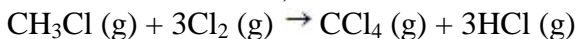


1. Consider the reaction;



[CH <sub>3</sub> Cl ] (M)	[Cl <sub>2</sub> ] (M)	Initial Rate (mol/L.s)
0.050	0.050	0.014
0.100	0.050	0.029
0.100	0.100	0.041
0.200	0.200	0.115

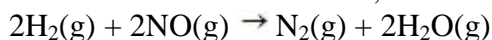
What is the overall order of the reaction?

- A. 3/2 (three half-order)
  - B. 2 (second-order)
  - C. 3 (third-order)
  - D. 1/2 (one half- order)
2. For the reaction;  $\text{A(g)} + 1/2 \text{ B(g)} \rightarrow 2\text{C(g)}$   
When C is increasing at a rate of 0.025 mol/L.s, how fast is B decreasing?
- A. 0.050 mol/L.s
  - B. 0.013 mol/L.s
  - C. 0.0063 mol/L.s
  - D. 0.025 mol/L.s
3. The following reaction was monitored as a function of time;  
 $\text{AB} \rightarrow \text{A} + \text{B}$   
A plot of  $1/[\text{AB}]$  versus time yields a straight line with slope 0.055 L/mol.s. If the initial concentration of AB is 0.250 M, and the reaction mixture initially contains no products, what is the concentration of A after 75 seconds?
- A. 0.26 M
  - B. 1.2 M
  - C. 0.74 M
  - D. 0.13 M

4. If a temperature increases from 20.0 °C to 35.0 °C triples the rate constant for a reaction, what is the value of the activation energy for the reaction?

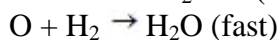
- A. 23.4 kJ/mol
- B. 122 kJ/mol
- C. 55.0 kJ/mol
- D. 83.7 kJ/mol

5. The rate law for the reaction;



is  $\text{rate} = k [\text{NO}]^2 [\text{H}_2]$ . Which of the following is/are acceptable mechanism(s)?

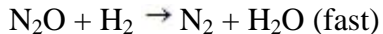
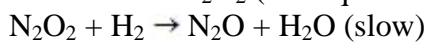
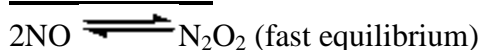
**Mechanism I**



**Mechanism II**



**Mechanism III**



- A. Only mechanism I
- B. Both mechanisms II and III
- C. Only mechanism II
- D. Both mechanisms I and II

6. The activation energy of the following reaction at 298 K,



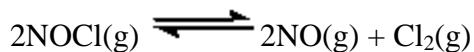
is 335 kJ/mol without a catalyst. If the reaction is catalyzed, the activation energy is 163 kJ/mol at 298 K. How many times faster is the reaction on the catalyst surface at 298 K?

- A.  $2.85 \times 10^{15}$
- B.  $1.41 \times 10^{30}$
- C.  $1.25 \times 10^{35}$
- D.  $4.52 \times 10^{10}$

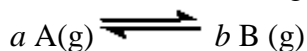
7. Which is correct?
- A. A catalyst is a substance that speeds up a reaction without being consumed itself.
  - B. A catalyst provides a new pathway for the reaction with a higher activation energy.
  - C. A homogeneous catalyst is one that is not present in the same phase as the reacting molecules.
  - D. A heterogeneous catalyst is one that is present in the same phase as the reacting molecules.
8. Which of the following is a Lewis acid?
- A.  $\text{H}_2\text{O}$
  - B.  $\text{CO}_2$
  - C.  $\text{I}^-$
  - D.  $\text{NH}_3$
9. Determine the pH of a 0.250 M  $\text{HNO}_2$  solution at 25°C.  
( $K_a$  of  $\text{HNO}_2 = 4.0 \times 10^{-4}$ )
- A. 3.39
  - B. 5.24
  - C. 2.00
  - D. 6.51
10. One mole of a weak acid, HA, was dissolved in 2.0 L of water. After the system had come to equilibrium, the concentration of HA was found to be 0.45 M. Calculate  $K_a$  for HA.
- A.  $3 \times 10^{-2}$
  - B.  $2.4 \times 10^{-4}$
  - C.  $6 \times 10^{-3}$
  - D.  $5.3 \times 10^{-1}$

