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| Division | 11th |
| Subject | Chemistry |
| Chapter | Equilibrium |
| Author | Ruhani kashni |
| Category | 01 |

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| Which of the following statements is true regarding the equilibrium constant (Kc) for a chemical reaction?  (2006) |
| Kc is temperature dependent. |
| Kc is influenced by the initial concentrations of reactants and products. |
| Kc is affected by the presence of a catalyst. |
| Kc is constant for a given reaction, regardless of the conditions. |
| a |
| Equilibrium constant Kc ratio of the concentrations of the products to the concentrations of the reactants |
| The equilibrium constant (Kc) for a chemical reaction is defined as the ratio of the concentrations of the products to the concentrations of the reactants with each concentration term raised to the power of its stoichiometric coefficient. Kc depends on the temperature at which the reaction is taking place. Changing the temperature alters the equilibrium position and consequently affects the value of Kc. Therefore, Kc is temperature-dependent is correct. |
| Equilibrium in physical processes |

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| The incorrect match in the following is  (2019) |
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| d |
| For an ideal gas .  and |
| The incorrect match is .  For an ideal gas .  and  The above equation is helpful in predicting the spontaneity of the reaction. e.g.  (i) If ve and and hence, . It means that the reaction occurs spontaneously in the forward direction or products predominate over reactants.  (ii) If ve and and hence, . It means that the reaction is non-spontaneous in forward direction (i.e. product side) but spontaneous in reverse direction (i.e. reactants predominate over products or the reaction occurs rarely).  (iii) When, then. This situation generally occurs at equilibrium.  is incorrect |
| Equilibrium in physical process |

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| For the reaction: N2(g) + 3H2(g) ⇌ 2NH3(g), if the volume of the container is decreased by reducing the volume, what will be the effect on the equilibrium  (2018) |
| The equilibrium will shift towards the reactants |
| The equilibrium will shift towards the products |
| The equilibrium will not be affected |
| The equilibrium will shift in an unpredictable manner |
| b |
| According to Le Chatelier's principle, when the volume of the container is decreased, the system will try to reduce the number of gas molecules to relieve the increased pressure |
| According to Le Chatelier's principle, when the volume of the container is decreased, the system will try to reduce the number of gas molecules to relieve the increased pressure. In this case by decreasing the volume, the system will shift towards the side with fewer gas molecules which is the product side (NH3). Therefore the equilibrium will shift towards the products. |
| Equilibrium in chemical processes |

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| Which of the following factors does NOT affect the equilibrium constant (Kc) for a chemical reaction  (2007) |
| Changes in temperature. |
| Changes in pressure. |
| Addition of a catalyst |
| Changes in the initial concentration of reactants. |
| c |
| Equilibrium constant (Kc) for a chemical reaction is determined solely by the stoichiometry and the temperature of the reaction |
| The equilibrium constant (Kc) for a chemical reaction is determined solely by the stoichiometry and the temperature of the reaction. It is not affected by changes in pressure, the addition of a catalyst, or the initial concentrations of reactants. A catalyst speeds up the attainment of equilibrium but does not affect the position of equilibrium or the value of Kc. |
| Equilibrium in chemical processes |

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| In a reversible chemical reaction at equilibrium, which of the following statements is correct  (2003) |
| The concentrations of reactants and products remain constant. |
| The rate of the forward reaction is equal to the rate of the backward reaction. |
| The reaction has reached completion |
| The equilibrium can only be achieved in irreversible reactions. |
| B |
| At equilibrium the reaction does not come to a complete stop it continues to form products and the products continue to react to form reactants. |
| In a reversible chemical reaction at equilibrium the reaction does not come to a complete stop but rather the reactants continue to form products and the products continue to react to form reactants. At equilibrium, the rate of the forward reaction becomes equal to the rate of the backward reaction, ensuring a dynamic balance. |
| Dynamic nature of equilibrium |

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| In which one of the following equilibria,  (2019) |
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|  |
| A |
| Key Idea The relationship between and is  where,  If then  If ve then  If ve then  Key Idea The relationship between and is  where,  If then  If ve then  If ve then |
| Consider the following equilibria reactions  (a)  So,  (b)  So,  (c)  (d)  So,  Therefore |
| Law of mass action |

