

**CHEM II Rate of Reactions and Equilibrium****Multiple Choice**

Identify the choice that best completes the statement or answers the question. Please show all work for full credit.

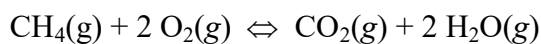
- \_\_\_\_\_ 1. Write a balanced reaction for which the following rate relationships are true.

$$\text{Rate} = -\frac{1}{2} \frac{\Delta[\text{N}_2\text{O}_5]}{\Delta t} = \frac{1}{4} \frac{\Delta[\text{NO}_2]}{\Delta t} = \frac{\Delta[\text{O}_2]}{\Delta t}$$

- a.  $2 \text{N}_2\text{O}_5 \rightarrow 4 \text{NO}_2 + \text{O}_2$   
b.  $4 \text{NO}_2 + \text{O}_2 \rightarrow 2 \text{N}_2\text{O}_5$   
c.  $2 \text{N}_2\text{O}_5 \rightarrow \text{NO}_2 + 4 \text{O}_2$   
d.  $\frac{1}{4} \text{NO}_2 + \text{O}_2 \rightarrow \frac{1}{2} \text{N}_2\text{O}_5$   
e.  $\frac{1}{2} \text{N}_2\text{O}_5 \rightarrow \frac{1}{4} \text{NO}_2 + \text{O}_2$
- \_\_\_\_\_ 2. Give the characteristic of a first-order reaction having only one reactant.
- a. The rate of the reaction is not proportional to the concentration of the reactant.  
b. The rate of the reaction is proportional to the square of the concentration of the reactant.  
c. The rate of the reaction is proportional to the square root of the concentration of the reactant.  
d. The rate of the reaction is proportional to the natural logarithm of the concentration of the reactant.  
e. The rate of the reaction is directly proportional to the concentration of the reactant.
- \_\_\_\_\_ 3. A rate is equal to 0.0200 M/s. If  $[\text{A}] = 0.100 \text{ M}$  and  $\text{rate} = k[\text{A}]^0$ , what is the new rate if the concentration of  $[\text{A}]$  is increased to 0.200 M?
- a. 0.0200 M/s  
b. 0.0400 M/s  
c. 0.0600 M/s  
d. 0.0800 M/s  
e. 0.100 M/s
- \_\_\_\_\_ 4. A rate is equal to 0.0200 M/s. If  $[\text{A}] = 0.100 \text{ M}$  and  $\text{rate} = k[\text{A}]^0[\text{B}]^2$ , what is the new rate if the concentration of  $[\text{A}]$  is increased to 0.200 M?
- a. 0.0200 M/s  
b. 0.0400 M/s  
c. 0.0600 M/s  
d. 0.0800 M/s  
e. 0.100 M/s

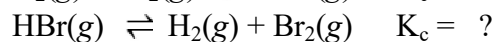
- \_\_\_\_\_ 5. What data should be plotted to show that experimental concentration data fits a first-order reaction?
- 1/[reactant] vs. time
  - [reactant] vs. time
  - ln[reactant] vs. time
  - ln(k) vs. 1/T
  - ln(k) vs.  $E_a$
- \_\_\_\_\_ 6. Identify the rate-determining step.
- the slowest step
  - the faster step
  - the fast step
  - always the last step
  - always the second step
- \_\_\_\_\_ 7. Given the following balanced equation, determine the rate of reaction with respect to  $[\text{SO}_3]$ .
- $$2 \text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{SO}_3(\text{g})$$
- Rate =  $-\frac{1}{2} \frac{\Delta[\text{SO}_3]}{\Delta t}$
  - Rate =  $+\frac{1}{2} \frac{\Delta[\text{SO}_3]}{\Delta t}$
  - Rate =  $+\frac{\Delta[\text{SO}_3]}{\Delta t}$
  - Rate =  $-\frac{3 \Delta[\text{SO}_3]}{\Delta t}$
  - It is not possible to determine without more information.
- \_\_\_\_\_ 8. Define *dynamic equilibrium*.
- no reactants react
  - no products are formed
  - the rate of the forward reaction is faster than the rate of the reverse reaction
  - the rate of the reverse reaction is faster than the rate of the forward reaction
  - the rate of the forward reaction equals the rate of the reverse reaction
- \_\_\_\_\_ 9. Which of the following statements is FALSE?
- When  $K \gg 1$ , the forward reaction is favored and essentially goes to completion.
  - When  $K \ll 1$ , the reverse reaction is favored and the forward reaction does not proceed to a great extent.
  - When  $K \approx 1$ , neither the forward or reverse reaction is strongly favored, and about the same amount of reactants and products exist at equilibrium.
  - $K \gg 1$  implies that the reaction is very fast at producing products.
  - None of the above.