11. What is the percent ionization in 0.010 M  $\text{NH}_3$  solution at 25 °C? ( $K_b = 1.8 \times 10^{-5}$ )
- A. 1.3%
  - B. 4.2%
  - C. 39%
  - D. 12%
12. What is the pH of a  $5.1 \times 10^{-6}$  M  $\text{Ca}(\text{OH})_2$  solution at 25°C?
- A. 12.2
  - B. 4.99
  - C. 8.71
  - D. 9.01
13. Arrange the following 0.10 M solution in order of most acidic to most basic. KOH, KCl, KCN,  $\text{NH}_4\text{Cl}$ , HCl
- A.  $\text{HCl} > \text{NH}_4\text{Cl} > \text{KCN} > \text{KCl} > \text{KOH}$
  - B.  $\text{KOH} > \text{KCN} > \text{KCl} > \text{NH}_4\text{Cl} > \text{HCl}$
  - C.  $\text{HCl} > \text{KCl} > \text{NH}_4\text{Cl} > \text{KCN} > \text{KOH}$
  - D.  $\text{HCl} > \text{NH}_4\text{Cl} > \text{KCl} > \text{KCN} > \text{KOH}$
14. Calculate the pH of a 2.0 M  $\text{H}_2\text{SO}_4$  solution. ( $K_{a2} = 1.2 \times 10^{-2}$ )
- A. -0.33
  - B. -0.82
  - C. 1.94
  - D. 2.32
15. Find  $K_c$  for the following reaction at 298 K;
- $$2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g}) \quad K_p = 2.2 \times 10^{12}$$
- A.  $4.2 \times 10^8$
  - B.  $2.7 \times 10^{15}$
  - C.  $7.4 \times 10^{11}$
  - D.  $5.4 \times 10^{13}$

16. At a particular temperature, a 3.0 L flask contains 2.4 mol  $\text{Cl}_2$ , 1.0 mol  $\text{NOCl}$ , and 0.0045 mol  $\text{NO}$ . Calculate  $K_c$  at this temperature for the following reaction.



- A.  $3.7 \times 10^6$   
B.  $5.4 \times 10^{-3}$   
C.  $4.1 \times 10^8$   
D.  $1.7 \times 10^{-5}$
17. Consider the following reaction;



If the data below represents equilibrium partial pressures of A and B under different initial conditions, find the values of  $a$  and  $b$ .

$P_A$  (atm)  $P_B$ (atm)

4.0 2.0

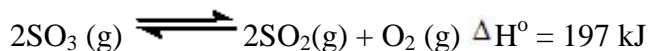
2.0 1.4

1.0 1.0

0.50 0.71

0.25 0.50

- A.  $a = 3$ ;  $b = 2$   
B.  $a = 2$ ;  $b = 1$   
C.  $a = 1$ ;  $b = 2$   
D.  $a = 1$ ;  $b = 1$
18. What will happen to the number of moles of  $\text{SO}_3$  in equilibrium with  $\text{SO}_2$  and  $\text{O}_2$  in the reaction;



when the pressure is increased by decreasing the volume of the reaction container?

- A. No effect on the moles of  $\text{SO}_3$ .  
B. The moles of  $\text{SO}_3$  will increase.  
C. The moles of  $\text{SO}_3$  will decrease.  
D. The moles of  $\text{O}_2$  will increase.

19. At 25 °C,  $K_p = 5.3 \times 10^5$  for the reaction;



When a certain pressure of  $\text{NH}_3(\text{g})$  is put into an otherwise empty rigid vessel at 25 °C, equilibrium is reached when 50.0% of the original  $\text{NH}_3(\text{g})$  has decomposed. What was the original partial pressure of  $\text{NH}_3(\text{g})$  before any decomposition occur?

- A.  $2.1 \times 10^{-3}$  atm
  - B.  $5.3 \times 10^{-4}$  atm
  - C.  $2.5 \times 10^{-1}$  atm
  - D.  $1.37 \times 10^{-5}$  atm
20. Which is correct?
- A. Equilibrium constant for a reaction is independent of temperature.
  - B. For a reaction at a given temperature, equilibrium constant depends only on the amounts of reactants that are mixed together initially.
  - C. For a reaction at a given temperature, there are many equilibrium positions with only one value for equilibrium constant.
  - D. For a reaction at a given temperature, there are many values for equilibrium constant but only one equilibrium position.