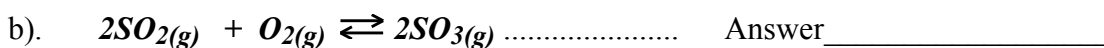
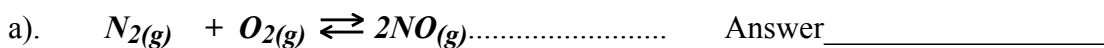


Chemistry 12
LE CHATELIER'S PRINCIPLE

1. In order to decide what effect a **change in total 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 **total pressure** is **increased**. (NOTE: Some may have no shift)



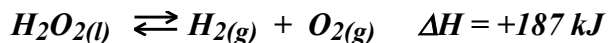
3. Which way will the following equilibrium shift if the **total pressure** on the system is **decreased**?



4. Explain why a flask filled with $NO_2(g)$ (dark brown) and $N_2O_4(g)$ (colourless) will get **darker** when heated. Use the equation: $N_2O_4(g) + \text{heat} \rightleftharpoons 2NO_2(g)$

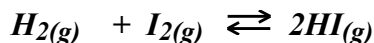
5. State **Le Chatelier's Principle**.

6. *Hydrogen peroxide* is decomposed as follows:



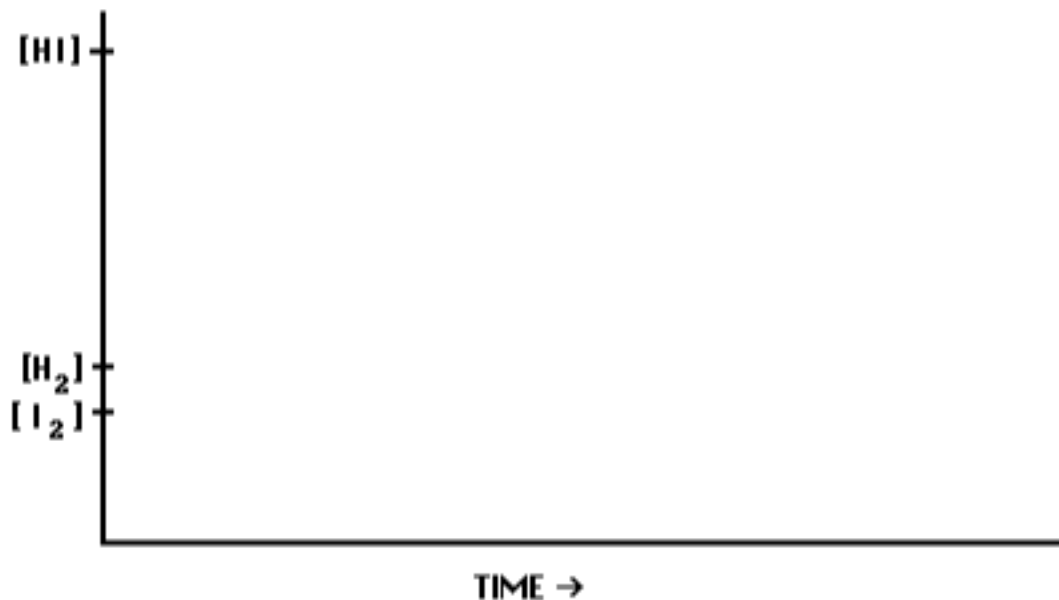
Predict the *direction of equilibrium shift* by each of the following imposed changes:

- a) **Increase** the $[\text{H}_2]$ Answer _____
- b) **Decrease** the $[\text{O}_2]$ 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:

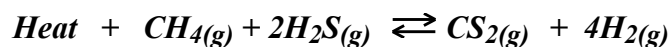


- a) Addition of more H_2 gas to the container will do what to the rate of the forward reaction?
Answer _____
- b) If, for a while, the rate of the *forward* reaction is **greater than** the rate of the *reverse* reaction, what will happen to the $[\text{HI}]$?
Answer _____
- c) As the $[\text{HI}]$ 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 _____ & _____

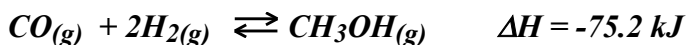
- f) Sketch a graph of the relative concentrations of each species as the process outlined in a-e of this question (on the last page) is carried out.



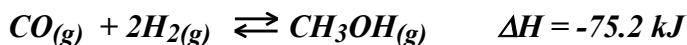
8. Consider the following equilibrium and state which way (left or right) the equilibrium shifts when each of the changes below are made.



