PRAADIS EDUCATION

CHEMISTRY XI

CHEMICAL EQUILIBRIUM

OBJECTIVE QUESTIONS

Equilibrium in Physical Processes

1. If both the forward and reverse reaction rates are equal in the equilibrium is said to be _____
a) dynamic equilibrium
b) equilibrium mixture
c) static equilibrium
d) newton equilibrium

Answer: a
Explanation: When the reactants are kept in a closed vessel at a certain temperature the concentration of reactants keep on decreasing while the concentration of products keep on increasing, at this stage when the rate of both the forward and the reverse reactions become equal, it is said to be in a dynamic equilibrium.

2. Physical equilibrium is the same as the chemical equilibrium.
a) true
b) false

Answer: b
Explanation: Equilibrium that is set up in a physical process like the evaporation of water melting of solids is called physical equilibrium. If a reversible reaction is carried out in a closed vessel chemical equilibrium occurs when the rate of both the forward and backward reactions are equal, so the above statement is false.

3. Which of the following characteristics of chemical equilibrium is true?
a) equilibrium is dynamic in nature
b) equilibrium cannot be attained from either side
c) equilibrium cannot be obtained in a closed container
d) equilibrium state is affected by the presence of a catalyst

Answer: a
Explanation: The correct statements of the wrong ones are; equilibrium can be attained from another side, the catalyst does not affect the equilibrium state and it can only be achieved in a closed container. Therefore, equilibrium is dynamic in nature is the true characteristic of chemical equilibrium in the given options.

4. Which of the following is an example of solid-liquid equilibrium?
a) water and steam at hundred degrees centigrade
b) water and ice at 0-degree centigrade
c) the point where Ammonia is sublimized
d) boiling point of water

Answer: b
Explanation: At zero degree centigrade, when water and ice are together the opposing process occurs simultaneously at the same rate, so the amount of Ice and water remains constant. It is an example of a solid-liquid equilibrium.

5. Amount of a gas that is dissolved in a solvent depends on the pressure of the solvent.
a) True
b) False

Answer: a
Explanation: The most common form of Henry’s law states that the partial pressure of the gas in the vapor phase is proportional to the mole fraction of the gas in a solution, therefore we can say that the above-given statement is true.

6. Which of the following statements is false regarding the equilibrium constant?
a) it has a definite value for every chemical reaction at a particular temperature
b) it is independent of initial concentrations of the reactants
c) it is dependent on the presence of a catalyst
d) if K is the equilibrium constant for a backward reaction then the forward reaction's equilibrium constant is 1/k

Answer: c
Explanation: Equilibrium constant is independent of the presence of a catalyst, so the statement regarding the catalyst is wrong. A catalyst helps reaction to attain its equilibrium faster but does not alter the equilibrium constant.

7. What will happen if the rate of evaporation is equal to the rate of condensation in the water?
a) solid-liquid equilibrium
b) liquid-vapor equilibrium
c) solid-vapor equilibrium
d) melting

Answer: b
Explanation: When the rate of evaporation is equal to the rate of condensation water in the liquid phase and steam in vapor phase remained at equilibrium because its forward rate of the reaction and the backward rate of the reaction is the same at this particular temperature.

8. The equilibrium in a chemical reaction is represented by the symbol _____
a) ↠
b) ⇐
c) ⇌
d) →

Answer: c
Explanation: The symbol that has both the left-sided harpoon and right-sided harpoon together is a symbol used for the equilibrium in a chemical reaction. It denotes that the backward and the forward rates are equal and is represented by the symbol "⇌".

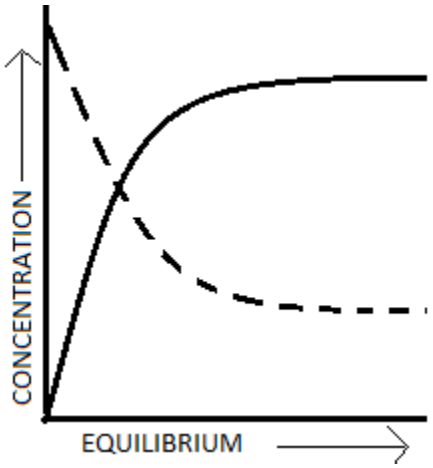
9. Select the correct equilibrium involving physical equilibrium.
a) it is possible only in a closed system at a given temperature
b) both forward and backward does not occur at the same rate
c) there is a dynamic but an unstable condition
d) measurable properties of the system do not remain constant

Answer: a
Explanation: The corrected statements of the wrong ones are that both backward and forward reactions occur at the same rate in a stable condition, while the measurable properties of the system remain constant.

10. When solid sugar dissolves in the solution _____ equilibrium is attained.
a) liquid vapor
b) solid liquid
c) solid vapor
d) no

Answer: b
Explanation: When sugar, which is in solid form dissolves in a solvent, forming sugar solution – a solid-liquid equilibrium is formed, where the rate of dissolution of sugar is equal to the rate of crystallization of sugar.

1. What does the dotted curve in the diagram given below represent?



a) concentration of reactants
b) equilibrium constant
c) concentration of products
d) concentration of catalyst

Answer: c
Explanation: The dotted curve in the above diagram the concentration of products as it is increasing with time and the attainment of equilibrium, the Strait curve is a concentration of reactants as it is decreasing as the reaction proceeds.

2. Synthesis of ammonia occurs through _____
a) Haber's process
b) The carbon cycle
c) Nitrogen cycle
d) Hydrogen cycle

Answer: a
Explanation: Haber's process allows nitrogen from the air to combine with hydrogen in order to form ammonia, this process is reversible and exothermic. This process occurs at high temperatures and a catalyst is a form of iron.

3. Equilibrium can be attained only from one side.
a) true

b) false

Answer: b
Explanation: An equilibrium can be obtained from both sides this is because a chemical reaction that reaches a state of dynamic equilibrium in which there are equal rates of forwarding and backward reactions and there is no net change in composition.

4. At dynamic equilibrium the concentration of both the reactants and products are _____
a) equal
b) not equal
c) cannot predict
d) sometimes equal sometimes not equal

Answer: b
Explanation: A dynamic equilibrium in a chemical reaction, both forward and backward rates are always equal. As the reaction occurs the concentration of product increases and the concentration of reactants decrease at equilibrium they are not equal.

5. In which of the following conditions do you think the rates of both forward and backward reactions are the same?
a) unstable equilibrium
b) not in an equilibrium
c) the beginning of a reaction
d) equilibrium

Answer: d
Explanation: In a chemical reaction a state comes when both the forward and reverse reactions occur at the same rate and this state is known as equilibrium. At the beginning of the reaction, the rate of the Forward reaction is higher than the rate of backward reaction.

6. What is the reverse reaction of s of water?
a) conversion into ice

b) conversion into steam
c) conversion into water
d) equilibria

Answer: c
Explanation: The process of solidifying of water is nothing but the formation of ice that is a condensation of water the reverse reaction of condensation of water is the melting of water, that is the formation of water from ice.

