1. (a) enthalpy (or energy) to break (or dissociate) a bond;

1

averaged over different molecules (environments);

1

enthalpy (or heat energy) change when one mole of a compound;

1

is formed from its elements;

1

in their standard states;

1

(b) enthalpy change = Σ(bonds broken) – Σ(bonds formed) or cycle;

1

= 4 × 388 +163 + 2 × 146 + 4 × 463 – (944 + 8 × 463);
(or similar)

1

= –789;
(+ 789 scores 1 only)

1

(c) (i) zero;

1

(ii) *AH* = Σ (enthalpies of formation of products)
–Σ (enthalpies of formation of reactants)

1

= 4 × –242-(75 + 2 × –133);

1

= –777;
(+ 777 scores one only)

1

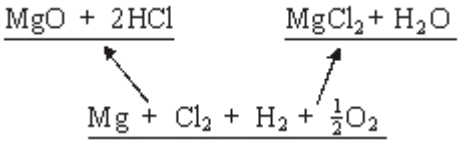
(d) mean bond enthalpies are not exact
(or indication that actual values are different from real values)

1

[13]

2. (a) enthalpy change (or enthalpy of reaction) is independent of route **(1)**

$\Delta H = \Sigma\Delta H_f^{\ominus}$ prods - $\Sigma\Delta H_f^{\ominus}$ reactants (or cycle) **(1)**
minimum correct cycle is:



ΔH = -642 – 286 – (–602 + 2 × –92) **(1)**
= –142 (kJ mol^{-1}) **(1)**
penalise this mark for wrong units
+142 scores 1 mark out of the last three

4

(b) $\Delta H = mcT$ **(1)** (or $mc\Delta T$)
= 50 × 4.2 × 32 = 6720 J = 6.72kJ **(1)**
mark is for 6720 J or 6.72 kJ

moles HCl = $\frac{\text{vol}}{1000}$ × conc = $\frac{50}{1000}$ × 3 **(1)**

= 0.15 **(1)**
if error here mark on conseq.

Therefore moles of MgO reacted = moles HCl/2 **(1)**
(mark is for/2, CE if not/2)
= 0.15/2 = 0.075

Therefore ΔH = 6.72/0.075 **(1)**
= –90 kJ (mol^{-1})
kJ must be given, allow 89 to 91
*value **(1)***
*sign **(1)**; this mark can be given despite CE for /2*

8

Note various combinations of answers to part (c) score as follows:

–89 to –91 kJ **(8)** (or –89000 to 91000J)
*no units **(7)***

+89 to +91 kJ **(7)** (or + 89000 to +91000J)
*no units **(6)***

–44 to –46 kJ **(5)** (or -44000 to -46000J)
*no units **(4)** if units after 6.72 or 6720 (5)*

+44 to +46 kJ **(4)** (or +44000 to + 46000)
if no units and
*if no units after 6.72 or 6720 **(3)***
*otherwise check, could be **(4)***

[12]

3. (a) (i) $1/2\ N_2 + 3/2\ H_2 \rightarrow NH_3$ **(1)**

Ignore s s

(ii) ΔH = (Σ)bonds broken – (Σ)bonds formed **(1)**
= 1/2 × 944 + 3/2 × 436 – 3 × 388 **(1)**
= –38 kJ mol^{-1} **(1)**

Ignore no units, penalise wrong units
Score 2/3 for -76
1/3 for +38
Allow 1/3 for +76

4

(b) 4 (C–H) + (C=C) + (H–H) – (6 (C–H) + (C–C)) = –136 **(1)**
OR (C=C) + (H–H) – ((C–C) + 2 (C–H)) = –136
2 (C–H) = 836 **(1)**
(C–H) = 418 (kJ mol^{-1}) **(1)**

Note: allow (1) for –836
another (1) for –418

3

[7]

4. (a) $C_3H_6O + 4O_2 \rightarrow 3CO_2 + 3H_2O$ **(1)** (or multiple) 1

(b) (i) $\frac{1.45}{58}$ **(1)** = 0.0250 **(1)**

allow 0.025
allow conseq on wrong M_r

1.45/100, CE; $\frac{1.45}{58.1}$ *C.E.*

(ii) heat released = mcΔT
= 100 × 4.18 × 58.1 **(1)**

if 1.45 used in place of 100 CE = 0

= 24300 J **(1)** (or 24.3kJ)

allow 24200 to 24300
ignore decimal places
units tied to answer
If use 0.1 × 4.18 × 51.8 allow ½ for 24.3 with no units

(iii) $\frac{24.3}{0.0250}$ = –972 (kJ mol^{-1}) **(1)**

allow –968 to –973
allow +972
allow conseq
allow no units
penalise wrong units

5

(c) (i) Heat loss **(1)** or energy loss

do not allow incomplete combustion

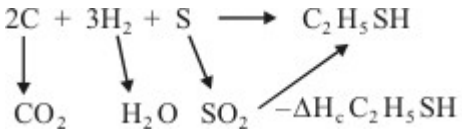
(ii) *Difference*: more negative **(1)** (or more exothermic)

QoL mark

Explanation: heat (*or energy*) released when water vapour condenses **(1)**
or heat/energy required to vaporise water
or water molecules have more energy in the gaseous state

3

(d) $\Delta H = \Sigma \Delta H_{reactants} - \Sigma \Delta H_{products}$ **(1)**

(or cycle 

)

= (2 × –394) + (3 × –286) + (–297) – (–1170) **(1)**
= –773 **(1)**

ignore units even if wrong

Allow 1/3 for +773

3

[12]

5. D

[1]

6. D

[1]

7. B

[1]

8. C

[1]

9. A

[1]

10. A

[1]