

Chapter 17

Equilibrium

I. Matching

Match the description in Column B with the correct term in Column A. Write the letter in the blank provided. Each term matches with only one description, so be sure to choose the best description for each term.

Column A

- _____ 1. activation energy
- _____ 2. catalyst
- _____ 3. enzyme
- _____ 4. equilibrium
- _____ 5. chemical equilibrium
- _____ 6. equilibrium expression
- _____ 7. equilibrium position
- _____ 8. homogeneous equilibrium
- _____ 9. heterogeneous equilibrium
- _____ 10. LeChatelier's principle
- _____ 11. solubility product

Column B

- A. substances in a system are in more than one state
- B. dynamic state where concentrations of all reactants and products remain constant
- C. set of equilibrium concentrations
- D. equilibrium expression for a solid dissolving in water
- E. minimum amount of energy required for a reaction to occur
- F. exact balancing of two processes, one of which is the opposite of the other
- G. biological catalyst
- H. when a change is imposed on a system at equilibrium, the position of the equilibrium shifts in the direction that reduces the effect of the change
- I. substance that speeds up a reaction without being consumed
- J. special ratio of concentrations of products to concentrations of reactants
- K. all substances in a system are in the same state

II. Multiple Choice

Choose the one best answer and write its letter in the blank.

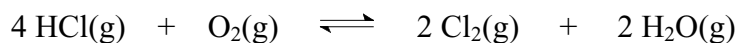
- _____ 12. Increasing the surface area of reactants generally
- a) increases the rate of a reaction. c) stops a reaction entirely.
b) decreases the rate of a reaction. d) has no effect on the rate of a reaction.

- _____ 13. Adding a catalyst generally speeds up the rate of a reaction by
- a) raising the activation energy. c) raising the heat of the reaction.
b) lowering the activation energy. d) lowering the heat of the reaction.

- _____ 14. How chemical reactions occur is generally explained by using
- a) the quantum mechanical model of the atom.
b) probability calculations.
c) the Heisenberg uncertainty principle.
d) the collision model.

- _____ 15. Biochemical changes that occur in the human body are assisted by catalysts called
- a) pharmaceuticals.
b) inhibitors.
c) enzymes.
d) cooperators.

- _____ 16. The equilibrium expression for the reaction



would be

a)
$$K = \frac{[\text{HCl}][\text{O}_2]}{[\text{Cl}_2][\text{H}_2\text{O}]}$$

c)
$$K = \frac{[\text{Cl}_2]^2[\text{H}_2\text{O}]^2}{[\text{HCl}]^4[\text{O}_2]}$$

b)
$$K = \frac{[\text{HCl}]^4[\text{O}_2]}{[\text{Cl}_2]^2[\text{H}_2\text{O}]^2}$$

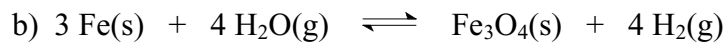
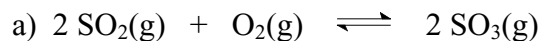
d)
$$K = \frac{[2\text{Cl}_2][2\text{H}_2\text{O}]}{[4\text{HCl}][\text{O}_2]}$$

- _____ 17. If $K = 4.5 \times 10^{-11}$ for a reaction, which of the following would be true?
- reactants are favored at equilibrium
 - products are favored at equilibrium
 - reactants and products are equally favored at equilibrium
 - the reaction proceeds very rapidly
- _____ 18. For the system $\text{SO}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightleftharpoons \text{SO}_2\text{Cl}_2(\text{g})$ at equilibrium, adding $\text{Cl}_2(\text{g})$ to the reaction container will have which of the following effects?
- the reaction will shift to the right
 - the concentration of $\text{SO}_2\text{Cl}_2(\text{g})$ will increase
 - the concentration of $\text{SO}_2(\text{g})$ will decrease
 - all of the above will occur
- _____ 19. If the equilibrium concentrations of $\text{A}(\text{g}) + 2 \text{B}(\text{g}) \rightleftharpoons \text{C}(\text{g})$ are found to be $[\text{A}] = 0.015 \text{ M}$, $[\text{B}] = 2.0 \times 10^{-4} \text{ M}$, and $[\text{C}] = 3.0 \times 10^{-9} \text{ M}$, the equilibrium constant would be:
- 5.0
 - 0.20
 - 1.0×10^{-3}
 - 9.0×10^{-15}
- _____ 20. For the endothermic reaction $\text{A}(\text{g}) + 2 \text{B}(\text{g}) \rightleftharpoons \text{C}(\text{g})$, which of the following will drive the reaction towards the products?
- lowering the temperature
 - decreasing the volume
 - adding more $\text{C}(\text{g})$
 - removing some $\text{A}(\text{g})$
- _____ 21. The equilibrium expression for the reaction
- $$4 \text{CuO}(\text{s}) \rightleftharpoons 2 \text{Cu}_2\text{O}(\text{s}) + \text{O}_2(\text{g})$$
- would be:
- $$K = \frac{[\text{Cu}_2\text{O}][\text{O}_2]}{[\text{CuO}]}$$
 - $$K = \frac{[\text{Cu}_2\text{O}]^2[\text{O}_2]}{[\text{CuO}]^4}$$
 - $$K = \frac{[\text{CuO}]^4}{[\text{Cu}_2\text{O}][\text{O}_2]^2}$$
 - $$K = [\text{O}_2]$$

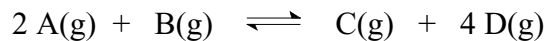
III. Free Response

Answer the questions in the space provided. Show your work for any calculations.

22. Write equilibrium expressions for the following reactions:



23. Calculate the equilibrium constant for the following reaction if at equilibrium the concentrations of the reactants and products are as follows: $[\text{A}] = 0.025 \text{ M}$, $[\text{B}] = 0.450 \text{ M}$, $[\text{C}] = 1.2 \text{ M}$ and $[\text{D}] = 0.30 \text{ M}$.



24. K_{sp} for $\text{MgF}_2 = 3.7 \times 10^{-8}$. For a saturated MgF_2 solution, the $[\text{F}^-]$ concentration is found to be $4.2 \times 10^{-3} \text{ M}$. Calculate the $[\text{Mg}^{2+}]$.

25. K_{sp} for $\text{PbI}_2 = 7.1 \times 10^{-9}$ at 25°C . Calculate the solubility of PbI_2 in grams/liter at this temperature.