Born-Haber Cycles

Mark Scheme 3

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Chemical Energetics
Sub-Topic	Born-Haber Cycles
Paper Type	Theory
Booklet	Mark Scheme 3

Time Allowed: 56 minutes

Score: /46

Percentage: /100

Grade Boundaries:

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

1 **(a** **(i)** $Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$ eqn.
                                                                                        state symbols (1)

       (ii) $736 + 1450 = +2186 \text{ kJ mol}^{-1}$ (1)

   (b) **(i)** dissolves
              $6 - 7$ (1)

        (ii) does not dissolve/slightly soluble   (1)
              $8 - 11$ (1)   [4]

   (c) **(i)** $Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$ (1)

        (ii) Mg_3N_2 N is -3 (1)
              NH_3 N is -3 (1)

              No **because**
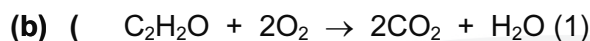   there is no change in the oxidation no. of N   (1)   [4]
              e.c.f on **(c)(i)** and values of oxidation numbers

                                                                                            [Total: 11]

2 (a (i) H–C–H 117 to 120° (1)
C=C=O ° (1)
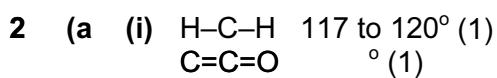
(ii) molecule contains **both** ketone **and** alkene (1)   [3]

(b) ($C_2H_2O + 2O_2 \rightarrow 2CO_2 + H_2O$ (1)

(ii) from eqn.,   42 g $C_2H_2O \rightarrow$ 48 dm³ of CO_2 (1)

whence 3.5 g $C_2H_2O \rightarrow \dfrac{48 \times 3.5}{42}$ dm³ of CO_2 (1)

= 4.0 dm³ of CO_2 (1)

or $n(C_2H_2O) = \dfrac{42}{3.5} = 0.0833$ (1)
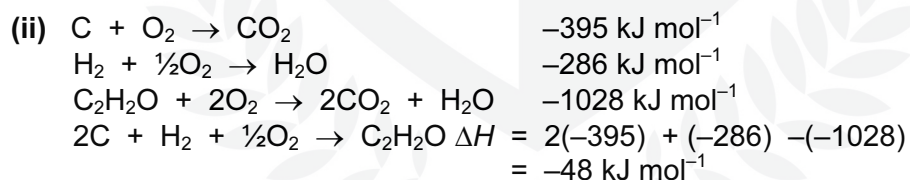
$n(CO_2) = 2 \times 0.083 = 0.0166$ (1)
vol. of $CO_2 = 0.0166 \times 24 = 4.0$ dm³ (1)
allow e.c.f. on wrong eqn. in **(b)(i)**
penalise significant figure error   [4]

(c) (enthalpy change when
1 mol of a compound is formed (1)
from its elements (1)
in their standard states under standard conditions (1)

(ii) $C + O_2 \rightarrow CO_2$ -395 kJ mol⁻¹
$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ -286 kJ mol⁻¹
$C_2H_2O + 2O_2 \rightarrow 2CO_2 + H_2O$ -1028 kJ mol⁻¹
$2C + H_2 + \frac{1}{2}O_2 \rightarrow C_2H_2O$ $\Delta H = 2(-395) + (-286) - (-1028)$
            $= -48$ kJ mol⁻¹
correct cycle (1)   use of 2 for C/CO_2 (1)   answer (1)   [6]

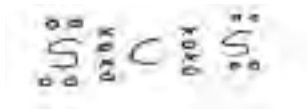**(d)** H_2O/water/steam (1)   [1]

[Total: 14]

3 **(a)** molecules (1)

I_2 (1) **[2]**

(b) **(i)** cations held in 'sea' of delocalised electrons (1)

by strong metallic bonds (1)

(ii) van der Waals' forces between molecules (1)

van der Waals' forces are weak (1) **[4]**

(c) oxidising agent (1)

(ii) iodine is a weaker oxidising agent than chlorine (1) **[2]**

[Total: 8]

4   **(a)**

sulphur atom has 6 /carbon atom has 4 electrons   (1)

S=C double bonds (4 electrons) clearly shown   (1)   **[2]**

(b)   linear   (1)

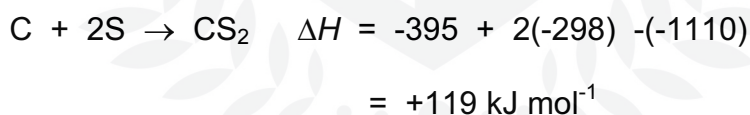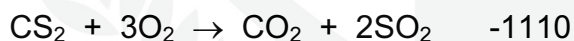180°   (1)   **[2]**

(c)   the enthalpy change when 1 mol of a compound   (1)

is formed from its elements in their standard states   (1)

under standard conditions (may be quoted)   (1)   **[3]**

(d)   C + O_2 → CO_2 -395

S + O_2 → SO_2 -298

CS_2 + $3O_2$ → CO_2 + $2SO_2$ -1110

C + 2S → CS_2 ΔH = -395 + 2(-298) -(-1110)

= +119 kJ mol^{-1}

cycle (1)   use of 2 for S/SO_2 (1)   answer   (1)   **[3]**

(e) CO_2 (1)

N_2 (1)

CS_2 + 2NO → CO_2 + 2S + N_2 (1)

completely correct equation gets (3)
consequential errors to be decided at co-ordination   **[3]**

[Total: 13]