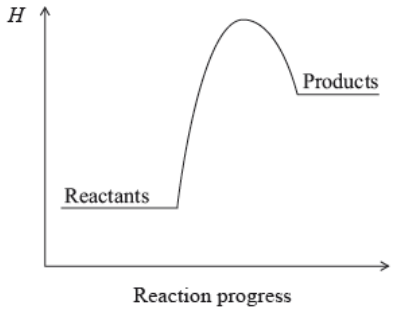
Practice Test for Topic 5 Thermochemistry *[22 marks]*

1. Which statement is correct for the reaction with this enthalpy level diagram? *[1 mark]*



A. Heat energy is released during the reaction and the reactants are more stable than the products.

B. Heat energy is absorbed during the reaction and the reactants are more stable than the products.

C. Heat energy is released during the reaction and the products are more stable than the reactants.

D. Heat energy is absorbed during the reaction and the products are more stable than the reactants.

2a. The enthalpy changes of three reactions are given below. *[1 mark]*

$2\text{HCOOH(l)} + \text{O}_2\text{(g)} \rightarrow 2\text{CO}_2\text{(g)} + 2\text{H}_2\text{O(l)} \quad \Delta H = a$

$\text{C}_2\text{H}_5\text{OH(l)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{CO}_2\text{(g)} + 3\text{H}_2\text{O(l)} \quad \Delta H = b$

$2\text{HCOOC}_2\text{H}_5\text{(l)} + 7\text{O}_2\text{(g)} \rightarrow 6\text{CO}_2\text{(g)} + 6\text{H}_2\text{O(l)} \quad \Delta H = c$

What is the enthalpy change for the following reaction?

$$\text{HCOOH(l)} + \text{C}_2\text{H}_5\text{OH(l)} \rightarrow \text{HCOOC}_2\text{H}_5\text{(l)} + \text{H}_2\text{O(l)}$$

A. $a + b + c$

B. $a + 2b - c$

C. $\frac{1}{2}a + b + \frac{1}{2}c$

D. $\frac{1}{2}a + b - \frac{1}{2}c$

2b. The specific heat capacities of two substances are given in the table below. *[1 mark]*

Substance	Specific heat capacity / J g^{-1} K^{-1}
Ethanol	2.43
Water	4.18

Which statement is correct?

A. More heat is needed to increase the temperature of 50 g of water by 50 °C than 50 g of ethanol by 50 °C.

B. If the same heat is supplied to equal masses of ethanol and water, the temperature of the water increases more.

C. If equal masses of water at 20 °C and ethanol at 50 °C are mixed, the final temperature is 35 °C .

D. If equal masses of water and ethanol at 50 °C cool down to room temperature, ethanol liberates more heat.

3. Enthalpy changes of reaction are provided for the following reactions. *[1 mark]*

$$2C(s) + 2H_2(g) \rightarrow C_2H_4(g) \quad \Delta H^{\ominus} = +52\ \text{kJ mol}^{-1}$$
$$2C(s) + 3H_2(g) \rightarrow C_2H_6(g) \quad \Delta H^{\ominus} = -85\ \text{kJ mol}^{-1}$$

What is the enthalpy change, in kJ mol^{-1}, for the reaction between ethene and hydrogen?

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

A. –137

B. –33

C. +33

D. +137

4. Which combination is correct about the energy changes during bond breaking and bond formation? *[1 mark]*

	Bond breaking	Bond formation
A.	exothermic	exothermic
B.	exothermic	endothermic
C.	endothermic	exothermic
D.	endothermic	endothermic

5. Which equation best represents the bond enthalpy of HCl? *[1 mark]*

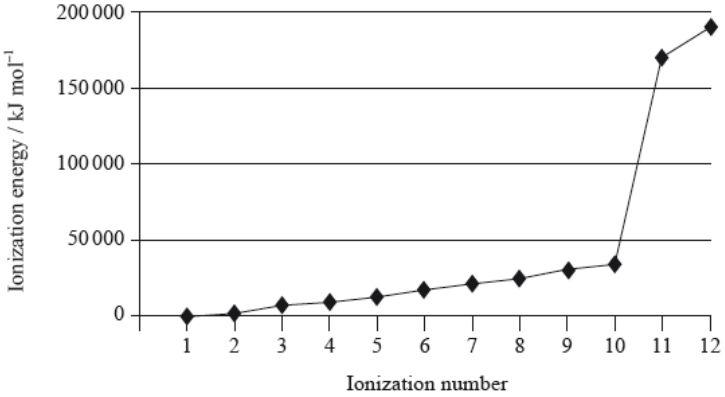
A. $HCl(g) \rightarrow H^+(g) + Cl^-(g)$