7. Dynamic equilibrium mainly concerns about _____
a) spontaneous reactions
b) nonspontaneous reactions
c) reversible reactions
d) Irreversible reactions

Answer: d
Explanation: In case of dynamic equilibrium, the ratio of reactants and products changes. The net change equals zero, as there is no net movement of particles. The formation of the reactants is equal to the formation of products here in dynamic equilibrium.

8. At which of the following temperatures water is a dynamic equilibrium with ice?
a) 0 Kelvin
b) zero degree centigrade
c) zero degree Fahrenheit
d) 100 Kelvin

Answer: b
Explanation: Water is a dynamic equilibrium with ice at the freezing point of water that is zero degrees centigrade, 273 Kelvin and 32-degree Fahrenheit. Because at zero degrees centigrade the phase transition occurs.

9. When a chemical reaction is written the products are written on the _____
a) left side
b) right side
c) either left side or right side
d) depends on the chemicals present

Answer: b
Explanation: When a chemical reaction is written, the reactants are written on the left side and the products are written on the right side, while both parts of the reaction are joined by an arrow mark (→).

10. Equilibrium of a reaction depends on the concentration of reactants.
a) true
b) false

Answer: b
Explanation: In a chemical reaction equilibrium does not depend on the concentration of reactants as well as a concentration of products. Equilibrium is attained when the rates of both forward and backward reactions are equal.

Law of Chemical Equilibrium and Equilibrium Constant

1. A reaction is given by aA + bB → cC + dD. How do you represent an equilibrium constant?
a) $[A]^a[B]^b/[C]^c[D]^d$
b) $[C]^c[D]^d/[A]^a[B]^b$
c) [A][B]/[C][D]
d) [C][D]/[A][B]

Answer: b
Explanation: An equilibrium constant in a chemical reaction As given by the ratio of Forward reaction rate by backward reaction rate its units are

$(mol/L)^{\Delta n_g}$, where Δn_g is moles of products – moles of reactants which are in the gaseous state only.

2. The value of equilibrium constant for different chemical reactions at a particular temperature is _____
a) constant
b) unique
c) the same
d) cannot say

Answer: b
Explanation: The value of the equilibrium constant changes with temperature i.e. it's different for different temperatures and is unique for every reaction at a constant temperature or given temperature.

3. What does it indicate having a higher equilibrium constant?
a) reaction occurs faster
b) rate of backward reaction is faster
c) both the backward and forward reactions are equal
d) reaction may be slower than usual

Answer: a
Explanation: As we know that the equilibrium constant is the ratio of the forward reaction rate to the backward reaction rate. Having higher equilibrium constant depicts that the reaction that is forward occurring faster then the backward one and the extension of completion of the reaction is more.

4. The equilibrium constant of a reaction is 20 units and the equilibrium constant of other reaction is 30 units when both the reactions are added up together then the equilibrium constant of the resultant reaction is given by _____
a) 20 units
b) 600 units
c) 50 units

d) 10 units

Answer: b
Explanation: When the reaction can be expressed as the sum of two other reactions, the equilibrium constant of the overall reaction is equal to the product of equilibrium constants of individual reactions, so 20 units x 30 units = 600 units.

5. If the initial concentrations of reactants in a reaction increase then the equilibrium constant _____
a) also increases
b) decreases
c) remains constant
d) may increase or decrease

Answer: c
Explanation: The equilibrium constant of a chemical reaction is independent of the initial concentrations of the reactants. So when the initial concentrations of the reactants increase in a reaction the equilibrium constant remains the same.

6. If we use activities in place of molar concentration in an equilibrium constant expression then what is the dimension of k?
a) it becomes dimensionless
b) the same units of molar concentration
c) units are related to the activity
d) cannot predict it

Answer: a
Explanation: In equilibrium constant expression of a chemical reaction, (equilibrium constant is represented by the letter K) if the activities are used in place of the molar concentration K becomes dimensionless, that means it has no dimensions.

7. What is the equilibrium constant of the following reaction: $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$?

a) $[NO][H_2O]/[NH_3][O_2]$
b) $[C]^c[D]^d/[A]^a[B]^b$
c) $[NO_4[H_2]^6/NH_3]^4[O_2]^5$
d) $[NO]^4[H_2O]^6/[NH_3]^4[O_2]^5$

Answer: d
Explanation: the above given chemical reaction $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$ is in the form of $aA + bB \rightarrow cC + dD$. We know that the equilibrium constant of this reaction is $[C]^c[D]^d/[A]^a[B]^b$, show the required answer is $[NO]^4[H_2O]^6/[NH_3]^4[O_2]^5$.

8. for the reaction $H_{2(g)} + Br_{2(g)} \leftrightarrow 2HBr_{(g)}$ the equilibrium constant is given as 0.04 then what is the equilibrium constant for the reaction $2HBr_{(g)} \leftrightarrow H_{2(g)} + Br_{2(g)}$?
a) 0.04
b) 4
c) 25
d) 100

Answer: c
Explanation: In a chemical reaction if the equilibrium constant for a backward reaction is given by k then the equilibrium constant for the forward reaction is given by 1/k, so your the resultant answer becomes 1/0.04 = 25.

9. Given that at 800k the concentrations are as follows: $N_2=3.0 \times 10^{-3}M$, $O_2 = 4.2 \times 10^{-3}M$ and $NO = 2.8 \times 10^{-3}M$, what is the equilibrium constant for the reaction $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$?
a) 0.622
b) 0.6
c) 0.63
d) 0.94

Answer: a
Explanation: For the reaction, $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$, the equilibrium constant is given by $[NO]^2/[N_2][O_2]$. So the equilibrium constant K is

given by $(2.8 \times 10^{-3}\ M)(2.8 \times 10^{-3}\ M)/(3.0 \times 10^{-3}\ M)(4.2 \times 10^{-3}\ M) = 0.622$, there are no units as $\Delta n_g = 0$.

10. If the chemical reaction is: $aA + bB \rightarrow cC + dD$ and K is the equilibrium constant. Then what is the equilibrium constant of the reaction $naA + nbB \rightarrow ncC + ndD$?
a) K
b) nK
c) K^n
d) K/n

Answer: c
Explanation: If a chemical reaction is multiplied by a constant then the equilibrium constant of the particular chemical reaction is raised to the power of the constant by which the chemical reaction is multiplied, so here and is a constant and equilibrium constant of the reaction is k^n

Homogeneous Equilibria

1. The equilibrium $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$, is an example of _____
a) homogeneous chemical equilibrium
b) heterogeneous chemical equilibrium
c) neither homogeneous nor heterogeneous
d) both homogeneous and heterogeneous

Answer: a
Explanation: In homogeneous equilibrium, the reactants and products are present in the same phase or physical state. Nitrogen, Oxygen, and nitrogen monoxide are present in a gaseous state, so it is homogeneous chemical equilibrium.

2. The units of K_P and K_C are equal.
a) true
b) false

Answer: b
Explanation: The units of K_P are $(atm)^{\Delta ng}$ and the units of K_C are $(mol/L)^{\Delta ng}$. Where Δng = moles of products – moles of reactants which are in the gaseous state only. As the units of K_P and K_C are not equal the above statement is considered to be false.