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| For the reaction A(g) + B(g) ⇌ C(g), the equilibrium constant expression (Kc) is given as  (2016) |
| [C]/[A][B] |
| [A][B]/[C] |
| [C]/[A]+[B] |
| [A]+[B]/[C] |
| A |
| Law of Mass Action |
| According to the Law of Mass Action, the equilibrium constant (Kc) for a reaction is expressed as the ratio of the product concentrations to the reactant concentrations, with each concentration term raised to the power of its stoichiometric coefficient. In this case, the equilibrium constant expression (Kc) is [C]/[A][B]. |
| Law of mass action |

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| Reaction,  ,  In equilibrium condition, pressure of depends on  (2005) |
| increased mass of |
| increased mass of |
| increased temperature of equilibrium |
| increased mass of and both |
| c |
| According to law of mass action, the rate of forward reaction  or |
| According to law of mass action, the rate of forward reaction  or  is solid substance in pure state concentration  then,  Similarly the rate of backward reaction  or  Concentration of solid  At equilibrium,  or  where, partial pressure of  or (equilibrium  constant)  or  So, from the above it is clear that  pressure of does not depend upon the concentration of reactants. The given equation is an endothermic reaction. If the temperature of such reaction is increased, then dissociation of would increase and more is produced. |
| Equilibrium constant |

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| Which one of the following conditions will favour maximum formation of the product in the reaction, XKJ?  2018 |
| High temperature and high pressure |
| Low temperature and low pressure |
| Low temperature and high pressure |
| High temperature and low pressure |
| C |
|  |
| The given question is based upon Le-Chatelier's principle. According to this principle, if a stress is applied to a reaction mixture at equilibrium, reaction proceeds in such a direction that relieves the stress.  The given reaction is  According to Le-Chatelier's principle, with increase in temperature the equilibrium shifts in the direction of endothermic reaction (i.e., heat is absorbed).  Alternatively, the decrease in temperature shifts the equilibrium towards the direction of exothermic reaction (i.e. heat is produced).  Similarly, an increase in pressure will shifts the equilibrium to that direction which leads to decrease in total number of gaseous moles. Whereas, a decrease in the pressure will shift the equilibrium to that direction which leads to an increase in total number of gaseous moles.  For,  Thus, low temperature and high pressure will favour maximum formation of the product in the given reaction. |
| Equilibrium constant |

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| The value of for the reaction,  is less than zero. Formation of will be favoured at  (2011) |
| low pressure and low temperature |
| high temperature and low pressure |
| high pressure and low temperature |
| high temperature and high pressure |
| C |
|  |
| ; where  and  The forward reaction is favoured at high pressure and low temperature. (According to Le-Chatelier's principle) |
| Factors affecting equilibrium |

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| According to Le-Chatelier's principle, adding heat to a solid liquid equilibrium will cause the  (2002) |
| temperature to increase |
| temperature to decrease |
| amount of liquid to decrease |
| amount of solid to decrease |
| D |
| Le-Chatelier's principle |
| When we add heat to the equilibrium between solid and liquid, then the equilibrium shifts towards liquid and hence, the amount of solid decrease and amount of liquid increase. |
| Factors affecting equilibrium |

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| Le Chatelier's principle states that when a system in equilibrium is subjected to an external stress, the system will  (2013) |
| Stay at equilibrium with no change. |
| Shift in the direction that relieves the stress. |
| Shift in the opposite direction of the stress. |
| Completely disrupt the equilibrium. |
| b |
| Le Chatelier's principle |
| According to Le Chatelier's principle, when a system in equilibrium is disturbed by an external stress such as changes in temperature, pressure, or concentration, the system will respond by shifting in the direction that helps alleviate the stress. This shift allows the system to re-establish equilibrium. |
| Postulates of Le Chatelier’s principle |