- a) CH₄ gas is added Answer _____
- b) CS₂ gas is removed..... Answer _____
- c) H₂ gas is added Answer _____
- d) The *total volume* of the container is decreased Answer _____
- e) The *temperature* is increased Answer _____
- f) The *total 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 CH₃OH gas* when each of the following changes are made:

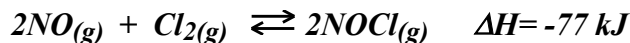


- a) CO gas is added to the container Answer _____
- b) The *temperature* is increased Answer _____
- c) The *total pressure* of the system is increased..... Answer _____



- d) H₂ gas is removed from the system..... Answer _____
- e) A *catalyst* is added..... Answer _____
- f) The *total volume* of the container is increased..... Answer _____

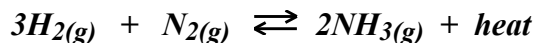
10. For the reaction:



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

1. _____ pressure 2. _____ temperature

11. For the reaction:



state the *optimal conditions* for a **high yield** of *ammonia* (NH₃). (*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:



- a) The *volume* of the container is halved..... Answer _____
- b) The *temperature* is decreased Answer _____
- c) CO₂ is added to the container..... Answer _____
- d) The *total pressure* is increased Answer _____
- e) O₂ gas is removed from the system Answer _____
- f) Neon gas is added to increase the total pressure Answer _____
- h) A *catalyst* is added..... Answer _____

13. Using the equilibrium: $\text{N}_{2(g)} + \text{O}_{2(g)} + \text{heat} \rightleftharpoons 2\text{NO}_{(g)}$

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.

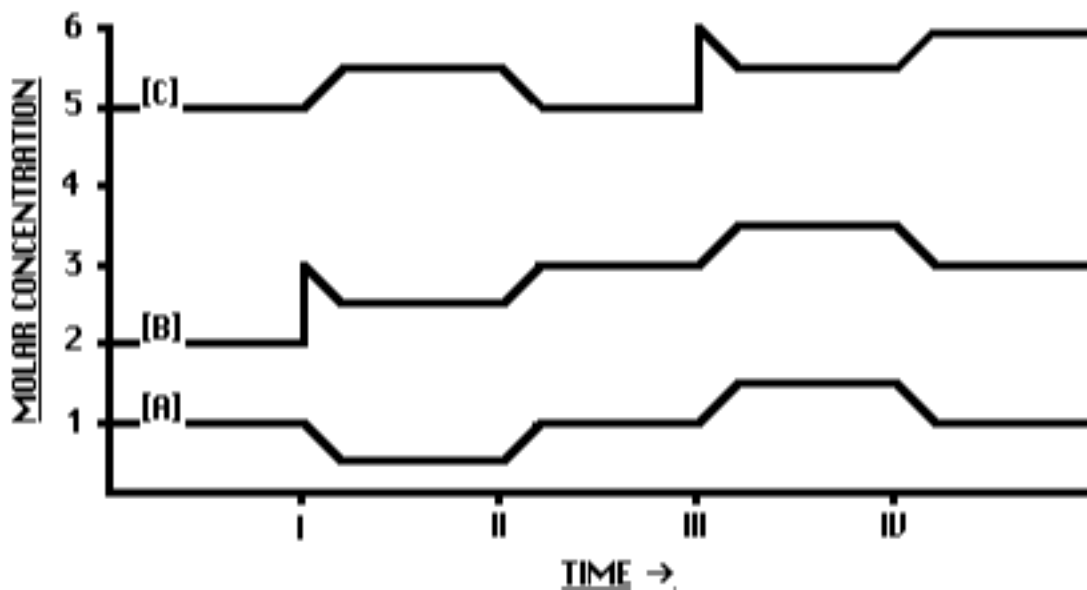
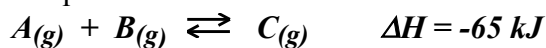
14. Explain why a syringe containing NO₂ gas will first get *darker* and *then lighter* in colour when compressed. Use the equilibrium equation:



15. Explain why a flask containing NO₂ will get *lighter* in colour when put into *ice water*. Use the equation:

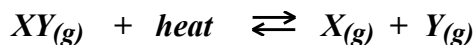


16. Given the following graph showing the concentrations of species A, B and C, state what changes in **temperature** or **concentration** are responsible for each of the shifts shown on the graph. The equilibrium equation is:



- a) At time I, _____
- b) At time II, _____
- c) At time III, _____
- d) At time IV, _____