3. $Br_2(l) \rightleftharpoons Br_2(g)$ is in _____
a) homogeneous equilibrium
b) not in both Homogeneous and heterogeneous equilibrium
c) cannot say
d) may or may not be in Homogeneous equilibrium

Answer: b
Explanation: As we know that in Homogeneous equilibrium the reactants and products are present in the same phase or physical state but here it is in a liquid state and gaseous state, so it is not in Homogeneous equilibrium.

4. Write pressure in terms of concentration and temperature.
a) P = CRT
b) P = nrt
c) p = CT
d) C = PT

Answer: a
Explanation: We all know that the ideal gas equation is PV = nRT; P = nRT/V; P = CRT here N/v is concentration, P is the pressure, V is the volume, n is the number of moles, C is the concentration, R is the universal gas constant and T is the temperature.

5. At constant temperature, the pressure is directly proportional to the concentration of the gas.
a) true
b) false

Answer: a
Explanation: We have P = CRT e where p is pressure, R is a universal constant and T is the temperature, we derive the equation from the ideal gas equation PV=nRT. So from P = CRT, we can say that at a constant temperature the pressure is directly proportional to the concentration of the gas.

6. For the following equation, $2HBr_{(g)} \rightleftharpoons H_{2(g)} + Br_{2(g)}$; are both K_P and K_C are equal?
a) yes
b) cannot say
c) no
d) depends on the temperature

Answer: a
Explanation: We have here $K_C = [H_2][Br_2]/[HBr]^2$; $K_P = [pH_2][pBr_2]/[pHBr]^2$, where $pH_2 = [H_2]RT$, $pBr_2 = [Br_2]RT$ and $[pHBr] = [HBr]RT$. So in this case as $\Delta ng = 0$, where Δng = moles of products – moles of reactants which are in gaseous state only, both K_P and K_C are equal.

7. What is the relation between K_P and K_C?
a) $K_C = K_P$
b) $K_C = K_P(RT)$
c) $K_C = K_P(RT)^{\Delta ng}$
d) $K_P = K_C(RT)^{\Delta ng}$

Answer: c
Explanation: For example, take the reaction $2HBr(g) \leftrightarrow H_{2(g)} + Br_{2(g)}$, $K_C = [H_2][Br_2]/[HBr]^2$; $K_P = [pH_2][pBr_2]/[pHBr]^2$, where $pH_2 = [H_2]RT$, $pBr_2 = [Br_2]RT$ and $[pHBr] = [HBr]RT$. So we can say that $K_C = K_P(RT)^{\Delta ng}$, where Δng = moles of products – moles of reactants which are in gaseous state only.

8. If K_C of a reaction $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$ is 2×10^{-3}, then what is the K_P?

a) 4×10^{-3}
b) 1×10^{-3}
c) 3×10^{-3}
d) 2×10^{-3}

Answer: d
Explanation: As we know that $K_C = K_P(RT)^{\Delta ng}$, here Δng = moles of products – moles of reactants which are in gaseous state only = 2 – (1+1) = 0. So $K_C = K_P(RT)^0$, $K_C = K_P(1) = K_P$; $K_C = K_P$, therefore K_P is same as K_C and K_P is 2×10^{-3}.

9. $CO_{2(g)} + C_{(s)} \rightleftharpoons 2CO_{(g)}$ is an example of _____
a) homogeneous equilibrium
b) heterogeneous equilibrium
c) neither homogeneous nor heterogeneous
d) both homogeneous and heterogeneous

Answer: b
Explanation: In heterogeneous equilibrium, the reactants and products are present in two or more physical States or phases. Here carbon dioxide is present in the gaseous state while carbon is present in the solid state, so it is an example of heterogeneous equilibrium.

10. WHat is the expression of K_C of the chemical equation $Ag_2O_{(s)} + 2HNO_{3(aq)} \rightleftharpoons 2AgNO_{3(aq)} + H_2O_{(l)}$?
a) $[AgNO_{3(aq)}]^2/[HNO_{3(aq)}]^2$
b) $[AgNO_{3(aq)}]/[HNO_{3(aq)}]^2$
c) $[AgNO_{3(aq)}]^2/[HNO_{3(aq)}]$
d) $[AgNO_{(aq)}]^2/[HNO_{3(aq)}]^2$

Answer: a
Explanation: It is important that for the existence of heterogeneous equilibrium pure solid or liquid must also be at equilibrium, but their concentrations do not appear in the expression of the equilibrium constant. So here $K_C = [AgNO_{3(aq)}]^2/[HNO_{3(aq)}]^2$.

Applications of Equilibrium Constants

1. If $K_C > 10x$, the products predominate over reactants. Then what is the value of x?
a) 2
b) 3
c) 4
d) 1
Answer: b
Explanation: If $K_C > 10x$, the products are predominant, over the reactants in a chemical reaction because if K_C is very large the reaction proceeds nearly to completion an example for this is at 300K, $H_{2(g)} + Cl_{2(g)} \rightleftharpoons 2HCl_{(g)}$, $K_C = 4 \times 10^{31}$.
2. What will happen if $K_C > 10^{-3}$ in a chemical reaction?
a) products are predominant
b) reactants are predominant
c) equilibrium
d) dynamic equilibrium

Answer: d
Explanation: If $K_C > 10^{-3}$, the reactants are predominant over the products in a chemical reaction and the products are predominant, over the reactants in a chemical reaction, if $K_C > 10^3$, where K_C is the equilibrium constant.

3. Reaction quotient is depicted by this symbol _____
a) K
b) Q_C
c) R
d) q

Answer: b
Explanation: For any reversible reaction at any stage other than equilibrium, the ratio of the molar concentrations of the products to that of the reactants, where is concentration term is raised to the power equal

to the stoichiometric efficient to the substance concerned is called the reaction quotient, Q_C.

4. For a reaction $aA + bB \rightarrow cC + dD$, which is not in equilibrium the Q_C is given as _____
a) $[A]^a[B]^b/[C]^c[D]^d$
b) $[C]^c[D]^d/[A]^a[B]^b$
c) [A][B]/[C][D]
d) [C][D]/[A][B]

Answer: b
Explanation: A very basic reaction like $aA + bB \rightarrow cC + dD$, where the capital letters represent the compounds or molecules and the small letters are the coefficients of them the reaction quotient Q_C, is given by $[C]^c[D]^d/[A]^a[B]^b$.

5. What will happen If $Q_C > K_C$?
a) Q_C decreases till equilibrium
b) Q_C increases till equilibrium
c) Q_C remains constant
d) cannot say

Answer: a
Explanation: If $Q_C > K_C$, the value of Q_C will tend to decrease to reach the value of equilibrium constant (that is towards equilibrium) and the reaction will continue in the opposite direction, where Q_C is reaction quotient and K_C is the equilibrium constant.

6. At equilibrium, K_C is _____
a) greater than reaction quotient
b) equal to the reaction quotient
c) less than the reaction question
d) independent of reaction question

Answer: b
Explanation: At equilibrium, the equilibrium constant and the reaction

quotient is equal. The equilibrium constant is depicted by the symbol K_C and the reaction quotient is represented by the symbol Q_C.

