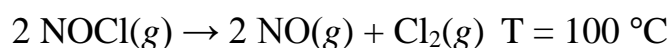


1. Which of the following has a **correct** van't Hoff factor indicated?
- | | |
|--|---|
| A. $\text{Al}_2(\text{SO}_4)_3, i = 5$ | C. $\text{CaBr}_2, i = 2$ |
| B. $\text{Na}_2\text{CO}_3, i = 6$ | D. $\text{C}_6\text{H}_{12}\text{O}_6, i = 3$ |
-
2. Calculate the vapor pressure of a solution containing 35.5 g of glycerin ($\text{C}_3\text{H}_8\text{O}_3$) in 155 g of water at 30.0 °C.
- The vapor pressure of pure water at 30.0 °C is 31.8 torr. The molar mass of glycerin is 92.01 g/mol and the molar mass of water is 18.02 g/mol. Assume that glycerin is a nonvolatile nonelectrolyte.
- | | |
|--------------|--------------|
| A. 42.3 torr | C. 29.7 torr |
| B. 30.4 torr | D. 30.1 torr |
-
3. The osmotic pressure of a 150.0 mL solution of an unknown nonelectrolyte is 122 torr at 25 °C. Determine the molarity of the solution.
- | | |
|------------------------------------|------------------------------------|
| A. $4.87 \times 10^{-3} \text{ M}$ | C. $6.56 \times 10^{-3} \text{ M}$ |
| B. 3.72 M | D. 0.685 M |
-
4. Which solution would you expect to experience the **smallest** boiling point elevation?
- | | |
|---------------------------|------------------------------------|
| A. 0.20 M CaCl_2 | C. 0.20 M K_2SO_4 |
| B. 0.20 M NaNO_3 | D. 0.20 M Li_3PO_4 |
-
5. The rate of a reaction is determined by monitoring the
- | |
|--|
| A. distance traveled over time. |
| B. temperature change of the reaction over time. |
| C. change in activation energy over time. |
| D. change in concentration over time. |
-

-
6. Consider the reaction $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2 \text{HCl}(\text{g})$. During a 20.0 second period, the concentration of HCl increases from 0.100 M to 0.470 M. Determine the rate of the **reaction** during this time interval.

- A. 0.110 M/s
B. 0.220 M/s
C. 4.40×10^{-3} M/s
D. 9.25×10^{-3} M/s

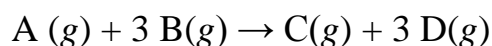
-
7. The decomposition of $\text{NOCl}(\text{g})$ is second order with respect to $[\text{NOCl}]$ and proceeds as follows:



If the initial rate is 3.12×10^{-6} M/s when $[\text{NOCl}] = 0.183$ M, what will the initial rate be when the concentration of NOCl is decreased to 0.121 M?

- A. 4.76×10^{-6} M/s
B. 1.42×10^{-5} M/s
C. 1.36×10^{-6} M/s
D. 5.01×10^{-7} M/s

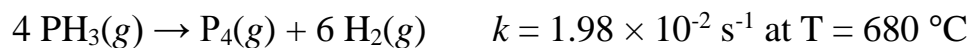
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8. Use the data in the table provided to determine the rate law of the reaction



Experiment	[A], (M)	[B], (M)	Initial Rate (M/s)
1	0.100	0.100	0.028
2	0.200	0.100	0.113
3	0.200	0.200	0.221
4	0.400	0.400	1.79

- A. Rate = $k[\text{A}][\text{B}]^3$
B. Rate = $k[\text{A}]^2[\text{B}]$
C. Rate = $k[\text{A}][\text{B}]^2$
D. Rate = $k[\text{A}][\text{B}]$
-

-
9. The thermal decomposition of phosphine, PH_3 , into phosphorus and hydrogen is a first-order reaction:



If the concentration of PH_3 is 0.462 M at the end of 65.0 seconds, what concentration of phosphine was originally present?

