Chemistry 12
Worksheet 2-2
LeChatelier's Principle Name_____

1. In order to decide what effect a ***change in pressure*** will have on an equilibrium system with gases, what is the first thing you should do when given the balanced equation?

   _____

2. Predict which way the following equilibrium systems will shift when the ***pressure*** is ***increased***.(NOTE: Some may have no shift)

   a). $N_{2(g)} + O_{2(g)} \rightleftarrows 2NO_{(g)}$..... Answer_____

   b). $2SO_{2(g)} + O_{2(g)} \rightleftarrows 2SO_{3(g)}$ ..... Answer_____

   c). $4NH_{3(g)} + 5O_{2(g)} \rightleftarrows 4NO_{(g)} + 6H_2O_{(g)}$..... Answer_____

3. Which way will the following equilibrium shift if the ***pressure*** on the system is ***decreased***?

   $2C_2H_{6(g)} + 7O_{2(g)} \rightleftarrows 4CO_{2(g)} + 6H_2O_{(g)}$ Answer_____

4. Explain why a flask filled with $NO_{2(g)}$ and $N_2O_{4(g)}$ will get **darker** when heated. Use the equation: $N_2O_{4(g)} + heat \rightleftarrows 2NO_{2(g)}$

   _____

   _____

   _____

   _____

5. State ***Le Chatelier's Principle***.

   _____

   _____

   _____

6. ***Hydrogen peroxide*** is decomposed as follows:

$$H_2O_{2(l)} \rightleftarrows H_{2(g)} + O_{2(g)} \quad \Delta H = +187\ kJ$$

Predict the ***direction of equilibrium shift*** by each of the following imposed changes:

a) ***Increase*** the $[H_2]$ ..... Answer _____

b) ***Decrease*** the $[O_2]$ ..... Answer _____

c) ***Decrease*** the ***total pressure*** ..... Answer _____

d) ***Increase*** the ***temperature***..... Answer _____

e) Add MnO_2 as a ***catalyst***..... Answer _____

7. Consider the following reaction at equilibrium:

$$H_{2(g)} + I_{2(g)} \rightleftarrows 2HI_{(g)}$$

a) Addition of more H_2 gas to the container will do what to the rate of the forward reaction?

Answer _____

b) If, for a while, the rate of the *forward* reaction is ***greater than*** the rate of the *reverse* reaction, what will happen to the [HI]?

Answer _____

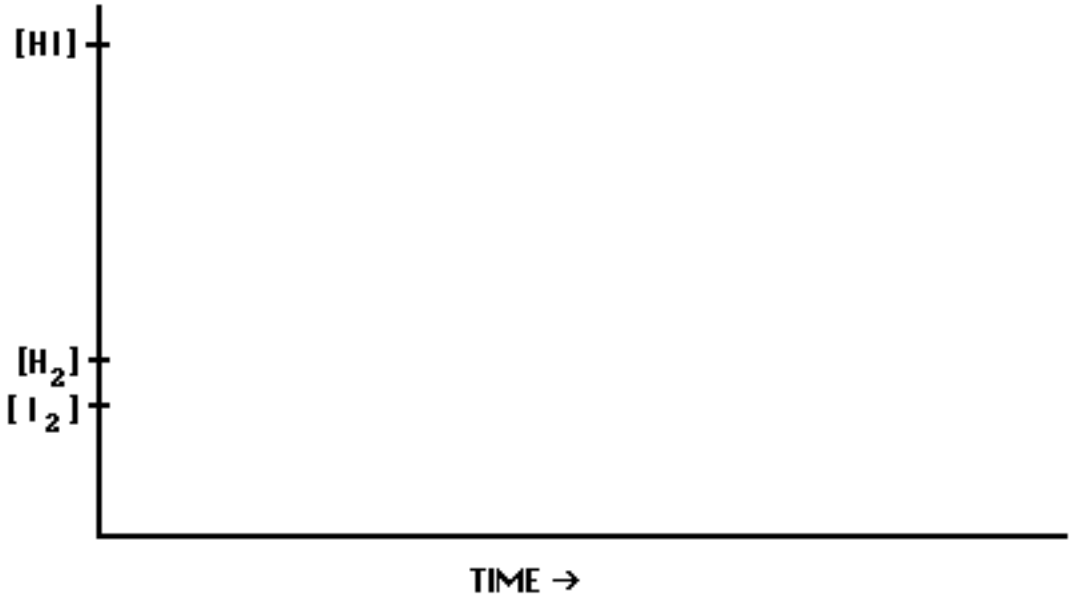
c) As the [HI] is increased, what will happen to the rate of the *reverse* reaction?

