

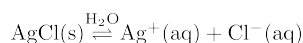
1. Which equation represents a chemical equilibrium?

- A) $\text{N}_2(\ell) \rightleftharpoons \text{N}_2(\text{g})$
 B) $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
 C) $\text{CO}_2(\text{s}) \rightleftharpoons \text{CO}_2(\text{g})$
 D) $\text{NH}_3(\ell) \rightleftharpoons \text{NH}_3(\text{g})$

2. When a reversible reaction is at equilibrium, the concentration of products and the concentration of reactants must be

- A) decreasing B) increasing
 C) constant D) equal

3. Given the equation representing a system at equilibrium:



When the concentration of $\text{Cl}^-(\text{aq})$ is increased, the concentration of $\text{Ag}^+(\text{aq})$

- A) decreases, and the amount of $\text{AgCl}(\text{s})$ increases
 B) decreases, and the amount of $\text{AgCl}(\text{s})$ decreases
 C) increases, and the amount of $\text{AgCl}(\text{s})$ increases
 D) increases, and the amount of $\text{AgCl}(\text{s})$ decreases

4. Some solid KNO_3 remains at the bottom of a stoppered flask containing a saturated $\text{KNO}_3(\text{aq})$ solution at 22°C . Which statement explains why the contents of the flask are at equilibrium?

- A) The rate of dissolving is equal to the rate of crystallization.
 B) The rate of dissolving is greater than the rate of crystallization.
 C) The concentration of the solid is equal to the concentration of the solution.
 D) The concentration of the solid is greater than the concentration of the solution.

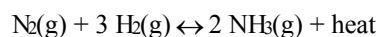
5. Which type of equilibrium exists in a sealed flask containing $\text{Br}_2(\ell)$ and $\text{Br}_2(\text{g})$ at 298 K and 1.0 atm?

- A) static phase equilibrium
 B) static solution equilibrium
 C) dynamic phase equilibrium
 D) dynamic solution equilibrium

6. Which balanced equation represents a phase equilibrium?

- A) $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$
 B) $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$ C) $\text{Cl}_2(\text{g}) \rightleftharpoons \text{Cl}_2(\ell)$
 D) $3\text{O}_2(\text{g}) \rightleftharpoons 2\text{O}_3(\text{g})$

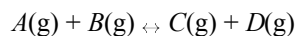
7. Ammonia is produced commercially by the Haber reaction:



The formation of ammonia is favored by

- A) an increase in pressure B) a decrease in pressure
 C) removal of $\text{N}_2(\text{g})$ D) removal of $\text{H}_2(\text{g})$

8. Given the reaction at equilibrium:



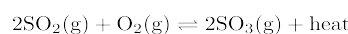
The addition of a catalyst will

- A) shift the equilibrium to the right
 B) shift the equilibrium to the left
 C) increase the rate of forward and reverse reactions equally
 D) have no effect on the forward or reverse reactions

9. What occurs when a catalyst is added to a chemical reaction?

- A) an alternate reaction pathway with a lower activation energy
 B) an alternate reaction pathway with a higher activation energy
 C) the same reaction pathway with a lower activation energy
 D) the same reaction pathway with a higher activation energy

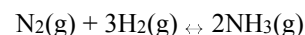
10. Given the equation representing a reaction at equilibrium:



Which change causes the equilibrium to shift to the right?

- A) adding a catalyst
 B) adding more $\text{O}_2(\text{g})$
 C) decreasing the pressure
 D) increasing the temperature

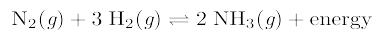
11. Given the equation representing a reaction at equilibrium:



What occurs when the concentration of $\text{H}_2(\text{g})$ is increased?

- A) The equilibrium shifts to the left, and the concentration of $\text{N}_2(\text{g})$ decreases.
 B) The equilibrium shifts to the left, and the concentration of $\text{N}_2(\text{g})$ increases.
 C) The equilibrium shifts to the right, and the concentration of $\text{N}_2(\text{g})$ decreases.
 D) The equilibrium shifts to the right, and the concentration of $\text{N}_2(\text{g})$ increases

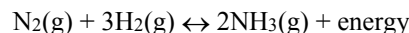
12. Given the equation representing a reaction at equilibrium:



Which change causes the equilibrium to shift to the right?

- A) decreasing the concentration of $\text{H}_2(g)$
- B) decreasing the pressure
- C) increasing the concentration of $\text{N}_2(g)$
- D) increasing the temperature

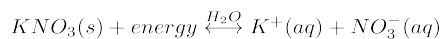
13. Given the equation representing a system at equilibrium:



Which changes occur when the temperature of this system is *decreased*?

- A) The concentration of $\text{H}_2(g)$ increases and the concentration of $\text{N}_2(g)$ increases.
- B) The concentration of $\text{H}_2(g)$ decreases and the concentration of $\text{N}_2(g)$ increases.
- C) The concentration of $\text{H}_2(g)$ decreases and the concentration of $\text{NH}_3(g)$ decreases.
- D) The concentration of $\text{H}_2(g)$ decreases and the concentration of $\text{NH}_3(g)$ increases.

14. Given the equation representing a system at equilibrium:



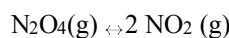
Which change causes the equilibrium to shift?

- A) increasing pressure
- B) increasing temperature
- C) adding a noble gas
- D) adding a catalyst

15. Which system at equilibrium will shift to the right when the pressure is increased?

- A) $\text{NaCl}(s) \xrightleftharpoons{\text{H}_2\text{O}} \text{Na}^+(aq) + \text{Cl}^-(aq)$
- B) $\text{C}_2\text{H}_5\text{OH}(l) \xrightleftharpoons{\text{H}_2\text{O}} \text{C}_2\text{H}_5\text{OH}(aq)$
- C) $\text{NH}_3(g) \xrightleftharpoons{\text{H}_2\text{O}} \text{NH}_3(aq)$
- D) $\text{C}_6\text{H}_{12}\text{O}_6(s) \xrightleftharpoons{\text{H}_2\text{O}} \text{C}_6\text{H}_{12}\text{O}_6(aq)$

16. Given the equilibrium reaction at STP:



Which statement correctly describes this system?

- A) The forward and reverse reaction rates are equal.
- B) The forward and reverse reaction rates are both increasing.
- C) The concentrations of N_2O_4 and NO_2 are equal.
- D) The concentrations of N_2O_4 and NO_2 are both increasing.