- \_\_\_\_\_ 10. Give the direction of the reaction, if  $K \gg 1$ .
- The forward reaction is favored.
  - The reverse reaction is favored.
  - Neither direction is favored.
  - If the temperature is raised, then the forward reaction is favored.
  - If the temperature is raised, then the reverse reaction is favored.
- \_\_\_\_\_ 11. Give the direction of the reaction, if  $K \ll 1$ .
- The forward reaction is favored.
  - The reverse reaction is favored.
  - Neither direction is favored.
  - If the temperature is raised, then the forward reaction is favored.
  - If the temperature is raised, then the reverse reaction is favored.
- \_\_\_\_\_ 12. Give the direction of the reaction, if  $K \approx 1$ .
- The forward reaction is favored.
  - The reverse reaction is favored.
  - Neither direction is favored.
  - If the temperature is raised, then the forward reaction is favored.
  - If the temperature is raised, then the reverse reaction is favored.
- \_\_\_\_\_ 13. Express the equilibrium constant for the following reaction.

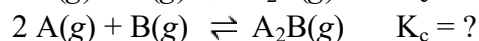
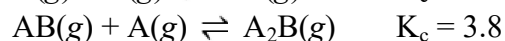
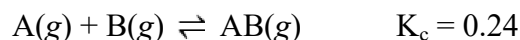


- $$K = \frac{[\text{CH}_4][\text{O}_2]}{[\text{CO}_2][\text{H}_2\text{O}]}$$
- $$K = \frac{[\text{CH}_4][2\text{O}_2]^2}{[\text{CO}_2][2\text{H}_2\text{O}]^2}$$
- $$K = \frac{[\text{CO}_2][\text{H}_2\text{O}]^2}{[\text{CH}_4][\text{O}_2]^2}$$
- $$K = \frac{[\text{CO}_2][2\text{H}_2\text{O}]^2}{[\text{CH}_4][2\text{O}_2]^2}$$
- $$K = \frac{[\text{CH}_4][\text{O}_2]^2}{[\text{CO}_2][\text{H}_2\text{O}]^2}$$

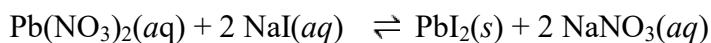
- \_\_\_\_\_ 14. The equilibrium constant is given for one of the reactions below. Determine the value of the missing equilibrium constant.



- a.  $1.9 \times 10^4$   
b.  $5.3 \times 10^{-5}$   
c.  $2.6 \times 10^{-5}$   
d.  $6.4 \times 10^{-4}$   
e.  $1.6 \times 10^3$
- \_\_\_\_\_ 15. The equilibrium constant is given for two of the reactions below. Determine the value of the missing equilibrium constant.



- a. 4.0  
b. 0.91  
c. 3.6  
d. 16  
e. 0.063
- \_\_\_\_\_ 16. Express the equilibrium constant for the following reaction.



a.  $K = \frac{[\text{2NaNO}_3]^2[\text{PbI}_2]}{[\text{Pb}(\text{NO}_3)_2][\text{2NaI}]^2}$

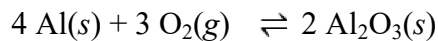
b.  $K = \frac{[\text{2NaNO}_3]^2}{[\text{Pb}(\text{NO}_3)_2][\text{2NaI}]^2}$

c.  $K = \frac{[\text{NaNO}_3]^2[\text{PbI}_2]}{[\text{Pb}(\text{NO}_3)_2][\text{NaI}]^2}$

d.  $K = \frac{[\text{NaNO}_3]^2}{[\text{Pb}(\text{NO}_3)_2][\text{NaI}]^2}$

e.  $K = \frac{[\text{Pb}(\text{NO}_3)_2][\text{NaI}]^2}{[\text{NaNO}_3]^2}$

\_\_\_\_ 17. Express the equilibrium constant for the following reaction.



