

Q1. A system is said to be in equilibrium when:

- A. Forward reaction stops completely
- B. Backward reaction becomes irreversible
- C. Rate of forward reaction equals rate of backward reaction
- D. Concentration of reactants becomes zero

Answer: C. Rate of forward reaction equals rate of backward reaction

Explanation:

At equilibrium, dynamic balance is achieved — both reactions continue, but their rates are equal, so concentrations remain constant.

Q2. The equilibrium constant K_p for a reaction is 1.5×10^4 at 298 K. What can be concluded about the reaction?

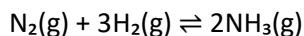
- A. Reactants are favored
- B. Products are favored
- C. System is at equilibrium
- D. Rate of forward reaction is slow

Answer: B. Products are favored

Explanation:

A large K_p ($> 10^3$) means the equilibrium lies far to the right, i.e., products dominate.

Q3. For the reaction:



If pressure is increased at constant temperature, the equilibrium will:

- A. Shift to left
- B. Shift to right
- C. Remain unaffected
- D. Cannot be predicted

Answer: B. Shift to right

Explanation:

According to Le Chatelier's Principle, increasing pressure shifts equilibrium to the side with fewer moles of gas (from 4 mol to 2 mol here).

Q4. Assertion (A): Equilibrium constant changes with temperature.

Reason (R): $K_p = K_c(RT)^{\Delta n}$

- A. Both A and R are true, and R is the correct explanation
- B. Both A and R are true, but R is not the correct explanation
- C. A is true, R is false
- D. A is false, R is true

Answer: B. Both A and R are true, but R is not the correct explanation

Explanation:

$K_p = K_c(RT)^{\Delta n}$ relates pressure and concentration equilibrium constants. Temperature dependence of K comes from Van't Hoff equation.

Q5. Which of the following statements is incorrect?

- A. A catalyst affects the equilibrium constant
- B. K_c is constant at constant temperature
- C. Equilibrium is dynamic in nature
- D. $K_p = K_c$ when $\Delta n = 0$

Answer: A. A catalyst affects the equilibrium constant

Explanation:

Catalysts only speed up the approach to equilibrium but do not alter the equilibrium constant.

Q6. If K_c for a reaction is 10, what will be the value of K for the reverse reaction?

- A. 10
- B. 0.1
- C. 1
- D. 0.01

Answer: B. 0.1

Explanation:

For reverse reaction, $K_{\text{reverse}} = 1/K_{\text{forward}} = 1/10 = 0.1$

Q7. Which of the following will increase the degree of dissociation of a weak electrolyte?

- A. Adding common ion
- B. Increasing concentration
- C. Adding inert solvent (dilution)
- D. Increasing temperature

Answer: C. Adding inert solvent (dilution)

Explanation:

According to Ostwald's dilution law, degree of dissociation increases with dilution.

Q8. Match the following:

Column I

- A. $K_p = K_c$
- B. Le Chatelier's Principle
- C. Ionic Product > Solubility Product
- D. Buffer Solution

Column II

- 1. $\Delta n = 0$
- 2. Common ion effect
- 3. Precipitation occurs
- 4. Opposes change

Answer: A. 1 – 4 – 3 – 2

Q9. Which of the following solutions acts as a buffer?

- A. $\text{HCl} + \text{NaOH}$
- B. $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$
- C. $\text{NH}_4\text{Cl} + \text{NaCl}$

D. NaOH + NaCl

Answer: B. $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$

Explanation:

This is a classic acidic buffer of weak acid + its salt with strong base.

Q10. At equilibrium, which of the following remains constant?

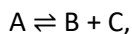
- A. Concentration of reactants and products
- B. Rate of forward reaction
- C. Rate of backward reaction
- D. All of the above

Answer: D. All of the above

Explanation:

At dynamic equilibrium, concentrations and rates remain constant though reactions are still occurring.

Q11. In the reaction:



If concentration of A is increased, the equilibrium will:

- A. Shift to left
- B. Shift to right
- C. Remain unchanged
- D. Stop the reaction

Answer: B. Shift to right

Explanation:

Increasing reactant shifts equilibrium toward product side.

Q12. The dissociation constant of acetic acid is 1.8×10^{-5} . What will be its pKa?

- A. 4.74
- B. 5.2

C. 6.0

D. 3.2

Answer: A. 4.74

Explanation:

$$\text{pKa} = -\log K_a = -\log(1.8 \times 10^{-5}) \approx 4.74$$

Q13. A saturated solution of AgCl has a solubility of 1.3×10^{-5} mol/L. What is the K_{sp} ?

