Equilibrium Questions

1 What would be the effect, on the yield and the reaction rate, of increasing pressure on these reactions:

(a) $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

(b) $2NO_2(g) \rightleftharpoons N_2O_4(g)$

(c) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

2 What would be the effect of decreased temperature on these reactions? State the effect on the yield and the reaction rates.

(a) $4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$. Reaction enthalpy = -905 kJ mol^{-1}

(b) $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$. This reaction is endothermic.

(c) Acid + alcohol $\rightleftharpoons$ ester + water. The reaction enthalpy is zero.

3 Ammonia is produced in large quantities to make fertilizers. It is made by the Haber process: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. This reaction is exothermic.

(a) If the reaction was at equilibrium, what would happen to the yield of ammonia if

(i) the temperature was increased?

(ii) the pressure was increased?

(iii) a catalyst was added?

(b) What would happen to the reaction rate if

(i) the temperature was increased?

(ii) the pressure was increased?

(iii) a catalyst was added?

(c) What would be the optimum conditions for the production of ammonia? Remember the best yield must be obtained at the fastest rate.