LE CHATELIER'S PRINCIPLE

1. If a dynamic equilibrium is disturbed by changing the conditions, the position of equilibrium moves to counteract the change.

2. a) A higher percentage would be converted. If you disturb the equilibrium by adding more ethanol, Le Chatelier says that the position of equilibrium will move to remove it again. It can only do that by reacting it with ethanoic acid to make more ethyl ethanoate.

   b) (i) It has no effect. A catalyst speeds up the forward and back reactions equally, and so there is no change in the position of equilibrium.

   (ii) Dilute sulphuric acid contains lots of water, and water appears on the right-hand side of this equilibrium. According to Le Chatelier, the position of equilibrium will move to remove the extra water, which it does by favouring the back reaction. That converts some of the ethyl ethanoate back into ethanoic acid and ethanol again. The equilibrium mixture will now contain less ethyl ethanoate than it would otherwise have done. Well done if you got this right!

3. a) The position of equilibrium would move to the right - more ammonia would be formed. According to Le Chatelier, if you increase the pressure, the system will respond by reducing it again. Pressure is caused by molecules hitting the sides of the container. If you have fewer molecules, then the pressure will be lower. The forward reaction produces 2 molecules for every 4 you started with, and so the forward reaction will cause the pressure to reduce.

   b) You would choose a low temperature. Lowering the temperature, according to Le Chatelier, will cause the reaction to move in such a way as to increase it again. The forward reaction is exothermic, which means that it produces heat energy which would cause the temperature to increase again.

   c) Nitrogen and hydrogen don't actually react at low temperatures, because the activation energy of the reaction is so high. Even at moderately raised temperatures, the reaction is very slow. So although a low temperature might eventually give you a very high percentage conversion of nitrogen and hydrogen into ammonia, you might have to wait a very long time for it to reach equilibrium. From a manufacturer's point of view, that's perhaps not ideal!