A. 1.3×10^{-5}

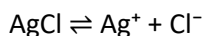
B. 1.69×10^{-10}

C. 2.6×10^{-5}

D. 1.69×10^{-5}

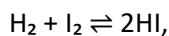
Answer: B. 1.69×10^{-10}

Explanation:



$$K_{sp} = [\text{Ag}^+][\text{Cl}^-] = (1.3 \times 10^{-5})^2 = 1.69 \times 10^{-10}$$

Q14. In the reaction:



Initial pressure of all gases = 1 atm. At equilibrium, HI = 1.8 atm. Find equilibrium constant K_p .

A. 1.5

B. 6.5

C. 9

D. 3.24

Answer: C. 9

Explanation:

Let x = pressure of HI formed = 1.8 atm

Then decrease in H_2 and $\text{I}_2 = x/2 = 0.9$ atm

$$K_p = (\text{PHI})^2 / (\text{PH}_2 \times \text{PI}_2) = (1.8)^2 / (0.1 \times 0.1) = 3.24 / 0.01 = 9$$

Q15. Which of the following statements is true regarding equilibrium constant?

- A. Depends on pressure
- B. Depends on temperature
- C. Depends on volume
- D. Depends on catalyst

Answer: B. Depends on temperature

Explanation:

Only temperature affects the value of equilibrium constant. Catalyst only speeds up equilibrium attainment.

Q16. The pH of 0.01 M HCl solution is:

- A. 1
- B. 2
- C. 12
- D. 14

Answer: B. 2

Explanation:

HCl is a strong acid, so it dissociates completely:

$$[\text{H}^+] = 0.01 \text{ M} \rightarrow \text{pH} = -\log(0.01) = 2$$

Q17. Which of the following salts will not undergo hydrolysis in water?

- A. CH_3COONa
- B. NH_4Cl
- C. NaCl
- D. FeCl_3

Answer: C. NaCl

Explanation:

NaCl is a neutral salt (from strong acid + strong base), so no hydrolysis occurs.

Q18. What is the $[\text{H}^+]$ in a buffer solution containing 0.2 M CH_3COOH and 0.1 M CH_3COONa ? ($K_a = 1.8 \times 10^{-5}$)

- A. 1.8×10^{-5}
- B. 3.6×10^{-5}
- C. 0.9×10^{-5}
- D. 2.4×10^{-5}

Answer: B. 3.6×10^{-5}

Explanation:

Use Henderson–Hasselbalch equation:

$$[\text{H}^+] = K_a \times [\text{acid}]/[\text{salt}] = 1.8 \times 10^{-5} \times 0.2 / 0.1 = 3.6 \times 10^{-5}$$

Q19. What is the pH of a 0.1 M NH_4OH solution? ($K_b = 1.8 \times 10^{-5}$)

- A. 11.13
- B. 9.13
- C. 3.13
- D. 8.87

Answer: A. 11.13

Explanation:

$$[\text{OH}^-] = \sqrt{K_b \times C} = \sqrt{1.8 \times 10^{-5} \times 0.1} = \sqrt{1.8 \times 10^{-6}} \approx 1.34 \times 10^{-3}$$

$$\text{pOH} \approx 2.87 \rightarrow \text{pH} = 14 - 2.87 = 11.13$$

Q20. In which of the following will increase in temperature shift the equilibrium to the right?

- A. $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ ($\Delta H = -\text{ve}$)
- B. $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$ ($\Delta H = -\text{ve}$)
- C. $\text{CaCO}_3 \rightleftharpoons \text{CaO} + \text{CO}_2$ ($\Delta H = +\text{ve}$)
- D. $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$ ($\Delta H = -\text{ve}$)

Answer: C. $\text{CaCO}_3 \rightleftharpoons \text{CaO} + \text{CO}_2$ ($\Delta H = +\text{ve}$)

Explanation:

For endothermic reactions (ΔH positive), increasing temperature favors forward reaction.

Q21. For the weak base NH_4OH , which of the following equilibrium exists?

- A. $\text{NH}_4\text{OH} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$
- B. $\text{NH}_4\text{OH} \rightleftharpoons \text{NH}_3 + \text{H}^+$
- C. $\text{NH}_4\text{OH} \rightleftharpoons \text{NH}_3 + \text{OH}^-$
- D. $\text{NH}_4\text{OH} \rightleftharpoons \text{NH}_4^+ + \text{H}^+$

Answer: C. $\text{NH}_4\text{OH} \rightleftharpoons \text{NH}_3 + \text{OH}^-$

Explanation:

NH_4OH dissociates into NH_3 and OH^- in aqueous solution.