Answer _____

d) When the rate of the *reverse* reaction once again becomes ***equal*** to the rate of the *forward* reaction, a new_____ has been reached.

e) Since the rate of the *forward* reaction was, for a while, greater than the rate of the *reverse* reaction, the new equilibrium will have a slightly higher concentration of _____ and a slightly lower concentration of _____ & _____

f) Sketch a graph of the relative concentrations of each species as the process outlined in **a-e** of this question (*on the last page*) is carried out.



8. Consider the following equilibrium and state which way (left or right) the equilibrium shifts when each of the changes below are made.

$$Heat + CH_{4(g)} + 2H_2S_{(g)} \rightleftarrows CS_{2(g)} + 4H_{2(g)}$$

a) CH_4 gas is added ..... Answer _____

b) CS_2 gas is removed..... Answer _____

c) H_2 gas is added ..... Answer _____

d) The *volume* of the container is decreased ..... Answer _____

e) The *temperature* is increased ..... Answer _____

f) The *pressure* is decreased ..... Answer _____

g) Helium gas is added to increase the total pressure.... Answer _____

9. Using the following equilibrium, state what would happen to the equilibrium *partial pressure of CH_3OH gas* when each of the following changes are made:

$$CO_{(g)} + 2H_{2(g)} \rightleftarrows CH_3OH_{(g)} \qquad \Delta H = -75.2\ kJ$$

a) CO gas is added to the container ..... Answer _____

b) The *temperature* is increased ..... Answer _____

c) The *total pressure* of the system is increased..... Answer _____

$$CO_{(g)} + 2H_{2(g)} \rightleftarrows CH_3OH_{(g)} \qquad \Delta H = -75.2\ kJ$$

d) H_2 gas is removed from the system..... Answer _____

e) A *catalyst* is added..... Answer _____

f) The *volume* of the container is increased..... Answer _____

10. For the reaction:

$$2NO_{(g)} + Cl_{2(g)} \rightleftarrows 2NOCl_{(g)} \qquad \Delta H = -77\ kJ$$

state the **optimal pressure and temperature conditions** necessary for maximum production of NOCl.(*high or low?*)

1. _____pressure 2 _____ temperature

11. For the reaction:

$$3H_{2(g)} + N_{2(g)} \rightleftarrows 2NH_{3(g)} + heat$$

state the *optimal conditions* for a **high yield** of ***ammonia (NH_3)***. (*high or low?*)

1. _____pressure 2 _____ temperature

12. Given the following equilibrium system, state which way the equilibrium will shift when the changes below are made:

$$2C_2H_{6(g)} + 7O_{2(g)} \rightleftarrows 4CO_{2(g)} + 6H_2O_{(g)} + heat$$

a) The *volume* of the container is halved..... Answer _____

b) The *temperature* is decreased ..... Answer _____

c) CO_2 is added to the container..... Answer _____

d) The *pressure* is increased ..... Answer _____

e) O_2 gas is removed from the system ..... Answer _____

f) Neon gas is added to increase the pressure ..... Answer _____

h) A *catalyst* is added..... Answer _____

13. Using the equilibrium: $N_{2(g)} + O_{2(g)} + heat \rightleftarrows 2NO_{(g)}$
Explain why nitric oxide (NO) does ***not*** generally form in the atmosphere but ***is*** formed in the internal combustion engine of an automobile or during a lightning storm.

