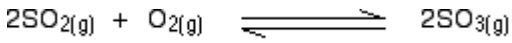
EQUILIBRIUM CONSTANTS AND LE CHATELIER'S PRINCIPLE

1. Which of the following will change the value of an equilibrium constant?

   - increasing the temperature;
   - decreasing the temperature;
   - lowering the concentration of one of the products of the reaction;
   - increasing the concentration of one of the reactants;
   - increasing the pressure on a reaction with different numbers of molecules on each side of the equation;
   - increasing the pressure on a reaction with the same number of molecules on each side of the equation;
   - adding a catalyst to the reaction.

2. The equilibrium at the heart of the Contact Process is



   a) Write the expression for the equilibrium constant, K_C, for this reaction.

   b) Le Chatelier tells us that the percentage conversion of sulphur dioxide into sulphur trioxide is greater if you increase the proportion of oxygen in the reaction mixture. Using the expression you have just written, explain why that is.

3. This question involves the equilibrium in the Haber Process:

   The equilibrium constant K_P is given by the expression:

$$K_P = \frac{P_{NH_3}^2}{P_{N_2} \times P_{H_2}^3}$$

   a) The pressures in this expression are the partial pressures of the various gases. What do you understand by the term *partial pressure*?

   b) The partial pressure of ammonia in the mixture is given by the equation:

   partial pressure of ammonia = mole fraction of ammonia x total pressure of the mixture

   What do you understand by the term *mole fraction*?

   c) Rewrite the K_p expression in terms of the mole fractions of the various gases, and the total pressure, P, of the mixture, simplifying it as much as you can.

d) Use this new expression to explain why the percentage of ammonia in the mixture is increased by raising the total pressure of the system.

e) The value of K_P for this equilibrium changes with temperature. Two values, showing what happens if you increase the temperature, are:

temperature (K)	K_P (atm^{-2})
500	3.55×10^{-2}
700	7.76×10^{-5}

Use the K_p expression at the beginning of this question to explain what will happen to the percentage of ammonia in the equilibrium mixture as the temperature is raised from 500K to 700K.

Explain whether your answer is consistent with predictions from Le Chatelier's Principle.