Q22. The solubility of a salt MX_2 is S mol/L. What is its K_{sp} ?

- A. S^3
- B. $4S^3$
- C. $27S^2$
- D. S^2

Answer: B. $4S^3$

Explanation:



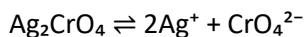
$$K_{sp} = [\text{M}^{2+}][\text{X}^-]^2 = (S)(2S)^2 = 4S^3$$

Q23. The solubility of Ag_2CrO_4 is 1.3×10^{-4} mol/L. Calculate K_{sp} .

- A. 1.3×10^{-4}
- B. 2.2×10^{-12}
- C. 8.8×10^{-12}
- D. 2.2×10^{-7}

Answer: C. 8.8×10^{-12}

Explanation:



$$K_{sp} = (2S)^2 \times S = 4S^3 = 4 \times (1.3 \times 10^{-4})^3 = 8.8 \times 10^{-12}$$

Q24. Which of the following has highest degree of dissociation?

- A. 0.01 M CH_3COOH
- B. 0.1 M CH_3COOH
- C. 1.0 M CH_3COOH
- D. All have same

Answer: A. 0.01 M CH_3COOH

Explanation:

According to Ostwald's dilution law, $\alpha \propto 1/\sqrt{C}$ — so lower the concentration, higher the dissociation.

Q25. At 25°C , the ionization constant of water (K_w) is:

- A. 1.0×10^{-14}
- B. 1.0×10^{-7}
- C. 1.0×10^{-12}
- D. 1.0×10^{-6}

Answer: A. 1.0×10^{-14}

Explanation:

$$K_w = [\text{H}^+][\text{OH}^-] = 1.0 \times 10^{-7} \times 1.0 \times 10^{-7} = 1.0 \times 10^{-14}$$

Q26. The hydrolysis constant (K_h) of a salt from weak base and strong acid is given by:

- A. K_w/K_a
- B. K_w/K_b
- C. $K_w/(K_a \times K_b)$
- D. K_a/K_w

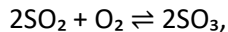
Answer: B. K_w/K_b

Explanation:

For weak base + strong acid:

$$K_h = K_w / K_b$$

Q27. For the reaction:



If O_2 is removed from the system at equilibrium, what happens?

- A. Reaction shifts to right
- B. Reaction shifts to left
- C. Reaction stops
- D. Equilibrium constant increases

Answer: B. Reaction shifts to left

Explanation:

Removing O_2 disturbs the equilibrium \rightarrow system tries to replace it \rightarrow shifts to left.

Q28. The pH of a solution is 5. What is the concentration of H^+ ions?

- A. $1 \times 10^5 \text{ M}$
- B. $5 \times 10^{-5} \text{ M}$
- C. $1 \times 10^{-5} \text{ M}$
- D. $1 \times 10^{-9} \text{ M}$

Answer: C. $1 \times 10^{-5} \text{ M}$

Explanation:

$$\text{pH} = -\log[\text{H}^+] \Rightarrow [\text{H}^+] = 10^{-5} \text{ M}$$

Q29. Which of the following expressions is correct for K_p and K_c relation?

- A. $K_p = K_c$
- B. $K_p = K_c \times (RT)^{\Delta n}$
- C. $K_p = K_c / (RT)^{\Delta n}$
- D. $K_p = K_c \times \log(RT)$

Answer: B. $K_p = K_c \times (RT)^{\Delta n}$

Explanation:

Standard thermodynamic relation: $K_p = K_c(RT)^{\Delta n}$

Q30. Which condition will increase the rate of attainment of equilibrium?

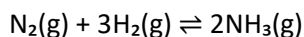
- A. Increasing temperature
- B. Adding catalyst
- C. Removing products
- D. All of the above

Answer: B. Adding catalyst

Explanation:

Only catalyst increases rate of attainment, without changing equilibrium position or K_c .

Q31. The equilibrium constant for the reaction



is $K_p = 6.0 \times 10^5$ at 400°C . What will happen if the pressure is increased?

