CHEMISTRY ONLINE
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CHEMISTRY

Physical Chemistry

Level & Board	AQA (A-LEVEL)
TOPIC:	ENERGETICS
PAPER TYPE:	QUESTION PAPER - 4
TOTAL QUESTIONS	10
TOTAL MARKS	42

Energetics - 4

1. This question is about enthalpy.

(a) Define the term standard enthalpy of formation.

(2)

(b) State Hess's Law and use it, together with the data given in the table below, to calculate the standard enthalpy change for the following reaction.

$MgO(s) + 2HCl(g) \rightarrow MgCl_2(s) + H_2O(l)$

	MgO	HCl(g)	$MgCl_2$	H_2O
ΔH_f /kJ mol^{-1}	–602	–92	–642	–286

(3)

(c) In an experiment, an excess of solid magnesium oxide was added to 50 cm^3 of 3.0 mol dm^{-3} hydrochloric acid.
The initial temperature of the solution was 21 °C. After reaction, the temperature had risen to 53 °C.

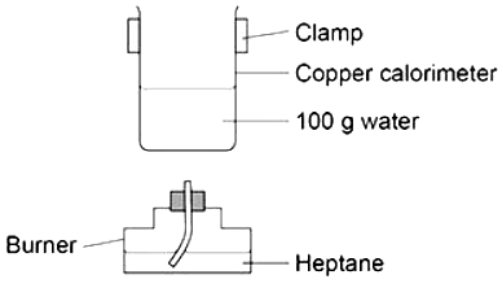
(The specific heat capacity of water is 4.2 J K^{-1} g^{-1})

Use this information to calculate the enthalpy change for the reaction of one mole of magnesium oxide with hydrochloric acid.

For your calculation you should assume that all the heat from the reaction is used to raise the temperature of 50 g of water.

(6)

2. A student conducts an experiment to determine the enthalpy of combustion for heptane.
The image provided below illustrates some of the apparatus used.



(a) Create a table layout to record all the necessary measurements for calculating the experimental enthalpy of combustion for heptane in this experiment.

(2)

(b) The student contemplates employing a glass beaker on a tripod and gauze instead of the clamped copper calorimeter.
Mention two drawbacks of utilizing a glass beaker on a tripod and gauze.

(2)

(c) Propose two factors explaining why the enthalpy of combustion obtained in this experiment might be less exothermic compared to the value found in a data book.

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(2)

(d) Suggest one modification to this apparatus that would enhance the accuracy of the enthalpy value obtained.

(1)

3. State what is meant by the term mean bond enthalpy?

(2)

4. When ethanamide (CH_3CONH_2) burns in oxygen the carbon is converted into carbon dioxide, the hydrogen is converted into water and the nitrogen forms nitrogen gas.

Substance	ethanamide	carbon dioxide	water
Enthalpy of formation / kJ mol^{-1}	−320	−394	−286

Using the data above, which one of the following is a correct value for the enthalpy of combustion of ethanamide?

A. −1823 kJ mol^{-1}
B. −1183 kJ mol^{-1}
C. −1000 kJ mol^{-1}
D. −360 kJ mol^{-1}

(1)

5. Given the following data

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$C(s) + 2H_2(g) \rightarrow CH_4(g)$ $\Delta H = -75$ kJ mol^{-1}

$H_2(g) \rightarrow 2H(g)$ $\Delta H = +436$ kJ mol^{-1}

which one of the following is the enthalpy change, in kJ mol^{-1}, of the reaction below?

$CH_4(g) \rightarrow C(s) + 4H(g)$

A. −947
B. +511
C. +797
D. +947

(1)

6.

(a) Write an equation for the complete combustion of propanone, C_3H_6O, to form carbon dioxide and water.

(1)

(b) In a laboratory experiment, 1.45 g of propanone were burned completely in oxygen.

The heat from this combustion was used to raise the temperature of 100 g of water from 293.1 K to 351.2 K.

i. Calculate the number of moles of propanone in the 1.45 g.

(1)

ii. Calculate the heat energy required to raise the temperature of 100 g of water from 293.1 K to 351.2 K.

(The specific heat capacity of water is 4.18 J K^{-1} g^{-1})

(2)

iii. Hence, calculate a value, in kJ mol^{-1} , for the enthalpy of combustion of propanone.

(2)

7. Some fuel in a spirit burner is burned, and the heat produced is used to heat a container of water.
In this experiment:
The mass of water heated = mg
The temperature rise = y °C
The specific heat capacity of water = c J K^{-1} g^{-1}
What is the amount of heat energy absorbed by the water?

A. mcy
B. mc(y + 273)
C. y / mc
D. (y + 273) / mc

(1)

8. Nitrogen dioxide is produced from ammonia and air as shown in these equations

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$ $\Delta H = -909$ kJ mol^{-1}

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ $\Delta H = -115$ kJ mol^{-1}

What is the enthalpy change (in kJ mol^{-1}) for the following reaction?

$4NH_3(g) + 7O_2(g) \rightarrow 4NO_2(g) + 6H_2O(g)$

A. −679
B. −794
C. −1024
D. −1139

(1)

9. Define the terms enthalpy of atomisation and lattice dissociation enthalpy.

(4)

10. A 50.0 cm^3 sample of a 0.200 mol dm^{-3} solution of silver nitrate was placed in a polystyrene beaker.

An excess of powdered zinc was added to this solution and the mixture stirred. Zinc nitrate, $Zn(NO_3)_2$, and silver were formed and a rise in temperature of 3.20 °C was recorded.

(a) Write an equation for the reaction between silver nitrate and zinc.

(1)

(b) Calculate the number of moles of silver nitrate used in the experiment.

(2)

(c) Calculate the heat energy evolved by the reaction in this experiment assuming that all the energy evolved is used to heat only the 50.0 g of water in the mixture.

(Specific heat capacity of water is 4.18 J g^{-1} K^{-1})

(2)

(d) Calculate the heat energy change for the reaction per mole of zinc reacted.

(2)

(e) Explain why the experimental value for the heat energy evolved in this experiment is less than the correct value.

(1)

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