VARIOUS ENTHALPY CHANGE DEFINITIONS

1. a) (i) 298K (25°C)
   (ii) 1 bar (100 kPa) (or 1 atmosphere if your syllabus says that)
   (iii) 1 mol dm^{-3}

   b) (i) O_2 gas
   (ii) H_2 gas
   (iii) liquid
   (iv) gas
   (v) solid graphite, C
   (vi) solid
   (vii) Na solid
   (viii) gas
   (ix) Br_2 liquid
   (x) NH_3 gas

   (Where you weren't given the formula, it is important to state it. For example, it is important to show that you know that the standard state of oxygen is not only a gas, but that it consists of O_2 molecules - not O_3 molecules or O atoms.)

2. a) Enthalpy change is the name given to the amount of heat evolved or absorbed in a reaction carried out at constant pressure.

   b) The standard enthalpy change of a reaction is the enthalpy change which occurs when equation quantities of materials react under standard conditions, and with everything in its standard state.

   $$2C_2H_{6(g)} + 7O_{2(g)} \longrightarrow 4CO_{2(g)} + 6H_2O_{(l)} \qquad \Delta H = -3120 \text{ kJ mol}^{-1}$$
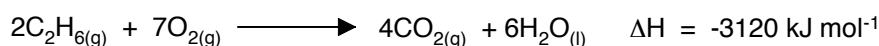
   So if you react 2 moles of ethane gas with 7 moles of oxygen gas to give 4 moles of carbon dioxide gas and 6 moles of liquid water under standard conditions, you will get 3120 kJ of heat evolved.

   (You can't, of course, react ethane and oxygen under standard conditions - the activation energy barrier is too high. So this value is measured by doing the reaction under more realistic conditions, and then calculating back to find what it would have been under standard conditions. You just need to be aware of this, but you *don't* need to mention it every time you talk about a standard enthalpy change for a reaction which won't actually happen under standard conditions.)

   c) The standard enthalpy change of combustion of a compound is the enthalpy change which occurs when one mole of the compound is burned completely in oxygen under standard conditions, and with everything in its standard state.

   The equation shows the burning of 2 moles of ethane, whereas the enthalpy of combustion refers to the burning of 1 mole. The enthalpy of combustion equation would be:

   $$C_2H_{6(g)} + 3\tfrac{1}{2}O_{2(g)} \longrightarrow 2CO_{2(g)} + 3H_2O_{(l)} \qquad \Delta H = -1560 \text{ kJ mol}^{-1}$$
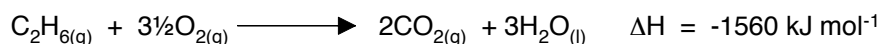
3. a) The standard enthalpy change of formation of a compound is the enthalpy change which occurs when one mole of the compound is formed from its elements under standard conditions, and with everything in its standard state.

b)

(i) $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}$

(ii) $3C_{(s)} + 4H_{2(g)} \longrightarrow C_3H_{8(g)}$

(iii) $Na_{(s)} + \frac{1}{2}Cl_{2(g)} \longrightarrow NaCl_{(s)}$

(iv) $2C_{(s)} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow C_2H_5OH_{(l)}$

(v) $\frac{1}{2}N_{2(g)} + 2H_{2(g)} + \frac{1}{2}Cl_{2(g)} \longrightarrow NH_4Cl_{(s)}$

(vi) $2Na_{(s)} + S_{(s)} + 2O_{2(g)} \longrightarrow Na_2SO_{4(s)}$