- A. Reaction will shift to right
- B. Reaction will shift to left
- C. No change
- D. K_p will increase

Answer: A. Reaction will shift to right

Explanation:

There are fewer moles of gas on the right (2) than left (4). Increasing pressure shifts equilibrium toward fewer gas moles.

Q32. What is the conjugate acid of NH_3 ?

- A. NH_4^+
- B. NH_2^-
- C. NH_4OH
- D. H_3O^+

Answer: A. NH_4^+

Explanation:



Q33. Which of the following is not a buffer solution?

- A. $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$
- B. $\text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$
- C. $\text{HCl} + \text{NaCl}$
- D. $\text{HCOOH} + \text{HCOONa}$

Answer: C. $\text{HCl} + \text{NaCl}$

Explanation:

Buffer = weak acid/base + its salt. HCl is a strong acid \rightarrow no buffer action.

Q34. The addition of NaOH to CH_3COOH will:

- A. Increase pH slowly
- B. Decrease pH
- C. Increase pH sharply
- D. Keep pH constant

Answer: A. Increase pH slowly

Explanation:

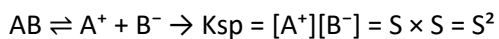
NaOH reacts with CH_3COOH forming $\text{CH}_3\text{COONa} \rightarrow$ creates a buffer \rightarrow slow rise in pH.

Q35. The solubility of a salt AB is S mol/L. What is the expression for its solubility product (K_{sp})?

- A. S
- B. $2S^2$
- C. S^2
- D. $4S^3$

Answer: C. S^2

Explanation:



Q36. Which of the following will decrease the degree of dissociation of acetic acid?

- A. Dilution
- B. Addition of NaCl
- C. Addition of CH_3COONa
- D. Heating

Answer: C. Addition of CH_3COONa

Explanation:

Common ion (CH_3COO^-) suppresses dissociation due to common ion effect.

Q37. Which change does not affect the equilibrium constant (K)?

- A. Pressure
- B. Temperature
- C. Catalyst
- D. Concentration

Answer: A. Pressure

Correction: C. Catalyst

Explanation:

Only temperature affects K. Catalyst affects rate, not position or value of K.

Q38. Which is correct about the pH of blood?

- A. Always acidic
- B. Always basic
- C. Slightly alkaline and buffered
- D. Neutral

Answer: C. Slightly alkaline and buffered

Explanation:

Blood has pH ~ 7.4 and contains buffers like $\text{HCO}_3^-/\text{H}_2\text{CO}_3$.

Q39. At equilibrium, which of the following is true?

- A. Concentrations of reactants = products
- B. Rate of forward reaction = rate of backward reaction
- C. Reactions stop
- D. All concentrations become zero

Answer: B. Rate of forward = rate of backward

Explanation:

Equilibrium is dynamic: reactions continue at equal rate, concentrations stay constant.

Q40. If pH of a solution is 3, then the pOH is:

- A. 3
- B. 11
- C. 7
- D. 1

Answer: B. 11

Explanation:

$$\text{pH} + \text{pOH} = 14 \Rightarrow \text{pOH} = 14 - 3 = 11$$

Q41. Which of the following is a correct buffer pair?

- A. HCl and NaCl
- B. NH_4OH and NaOH
- C. HCOOH and HCOONa
- D. NaOH and NaCl

Answer: C. HCOOH and HCOONa

Explanation:

Weak acid + its salt = buffer system.

Q42. A solution of KCN is:

- A. Acidic
- B. Basic

- C. Neutral
- D. Amphoteric

Answer: B. Basic

Explanation:

CN^- undergoes hydrolysis \rightarrow forms $\text{OH}^- \rightarrow$ basic solution.

Q43. Which of the following represents Bronsted-Lowry base?

- A. HCl
- B. H_2O
- C. NH_3
- D. NH_4^+

Answer: C. NH_3

Explanation:

A Bronsted base accepts H^+ . NH_3 accepts H^+ to form NH_4^+ .

Q44. Which statement is correct for solubility product (K_{sp})?

- A. Depends on temperature
- B. Independent of salt type
- C. Changes with pressure
- D. Same for all salts

Answer: A. Depends on temperature

Explanation:

K_{sp} is constant at a given temperature only.

Q45. A solution has $[\text{OH}^-] = 1 \times 10^{-3} \text{ M}$. What is its pH?

- A. 3
- B. 11
- C. 7
- D. 9

Answer: B. 11

Explanation:

$$\text{pOH} = -\log(1 \times 10^{-3}) = 3 \rightarrow \text{pH} = 14 - 3 = 11$$