermal chemical reaction between carbon and sulphur is as shown by the equation below



On the grid below, sketch and label the energy diagram for the reaction. (2 marks)

Energy



Reaction co-ordinate

43. 2011 Q 7 P2

a) What is meant by molar heat of combustion? (1 mark)

b) State the Hess's Law. (1 mark)

Use the following standard enthalpies of combustion of graphite, hydrogen and enthalpy of formation of propane.

$$\Delta H_c (\text{Graphite}) = -393 \text{ KJ mol}^{-1}$$

$$\Delta H_c (\text{H}_2(\text{g})) = -286 \text{ KJ mol}^{-1}$$

$$\Delta H_f (\text{C}_3\text{H}_8(\text{g})) = -104 \text{ KJ mol}^{-1}$$

i) Write the equation for the formation of propane. (1 mark)

ii) Draw an energy cycle diagram that links the heat of formation of propane with its heat of combustion of graphite and hydrogen. (3 marks)

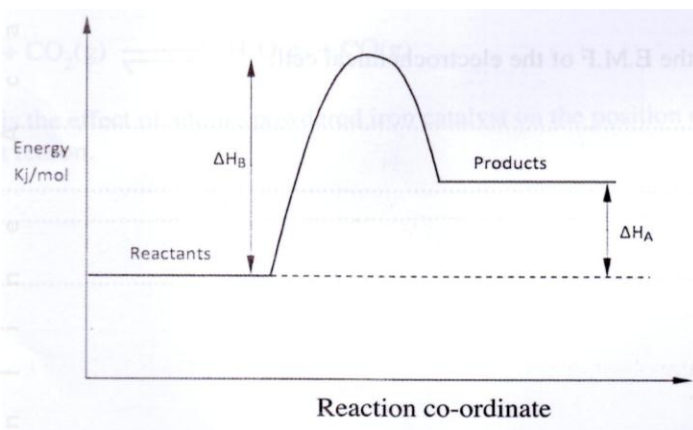
iii) Calculate the standard heat of combustion of propane (2 marks)

d) Other than the enthalpy of combustion, state one factor which should be considered when choosing a fuel. (1 mark)

e) The molar enthalpies of neutralization for dilute hydrochloric acid and dilute nitric (V) acid are 57.22 KJ/mol while that of ethanoic acid is -55.2 KJ/mol. Explain this observation. (2 marks)

44. 2012 Q17 P1

Study the energy level diagram below and answer the questions that follow.



(a) Give the name of  $\Delta H_A$  (2 marks)

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(b) How can  $\Delta H_B$  be reduced? Give a reason (2 marks)

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