7. What do you think will happen if reaction quotient is smaller than the equilibrium constant?
a) equilibrium constant will change
b) reaction quotient remains constant
c) reaction quotient increases continuously
d) reaction quotient increases till K_C

Answer: d
Explanation: If the reaction quotient is less than the equilibrium constant K_C, the reaction quotient will tend to increase and the reaction will proceed in the forward direction, till it reaches the value of the equilibrium constant.

8. If $[H_2]t=0.10$ M, $[I_2]t = 0.20$ M and $[HI]t = 0.40$ M, in the reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$, what is the value of Q_C?
a) 8
b) 4
c) 2
d) 1

Answer: a
Explanation: We know that reaction quotient $Q_c = [HI]t^2 / [H_2]t[I_2]t$ and given that $[H_2]t=0.10$ M, $[I_2]t = 0.20$ M and $[HI]t = 0.40$ M, So by substituting, we get $Q_c = (0.40 \text{ M} \times 0.40 \text{ M})/(0.20 \text{ M} \times 0.10 \text{ M}) = 8.0$, 8 is the answer.

9. What do you understand from the reaction if reaction quotient is 2 and the equilibrium constant is 3?
a) the equilibrium constant increases
b) the equilibrium constant decreases
c) the equilibrium constant remains the same
d) reaction quotient increases

Answer: d
Explanation: In a reaction, if reaction quotient is less than the equilibrium constant, the reaction quotient will tend to increase and the reaction will proceed in the forward direction till it reaches equilibrium.

10. Equilibrium constant depends on the temperature.
a) true
b) false

Answer: a
Explanation: Yes, the equilibrium constant depends on the temperature and its unique for a chemical reaction at a given temperature. So the above-given statement about the equilibrium constant is considered to be true

Relationship between Equilibrium Constant K, Reaction Quotient Q and Gibbs Energy G

1. In a reaction, at 300k, K_C is given as 2×10^{13}, then what is the value of ΔG?
a) -7.64×10^4 J
b) -7.64×10^4 J mol^{-1}
c) -7.64×10 J mol^{-1}
d) -7.64×10^4 mol^{-1}

Answer: b
Explanation: We know that $\Delta G_0 = -RT \ln K_c$, where ΔG_0 is the standard Gibbs free energy, R is universal gas constant, T is the temperature and K_C is equilibrium constant; substituting K_C as 2×10^{13}, $\Delta G_0 = (-8.314 J\ mol^{-1}K^{-1} \times 300K) \times \ln(2 \times 10^{13})$; $\Delta G_0 = -7.64 \times 10^4$ J mol^{-1}.

2. For a chemical reaction, the value of ΔG_0 is -831.4 J/mol. Then what is the value of K_C at 100 k?
a) 1.0077
b) 1.077
c) 1.007

d) 2.7

Answer: d
Explanation: We know that $\Delta G_0 = -RT \ln K_c$, where ΔG_0 is the standard Gibbs free energy, R is universal gas constant, T is the temperature and K_C is equilibrium constant; substituting ΔG_0 as -831.4 J/mol, we get lnk = -831.4J/mol divided by -8.314J $mol^{-1}K^{-1}$ × 100K = 1; lnk = 1; K = e^1 = 2.7

3. If the value of ΔG_0 is -2502 J/mol and K is 2, what is the temperature of the reaction that is occurring?
a) 200 k
b) 101 k
c) 100 k
d) 300 k

Answer: c
Explanation: We know that $\Delta G_0 = -RT \ln K_c$, where ΔG_0 is the standard Gibbs free energy, R is universal gas constant, T is the temperature and K_C is equilibrium constant; substituting ΔG_0 as -2502 J/mol, we get -2502 J/mol = -8.314J $mol^{-1}K^{-1}$ × T ln2 = 2502 J/mol = T = 2502/2.502 = 100 k.

4. In a reaction, if the value of Gibbs free energy is greater than zero what does it infer?
a) K is greater than 1
b) K is less than 1
c) K is equal to 1
d) Cannot deduce K from Gibbs free energy

Answer: b
Explanation: If the value of Gibbs free energy is greater than the zero that means, $-\Delta G_0/RT$ is negative and that $e^{-\Delta G}{}_0/RT$ is greater than 1, so the K is greater than 1 this means the reaction is nonspontaneous and proceeds in the forward direction.

5. When is a reaction nonspontaneous?
a) Gibbs free energy is positive
b) Gibbs free energy is negative
c) Gibbs free energy is zero
d) Does not depend on Gibbs free energy

Answer: a
Explanation: When Gibbs free energy is positive, the reaction that occurs is nonspontaneous and a reaction occurs backward that is the products are converted into reactants. Simply the reverse reaction could occur.

6. What did the Q depicted in the equation; $\Delta G = \Delta G_0 + RT \ln Q$?
a) reaction coefficient
b) reaction quotient
c) equilibrium constant
d) free energy

Answer: b
Explanation: In the equation $\Delta G = \Delta G_0 + RT \ln Q$, ΔG is the Gibbs free energy, R is the universal gas constant, T is the temperature and Q is the reaction quotient. When Gibbs free energy is zero, the reaction quotient becomes equilibrium constant.

7. If the value of Gibbs free energy for a reaction is 20J/mol, the reaction is _____
a) spontaneous
b) nonspontaneous
c) may be spontaneous
d) may not be spontaneous

Answer: b
Explanation: Is the value of Gibbs free energy for a reaction is 20 J/mol, that means it is positive, $-\Delta G_0/RT$ is negative and that $e^{-\Delta G}{}_0/RT$ is greater than 1, so the K is greater than 1 this means the reaction is nonspontaneous.

8. For a reaction, $K_c = 3.81 \times 10^{-3}$ and $\Delta G_0 = 13.8$ kJ/mol. Then what is the value of R?
a) -8.314J $mol^{-1}K^{-1}$
b) 8.314J $mol^{-1}K^{-1}$
c) cannot say as the temperature is not given
d) -8.314J mol^{-1}

Answer: b
Explanation: Though the temperature is not given, universal gas constant value always remains the same, whatever may be the other values. So the universal gas constant is given by a constant value that is -8.314J $mol^{-1}K^{-1}$.

9. What happens when reaction quotient is equal to the equilibrium constant?
a) the reaction proceeds in the forward direction
b) the reaction proceeds in the backward direction
c) the reaction reaches equilibrium
d) cannot predict

Answer: c
Explanation: When Gibbs free energy is zero, the reaction reaches equilibrium and at equilibrium, the reaction quotient is replaced by the equilibrium constant, as both the values are equal. That is when reaction quotient is equal to the equilibrium constant reaction reaches equilibrium.

10. Is a relationship between reaction quotient and Gibbs free energy at a temperature T?
a) $\Delta G = \Delta G_0 + RT \ln Q$
b) $\Delta G = \Delta G_0 + RT \ln k$
c) $\Delta G = \Delta G_0 + R \ln Q$
d) $\Delta D = \Delta G_0 + RT \ln Q$

Answer: a
Explanation: The relationship between reaction quotient and Gibbs free

energy at temperature t is given as as $\Delta G = \Delta G_0 + RT \ln Q$, where ΔG is the Gibbs free energy, R is the universal gas constant, T is the temperature and Q is the reaction quotient.