B. $HCl(g) \rightarrow H(g) + Cl(g)$

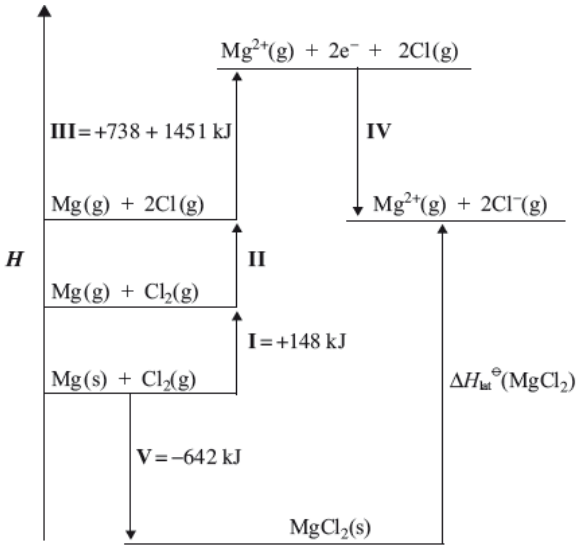
C. $HCl(g) \rightarrow \frac{1}{2}H_2(g) + \frac{1}{2}Cl_2(g)$

D. $2HCl(g) \rightarrow H_2(g) + Cl_2(g)$

Magnesium is the eighth most abundant element in the earth's crust. The successive ionization energies of the element are shown below.



The lattice enthalpy of magnesium chloride can be calculated from the Born-Haber cycle shown below.



6. (i) Identify the enthalpy changes labelled by **I** and **V** in the cycle. *[10 marks]*

(ii) Use the ionization energies given in the cycle above and further data from the Data Booklet to calculate a value for the lattice enthalpy of magnesium chloride.

(iii) The theoretically calculated value for the lattice enthalpy of magnesium chloride is +2326 kJ. Explain the difference between the theoretically calculated value and the experimental value.

(iv) The experimental lattice enthalpy of magnesium oxide is given in Table 13 of the Data Booklet. Explain why magnesium oxide has a higher lattice enthalpy than magnesium chloride.

7. Which step(s) is/are endothermic in the Born-Haber cycle for the formation of LiCl? *[1 mark]*

A. $\frac{1}{2}\mathrm{Cl_2(g)} \rightarrow \mathrm{Cl(g)}$ **and** $\mathrm{Li(s)} \rightarrow \mathrm{Li(g)}$

B. $\mathrm{Cl(g)} + \mathrm{e^-} \rightarrow \mathrm{Cl^-(g)}$ **and** $\mathrm{Li(g)} \rightarrow \mathrm{Li^+(g)} + \mathrm{e^-}$

C. $\mathrm{Li^+(g)} + \mathrm{Cl^-(g)} \rightarrow \mathrm{LiCl(s)}$

D. $\frac{1}{2}\mathrm{Cl_2(g)} \rightarrow \mathrm{Cl(g)}$ **and** $\mathrm{Cl(g)} + \mathrm{e^-} \rightarrow \mathrm{Cl^-(g)}$

8. Which ionic compound has the greatest lattice enthalpy? *[1 mark]*

A. MgO

B. CaO

C. NaF

D. KF

9. Which equation represents the electron affinity of chlorine? *[1 mark]*

A. $\mathrm{Cl(g) + e^- \rightarrow Cl^-(g)}$

B. $\mathrm{Cl(g) + e^- \rightarrow Cl(g)}$

C. $\mathrm{Cl_2(g) + 2e^- \rightarrow 2Cl^-(g)}$

D. $\mathrm{Cl(g) \rightarrow Cl^+(g) + e^-}$

10. Which combination of ΔH and ΔS signs will always result in a spontaneous reaction at all temperatures? *[1 mark]*

	ΔH	ΔS
A.	+	+
B.	+	–
C.	–	–
D.	–	+

11b. Which reaction has the largest increase in entropy? *[1 mark]*

A. $\mathrm{H_2(g) + Cl_2(g) \rightarrow 2HCl(g)}$

B. $\mathrm{Al(OH)_3(s) + NaOH(aq) \rightarrow Al(OH)_4^-(aq) + Na^+(aq)}$

C. $\mathrm{Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)}$

D. $\mathrm{BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)}$

11a. Which reaction has the largest increase in entropy? *[1 mark]*

A. $\mathrm{H_2(g) + Cl_2(g) \rightarrow 2HCl(g)}$

B. $\mathrm{Al(OH)_3(s) + NaOH(aq) \rightarrow Al(OH)_4^-(aq) + Na^+(aq)}$

C. $\mathrm{Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)}$

D. $\mathrm{BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)}$