- A. 1.67 M
B. 0.260 M
C. 1.25 M
D. 0.462 M

-
10. For a certain first-order reaction, the half-life is 1.55 s. What fraction of the reactant will remain after 7.25 seconds?

- A. 0.0391
B. 0.404
C. 0.182
D. 0.0224

-
11. Which statement is **false**?

- A. The rate of a reaction decreases with decreasing temperature.
B. As temperature decreases, fewer molecules have the minimum energy required to initiate a chemical reaction.
C. As the temperature decreases, the kinetic energy of the molecules decreases.
D. As temperature decreases, the rate constant of a reaction increases.
-

12. The rate constant for a reaction at 37.0 °C is 0.00434 s⁻¹. The rate constant for the same reaction at 97.0 °C is 0.316 s⁻¹. Determine the activation energy for the reaction.

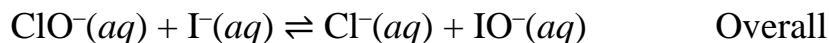
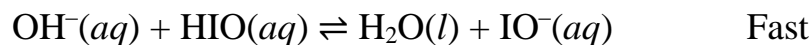
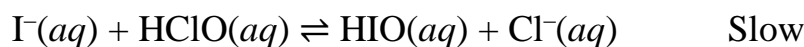
A. 96.7 kJ/mol

C. 68.1 kJ/mol

B. 641 kJ/mol

D. 2.26 kJ/mol

13. Given the following mechanism, determine which species, if any, could be functioning as reaction intermediates and which species, if any, could be functioning as catalysts.



A. Intermediates: HClO, OH⁻, HIO; Catalyst: H₂O

B. Intermediates: OH⁻, HIO; Catalysts: H₂O, HClO

C. Intermediate: H₂O; Catalyst: HClO

D. Intermediates: ClO⁻, I⁻; Catalysts: Cl⁻, IO⁻

14. What is the intermediate *and* expected rate law for the **overall reaction** with the following two-step mechanism?



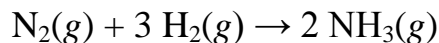
A. Intermediate: Cl(g); Rate = $k[\text{NO}_2]^2[\text{Cl}_2]$

B. Intermediate: ClNO₂(g); Rate = $k[\text{NO}_2][\text{Cl}_2]$

C. Intermediate: ClNO₂(g); Rate = $k[\text{NO}_2]^2[\text{Cl}_2]$

D. Intermediate: Cl(g); Rate = $k[\text{NO}_2][\text{Cl}_2]$

-
15. The formation of ammonia, NH_3 , is an energy-intensive process because breaking the $\text{N}\equiv\text{N}$ bond in N_2 requires a great deal of energy for the reaction to proceed as written:



If a chemist were to add $\text{Fe}_3\text{O}_4(s)$ and observe an **increase** in the reaction rate, how would you characterize the function of the $\text{Fe}_3\text{O}_4(s)$ in this reaction?

- A. $\text{Fe}_3\text{O}_4(s)$ is a heterogeneous reaction intermediate.
- B. $\text{Fe}_3\text{O}_4(s)$ is a heterogeneous catalyst.
- C. $\text{Fe}_3\text{O}_4(s)$ is a homogeneous reaction intermediate.
- D. $\text{Fe}_3\text{O}_4(s)$ is a homogeneous catalyst.

-
16. Which statement is **true**?

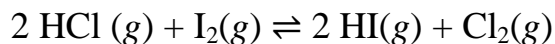
- A. Once equilibrium is established for a given reversible reaction, the reaction stops.
- B. The time required to reach equilibrium is the same for all reactions.
- C. When equilibrium is established for a reaction with a large equilibrium constant, the rate of the forward reaction is greater than the rate of the reverse reaction.
- D. A reaction is at equilibrium when the rate of the forward reaction is equal to the rate of the reverse reaction.

-
17. What can be said about the direction of the following reaction?