Factors Affecting Equilibria

1. Which of the following factors do you think will not affect the state of the equilibrium?
a) concentration
b) pressure
c) temperature
d) color

Answer: d
Explanation: According to Le chatelier's principle, if a system at equilibrium is subjected to a change in concentration, pressure or temperature the equilibrium shifts in the direction that tends to nullify the effect of the change.

2. What will happen if at equilibrium the concentration of one of the reactants is increased?
a) equilibrium will shift in the forward direction
b) equilibrium population will not change
c) equilibrium will shift in the backward direction
d) equilibrium will move to and fro

Answer: a
Explanation: As per the Le chatelier's principle, if the concentration of one of the reactants is increased at equilibrium the equilibrium will shift in the forward direction and vice versa is also possible. Therefore we can say that there is an effect of change of concentration on equilibrium.

3. In the reaction, $H_{2(g)} + Br_{2(g)} \rightleftharpoons 2HBr_{(g)}$, what will happen if there is a change in pressure?
a) equilibrium moves left
b) equilibrium moves right
c) there is no change in equilibrium

d) we cannot say

Answer: c
Explanation: According to Le chatelier's principle, there will be no effect of pressure on equilibrium if the chemical equation has the same number of moles of reactants and products hear the moles on the left side is equal to the moles on the right side that is 2.

4. Consider the chemical equation $TiCl_4 + 2\ H_2O \rightleftharpoons TiO_2 + 4\ HCl$ if the pressure is increased what will happen to the equilibrium?
a) it moves backward direction
b) moves forward direction
c) remains constant
d) cannot say

Answer: a
Explanation: When there is a change in a number of moles, the equilibrium will shift in the direction having a smaller number of moles when the pressure is increased and vice-versa. Here the equilibrium moves in the backward direction because the reactants have less number of moles than products.

5. If a reaction produces heat during the process then it is _____
a) exothermic
b) endothermic
c) both exothermic and endothermic
d) neither exothermic nor endothermic

Answer: a
Explanation: If a reaction releases heat then it is exothermic in nature and if the reaction consumes heat it is endothermic in nature. An example of the exothermic reaction is the mixing of washing soda in water and mixing glucose in water is an example of an endothermic reaction.

6. The formation of products is favoured by _____ temperature in an endothermic reaction.
a) high
b) low
c) moderate
d) 0

Answer: a
Explanation: When the process is exothermic, low temperature of favors Forward reaction and when the process is endothermic high temperature favors the formation of the products. This is according to le chatelier's principle.

7. At constant pressure, if the inert gases added then the equilibrium will shift in the direction of _____
a) decrease in the number of moles
b) increase in the number of moles
c) does not depend on the number of moles
d) does not change

Answer: b
Explanation: At constant pressure, if inert gas added, it will increase the volume of the system there for the equilibrium will shift in a direction, in which there is an increase in the number of moles of gases as per le chatelier's principle.

8. Which side does the catalyst shift the equilibrium position?
a) left side
b) right side
c) may be left or right side
d) does change the position

Answer: d
Explanation: As per Le chatelier's principle on the effect of catalyst states that the presence of the catalyst does not change the position of the equilibrium it simply fast and the attainment of the equilibrium.

9. The equilibrium position does not change when there is an addition of inert gas at constant volume.
a) true
b) false

Answer: a
Explanation: If keeping the volume of the system constant and inert gases added the relative molar concentration of the substance will not change hence the equilibrium position of the reaction remains unaffected.

10. What will happen to the position of equilibrium if the concentration of one of the products is increased?
a) shifts left
b) shift right
c) does not change
d) main shift left or right

Answer: a
Explanation: According to Le chatelier's principle if at equilibrium the concentration of one of the products is increased the equilibrium will shift in the backward direction that is towards the left side and vice versa.

Ionic Equilibrium in Solution

1. $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ is in _____
a) ionic equilibrium
b) chemical equilibrium
c) dynamic equilibrium
d) physical equilibrium

Answer: a
Explanation: The equilibrium that is attained between the ionized molecules and the ions in the solution of weak electrolyte is called Ionic Equilibrium. $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$ is an example; CH_3COO^- and H^+ are ions.

2. Electrolytes conduct electricity.
a) True
b) False

Answer: a
Explanation: Chemical substances which can conduct electricity in their Aqua state or in the molten state are called electrolytes. The conduction of current through the electrolyte is due to the movement of Ions, hence the above statement is true.

3. Which of the following may not be a strong electrolyte?
a) hydrochloric acid
b) sulfuric acid
c) nitric acid
d) ammonia

Answer: d
Explanation: Electrolytes which dissociate almost completely into constituent ions in aqueous solutions are known as strong electrolytes. Therefore ammonia is not a strong electrolyte because it can't dissociate completely.

4. All organic acids except sulfonic acid are _____ electrolytes.
a) weak
b) strong
c) not
d) neither strong nor weak

Answer: a
Explanation: Electrolytes which dissociate into a lesser extent in aqua solution are called weak electrolytes. All organic acids except sulfonic acids and bases like Ammonia, Ammonium hydroxide, amines, etc are weak electrolytes.

5. Can nonelectrolytes conduct electricity?
a) yes
b) no
c) sometimes
d) cannot say

Answer: b
Explanation: Michael Faraday classified substances into two categories; one is electrolytes and nonelectrolytes, nonelectrolytes do not dissociate into ions in a solution. So they do not conduct electricity.

6. Sugar solution _____ electricity.
a) do not conduct
b) conducts
c) depends on the type of sugar
d) cannot say

Answer: a
Explanation: Aqueous solution of sugar does not conduct electricity, but Aqueous solution of sugar conducts electricity. This is because the aqueous solution of sugar is a nonelectrolyte, whereas the salt solution is an electrolyte.

7. Which of the following is in Ionic Equilibrium?
a) $2AgI + Na_2S \rightleftharpoons Ag_2S + 2NaI$
b) $4\ NH_3 + 5\ O_2 \rightleftharpoons 4\ NO + 6\ H_2O$
c) $TiCl_4 + 2\ H_2O \rightleftharpoons TiO_2 + 4\ HCl$
d) $H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$

Answer: d
Explanation: Only $H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$ is in ionic equilibrium. As the equilibrium established between the unionized molecules and the ions in the solution of weak electrolytes is known as Ionic Equilibrium.

8. What is the degree of dissociation for strong electrolytes?
a) 1

b) 0
c) less than 1
d) greater than 1

Answer: a
Explanation: Degree of dissociation is the fraction of the total number of molecules which dissociate into constituent ions, it is represented by the symbol α. As a strong electrolyte dissociate completely, it values is 1.

9. Degree of dissociation does not depend on which of the following factors?
a) nature of the solute
b) nature of the solvent
c) sound
d) concentration

Answer: c
Explanation: Values of the degree of dissociation or degree of ionization depends upon the following factors: 1) the nature of the solute, 2) the nature of the solvent 3) concentration and 4) temperature of the solution.

