5.1 test ms

1. (a) energy <u>or</u> heat **(1)**
to break a <u>covalent</u> bond **(1)**
<u>averaged</u> over several compounds **(1)** 3

(b) propane : $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$
propene : $C_3H_6(g) + 4\frac{1}{2}\,O_2(g) \rightarrow 3CO_2(g) + 3H_2O(g)$ **(1)**

———————————————————————

overall: $C_3H_8(g) + \frac{1}{2}\,O_2(g) \rightarrow C_3H_6(g) + H_2O(g)$

[<u>Or</u> balanced cycle **(1)**]

ΔH = = –2102 + 1977 **(1)**
= –125 kJ mol^{-1} **(1)** 3

(c) *Bonds broken* 2 × (C – C) + 8 × (C – H) + $\frac{1}{2}$ (O = O)

or nett : 1 × (C – C) + 2 × (C – H) + $\frac{1}{2}$ (O = O) **(1)**

Bonds formed 1 × (C – C) + 6 × (C – H) + 1 × (C = C) + 2 × (O – H)

or nett : 1 × (C=C) + 2 × (O – H) **(1)**

Bond enthalpy of O=O $\Delta H = \Sigma B$(bonds broken) – ΣB(bonds formed) **(1)**

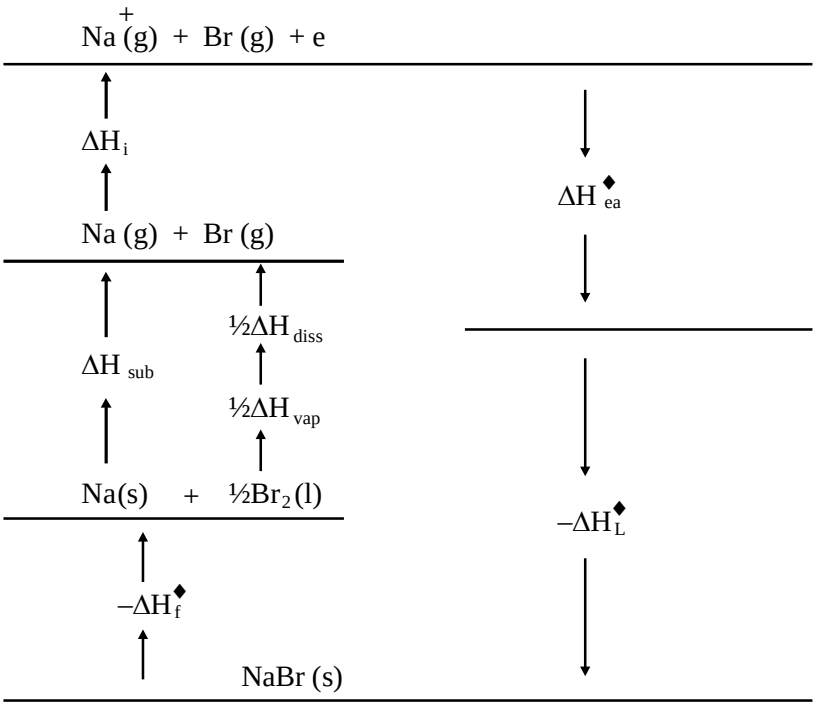
$\therefore$ –125 = B(C – C) + 2B(C – H) + $\frac{1}{2}$ B(O = O) – B(C = C) – 2B(O – H)

$\therefore$ B(O = O) = 2(–125 –348 –2 × 413 + 612 + 2 × 463

= +2 × 239 = 478 kJ mol^{-1} **(1)** 4

[10]

2. (a)



7 steps **(1)**
(ss) correct **(1)**
$\frac{1}{2}Br_2(g) \rightarrow Br(g)$ **(1)**
ΔH_{vap} Br shown **(1)**
ΔH_L with –ve sign **(1)**
e^- balanced **(1)**

6

(b) $-\Delta H_f + \Delta H_{sub} + \Delta H_i + \frac{1}{2}\Delta H_{vap} + \frac{1}{2}\Delta H_{diss} + \Delta H_{ea} - \Delta H_L = O$ **(1)**

