Chemistry 12

LE CHATELIER SHIFTS

A NOTE ON HOW TO SOLVE THE FOLLOWING EXERCISES

Be careful to separate two things in your mind:
- what you do to the equilibrium, and
- what the equilibrium does in response to your changes.

In deciding how an equilibrium responds, ask yourself these questions:

What is being done to the system?
The opposite of the change imposed on the system will be what the system does.

or

What is the system doing?
The opposite of what the system does is the change imposed on the system.

***EXERCISES*:**

A. Use Le Chatelier's Principle to describe the effect of the following changes on the position of the equilibrium.

17. The equilibrium is: $N_2O_3(g) \rightleftharpoons NO(g) + NO_2(g)$.
    a) increase the [NO]
    b) increase the $[N_2O_3]$
    c) increase the pressure by decreasing the volume
    d) add a catalyst

18. The equilibrium is: $2\,H_2(g) + 2\,NO(g) \rightleftharpoons N_2(g) + 2\,H_2O(g)$.
    a) decrease the $[N_2]$
    b) decrease the [NO]
    c) decrease the pressure by increasing the volume

19. The equilibrium is: $2\,CO(g) + O_2(g) \rightleftharpoons 2\,CO_2(g) + 566\ kJ$.
    a) increase the temperature
    b) increase the $[O_2]$
    c) introduce a catalyst

20. The equilibrium is: $I_2(g) + Cl_2(g) \rightleftharpoons 2\,ICl(g)$; $\Delta H = 35.0$ kJ.
    a) decrease the temperature
    b) decrease the $[Cl_2]$
    c) increase the pressure by decreasing the volume

B. For each of Exercises 21 – 23, describe the effect on the concentration of the bold substance by the following changes. Write **INC** for increase, **DEC** for decrease or **NC** for no change.

21. The equilibrium is: $N_2(g) + 3\,\mathbf{H_2(g)} \rightleftharpoons 2\,NH_3(g)$; $\Delta H = -92$ kJ.
    a) increase the $[N_2]$
    b) increase the temperature
    c) increase the volume
    d) add a catalyst

22. The equilibrium is: $2\,HF(g) \rightleftharpoons \mathbf{F_2(g)} + H_2(g)$; $\Delta H = 536$ kJ.
    a) decrease the temperature
    b) decrease the $[H_2]$
    c) decrease the volume

23. The equilibrium is: $SnO_2(s) + 2\,CO(g) \rightleftharpoons Sn(s) + \mathbf{2\,CO_2(g)}$; $\Delta H = 13$ kJ.
    a) increase the temperature
    b) add a catalyst
    c) increase the [CO]

C. Show the following situations graphically.

NOTE: In Exercises 24–26 the relative positioning of the molecules is not relevant; simply place them on the graph so the reactants are separated from the products. The only thing required here is to show what an individual substance's concentration does after the conditions change.

24. The equilibrium is: $H_2(g) + I_2(g) \rightleftharpoons 2\,HI(g) + 52\,kJ$.
    a) increase the temperature
    b) inject some $H_2(g)$
    c) decrease the volume
    d) add a catalyst

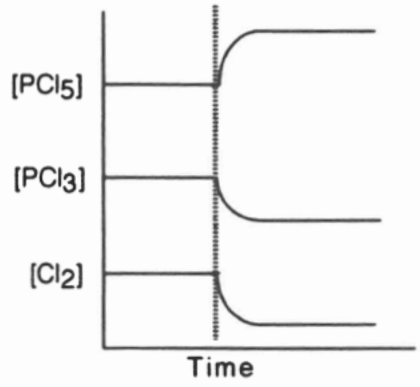
25. The equilibrium is: $2\,SO_2(g) + O_2(g) \rightleftharpoons 2\,SO_3(g)$; $\Delta H = -197$ kJ.
    a) inject some $SO_2(g)$
    b) increase the volume
    c) decrease the temperature
    d) increase the $[SO_3]$

26. The equilibrium is: $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$; $\Delta H = -41$ kJ.
    a) inject some $CO_2(g)$
    b) remove some of the $H_2O(g)$ with a very rapidly acting drying agent
    c) increase the temperature
    d) decrease the pressure by increasing the volume

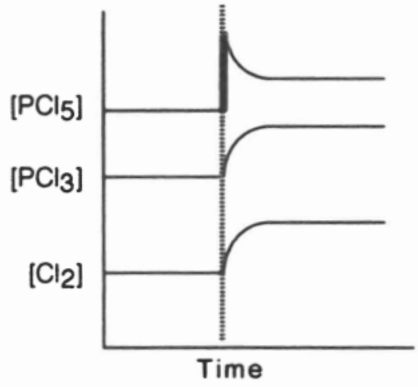
D. Interpret the following graphs in terms of the changes which must have been imposed on the equilibrium.

27. The equilibrium is: $PCl_5(g) + 92.5\,kJ \rightleftharpoons PCl_3(g) + Cl_2(g)$.

a)

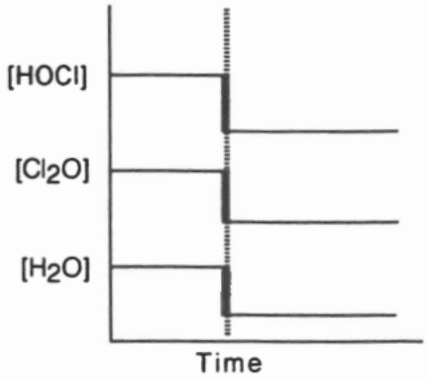


b)



28. The equilibrium is: $H_2O(g) + Cl_2O(g) \rightleftharpoons 2\,HOCl(g) + 70\,kJ$.

a)



b)