10. K in $K = C\alpha^2/1 - \alpha$ represents _____
a) dissociation constant
b) molar concentration
c) degree of dissociation degree of ionization
d) degree of ionization

Answer: a
Explanation: The above equation represents Ostwald's dilution law, where K is the dissociation constant, C is the molar concentration of the solution and α is a degree of dissociation or degree of ionization of the solution.

Acids, Bases and Salts

1. Which of the following is not a property of an acid according to Robert Boyle?
a) turns blue Litmus red
b) sour in taste
c) neutralize bases
d) bitter in taste

Answer: d
Explanation: According to Robert Boyle, acids are the substances which have a sour taste, turns blue Litmus red, liberate hydrogen with metals conduct electricity in aqueous solution and neutralize bases. They do not have a bitter taste.

2. Bases turn red litmus blue.
a) True
b) False

Answer: a
Explanation: Litmus is a mixture of different dyes from lichens that is water soluble. Acids change blue litmus red and bases change red litmus blue. The original colour of Litmus is purple. The pH of a base is in between 7 and 14.

3. HCl is an Arrhenius _____
a) acid
b) base
c) salt
d) water

Answer: a
Explanation: According to the Arrhenius concept of acids and bases, an acid is a chemical substance which dissociates in aqueous solution to give hydrogen ions or hydronium ions. Therefore HCl is an Arrhenius acid.

4. A proton donor is a _____ substance.
a) protongenic
b) protophilic
c) amphoteric
d) amphiprotic

Answer: a
Explanation: According to the bronsted concept of acids and bases, an acid that is a Proton Donor is proton genic and a base that is a Proton acceptor is protophilic, while an amphoteric substance is both base and acid.

5. Arrhenius theory could not explain the acidic and basic behaviour in non-aqueous solutions.
a) true
b) false

Answer: a
Explanation: The major drawback of Arrhenius theory is that it fails to explain the acidic and basic behaviour in non-aqueous solutions. It cannot explain the acidic character of aluminium chloride, Boron fluoride and basic character of NH_3 PH_3.

6. A strong acid has a _____
a) weak conjugate acid
b) weak conjugate base
c) strong conjugate base
d) strong conjugate acid

Answer: b
Explanation: As per the conjugate pairs in the bronsted concept of acid and bases, strong acid has a weak conjugate base and weak acid has a strong conjugate base. The strong base has weak conjugate acid and the weak base has strong conjugate acid.

7. Which of the following substances cannot act as both acid as well as a base?
a) amphoteric substance
b) amphiprotic substance
c) ampholyte
d) protophilic

Answer: d
Explanation: Amphoteric or amphiprotic substance or ampholytes are the substances which act as an acid as well as a base and example for this is water. It acts as an acid with Ammonia and base with acetic acid.

8. Which of the following is a Lewis base?
a) ammonia
b) magnesium chloride
c) aluminium chloride
d) sodium ion

Answer: a
Explanation: Lewis base is a chemical substance which can donate a pair of electrons. Examples are neutral molecules containing lone pairs like ammonia, negatively charged species and the ligands in coordination species.

9. Silver ion is a Lewis acid.
a) True
b) False

Answer: a
Explanation: Lewis acid is a chemical substance which can accept a pair of electrons. Examples are molecules with an incomplete octet of central atom simple cations like silver Ion molecules in West central atom has vacant d orbitals.

10. Lewis concept does explain the behaviour of _____
a) bases

b) salts
c) protonic acids
d) amphoteric substances

Answer: c
Explanation: The major limitations of the Lewis concept is that it does not explain the behaviour of protonic acids such as hydrochloric acid, sulphuric acid and nitric acid. It also does not predict the magnitude of the relative strength of acids and bases.

11. Identify a conjugate pair in the equation: $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$.
a) ammonia and water
b) water and hydroxide ion
c) ammonium ion and hydroxide ion
d) ammonia and hydroxide ion

Answer: b
Explanation: According to Bronsted concept of acids and bases, the two conjugate pairs in the above-given equation $NH_3 + H_2O \rightleftharpoons NH_4 + OH^-$ are Ammonia – ammonium Ion and water – Hydroxide ion. Here acids are water and ammonium ion.

12. Which of the following is the strongest hydracid known?
a) HCN
b) $HClO_4$
c) HCl
d) HNO_3

Answer: b
Explanation: $HClO_4$ which is called Perchloric acid, is the strongest hydracid known and HCN called Formonitrile, is the weakest hydracid known. CsOH called Caesium Hydroxide is the strongest base known.

13. Hydroxide ion is a bronsted base.
a) true

b) false

Answer: a
Explanation: According to the bronsted concept of acids and bases, acid is a chemical substance that can donate a Proton to some other substance and base is a chemical substance that can accept a Proton from other substance.

14. Water in case of HCl acts as a/an _____, in case of ammonia acts as a/an _____
a) base, base
b) base, acid
c) acid, base
d) acid, acid

Answer: b
Explanation: Water acts as a base in the presence of hydrochloric acid and acts as an acid in the presence of ammonia. According to bronsted, acid is a chemical substance that can donate a Proton and base can accept a Proton from other substances.

15. Which of the following is not a Lewis acid?
a) aluminium chloride
b) sodium ion
c) sulphur tetrafluoride
d) hydroxide ion

Answer: d
Explanation: Lewis acids are molecules with an incomplete octet of central atoms like aluminium chloride, simple cations like sodium ion, and molecules in which the central atom has vacant d-orbital like sulphur tetrafluoride, but hydroxide ion is a negatively charged species. So it is not a Lewis acid.

Ionization of Acids and Bases

1. What is the value of the ionic product of water at 298k?
a) $7 \times 10^{-14}/mol^2L^2$
b) $1 \times 10^{-10}/mol^2L^2$
c) $1 \times 10^{-14}/molL^2$
d) $1 \times 10^{-14}/mol^2L^2$

Answer: d
Explanation: Ionic product is a product of the concentration of hydronium ions and hydroxyl ions in pure water, which remains constant at a particular temperature. It is symbolized as K_W and is equal to $1 \times 10^{-14}/mol^2L^2$.

2. The ionization constant of water increases with increase in temperature.
a) true
b) false

Answer: a
Explanation: The ionization product of water is given by $[H_3O^+][OH^-] = 1 \times 10^{-14}/mol^2L^2$ at 298 k, the product of the concentration of hydronium ions and hydroxyl ions in pure water. Concentrations increase with temperature, so the ionization constant of water increases with increase in temperature.

3. Write pH in terms of concentration of hydrogen ion?
a) $[H^+] = 1^{-pH}$
b) $[H^+] = 10^{-pH}$
c) $[H^+] = 10^{pH}$
d) $[H] = 10^{-pH}$

Answer: b
Explanation: pH is defined as the negative logarithm of hydrogen ion concentration that is $pH = -\log[H^+]$. By rearranging pH in terms of concentration of hydrogen ions, we get $[H^+] = 10^{-pH}$. pH means potential of hydrogen.

