CHEMISTRY ONLINE
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CHEMISTRY

Physical Chemistry

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

Energetics - 4

1.

(a)

The standard enthalpy of formation (ΔH_f°) refers to the enthalpy change when one mole of a substance is formed from its constituent elements, with all substances in their standard states, usually at 298K (25°C) and 100 kPa (or standard conditions).

(2)

(b)

Hess's Law states that the total enthalpy change for a chemical reaction is the same, regardless of the number of steps taken to achieve the final products, provided the initial and final conditions are the same

$\Delta H = \Sigma\Delta H_f$ products - $\Sigma\Delta H_f$ reactants (or cycle)

$\Delta H = \Delta H$products$-\Delta H$reactants

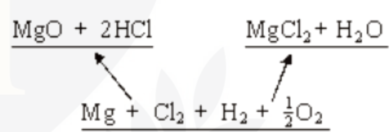
Given:

ΔH_f for MgO = -602 kJ/mol

ΔH_f for HCl = -92 kJ/mol

ΔH_f for $MgCl_2$ = -642 kJ/mol

ΔH_f for H_2O = -286 kJ/mol



The enthalpy change for the reaction

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

Can be calculated using the enthalpies of formation as:

$\Delta H = -642 kJ/mol - 286 kJ/mol - (-602 kJ/mol + 2\times(-92 kJ/mol))$

$\Delta H = -142 kJ/mol$

(3)

(c)

Given:

$m = 50g$

$c = 4.2 J\ K^{-1}g^{-1}$

$\Delta T = 32K$

$\Delta H = mc\Delta T$

$= 50 \times 4.2 \times 32$

$= 6720$ J

= 6.72kJ
Moles of HCl
=Volume×Concentration/1000
=50×3/1000
=0.15
Moles of MgO reacted
= moles HCl/2
= 0.15/2
= 0.075
Calculate the enthalpy change (ΔH):
$\Delta H = mc\Delta T$
=50×4.2×32
=6720J
=6.72kJ
ΔH=6.72kJ/0.075
$=-90 kJ\ mol^{-1}$

(6)

2.

(a)

A table layout is given below to record all the necessary measurements for calculating enthalpy of combustion for heptane:

	Temp/ °C		Mass /g
Initial		Burner before	
Final		Burner after	
(ΔT)		(Mass heptane burned)	

(2)

(b)

Two drawbacks of utilizing a glass beaker on a tripod and gauze could be:

- **Glass is a poorer conductor than copper:** copper conducts heat better than glass.
- **Tripod and gauze reduce direct heat transfer and maintain a fixed height above the flame:** this setup controls heat exposure but may lead to uneven heat distribution.

- **Metal (like copper) generally has lower heat capacity compared to glass:** metals usually have lower heat capacities compared to glass.

(2)

(c)

Following are the two factors:

- **Heat loss to surroundings :** Heat escaping to the surroundings or being absorbed by the apparatus (like the calorimeter) can lead to a lower measured enthalpy of combustion.
- **Incomplete combustion :** If the combustion process is incomplete, generating by-products like carbon monoxide or soot instead of complete conversion into expected products, it will release less energy, resulting in a lower observed enthalpy of combustion.

(2)

(d)

- **Wind Shield to Reduce Heat Loss:** Employ a wind shield to minimize heat loss caused by air currents.
- **Using a Lid:** Cover the calorimeter with a lid to contain heat and prevent heat loss due to evaporation or gas escape.

(1)

3.

The term "mean bond enthalpy" is the energy required to break a specific covalent bond in a molecule, calculated as an average value obtained by examining and measuring the bond's strength across a variety of different compounds.

(2)

4. (B)

(1)

5. (D)

(1)

6\.

(a)

$C_3H_6O + 4O_2 \rightarrow 3CO_2 + 3H_2O$

(1)

(b)

i\.

Molar mass of propanone (C_3H_6O) = 58.09 g/mol
Number of moles = Mass (in grams) / Molar mass
Number of moles = 1.45 g / 58.09 g/mol
Number of moles = 0.025 moles

(1)

ii\.

Given:

- m (mass of water) = 100 g
- $c = 4.18\ J\ K^{-1}\ g^{-1}$
- Initial temperature T1 = 293.1 K
- Final temperature T2 = 351.2 K

Calculate the change in temperature ΔT:

$\Delta T = T2 - T1$

$\Delta T = 351.2K - 293.1K$

$\Delta T = 58.1K$

$Q = mc\Delta T$

To calculate the heat energy:

$Q = 100\ g \times 4.18\ J\ K^{-1}\ g^{-1} \times 58.1\ K$

$Q = 24377.8\ J$

(2)

iii\.

Given:

Heat energy produced from burning 1.45 g of propanone =24.3778 kJ
Number of moles of propanone (C_3H_6O) = 0.0250 mol
Enthalpy of combustion of propanone (C_3H_6O)
= Heat energy / Number of moles
Enthalpy of combustion =24.3778 kJ / 0.0250 mol
= 975.112 kJ/mol

(2)

7. (A)

(1)

8. (D)

(1)

9.

Enthalpy of Atomization:

It is the Enthalpy change for the formation of 1 mol of gaseous atoms from the element in its standard state.
It represents the energy needed to form 1 mole of gaseous atoms from the corresponding element in its standard state.

Lattice Dissociation Enthalpy:

It is the Enthalpy change to separate 1 mol of an ionic lattice/solid/compound into its component gaseous ions.
It represents the energy required to completely break the ionic bonds in 1 mole of a solid ionic compound to yield gaseous ions.

(4)

10.

(a)

$2AgNO_3 + Zn \rightarrow Zn(NO_3)_2 + 2Ag$
Or
$2Ag^+ + Zn \rightarrow 2Ag + Zn^{2+}$

(1)

(b)

Given:
Volume of silver nitrate solution = 50.0 cm^3
Concentration of silver nitrate solution = 0.200mol dm^{-3}
Volume in dm^3
$=50.0\ cm^3/1000\ cm^3 \times dm^{-3}$
$=0.0500\ dm^3$
Moles=Concentration × Volume
Moles=0.200 mol $dm^{-3} \times 0.0500\ dm^3$
Moles=0.0100mol

(2)

(c)

Given:

Mass of water = 50.0 g

Specific heat capacity of water = 4.18J $g^{-1}K^{-1}$

Change in temperature ΔT = 3.20 °C or 3.20 K as it is difference so

$\Delta Q = mc\Delta T$

$Q = 50.0g \times 4.18J\ g^{-1}K^{-1} \times 3.20K$

$Q = 668.8J$

(2)

(d)

Given:

Heat energy evolved by the reaction and used to heat the water =668.8J

moles of silver nitrate used in the reaction was 0.0100mol.

The number of moles of zinc reacted is half that of silver nitrate:

0.0100 mol/2=0.0050 mol

Now, calculate the heat energy change per mole of zinc reacted:

= Heat energy evolved by reaction/Number of moles of zinc

Heat energy change per mole of zinc

=668.8 J/0.0050 mol

Heat energy change per mole of zinc

=133,760J/mol

=134 kJ mol^{-1}

(2)

(e)

The experimental value for the heat energy evolved in experiment is less than the correct value due to incomplete reaction or Heat loss.

(1)

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