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| The equilibrium constant (K) for a dissociation reaction of a weak acid is also known as:  (2003) |
| Acid dissociation constant (Ka) |
| Base dissociation constant (Kb) |
| Salt dissociation constant (Ks) |
| Solubility product constant (Ksp) |
| A |
| Equilibrium constant (K) |
| The equilibrium constant for the dissociation of a weak acid is denoted as Ka. |
| Ionic equilibrium |

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| For the weak acid HA (Ka = 1.0 × 10^−5), what is the pKa value  (2007) |
| 10 |
| 5 |
| −5 |
| −10 |
| B |
| pKa = −log10(Ka) |
| The pKa value is a logarithmic representation of the acid dissociation constant (Ka) of a weak acid. It is calculated as the negative logarithm (base 10) of the acid dissociation constant: pKa = −log10(Ka).  In this case, pKa = −log10(1.0 × 10^−5)  = −(−5)  = 5 |
| Ionic equilibrium |

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| Which of the following cannot act both as Bronsted acid and as Bronsted base?  (2020) |
| HCO3- |
| NH3 |
| HCL |
| HSO4- |
| C |
| Bronsted acid is a substance which tends to donate proton. Bronsted base is a substance which tends to accept proton. |
| Bronsted acid is a substance which tends to donate proton. Bronsted base is a substance which tends to accept proton.  can act as Bronsted acid becuase it can only donate proton.  Acid Base  The remaining options contains substances which act both as Bronsted acid and Bronsted base.  Therefore, HCL is correct. |
| Ionization of acids and bases |

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| Which of the following fluoro-compounds is most likely to behave as a Lewis base?  (2016) |
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| B |
| The molecule with lone pair at centre atom, will behave as Lewis’s base. |
| The molecule with lone pair at centre atom, will behave as Lewis’s base. In the given molecules, only has lone pair at as shown below.    Thus, acts as a Lewis base (electron-pair donor) due to presence of lone pair on P-atom. |
| Ionization of acids and bases |

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| Which of the following is electron deficient  (2005) |
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| C |
| Element of 13 group |
| Boron is an element of 13 group and contains three electrons in its valence shell. When its compound dimerises, each boron atom carries only 6 electrons that is their octet is incomplete. Hence, is an electron deficient compound.  In all other given molecules octet of central atom is complete. |
| Differences between strong and weak electrolytes |

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| 0.1M solution of which one of these substances will be basic  (2014) |
| Sodium borate |
| Calcium nitrate |
|  |
| Sodium sulphate |
| A |
| Hydrolysis process |
| On hydrolysis sodium borate form sodium hydroxide and boric acid, so the solution will show basic character because sodium hydroxide is strong base and boric acid is weak acid. While solution of sodium sulphate is neutral and that of and calcium nitrate is acidic. |
| Differences between strong and weak electrolytes |

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| Aqueous solution of acetic acid contains  (2021) |
| and |
| and |
| and |
| and |
| b |
|  |
| The aqueous solution of acetic acid ionise as follows:  Base Acid  So, the aqueous solution of acetic acid contains and . |
| Degree of ionization |

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| Which of the following statements about and ion concentration is incorrect?  (2000) |
| Addition of one drop of concentrated in solution decreases of the solution |
| A solution of the mixture of one equivalent of each of and has a of 7 |
| of pure neutral water is not zero |
| cold and concentrated has lower ion concentration than a dilute solution of |
| b |
| The solution will be basic having a pH more than 7. |
| is weak acid while is strong base, so one equivalent of cannot be neutralised with one equivalent of . Hence, one equivalent of each does not have value 7. As the is a strong base, the solution will be basic having a pH more than 7. |
| Degree of ionization |

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| Amongst the following hydroxides, the one which has the lowest value of at ordinary temperature (about ) is  (2008) |
|  |
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|  |
| D |
| Solubility increases down the group |
| In case of hydroxides of Group II A, solubility increases down the group. Be(OH)₂, being the smallest cation among Group II A elements, has the highest lattice energy and the lowest hydration energy. Therefore, is least soluble, has lowest value of . |
| Ionization of poly basic acids |

