AS 91164 Demonstrate understanding of bonding, structure, properties and energy changes

Help Sheet for the Energy Calculations 2

Questions involving calculations from equations e.g. questions that look like.....

2014:

Methanol and ethanol can both be used as fuels. Their combustion reactions can be represented by the following equations:

Methanol combustion: $2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ $\Delta_rH^o = -1450$ kJ mol^{-1}

Ethanol combustion: $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ $\Delta_rH^o = -1370$ kJ mol^{-1}

Justify which fuel, methanol or ethanol, will produce more heat energy when 345 g of each fuel is combusted in excess oxygen.

$M(CH_3OH) = 32.0$ g mol^{-1} $M(C_2H_5OH) = 46.0$ g mol^{-1}

Method 1 – by using ratios.

$2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ $\Delta_rH^o = -1450$ kJ mol^{-1}
2 mol 3 mol 2 mol 4 mol

2 mol CH_3OH would have a mass of 32.0 x 2 = 64.0 g

When 64.0 g (2 mol of methanol) burns, the energy released is 1450 kJ

When 345 g burns the energy released will be 345 / 64.0 x 1450 = 2816 kJ or 7820 kJ (3.s.f.)

Method 2 – by calculating moles.

$n(CH_3OH) = m/M$ $n(CH_3OH) = 345 / 32.0 =$ 10.8 mol.

$2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ $\Delta_rH^o = -1450$ kJ mol^{-1}

When 2 mol of methanol burns 1450 kJ of energy is released.

When 10.8 mol of methanol burns the energy released will be 10.8 / 2 x 1450 = 2816 kJ or 7820 kJ (3 s.f.)

Obviously to answer this question you also have to calculate the energy released by ethanol and compare the two alcohols.

Using Method 2 to calculate the energy released from 345 g of ethanol.

$n(C_2H_5OH) = m / M$ $n(C_2H_5OH) = 345/46.0 = 7.50$ mol.

$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ $\Delta_rH^o = -1370$ kJ mol^{-1}
1 mol 3 mol 2 mol 3 mol

When 1 mol of ethanol burns 1370 kJ of energy is released.

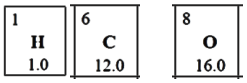
When 7.50 mol of ethanol burns the energy released will be 7.50 x 1370 = 10275 kJ or 10300 kJ (3 s.f.)

Therefore ethanol (C_2H_5OH) releases more energy when 345 g of the fuel is combusted.

$M(CH_3OH) = 32.0$ g mol^{-1} means that 1 mol of CH_3OH has a mass of 32.0g.

What happens if you are not given the $M(CH_3OH)$?

If you had to calculate from the values on the periodic table you would use the molar masses...



C 3 x H O H
12.0 + (3 x 1.0) + 16.0 + 1.0 = 32.0

UNITS

$\Delta_rH^o = -1370$ kJ mol^{-1} has the units kJ mol^{-1} because it represents the enthalpy change per mol of reaction Δ_rH^o. But if you are asked for the energy released or absorbed it's safer just to answer with x kJ absorbed or x kJ released.

Formula you MUST use to calculate moles (given on resource sheet)

$n = m / M$ $n = m \div M$

- n is the amount, in mol
- m is the mass, in g
- M is the molar mass, in g mol^{-1} BIG M is on the bottom!

When to use a sign and when not!

If the question asks for an enthalpy change, ΔH^o = ... then you need a - sign if the reaction is exothermic. You can use a + for an endothermic reaction BUT absence of a sign implies a positive number.

If you are asked for energy released or energy absorbed then just answer with a number with units and description e.g.
1234 kJ of energy is released or
5678 kJ of energy is absorbed.
"-1234 kJ of energy is released" makes absolutely no sense at all!