_____

14. Explain why a syringe containing NO_2 gas will first get *darker* and ***then lighter*** in colour when compressed. Use the equilibrium equation:

$$\underset{\text{colourless}}{N_2O_{4(g)}} + heat \rightleftarrows \underset{\text{brown}}{2NO_{2(g)}}$$

_____

_____

15. Explain why a flask containing NO_2 will get *lighter* in colour when put into *ice water*. Use the equation:

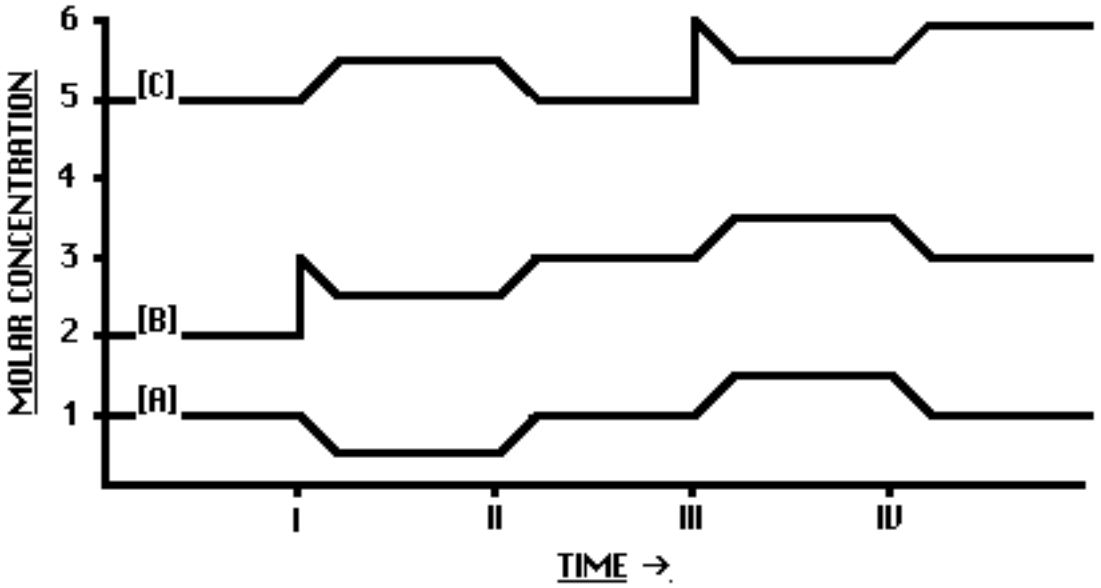
$$\underset{\text{colourless}}{N_2O_{4(g)}} + heat \rightleftarrows \underset{\text{brown}}{2NO_{2(g)}}$$

_____

_____

16. Given the following graph showing the concentrations of species A, B and C, state what changes in **temperature** or **concentration** are responsible for each of the shifts shown on the graph. The equilibrium equation is:

$$A_{(g)} + B_{(g)} \rightleftarrows C_{(g)} \qquad \Delta H = -65\ kJ$$



a) At time I, the _____

b) At time II, the _____

c) At time III, the _____

d) At time IV, the _____

17. Given the equilibrium equation:

$$XY_{(g)} + heat \rightleftarrows X_{(g)} + Y_{(g)}$$

If initially, at equilibrium, the [XY] = 3.0 M, the [X] = 5.0 M and the [Y] = 6.0 M, draw a graph *similar to the one in question 16* showing qualitatively what happens to the concentrations of each species as the following changes are made to the system:

Time I - The *temperature is increased*.
Time II - Some $X_{(g)}$ is *added* to the system
Time III - Some $Y_{(g)}$ is *removed* from the system
Time IV - The *temperature is decreased*.