a.  $K = \frac{[\text{Al}_2\text{O}_3]^2}{[\text{O}_2]^3[\text{Al}]^4}$

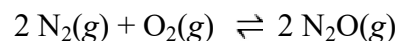
b.  $K = \frac{1}{[3\text{O}_2]^3}$

c.  $K = \frac{1}{[\text{O}_2]^3}$

d.  $K = [\text{O}_2]^3$

e.  $K = [3\text{O}_2]^3$

\_\_\_\_ 18. Determine the value of  $K_c$  for the following reaction if the equilibrium concentrations are as follows:  
 $[\text{N}_2]_{\text{eq}} = 3.6 \text{ M}$ ,  $[\text{O}_2]_{\text{eq}} = 4.1 \text{ M}$ ,  $[\text{N}_2\text{O}]_{\text{eq}} = 3.3 \times 10^{-18} \text{ M}$ .



a.  $2.2 \times 10^{-19}$

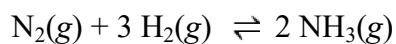
b.  $4.5 \times 10^{18}$

c.  $2.0 \times 10^{-37}$

d.  $5.0 \times 10^{36}$

e.  $4.9 \times 10^{-17}$

\_\_\_\_ 19. Determine the value of  $K_c$  for the following reaction if the equilibrium concentrations are as follows:  
 $[\text{N}_2]_{\text{eq}} = 1.5 \text{ M}$ ,  $[\text{H}_2]_{\text{eq}} = 1.1 \text{ M}$ ,  $[\text{NH}_3]_{\text{eq}} = 0.47 \text{ M}$ .



a. 3.5

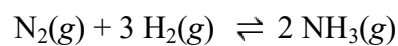
b. 0.28

c. 9.1

d. 0.11

e. 0.78

\_\_\_\_ 20. Calculate the value of  $[\text{N}_2]_{\text{eq}}$  if  $[\text{H}_2]_{\text{eq}} = 2.0 \text{ M}$ ,  $[\text{NH}_3]_{\text{eq}} = 0.5 \text{ M}$ , and  $K_c = 2$ .



a. 0.016 M

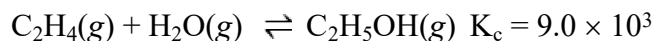
b. 0.031 M

c. 0.062 M

d. 0.40 M

e. 62.5 M

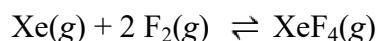
- \_\_\_ 21. Consider the following reaction, equilibrium concentrations, and equilibrium constant at a particular temperature. Determine the equilibrium concentration of  $\text{H}_2\text{O}(\text{g})$ .



$$[\text{C}_2\text{H}_4]_{\text{eq}} = 0.015 \text{ M}$$

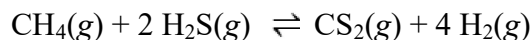
$$[\text{C}_2\text{H}_5\text{OH}]_{\text{eq}} = 1.69 \text{ M}$$

- a.  $9.9 \times 10^{-7} \text{ M}$   
b. 80. M  
c. 1.0 M  
d. 1.68 M  
e. 0.013 M
- \_\_\_ 22. Consider the following reaction:



A reaction mixture initially contains 2.24 atm Xe and 4.27 atm  $\text{F}_2$ . If the equilibrium pressure of Xe is 0.34 atm, find the equilibrium constant ( $K_p$ ) for the reaction.

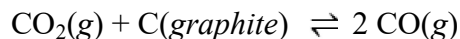
- a. 25  
b. 0.12  
c. 0.99  
d. 8.3  
e. 0.040
- \_\_\_ 23. Consider the following reaction:



A reaction mixture initially contains 0.50 M  $\text{CH}_4$  and 0.75 M  $\text{H}_2\text{S}$ . If the equilibrium concentration of  $\text{H}_2$  is 0.44 M, find the equilibrium constant ( $K_c$ ) for the reaction.

- a. 0.23  
b. 0.038  
c. 2.9  
d. 10.  
e. 0.34

\_\_\_ 24. Consider the following reaction:



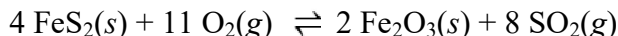
A reaction mixture initially contains 0.56 atm  $\text{CO}_2$  and 0.32 atm  $\text{CO}$ . Determine the equilibrium pressure of  $\text{CO}$  if  $K_p$  for the reaction at this temperature is 2.25.

- a. 0.83 atm
- b. 0.31 atm
- c. 0.26 atm
- d. 0.58 atm
- e. 0.42 atm

\_\_\_ 25. Define *Le Chatelier's Principle*.