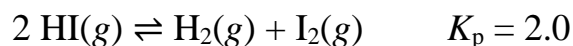
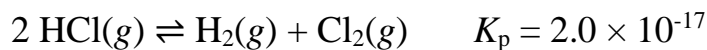


- A. The forward reaction is favored.
 - B. The reverse reaction is favored.
 - C. Neither direction is favored.
 - D. The favored direction cannot be deduced from the information given.
-

18. Determine the equilibrium constant, K_p , for this reaction at temperature, T,



Given the following equilibria at the same temperature:



A. 4.0×10^{16}

C. 1.0×10^{-17}

B. 2.5×10^{16}

D. 9.9×10^{-18}

19. Consider the reaction:



At a certain temperature, $K_p = 2.70 \times 10^{-3}$. Solid NH_4HS is placed in a reaction chamber and allowed to come to equilibrium. Calculate the total pressure once the system comes to equilibrium.

A. 10.2 atm

C. 0.131 atm

B. 0.104 atm

D. 0.0612 atm

20. Ethanol can be produced according to the following equation:



When the **initial** concentrations of C_2H_4 and H_2O are both 1.000 M, the **equilibrium** concentration of $\text{C}_2\text{H}_5\text{OH}$ is 0.990 M. What is the value of K_c ?

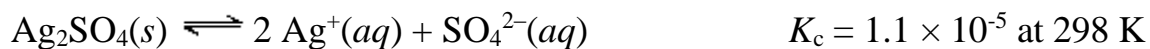
A. 8.17×10^3

C. 9.90×10^3

B. 98.9

D. 7.26×10^2

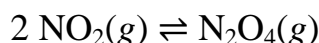
21. Silver sulfate dissolves in water according to the reaction:



A solution of Ag^+ ions and a solution of SO_4^{2-} ions are mixed such that a reaction quotient of 4.1×10^{-2} is obtained. Which statement is true?

- A. The reaction is at equilibrium.
- B. The reaction is not at equilibrium and will shift to the right to reach equilibrium.
- C. The reaction is not at equilibrium and will shift to the left to reach equilibrium.
- D. The reaction is not at equilibrium and cannot reach equilibrium under these conditions.

22. For the following reaction, at 298 K, $K_p = 6.7$



At equilibrium, the partial pressure of N_2O_4 is 0.127 atm. Determine the partial pressure of NO_2 at equilibrium.

- A. 0.017 atm
- B. 0.14 atm
- C. 7.7 atm
- D. 0.25 atm

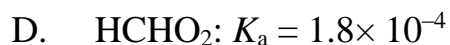
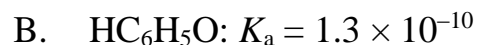
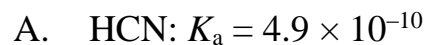
23. Consider the reaction



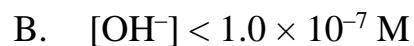
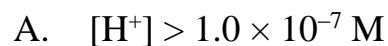
A 5.0-L reaction vessel is charged with 380 torr of COCl_2 . Calculate the equilibrium partial pressure of Cl_2 in the container.

- A. 12.2 torr
 - B. 312 torr
 - C. 450 torr
 - D. 206 torr
-

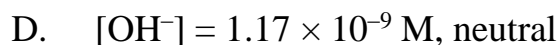
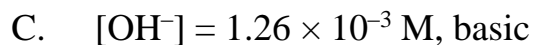
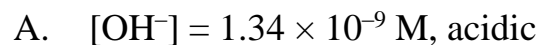
28. The K_a values for four acids are given below. Which acid is the **weakest** acid?



29. Which statement is **false** for an aqueous acid solution at 25 °C?



30. Calculate $[\text{OH}^-]$ at 25 °C for a solution with $[\text{H}_3\text{O}^+] = 7.48 \times 10^{-6} \text{ M}$ and indicate whether the solution is acidic, basic, or neutral.



Answer Key:

1. A
2. B
3. C
4. B
5. D
6. D
7. C
8. B
9. A
10. A
11. D
12. C
13. A
14. D
15. B
16. D
17. A
18. C
19. B
20. C
21. C
22. B
23. D
24. A
25. C
26. A
27. D
28. B
29. C
30. A