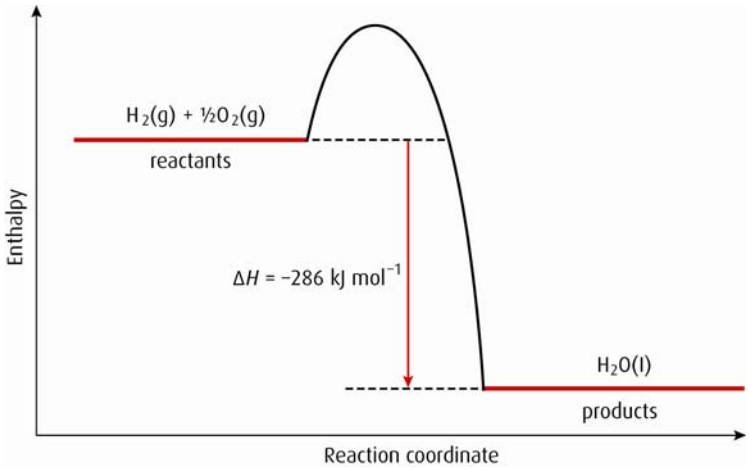
Marking scheme for Core Worksheet – Chapter 5

1 **a** the enthalpy change for this reaction is 286 kJ mol^{-1} [1]

the reaction is exothermic [1]

heat is given out [1]

b



products lower than reactants [1]

ΔH shown correctly [1]

everything else correct (activation energy not required) [1]

2 **a** 23.0 °C [1]

b gold [1]

c heat energy supplied to water = $100.0 \times 0.523 \times (75.0 - 51.0) = 1255.2$ J [1]

temperature change of water = $\dfrac{1255.2}{200 \times 4.18}$ [1]

= 1.50 °C [1]

the water in the beaker is now at 17.5 °C [1]

d heat given out by gold = $50.0 \times 0.130 \times (85.0 - T)$ where T is final temperature [1]

heat gained by water = $100.0 \times 4.18 \times (T - 20.0)$ [1]

$50.0 \times 0.130 \times (85.0 - T) = 100.0 \times 4.18 \times (T - 20.0)$ [1]

T = 21.0 °C [1]

3 **a** heat given out = $100.0 \times 4.18 \times 19.0 = 7942$ J [1]

moles of ethene = $\dfrac{0.21}{28.06} = 7.48 \times 10^{-3}$ mol [1]

enthalpy change when 1 mole is burnt = $\dfrac{7942}{7.48 \times 10^{-3}}$ [1]

–1060 kJ mol^{-1} [1]

b heat given out = $1000 \times 4.18 \times 10.9 = 45562$ J [1]

moles of benzene = $\frac{1.20}{78.12} = 1.54 \times 10^{-2}$ mol [1]

enthalpy change when 1 mole is burnt = $\frac{45562}{1.54 \times 10^{-2}}$ [1]

-2970 kJ mol^{-1} [1]

4 **a** $NaOH + HCl \rightarrow NaCl + H_2O$ [1]

b number of moles of NaOH = $\frac{50.0}{1000} \times 1.50 = 0.0750$ mol [1]

number of moles of HCl = $\frac{100.0}{1000} \times 1.00 = 0.100$ mol [1]

c heat energy supplied to water = $150.0 \times 4.18 \times 9.0 = 5643$ J [1]

energy per mole of water = $\frac{5643}{0.1} = 56430$ J [1]

enthalpy change of neutralisation = -56.4 kJ mol^{-1} [1]

5 $-2055 + 2010$ [1]

-45 kJ mol^{-1} [1]

6 $+100 - 200$ [1]

-100 kJ mol^{-1} [1]

7 $HBr(g) \rightarrow H(g) + Br(g)$ [1]

8 **a**

Bond broken	**Bond energy / kJ mol^{-1}**	**Number of bonds**	**Total energy / kJ mol^{-1}**
C–H	412	4	1648
C=C	612	1	612
O=O	496	3	1488

total energy to break all bonds = 3748 kJ mol^{-1} [2]

Bond made	**Bond energy / kJ mol^{-1}**	**Number of bonds**	**Total energy / kJ mol^{-1}**
C=O	743	4	2972
O–H	463	4	1852

total energy released when all bonds made = 4824 kJ mol^{-1} [2]

enthalpy change = $3748 - 4824 = -1076$ kJ mol^{-1} [1]

b

Bond broken	Bond energy / kJ mol^{-1}	Number of bonds	Total energy / kJ mol^{-1}
C≡O	1070	1	1070
H–H	436	3	1308

total energy to break all bonds = 2378 kJ mol^{-1} [2]

Bond made	Bond energy / kJ mol^{-1}	Number of bonds	Total energy / kJ mol^{-1}
C–H	412	4	1648
O–H	463	2	926

total energy released when all bonds made = 2574 kJ mol^{-1} [2]

enthalpy change = 2378 – 2574 = –196 kJ mol^{-1} [1]

c

Bond broken	Bond energy / kJ mol^{-1}	Number of bonds	Total energy / kJ mol^{-1}
N–H	388	12	4656
O=O	496	3	1488

total energy to break all bonds = 6144 kJ mol^{-1} [2]

Bond made	Bond energy / kJ mol^{-1}	Number of bonds	Total energy /kJ mol^{-1}
N≡N	944	2	1888
O–H	463	12	5556

total energy released when all bonds made = 7444 kJ mol^{-1} [2]

enthalpy change = 6144 – 7444 = –1300 kJ mol^{-1} [1]

9

Bond broken	Bond energy / kJ mol^{-1}	Number of bonds	Total energy /kJ mol^{-1}
H–Cl	431	4	1724
O=O	496	1	496

total energy to break all bonds = 2220 kJ mol^{-1} [2]

Bond made	Bond energy / kJ mol^{-1}	Number of bonds	Total energy /kJ mol^{-1}
Cl–Cl	x	2	$2x$
O–H	463	4	1852

total energy released when all bonds made = 1852 + 2x kJ mol^{-1} [2]

–112 = 2220 – (1852 + 2x)

x = 240, therefore the Cl–Cl bond energy is 240 kJ mol^{-1} [1]

10 $MgCl_2(aq)$ is equivalent to $Mg^{2+}(aq) + 2Cl^-(aq)$ [1]

$MgCl_2(s) \rightarrow \cancel{Mg^{2+}(g) + 2Cl^-(g)}$ $\Delta H^\ominus = 2490$ kJ mol^{-1}

$\cancel{Mg^{2+}(g)} \rightarrow Mg^{2+}(aq)$ $\Delta H^\ominus = -1920$ kJ mol^{-1}

$\cancel{2Cl^-(g)} \rightarrow 2Cl^-(aq)$ $\Delta H^\ominus = -720$ kJ mol^{-1}

$MgCl_2(s) \rightarrow Mg^{2+}(aq) + 2Cl^-(aq)$ $\Delta H = 2490 - 1920 - 720$ [2]

$\Delta H = -150$ kJ mol^{-1} [1]