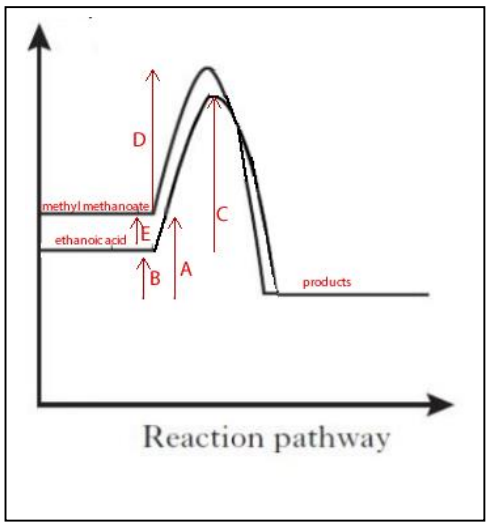
Friday worksheet 13

1) The heat of combustion of ethanoic acid, $C_2H_4O_2$, is −876 kJ mol^{-1} and the heat of combustion of methyl methanoate, $C_2H_4O_2$, is −973 kJ mol^{-1}. The auto-ignition temperature (the temperature at which a substance will combust in air without a source of ignition) of ethanoic acid is 485 °C and the auto-ignition temperature of methyl methanoate is 449 °C.

a. Write the thermochemical equations for the complete combustion of:
   - Methyl methanoate
     $C_2H_4O_2(l) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$ ΔH = -973 kJ mol^{-1}
   - Ethanoic acid
     $C_2H_4O_2(l) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$ ΔH = -876 kJ mol^{-1}

b. Given the information above, draw the energy profiles of the two reactions if one mol of each substance undergoes complete combustion in a sealed container. The relative energy content of the ethanoic acid is given on the diagram below. Label the:



   - ΔH of each reaction and give its sign and magnitude.
     ethanoic acid => B = -876 kJ mol^{-1}
     Methyl methanoate => A = - 973 kJ mol^{-1}
   - relative amount of activation energy for each reaction (magnitude not required)
     Ethanoic acid => C
     methyl methaonate => D
     => C > D
     It can be argued that the autoignition temperature gives an indication as to the amount of energy necessary to initiate a reaction ie. Activation energy.
     The energy profile showing the combustion of methyl methanoate should reach completion faster than the combustion of ethanoic acid. This, can be argued, is due to the higher energy release of methyl methanoate, which when coupled with the lower autoignition temperature, should increase the rate of combustion faster than ethanoic acid. As more energy is released the autoigniotion temperature of methyl methanoate will be reached sooner than the autoignotion temperature of ethanoic acid.
   - relative energy value of products for each reaction (magnitude not required)
     Since both reactions have exactly the same products so will the energy content of the products of each reaction also be the same.
   - difference in energy content, in kJ mol^{-1}, of the reactants between the two reactions
     E = 97 kJ mol^{-1}