4. What is the pK_W at 298 k?
a) 14
b) 7
c) 1
d) 0

Answer: a
Explanation: We know that the ionization constant of water at 298 k is given by $[H_3O^+][OH^-] = 1 \times 10^{-14}/mol^2L^2$. $pK_W = pH + pOH = -\log[H_3O^+] - \log[OH^-] = -\log[H_3O^+][OH^-] = -\log 10^{-14} = \log 10^{14} = 14$. Therefore pK_W at 298 k is 14.

5. Which of the following has a PH greater than 7?
a) gastric juice
b) vinegar
c) blood plasma
d) lemon juice

Answer: c
Explanation: Acids always have a pH below 7 and bases have a pH of above 7, while neutral compounds have a pH of 7. Here gastric juice, vinegar, and lemon are acids, so they have a pH of below 7, but blood plasma is a base. It has a pH greater than 7.

6. A neutralization reaction results in the formation of _____
a) salts
b) acid
c) base
d) hydrogen

Answer: a
Explanation: Salts are the products of the reaction between an acid and a base, these type of reactions are called neutralization reactions. There are many types of salts like normal, acidic, basic, double, complex and mixed salts.

7. NaCl is a _____ salt.
a) Normal
b) Acidic
c) Basic
d) Double

Answer: a
Explanation: Normal salts like NaCl are obtained by complete neutralization of an acid with a base. Acidic salts are formed by incomplete neutralization of polybasic acids and basic salts are formed by incomplete neutralization of poly acidic base. Double salts are formed by the combination of two simple salts and exist only in the solid state.

8. What is the reverse process of Neutralization?
a) formation
b) hydrolysis
c) reaction
d) splitting

Answer: b
Explanation: Salts are strong electrolytes and on dissolution in water split up into ions. Which react with hydrogen ions are Hydroxide ions furnished by water yielding an acidic or basic solution. This process is called salt hydrolysis and is the reverse process of neutralization.

9. Why is the aqueous solution of a salt of a weak acid and strong base is alkaline?
a) utilization
b) neutralization
c) cationic hydrolysis
d) anionic hydrolysis

Answer: d
Explanation: The aqueous solution of a salt of a weak acid and strong base is alkaline, due to the anionic hydrolysis and aqueous solution of a

salt of a strong acid and weak base is acidic, due to cationic hydrolysis with dilution degree of hydrolysis increases.

10. What is the hydrolysis constant of a weak acid-weak base?
a) K_W/K_b
b) K_W/K_a
c) K_W/K_aK_b
d) $1/K_aK_b$

Answer: c
Explanation: The hydrolysis constant of a weak acid and weak base is K_W/K_aK_b, the degree of hydrolysis is $\sqrt{K_W/K_aK_b}$ and the pH of the solution is given by $1/2pK_W + 1/2pK_a – 1/2pK_b$. An example of a salt of a weak acid and a weak base is $CH_3COOHNH_4$.

11. Formic acid has a concentration of 0.1M and K_a is 1.77×10^{-4}. What is the value of degree of dissociation?
a) 4
b) 4.2
c) 0.42
d) 42

Answer: b
Explanation: The dissociation constant $K = [H^+][HCOO^–]/[HCOOH] = x^2/0.1 – x = 1.77 \times 10^{-4}$; $x = [H^+] = 0.0042M$. The percent of dissociation is $x/0.1 = (0.042M)100\% = 4.2$. Therefore the value of degree of dissociation is 4.2

12. What is the pH of the solution of sulphuric acid having a concentration of 0.01M?
a) 1
b) 2
c) 3
d) 4

Answer: b
Explanation: pH is defined as the negative logarithm of hydrogen ion concentration that is pH = -log[H^+]. So here, the pH of the solution of sulphuric acid is -log[H^+], where concentration of hydrogen ion is 0.01M = -log[10^{-2}] = 2.

13. Acetic acid's pK_a is 4.2 and ammonium hydroxide pK_b is 3.24. What is the pH of the ammonium acetate solution?
a) 7.12
b) 7
c) 4.2
d) 7.48

Answer: d
Explanation: We know that the pH of the solution of a weak acid and a weak base is given by $1/2pK_W + 1/2pK_a - 1/2pK_b$. So pH = 7 + 12[4.2 – 3.24]; pH = 7 + 0.48 = 7.48, we get this by substituting acetic acid's pK_a as 4.2 and ammonium hydroxide pK_b as 3.24.

14. Acid strength increases in the order of _____
a) HF ≪ HCl ≪ HBr ≪ HI
b) HF ≪ HBr ≪ HCl ≪ HI
c) HI ≪ HCl ≪ HBr ≪ HF
d) HCl ≪ HF ≪ HBr ≪ HI

Answer: a
Explanation: The correct order of increase in acidic strength is HF ≪ HCl ≪ HBr ≪ HI. There are many factors affecting acid strength. Hear the hydrogen-acid Bond strength decreases, as the acid strength increases.

Buffer Solutions

1. Carbonic acid and sodium bicarbonate are present in blood as a buffer.
a) true

b) false

Answer: a
Explanation: A solution that resists the change in its PH value by the addition of a small amount of acid or base is called a buffer solution. The buffer system present in the blood is carbonic acid and sodium bicarbonate.

2. Which of the following is not an acidic buffer?
a) Acetic Acid-Sodium acetate
b) Boric acid-borax
c) Ammonium hydroxide-ammonium chloride
d) All are acidic buffers

Answer: c
Explanation: An acidic buffer has a pH value of less than 7, Acetic Acid-Sodium Acetate and boric acid-borax are examples of acidic buffers, but ammonium Hydroxide-ammonium chloride has a pH of greater than 7, so they are basic buffers.

3. Which of the following is an equation used to calculate the pH of a buffer solution for an acidic buffer?
a) $pH = pK_a + \log[salt]/[acid]$
b) $pOH = pK_a + \log[salt]/[acid]$
c) $pH = pK_b + \log[salt]/[acid]$
d) $pH = pK_a + \log[salt][acid]$

Answer: a
Explanation: Equation that is used to calculate the pH of a buffer solution for an acidic buffer is $pH = pK_a + \log[salt]/[acid]$. This equation is known as henderson-hasselbalch equation, it is used for making of buffer solutions.

4. Buffer solution is destroyed when _____
a) addition of weak base
b) addition of strong acid or base

c) addition of weak acid
d) addition of a salt

Answer: a
Explanation: If the addition of a strong acid or base changes the pH of a buffer by unit, the buffer solution is assumed to be destroyed that is new pH = $pK_a \pm 1$; that means [salt]/[acid] or [acid]/[salt] = 10 or 1/10.

5. What is the buffer capacity if 3 moles are added in 5 litres of the solution to change the pH by 2 units?
a) 0.2
b) 0.5
c) 0.15
d) 0.3

Answer: d
Explanation: Buffer capacity is defined as the number of moles of acid or base added in one litre of the solution to change the pH by Unity. Therefore here buffer capacity = 3/5 divided by 2 = 0.6/2 = 0.3. The buffer capacity is given as 0.3.