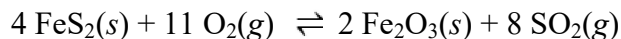
- a. When a chemical system at equilibrium is disturbed, the system shifts in a direction that maximizes the disturbance.
- b. A system will always change if the pressure changes.
- c. When a chemical system at equilibrium is disturbed, the system shifts in a direction that equals the disturbance.
- d. When a chemical system at equilibrium is disturbed, the system shifts in a direction that minimizes the disturbance.
- e. A system will always change if the volume changes.

\_\_\_ 26. Consider the following reaction at equilibrium. What will happen if  $\text{FeS}_2$  is added to the reaction?



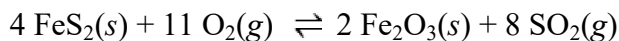
- a. The equilibrium constant will increase.
- b. The equilibrium will change in the direction of the reactants.
- c. The equilibrium will change in the direction of the products.
- d. No change in equilibrium is observed.
- e. The equilibrium constant will decrease.

\_\_\_ 27. Consider the following reaction at equilibrium. What will happen if  $\text{O}_2$  is added to the reaction?



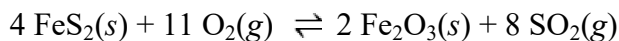
- a. The equilibrium constant will increase.
- b. The equilibrium will change in the direction of the reactants.
- c. The equilibrium will change in the direction of the products.
- d. No change in equilibrium is observed.
- e. The equilibrium constant will decrease.

\_\_\_ 28. Consider the following reaction at equilibrium. What will happen if the pressure **increased**?



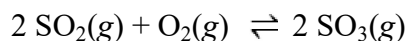
- The equilibrium constant will increase.
- The equilibrium will change in the direction of the reactants.
- The equilibrium will change in the direction of the products.
- No change in equilibrium is observed.
- The equilibrium constant will decrease.

\_\_\_ 29. Consider the following reaction at equilibrium. What will happen if the volume **increased**?



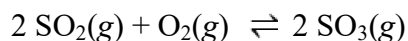
- The equilibrium constant will increase.
- The equilibrium will change in the direction of the reactants.
- The equilibrium will change in the direction of the products.
- No change in equilibrium is observed.
- The equilibrium constant will decrease.

\_\_\_ 30. The following reaction is exothermic. Which change will shift the equilibrium to the left?



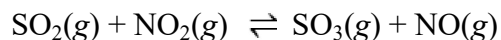
- raising the temperature
- adding  $\text{SO}_3$
- removing  $\text{O}_2$
- all of the above
- none of the above

\_\_\_ 31. The following reaction is exothermic. Which change will shift the equilibrium to the left?



- raising the temperature
- decrease pressure
- increase volume
- all of the above
- none of the above

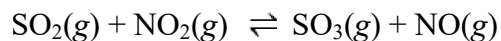
\_\_\_ 32. Consider the following reaction at equilibrium. What effect will adding more  $\text{SO}_3$  have on the system?



- The reaction will shift in the direction of products.
- The reaction will shift to decrease the pressure.
- No change will occur since  $\text{SO}_3$  is not included in the equilibrium expression.
- The reaction will shift in the direction of reactants.
- The equilibrium constant will decrease.

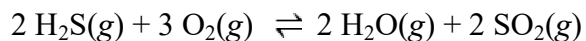


\_\_\_ 33. Consider the following reaction at equilibrium. What effect will removing  $\text{NO}_2$  have on the system?



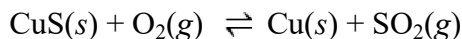
- The reaction will shift in the direction of products.
- The reaction will shift to decrease the pressure.
- No change will occur since  $\text{SO}_3$  is not included in the equilibrium expression.
- The reaction will shift in the direction of reactants.
- The equilibrium constant will decrease.

\_\_\_ 34. Consider the following reaction at equilibrium. What effect will **increasing** the volume of the reaction mixture have on the system?



- The reaction will shift to the right in the direction of products.
- No effect will be observed.
- The reaction will shift to the left in the direction of reactants.
- The equilibrium constant will decrease.
- The equilibrium constant will increase.

\_\_\_ 35. Consider the following reaction at equilibrium. What effect will **reducing** the volume of the reaction mixture have on the system?



- The equilibrium constant will decrease.
- No effect will be observed.
- The reaction will shift to the right in the direction of products.
- The equilibrium constant will increase.
- The reaction will shift to the left in the direction of reactants.