17. Given the equilibrium equation:



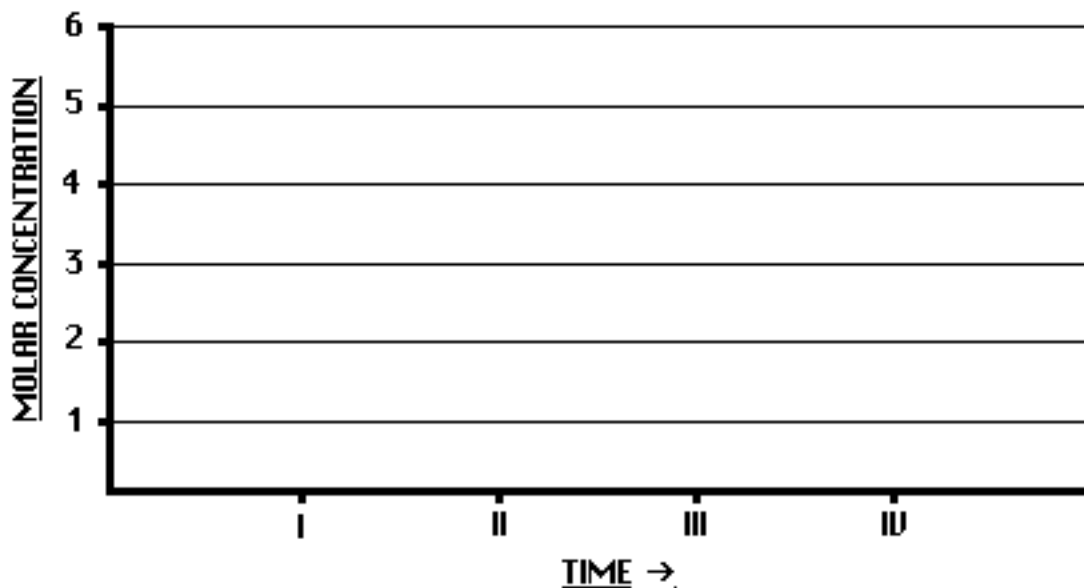
If initially, at equilibrium, the $[XY] = 3.0 \text{ M}$, the $[X] = 5.0 \text{ M}$ and the $[Y] = 6.0 \text{ M}$, draw a graph *similar to the one in question 16* showing qualitatively what happens to the concentrations of each species as the following changes are made to the system:

Time I - The *temperature is increased*.

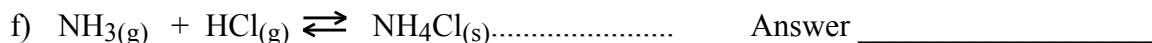
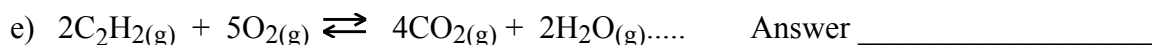
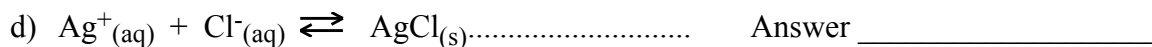
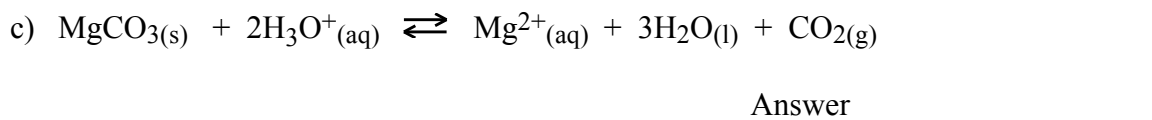
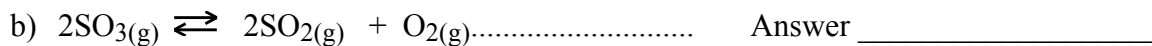
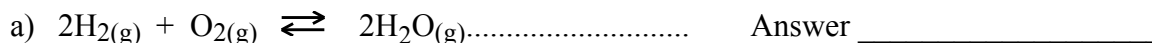
Time II - Some $X_{(g)}$ is *added* to the system

Time III - Some $Y_{(g)}$ is *removed* from the system

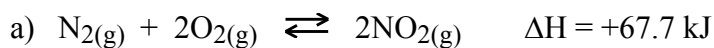
Time IV - The *temperature is decreased*.



18. For each of the following reactions, predict whether the *entropy* increases or decreases.



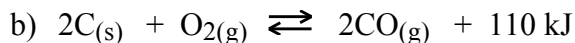
19. On the basis of **enthalpy** and **entropy**, predict whether each of the following reactions would be **spontaneous as written** or not at room temperature.



Minimum enthalpy favours (reactants/products)

Maximum entropy favours (reactants/products)

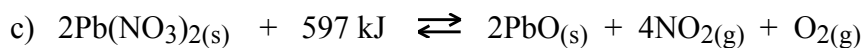
Spontaneous as written? (yes/no) Answer



Minimum enthalpy favours (reactants/products)

Maximum entropy favours (reactants/products)

Spontaneous as written? (yes/no) Answer



Minimum enthalpy favours (reactants/products)

Maximum entropy favours (reactants/products)

Spontaneous as written? (yes/no) Answer