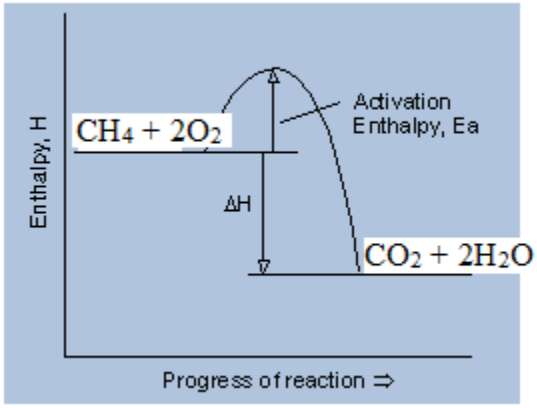
Topic 4 Answers to Exercises

Topic 4 Exercise 1

1. A reaction in which heat energy is released into the surroundings. Chemical potential energy (enthalpy) is converted into heat energy.

2.



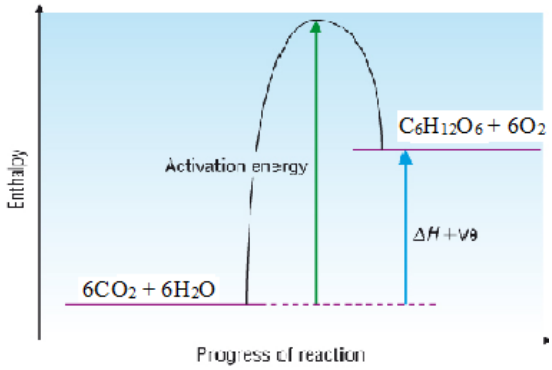
The enthalpy increases before it decreases because energy is required to break the existing bonds before the energy is released when the new bonds are made.

3. +890 $kJmol^{-1}$

4. a) 5560 kJ
b) 53.9 kJ
c) 899 g

5. A reaction in which heat energy is absorbed from the surroundings. Heat energy is converted into chemical potential energy (enthalpy).

6.



7. -2802 $kJmol^{-1}$

8. a) 15600 kJ
b) 9.43 kJ
c) 642.4 g

Topic 4 Exercise 2

1. The energy required to break one mole of a covalent bond
   Homolytically
   In the gas phase
   Averaged over a range of different environments
2. a) -40 $kJmol^{-1}$
   b) -818 $kJmol^{-1}$
   c) -537 $kJmol^{-1}$
   d) -96 $kJmol^{-1}$
3. 298 $kJmol^{-1}$
4. Bond energies are average values and the average value may be different from the bond energy in that particular environment

Topic 4 Exercise 3

1. -26.3 $kJmol^{-1}$ 2. -193.5 $kJmol^{-1}$ 3. +11.1 $kJmol^{-1}$
4. -118 $kJmol^{-1}$ 5. -56.8 $kJmol^{-1}$ 6. -52.0 $kJmol^{-1}$
7. -930 $kJmol^{-1}$ 8. -1530 $kJmol^{-1}$
9. They do not take into account heat loss to the surroundings or the heat capacity of the calorimeter.

Topic 4 Exercise 4

1. Enthalpy change when one mole of a compound
   Is formed from its elements
   With all reactants and products in their standard states under standard conditions
2. a) $Mg(s) + 1/2O_2(g) \rightarrow MgO(s)$
   b) $C(s) + O_2(g) \rightarrow CO_2(g)$
   c) $4C(s) + 5H_2(g) \rightarrow C_4H_{10}(g)$
   d) $2C(s) + 3H_2(g) + 1/2O_2(g) \rightarrow C_2H_6O(l)$
   e) $2Al(s) + 3/2O_2(g) \rightarrow Al_2O_3(s)$
3. By definition - because they are already elements in their standard states
4. Enthalpy change when one mole of a substance
   Is completely burned in excess oxygen
   With all reactants and products in their standard states under standard conditions
5. Write equations which represent the standard enthalpy of combustion of the following substances:
   a) $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$
   b) $C_6H_6(g) + 7.5O_2(g) \rightarrow 6CO_2(g) + 3H_2O(l)$
   c) $C_2H_6O(g) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$
   d) $H_2(g) + 1/2O_2(g) \rightarrow H_2O(l)$
   e) $Al(s) + 3/4O_2(g) \rightarrow 1/2Al_2O_3(s)$
6. O_2, CO_2, H_2O

Topic 4 Exercise 5

1. a) i) $C_2H_6(g) + 3½O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$
   ii) $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$
   b) i) -1558.9 $kJmol^{-1}$ ii) -1410 $kJmol^{-1}$
2. -152 $kJmol^{-1}$
3. -1532 $kJmol^{-1}$
4. diborane: -2027.4 $kJmol^{-1}$ benzene: -3167.9 $kJmol^{-1}$
5. -265.1 $kJmol^{-1}$
6. -126.8 $kJmol^{-1}$
7. -126 $kJmol^{-1}$
8. a) -75 $kJmol^{-1}$ b) -109 $kJmol^{-1}$ c) -606 $kJmol^{-1}$