

Energetics – A2 Chemistry P1

1. No.8

0 8

This question is about enthalpy changes.

0 8 . 1

Theoretical values for enthalpies of lattice dissociation can be calculated using a perfect ionic model.

State the meaning of the term perfect ionic model.

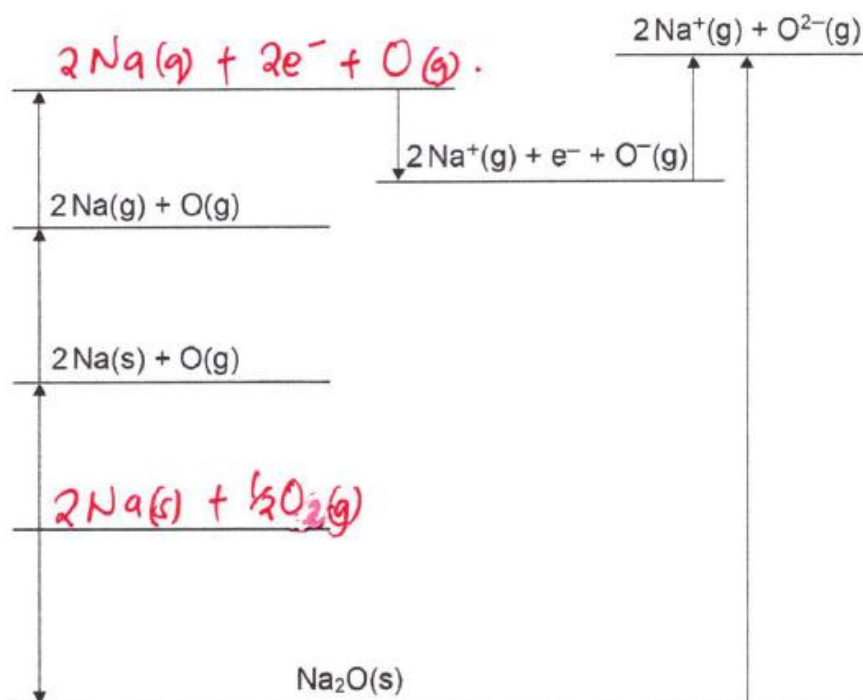
[1 mark]

ions are point charges with perfect spheres and have no covalent character.

0 8 . 2

Enthalpies of lattice dissociation can also be obtained from Born–Haber cycles.

Figure 3 shows an incomplete Born–Haber cycle for the formation of sodium oxide.

Figure 3

Complete **Figure 3** by writing formulas, including state symbols, of the appropriate species on each of the two blank lines.

[2 marks]

0 8 . 3 Table 4 shows some enthalpy changes.

Table 4

Enthalpy change	$\Delta H / \text{kJ mol}^{-1}$
Enthalpy of atomisation of oxygen	+248
Enthalpy of atomisation of sodium	+109
Enthalpy of formation of sodium oxide	-416
First ionisation energy of sodium	+494
First electron affinity of oxygen	-142
Second electron affinity of oxygen	+844

Use the data in Table 4 to calculate the enthalpy of lattice dissociation of sodium oxide.

[2 marks]

$$\begin{aligned}
 -416 + x &= 248 + (2 \times 109) + (2 \times 494) - 142 + 844 \\
 x &= 2572
 \end{aligned}$$

Enthalpy of lattice dissociation + 2572. kJ mol⁻¹

0 8 . 4 Explain why the second electron affinity of oxygen has a positive value.

[1 mark]

The O^- ion repels the incoming electron, so energy must be supplied to overcome repulsion.

0 8 . 5

Explain why the enthalpy of lattice dissociation for sodium oxide is greater than the enthalpy of lattice dissociation for sodium chloride.

[2 marks]

Oxides have higher charge of 2- and smaller size compared to chloride ion -1. This gives a higher charge density and stronger electrostatic attraction to Na^+ ions.

0 8 . 6

Sodium chloride dissolves in water.

Table 5 shows some more enthalpy changes.

Table 5

Enthalpy change	$\Delta H / \text{kJ mol}^{-1}$
Enthalpy of hydration for Cl^- ions	-364
Enthalpy of hydration for Na^+ ions	-406
Enthalpy of lattice dissociation for NaCl	+771

Use the data in Table 5 to calculate the enthalpy of solution for sodium chloride.

[2 marks]

$$\Delta H_{\text{solution}} = +771 - 406 - 364.$$

$$= +1 \text{ kJ mol}^{-1}$$

Enthalpy of solution +1 kJ mol⁻¹

0 8 7

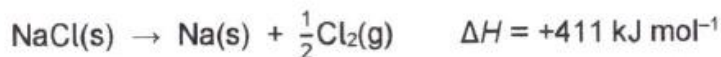
Give a reason why data books do not contain a value for the enthalpy of solution of sodium oxide.

[1 mark]

Na₂O reacts with water to form aqueous sodium hydroxide.

0 8 8

Calculate the temperature, in °C, at which this reaction becomes feasible.



$$\Delta S = +90.1 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta H = +411 \text{ kJ mol}^{-1} = 411000 \text{ J mol}^{-1}$$

[3 marks]

$$T = \frac{\Delta H}{\Delta S} = \frac{411000}{90.1} = 4562 \text{ K.}$$

Convert to °C.

$$= 4562 - 273$$

$$= 4289$$

Temperature 4289 °C