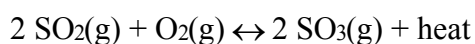


1. Ammonia is produced commercially by the Haber reaction:



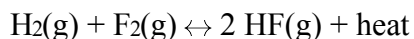
The formation of ammonia is favored by

- A) an increase in pressure
  - B) a decrease in pressure
  - C) removal of  $\text{N}_2(\text{g})$
  - D) removal of  $\text{H}_2(\text{g})$
2. Given the reaction at equilibrium:



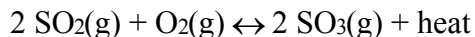
Which change will shift the equilibrium to the right?

- A) increasing the temperature
  - B) increasing the pressure
  - C) decreasing the amount of  $\text{SO}_2(\text{g})$
  - D) decreasing the amount of  $\text{O}_2(\text{g})$
3. Given the system at equilibrium:



Which change will *not* shift the point of equilibrium?

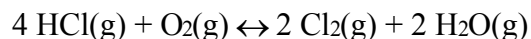
- A) changing the pressure
  - B) changing the temperature
  - C) changing the concentration of  $\text{H}_2(\text{g})$
  - D) changing the concentration of  $\text{HF}(\text{g})$
4. Given the reaction at equilibrium:



The concentration of  $\text{SO}_3(\text{g})$  may be increased by

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

5. Given the reaction at equilibrium:



If the pressure on the system is increased, the concentration of  $\text{Cl}_2(\text{g})$  will

- A) decrease
- B) increase
- C) remain the same

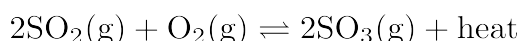
6. Given the closed system at equilibrium:



As the pressure on the system increases, the solubility of the  $\text{CO}_2(\text{g})$

- A) decreases
- B) increases
- C) remains the same

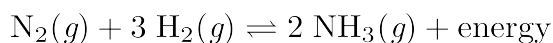
7. Given the equation representing a reaction at equilibrium:



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

8. Given the equation representing a reaction at equilibrium:



Which change causes the equilibrium to shift to the right?

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

9. Given the system at equilibrium:

$2 \text{POCl}_3(g) + \text{energy} \rightleftharpoons 2 \text{PCl}_3(g) + \text{O}_2(g)$   
Which changes occur when  $\text{O}_2(g)$  is added to this system?

- A) The equilibrium shifts to the right and the concentration of  $\text{PCl}_3(g)$  increases.
- B) The equilibrium shifts to the right and the concentration of  $\text{PCl}_3(g)$  decreases.
- C) The equilibrium shifts to the left and the concentration of  $\text{PCl}_3(g)$  increases.
- D) The equilibrium shifts to the left and the concentration of  $\text{PCl}_3(g)$  decreases.

10. Given the reaction at equilibrium:

$\text{N}_2(g) + \text{O}_2(g) + \text{energy} \leftrightarrow 2 \text{NO}(g)$   
Which change will result in a *decrease* in the amount of  $\text{NO}(g)$  formed?

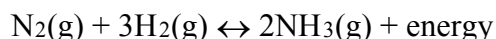
- A) decreasing the pressure
- B) decreasing the concentration of  $\text{N}_2(g)$
- C) increasing the concentration of  $\text{O}_2(g)$
- D) increasing the temperature

11. Given the reaction at equilibrium:

$A(g) + B(g) \rightleftharpoons AB(g) + \text{heat}$   
The concentration of  $A(g)$  can be increased by

- A) lowering the temperature
- B) adding a catalyst
- C) increasing the concentration of  $AB(g)$
- D) increasing the concentration of  $B(g)$

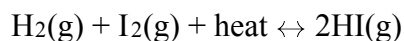
12. Given the equation representing a system at equilibrium:



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.

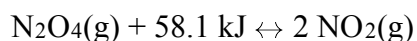
13. Given the equation representing a reaction at equilibrium:



Which change favors the reverse reaction?

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

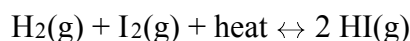
14. Given the system at equilibrium:



What will be the result of an increase in temperature at constant pressure?

- A) The equilibrium will shift to the left, and the concentration of  $\text{NO}_2(g)$  will decrease.
- B) The equilibrium will shift to the left, and the concentration of  $\text{NO}_2(g)$  will increase.
- C) The equilibrium will shift to the right, and the concentration of  $\text{NO}_2(g)$  will decrease.
- D) The equilibrium will shift to the right, and the concentration of  $\text{NO}_2(g)$  will increase.

15. Given the equilibrium reaction in a closed system:



What will be the result of an increase in temperature?

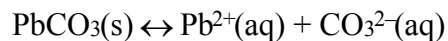
- A) The equilibrium will shift to the left and  $[\text{H}_2]$  will increase.
- B) The equilibrium will shift to the left and  $[\text{H}_2]$  will decrease.
- C) The equilibrium will shift to the right and  $[\text{HI}]$  will increase.
- D) The equilibrium will shift to the right and  $[\text{HI}]$  will decrease.

16. What occurs when the temperature is increased in a system at equilibrium at constant pressure?

- A) The rate of the forward reaction increases, and the rate of the reverse reaction decreases.
- B) The rate of the forward reaction decreases, and the rate of the reverse reaction increases.
- C) The rate of the endothermic reaction increases.
- D) The rate of the exothermic reaction decreases.

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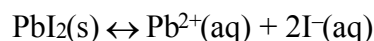
17. Given the system at equilibrium:



How will the addition of  $\text{Na}_2\text{CO}_3(\text{aq})$  affect  $[\text{Pb}^{2+}](\text{aq})$  and the mass of  $\text{PbCO}_3(\text{s})$ ?

- A)  $[\text{Pb}^{2+}](\text{aq})$  will decrease and the mass of  $\text{PbCO}_3(\text{s})$  will decrease.
- B)  $[\text{Pb}^{2+}](\text{aq})$  will decrease and the mass of  $\text{PbCO}_3(\text{s})$  will increase.
- C)  $[\text{Pb}^{2+}](\text{aq})$  will increase and the mass of  $\text{PbCO}_3(\text{s})$  will decrease.
- D)  $[\text{Pb}^{2+}](\text{aq})$  will increase and the mass of  $\text{PbCO}_3(\text{s})$  will increase.

18. Given the solution at equilibrium:



The addition of which nitrate salt will cause a decrease in the concentration of  $\text{I}^{-}(\text{aq})$ ?

- A)  $\text{Pb}(\text{NO}_3)_2$
- B)  $\text{Ca}(\text{NO}_3)_2$
- C)  $\text{LiNO}_3$
- D)  $\text{KNO}_3$

19. When a chemical reaction is at equilibrium, the concentration of each reactant and the concentration of each product must be

- A) constant
- B) variable
- C) equal
- D) zero

20. Which statement describes a chemical reaction at equilibrium?

- A) The products are completely consumed in the reaction.
- B) The reactants are completely consumed in the reaction.
- C) The concentrations of the products and reactants are equal.
- D) The concentrations of the products and reactants are constant.

21. Given the equation representing a closed system:



Which statement describes this system at equilibrium?

- A) The volume of the  $\text{NO}_2(\text{g})$  is greater than the volume of the  $\text{N}_2\text{O}_4(\text{g})$ .
  - B) The volume of the  $\text{NO}_2(\text{g})$  is less than the volume of the  $\text{N}_2\text{O}_4(\text{g})$ .
  - C) The rate of the forward reaction and the rate of the reverse reaction are equal.
  - D) The rate of the forward reaction and the rate of the reverse reaction are unequal.
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