1. a) closed system (total mass of reactants + products is constant) at a fixed temperature

   b) the forward and back reactions are both occurring (hence dynamic) but at the same rate, so the concentrations of all the reactants and products cease to change with time (therefore equilibrium)

2.

$$4NH_{3(g)} + 5O_{2(g)} \rightleftharpoons 4NO_{(g)} + 6H_2O_{(g)}$$

$$K_c = \frac{[NO]^4[H_2O]^6}{[NH_3]^4[O_2]^5}$$

3.

(a)

(i) and (ii)

	HCl	O_2	H_2O	Cl_2
Initial	3.0	1.0	0	0.0
Final	1.0	0.5	1.0	1.0
Change	*-2*	*-0.5*	*+1*	*+1*

(iii) $$K_c = \frac{[H_2O]^2[Cl_2]^2}{[HCl]^4[O_2]} = \frac{(1.0)^2(1.0)^2}{(1.0)^4(0.5)} = 2$$

(b) $$K_c = \frac{[H_2O]^2[Cl_2]^2}{[HCl]^4[O_2]}$$

$$\therefore [O_2] = \frac{[H_2O]^2[Cl_2]^2}{[HCl]^4 K_c} = \frac{(0.1)^2(0.1)^2}{(0.1)^4(2)} = 0.5 \text{ mol L}^{-1}$$

(c)

(i) K_c value only changes with temperature change; no change

(ii) Half the volume so greater pressure; the equilibrium shifts to the right (more products)

4. Dark brown NO_2 and pale yellow N_2O_4

$$2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$$

(a) Constant pressure, constant colour

(b) If it is dark brown at 80°C then increasing the temperature pushes the equilibrium to the left. LCP states the equilibrium change opposes a change in conditions, so the reaction is cooling down the temperature by going to the left. This means that going to the right is heating up i.e. exothermic. The sign for an exothermic ΔH is negative.

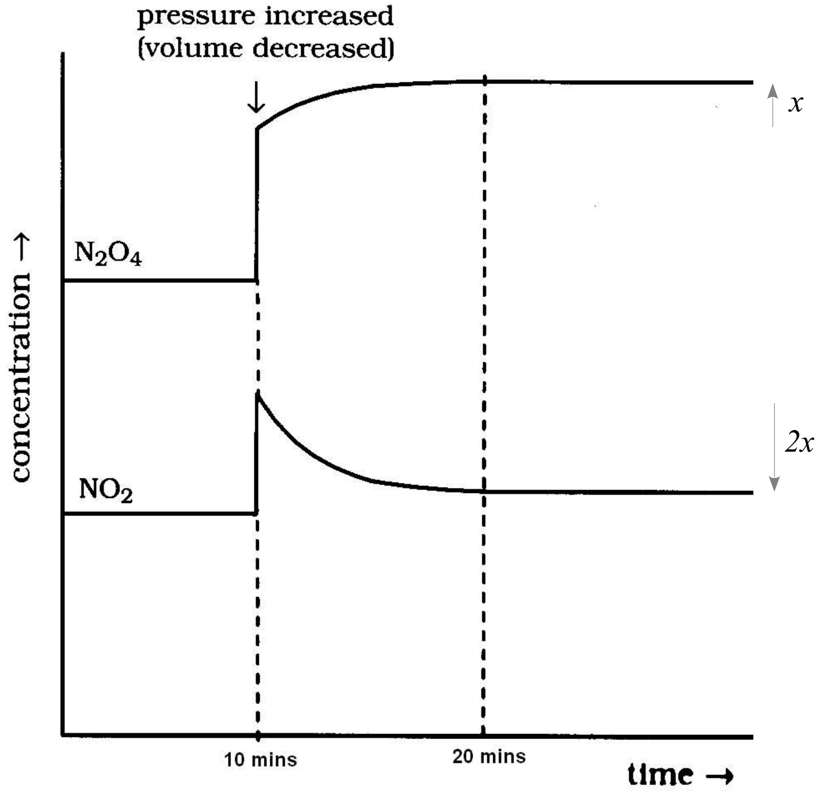
(c) $$C_{N_2O_4} = \frac{n_{N_2O_4}}{V} = \frac{0.08}{2} = 0.04 \text{ mol L}^{-1}$$

$$C_{NO_2} = \frac{n_{NO_2}}{V} = \frac{0.038}{2} = 0.019 \text{ mol L}^{-1}$$

$$K_c = \frac{[N_2O_4]}{[NO_2]^2} = \frac{0.04}{(0.019)^2} = 1\times10^2 \text{ (1 s.f.)}$$

(d) Decreasing the volume would increase the pressure. According to LCP the reaction will oppose the change i.e. decrease the moles of gas, shift equilibrium to the right. The concentration of N_2O_4 would increase and NO_2 decrease.

(e)



5. To increase yield is to push equilibrium to the right. There are more moles of gas on the left, so increase the pressure and according to LCP the equilibrium will shift to the side with less moles of gas (the right). The reaction is exothermic so decrease the temperature and according to LCP the reaction will shift to the right. So best yield will be with low temperature and high pressure.