6. Buffer capacity of a buffer is given as two units for a change in pH by Unity. Then what is the number of moles of acid or base, added in one litre of the solution?
a) 2
b) 0.5
c) 1
d) 4

Answer: a
Explanation: Buffer capacity is denoted by Φ = number of moles of acid or base added to one litre of the buffer by a change in pH. Here the change in pH is given by 1 and the buffer capacity is given by 2, therefore by substituting, we get that 2 moles of acid or base are added in one litre of the solution.

7. If 0.20 mol/L CH_3COOH and 0.50 mol/L CH_3COO^- together make a buffer solution, calculate the pH of the solution if the acid dissociation constant of CH_3COOH is 1.8×10^{-5}.
a) 2.09
b) 5.14
c) 2.65
d) 3.98

Answer: b
Explanation: We have henderson-hasselbalch equation as $pH = pK_a + \log[salt]/[acid]$. So by substituting the concentrations of silent and acid along with the acid dissociation constant, we get $pH = -\log[1.8 \times 10^{-5}] + \log [0.50mol/L]/[0.20mol/L] = 5.14$.

8. Note that the pK_a here is given by 4.752, a buffer is made using 0.8 M acetic acid and 1 M Sodium Acetate what do you think its pH is(log10/8 = 0.097)?
a) 4.84
b) 4.85
c) 4.849
d) 4.846

Answer: b
Explanation: According to the Henderson hasselbalch equation $pH = pK_a + \log[salt]/[acid]$, if we substitute the concentration of salt as 1 M and the concentration of acid as 0.8 M, pH = 4.752 + 0.097 = 4.849 is the required answer.

9. If the pH of a substance is given by 3 then what is the pOH of the substance?
a) 3
b) 7
c) 14
d) 11

Answer: d
Explanation: We know that the sum of the pH and pOH of any substance is equal to 14 that is pH + pOH = 14. So here the pH of a substance is given by 3 the pH of the substance = 14 – 3 = 11, 11 is the required answer.

10. Which of the following do you think is a correct statement?
a) Ammonium hydroxide / ammonium chloride is an acidic buffer
b) boric acid / borax is an acidic buffer
c) henderson hasselbalch equation is given by pH = pK_b + log[salt]/[acid]
d) PH + pOH = 4

Answer: b
Explanation: Ammonium hydroxide / ammonium chloride is a basic buffer, henderson hasselbalch equation is given by pH = pK_a + log[salt]/[acid] and pH + pOH = 14. So the only correct statement is that boric acid / borax is an acidic buffer.

Solubility Equilibria of Sparingly Soluble Salts

1.The degree of dissociation of Ammonium hydroxide increases in the presence of Ammonium Chloride because of _____
a) solubility product
b) common Ion effect
c) hydrolysis of the salt
d) mixed salts

Answer: c
Explanation: Common Ion effect is defined as the separation of the dissociation of a weak electrolyte by the addition of a strong electrolyte having some common ion. Therefore the degree of dissociation of Ammonium hydroxide decreases in the presence of Ammonium Chloride due to common Ion effect.

2. Common Ion effect can be used in which of the following cases?
a) cloth making
b) alcohol purification
c) quantitative analysis
d) qualitative analysis

Answer: d
Explanation: Common Ion effect is used in the purification of common salt, salting out of soap and qualitative analysis. In qualitative analysis, Ammonium Hydroxide is added in the presence of Ammonium Chloride to avoid the precipitation of V group radicals.

3. Hydroxide Ion concentration in calcium hydroxide and barium Hydroxide is an example of _____ solution.
a) isochoric solution
b) isohydric solutions
c) hypo solution
d) hyper solution

Answer: b
Explanation: In the solution of two electrolytes, if the common ions' concentration (Hydroxide Ion concentration in calcium hydroxide and barium hydroxide solution) is equal, then on mixing there is zero change in the degree of association in both of the electrolytes, such solutions are called isohydric solutions.

4. For the dissociation of an electrolyte A_xB_y, K_{sp} is given as $[A^{y+}]^x[B^{x+}]^y$. What is K_{sp}?
a) solubility product
b) soluble product
c) solution product
d) solvent product

Answer: a
Explanation: Solubility product K_{sp} is defined as the product of the concentrations of the ions of the salt in its standard solution at a given

temperature raised to the power of the ions produced by the dissociation of 1 mole of the salt.

5. Precipitate is formed if ionic product is _____
a) greater than the solubility product
b) less than the solubility product
c) equal to the solubility product
d) independent of the solubility product

Answer: a
Explanation: The concept of solubility product helps in predicting the formation of the precipitate. In general, if the ionic product is greater than the solubility product, the precipitate is formed and if the ionic product is less than the solubility product, the precipitate is not formed.

6. Solubility product can be used in predicting the solubility of a sparingly soluble salt.
a) true
b) false

Answer: a
Explanation: Yes, we can predict the solubility of a sparingly soluble salt, for example, consider the reaction; $A_xB_y = xA^{y+} + yB^{x+}$, the solubility of a sparingly soluble salt is given by $x^x.y^y.s^{x+y}$, knowing the values of K_{sp}, x and y, the solubility of the salt can be calculated.

7. A salt is soluble is the solubility is _____
a) less than 0.01 M
b) in between 0.01 M and 0.1 M
c) greater than 0.01 M
d) greater than 0.1 M

Answer: d
Explanation: A salt is soluble if the solubility is greater than 0.1 M. A salt is slightly soluble if the solubility is between 0.01 M and 0.1 M and the salt is sparingly soluble if the solubility is less than 0.01 M.

8. If K_{sp} of a salt A_2B_3 is given by 1×10^{-25}. Then find the solubility of the salt?
a) 10^{-3}
b) 10^{-4}
c) 10^{-5}
d) 10^{-8}

Answer: c
Explanation: For the salt A_xB_y, ($A_xB_y = xA^{y+} + yB^{x+}$), the solubility of a sparingly soluble salt is given by $x^x.y^y.s^{x+y}$. $K_{sp} = x^x.y^y.s^{x+y}$, where x = 2 and y = 3; $K_{sp} = 108S5 = 1 \times 10^{-25}$. $S = 10^{-5}$. The solubility of the salt is given by 10^{-5}.

9. The solubility for the salts of the type AB_3 is given by
_____
a) $(K_{sp}\ 27)^{1/4}$
b) $(K_{sp}/27)^{1/5}$
c) $(K_{sp}/27)^{3/4}$
d) $(K_{sp}/27)^{1/4}$

Answer: d
Explanation: For the salt A_xB_y, ($A_xB_y = xA^{y+} + yB^{x+}$), the solubility of a sparingly soluble salt is given by $x^x.y^y.s^{x+y}$. $K_{sp} = x^x.y^y.s^{x+y}$, where x = 1 and y = 3; $K_{sp} = 27S^4$, by rearranging, we get solubility denoted by S as $(K_{sp}/27)^{1/4}$.

10. Both the solubility product and ionic product are applicable to all types of solutions.
a) true
b) false

Answer: b
Explanation: Solubility of the product is only applicable to the saturated solutions, whereas an ionic product is applicable to all types of solutions. It is because the formation of a precipitate is dependent on the solubility product.