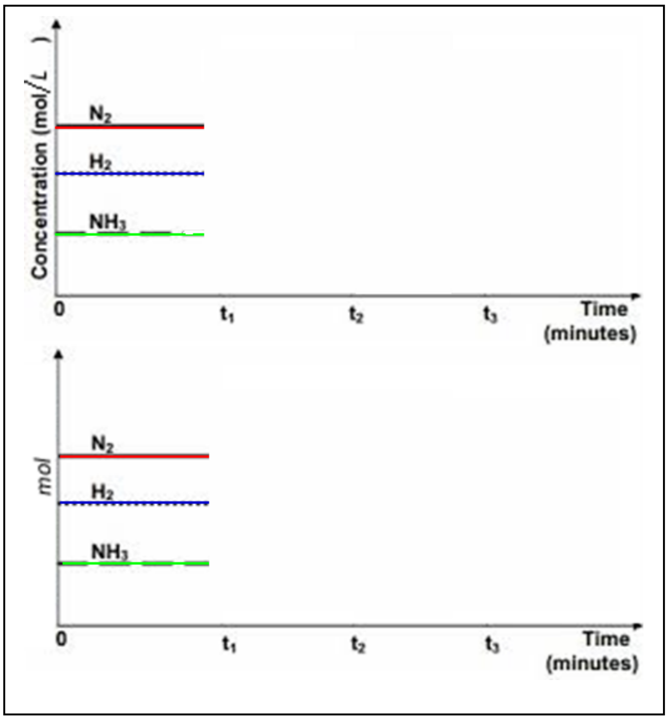
Revision 4

1) The following reaction is at equilibrium in a sealed container as shown by the two graphs on the right representing concentration and mol.

$3H_2(g) + N_2(g) \rightleftarrows 2NH_3(g)$ ΔH = negative



a) On each graph sketch the change that would occur and how the system would move to partially undo the change if:
   - N_2 was added to the system at t_1 and equilibrium was reached before t_2.
   - The volume of the container was doubled at t_2 and equilibrium was reached before t_3.
   - At t_3 a catalyst was added to the reaction vessel.

2) In the heat, chickens hyperventilate in order to cool down. This severely reduces the amount of carbon dioxide present in their lungs. Heat stressed chickens produce eggs with thinner and more fragile shells than chickens grown in cooler climates. This is due to a reduction in the amount of calcium carbonate deposited in the shell of hotter climate chickens.

In the lungs the following equilibrium is set up between the carbon dioxide in the air and the carbon dioxide in the blood.

$CO_2(g) \rightleftarrows CO_2(aq)$

In the blood the following equilibrium below is set up.

$CO_2(aq) + H_2O(l) \rightleftarrows H_2CO_3(aq) \rightleftarrows 2H^+(aq) + CO_3^{-2}(aq)$

In the tissues, where the egg shell is formed, yet another equilibrium is set up.

$CO_3^{-2}(aq) + Ca^{2+}(aq) \rightleftarrows CaCO_3(s)$

Apply your knowledge of Le Chatelier's Prinicple to the following questions.

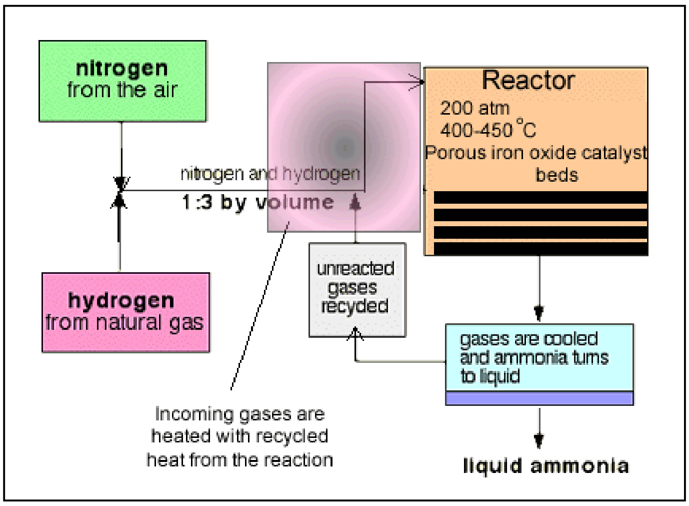
a) Suggest why hyperventilating reduces the amount of carbon dioxide in the blood.

b) Explain how hyperventilating directly causes the development of thin eggshells.

c) Providing carbonated drinking water to the chickens prevents the production of thin eggshells and restores the shells to natural state. Explain why.

3) Ammonia is produced commercially via the Haber process.
$3H_2(g) + N_2(g) \rightleftarrows 2NH_3(g)$ ($\Delta H = -92$ kJ/mol)
The industrial process is simplified in the diagram below.

High yield and a fast rate are essential for commercial viability of this process.



a) Describe the conditions that increase the rate of the reaction.

b) Describe the conditions that maximise yield.

c) Explain how the conditions for maximising yield and rate are at odds with each other.

d) Looking at the diagram above, of the industrial process of the synthesis of ammonia, explain how high yield and rate are achieved at a commercial level?

4) KSCN, $Fe(NO_3)_3$ and FeSCN $(NO3)_2$ were added to 2.00 litres of distilled water at 20°C in a sealed vessel and allowed to reach equilibrium. The initial concentrations of each species were 0.200M KSCN(aq) and 0.0351 M $Fe(NO_3)_3$ M and 2.10 $FeSCN^{2+}$ M
Given that the equilibrium constant for the reaction below at 20 °C is provided, answer the following questions.
$SCN^-(aq) + Fe^{3+}(aq) \rightleftarrows FeSCN^{2+}(aq)$ ΔH = negative $k_c = 1.1 \times 10^2\ M^-$ at 20°C

a) After equilibrium is established:
   i. Will the $[SCN^-]$ be lower, or higher than 0.200 M or remain unchanged. Explain
   ii. What will the value of the equation quotient be?
   iii. The volume of the reaction vessel is doubled and the system is allowed to reach equilibrium once more.
      - What happens to the $[SCN^-]$
        increase, decrease, remain unchanged
        Explain
      - What happens to the number of mol of SCN^- at this new equilibrium.
        increase, decrease, remain unchanged
        Explain

b) In another experiment conducted at 20°C it was found that the concentrations of Fe^{3+} and SCN^- were both 0.234 M.
   i. Find the $[FeSCN^{2+}]$.

   ii. The temperature was then increased to 100°C.
   How will the $[SCN^-]$ change? ***increase, decrease, remain unchanged.*** Explain