$\Delta H_{vap} = 2(\Delta H_f - \Delta H_{sub} - \Delta H_i - \frac{1}{2}\Delta H_{diss} - \Delta H_{ea} + \Delta H_L)$ **(1)**

$= 2\ (-361 - 107 - 498 - 97 + 325 + 753)$

$= +30\ kJ\ mol^{-1}$ **(1)** 3

[9]

3. (i) enthalpy / energy change / energy required / energy evolved when 1 mol of ionic solid / crystalline solid / crystals / compound / solid (**not** molecules) (is formed from) **(1)**

its gaseous ions
(must be stated, **not** transferred by inference from (ii) **(1)** 2

(ii) $Na^+(g) + Cl^-(g) \rightarrow NaCl(s)$
allow $NaCl(s) \rightarrow Na^+(g) + Cl^-(g)$ if definition reversed **(1)** 1

(iii) larger (cations) **not** atoms, Li, Na **(1)**

same charge on the cation / ratio of charge:size decreases / lower charge density **not** effective nuclear charge **(1)**

therefore weaker attractions between cation and anion **(1)**
(must clearly mean attraction between cation and anion) 3

(iv) smaller (cations) **not** atoms, Mg, Na
allow this mark if 'repeated error' from (iii) **(1)**

greater charge on the Group 2 cation / ratio of charge:
size increases / higher charge density **(1)**

therefore stronger attractions between cation and anion **(1)**
(must clearly mean attraction between cation and anion) 3

[9]

4. (i) $CaCl_2(s) \rightarrow Ca^{2}+ (aq) + 2Cl^{-} (aq)$ **(1)**

$Ca^{2+} (g) + 2Cl^{-} (g) \rightarrow CaCl_2(s)$ **(1)**

$Ca^{2+}(g) \rightarrow Ca^{2+} (aq)$ **(1)**

State symbols must be shown

(ii)

			$\Delta H^{\ominus}$/kJ mol^{-1}
$CaCl_2$ (s)	$\rightarrow$	Ca^{2+} (aq) +2Cl^{-} (aq)	–123
$Ca^{2+ (aq)}$	$\rightarrow$	Ca^{2+}(g)	+1650
$Ca^{2+ (g) +} 2Cl^{- (g)}$	$\rightarrow$	$CaCl_2$ (s)	–2255
$2Cl^{- (g)}$	$\rightarrow$	$2Cl^{- (aq)}$	–728

ΔH_{hyd} (Cl–(g) = $\frac{-728}{2}$ = –364 kJ mol^{-1}

3 equations **(3)** answer **(1)**

OR via cycle: 3 steps **(3)** answer **(1)** 7

[7]

5. (a) Steam condenses to water when $\Delta G \leq 0$ **(1)**
$\therefore \Delta H = T\Delta S$ **(1)**
$\Delta S = 189 - 70 = 119$ JK^{-1} mol^{-1} **(1)**
$\therefore \Delta H = 373 \times 119 = 44$ KJ mol^{-1} **(1)** 4

(b) spontaneous reaction when $\Delta G \leq 0$ **(1)**
$CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$ **(1)**
$\Delta S = 198 + 3 \times 131 - 189 - 186 = 216$ JK^{-1} mol^{-1} **(1)**
the entropy change in $-T\Delta S$ **(1)**
makes ΔG -ve once T is high enough **(1)** 6

(c) diamond $\rightarrow$ graphite $\Delta S = +3$ JK^{-1} mol^{-1} **(1)**
since $\Delta H < 0$, ΔG is always < 0 **(1)**
kinetics: large E_a makes reaction too slow **(1)** 3

(d) $CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$
$\Delta S = 90 - 40 - 214 = -164$ JK^{-} mol^{-1} **(1)**
$\Delta G = 0$, $\Delta H = T\Delta S$
$T_s = \frac{178 \times 1000}{164} = 1085$ K **(1)** 2

[15]