Part A: Understanding Le Chatelier's Principle

True or False and give briefly discuss your answer.

_____ Le Chatelier's Principle states: When a chemical system at equilibrium is disturbed, the system shifts to offset or counteract that change.

_____ Since you can not change the concentration of solids or liquids, adding either substance will have no affect on equilibrium.

_____ Temperature has no affect on equilibrium and therefore can be ignored.

_____ In an *exothermic* chemical reaction, heat is a product.

_____ Increasing the temperature causes an *endothermic* reaction to shift towards the products.

Part B: Understanding Le Châtelier's Principle

1. Predict the effect of each of the following disturbances below (a-e) on the concentration of CO_2. (i.e. increase, decrease, of no change). Briefly explain each answer in terms of Le Châtelier's Principle.

$$Ni(s) + CO_2(g) \rightleftharpoons NiO(s) + CO(g) \qquad \Delta H = -520 \text{ kJ/mol}$$

a) removing CO

b) decreasing the volume

c) adding NiO

d) decreasing the temperature

e) adding a catalyst

Part C: Le Châtelier's Principle Calculations

2. An equilibrium mixture of the following reaction at 458 ºC contains 0.112 mol H_2, 0.112 mol I_2 and 0.775 mol HI in a 5.00-L vessel.

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

a) Calculate K_c for this reaction at 458 ºC.

b) Imagine you then add 0.200 mol of HI to the above system at equilibrium. Based on Le Châtelier's Principle, in which direction would you predict the reaction to shift in order to return to equilibrium? Explain your answer in terms of Q_c.

c) Determine the actual concentrations when equilibrium is reestablished following the addition of the 0.200 mol of HI described in question 4b. [Hint: Is there a way to get around using the quadratic equation with this question?]

d) Do the new equilibrium concentrations you found in question 4c agree with the general prediction you made in question 4b? Briefly explain.

3) An equilibrium mixture contains $N_2O_4(g)$ at a partial pressure of 0.28 atm and NO_2 (g) at 1.1 atm; T = 350K. The volume of the container is doubled at constant temperature. Calculate the new pressures after equilibrium has been re-established.

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

a) First, write down the K_p expression.

b) Secondly, based on the partial pressures given in the first sentence, you can calculate a K_p.

c) Third, now the volume is doubled. What do you expect? Which direction will the equilibrium shift?

d) Finally, calculate the new pressures after the system re-establishes equilibrium.