Born-Haber Cycles

Question Paper 8

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Chemical Energetics
Sub-Topic	Born-Haber Cycles
Paper Type	Theory
Booklet	Question Paper 8

Time Allowed: **22 minutes**

Score: **/18**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 **(a)** By choosing the chlorides of **two** of the Group IV elements as examples, describe the trend in the reactions of these chlorides with water. Suggest an explanation for any differences, and write equations for any reactions that occur.

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.....[3]

(b) The standard enthalpy changes of formation of lead(II) chloride and lead(IV) chloride are given in the following table.

compound	$\Delta H_f^{\ominus}$ / kJ mol^{-1}
$PbCl_2(s)$	–359
$PbCl_4(l)$	–329

Use these data, and also bond energy data from the *Data Booklet*, to calculate the enthalpy changes for the following two reactions.

(i) $CCl_2(g) + Cl_2(g) \longrightarrow CCl_4(g)$

$\Delta H^{\ominus}$ = ... kJ mol^{-1}

(ii) $PbCl_2(s) + Cl_2(g) \longrightarrow PbCl_4(l)$

$\Delta H^{\ominus}$ = ... kJ mol^{-1}

(iii) Make use of your answers to parts **(i)** and **(ii)** to suggest how the relative stabilities of the two oxidation states vary down the Group.

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[3]

[Total: 6]

2 The unsaturated hydrocarbon ethyne (acetylene), C_2H_2, is widely used in 'oxy-acetylene torches' for cutting and welding metals. In the torch, ethyne is burned in oxygen to produce a flame with a temperature of 3400 K.

(a) Ethyne is a linear molecule with a triple bond, C≡C, between the two carbon atoms.

Draw a 'dot-and-cross' diagram of an ethyne molecule.

[1]

(b) When used for cutting or welding, ethyne is transported in cylinders which contain the gas under pressure. A typical cylinder has a volume of 76 dm^3 and contains ethyne gas at 1515 kPa pressure at a temperature of 25 °C.

Use the general gas equation, $pV = nRT$, to calculate the amount, in moles, of ethyne in this cylinder.

[2]

(c) In some countries, ethyne is manufactured from calcium carbide, CaC_2, which is produced by heating quicklime and coke together at 2300 K.

$$CaO + 3C \longrightarrow CaC_2 + CO$$

When water is added to the CaC_2, calcium hydroxide, $Ca(OH)_2$, and ethyne, C_2H_2, are produced.

(i) Construct a balanced equation for the formation of ethyne from calcium carbide.

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(ii) Use this equation and your answer to part **(b)** to calculate the mass of CaC_2 which will react with an excess of water to produce enough ethyne to fill 100 cylinders of the gas.

[3]

(d) The equation for the complete combustion of ethyne is given below.
Use appropriate bond energy data from the *Data Booklet* to calculate a value for the enthalpy change of combustion of ethyne.

$$C_2H_2(g) + 5/2O_2(g) \longrightarrow 2CO_2(g) + H_2O(g)$$

[3]

(e) The value for the standard enthalpy change of combustion of ethyne is $-1300\,kJ\,mol^{-1}$.

(i) Define the term *standard enthalpy change of combustion*.

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(ii) Explain why your answer to **(d)** does not have the same value as the standard enthalpy change of combustion.

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[3]

[Total: 12]