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| Be(OH)₂, being the smallest cation among Group II A elements, has the highest lattice energy and the lowest hydration energy. |
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|  |
| d |
| Smaller cation size leads to stronger attractions between the cation and the hydroxide ions in the solid lattice, resulting in higher lattice energy and lower solubility |
| The species formed after adding a proton to the base is known as conjugate acid of the base and the species formed after losing a proton is known as conjugate base of acid. So,  Base Conjugate acid  This is because the smaller cation size leads to stronger attractions between the cation and the hydroxide ions in the solid lattice, resulting in higher lattice energy and lower solubility. |
| Acid strength |

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| The of solution will be  (2021) |
| 7.01 |
| 2 |
| 12 |
| 9 |
| C |
|  |
| is a strong base, thus  We know that, |
| Concept of pH |

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| What is the of the resulting solution when equal volumes of 0.1 and are mixed?  (2015) |
|  |
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|  |
|  |
| a |
| When equal volumes of acid and base are mixed, then resulting solution become alkaline if concentration of base is taken high. |
| When equal volumes of acid and base are mixed, then resulting solution become alkaline if concentration of base is taken high.  Let normality of the solution after mixing and is . |
| Concept of pH |

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| Which among the following salt solutions is basic in nature  (2020) |
| Ammonium chloride |
| Ammonium sulphate |
| Ammonium nitrate |
| Sodium acetate |
| d |
| Nature of a salt solution depends on the nature of constituent acid and base whether they are strong or weak. |
| Nature of a salt solution depends on the nature of constituent acid and base whether they are strong or weak.  (a) is made of  Acidic solution.  (b) is made of Acidic solution.  (c) is made of Basic solution.  (d) is made of Basic solution.  Hence Sodium acetate chemical formula CH3COONa is correct. |
| Hydrolysis of salts |

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| A buffer solution is prepared by mixing equal volumes of a weak acid HAHA (pKa = 4) and its sodium salt NaA. The pH of the buffer will be closest to:  (2021) |
| 2 |
| 4 |
| 7 |
| 10 |
| b |
| Buffer solution is a solution that resists changes in pH |
| A buffer solution is a solution that resists changes in pH when an acid or base is added to it. It consists of a weak acid and its conjugate base (or a weak base and its conjugate acid). The buffer capacity is highest when the concentrations of the weak acid and its conjugate base are equal.  The of a buffer solution can be calculated using the Henderson-Hasselbalch equation:  Given that the of is 4 , and the volumes of the weak acid and its salt are equal, the concentrations of and are equal:  Substituting this into the Henderson-Hasselbalch equation:  Therefore, the pH of the buffer solution will be closest to the pKa of the weak acid, which is 4. |
| Buffer solution |

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| Which one of the following pairs of solution is not an acidic buffer  (2022) |
| and |
| and |
| and |
| and |
| a |
| Strong acid with its salt cannot form buffer solution. Hence, and is not an acidic buffer. |
| Buffers consist of a weak acid and its conjugate base. HClO₄ and NaClO₄, HClO₄ is a strong acid, dissociates in water to release H⁺ ions. NaClO₄, on the other hand is a strong electrolyte dissociates completely into Na⁺ and ClO₄⁻ ions. For a solution to act as a buffer, it should have a significant concentration of both a weak acid and its conjugate base (or a weak base and its conjugate acid) in order to resist pH changes. In the case of HClO₄ and NaClO₄, there is no significant concentration of a weak acid or its conjugate base, making it unable to function as a buffer. |
| Buffer solution |

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| The Henderson Equation is used to calculate the  (2009) |
| pH of a buffer solution. |
| pOH of a buffer solution. |
| concentration of the acidic component in a buffer solution. |
| concentration of the basic component in a buffer solution. |
| a |
| The ratio of the concentration of a weak acid (HA) to its conjugate base (A⁻) with the pH of the buffer solution |
| The Henderson equation, also known as the Henderson-Hasselbalch equation, is used to calculate the pH of a buffer solution. It relates the ratio of the concentration of a weak acid (HA) to its conjugate base (A⁻) with the pH of the buffer solution. The equation is given as: pH = pKa + log([A⁻]/[HA]), where pKa is the negative logarithm of the acid dissociation constant (Ka). |
| Henderson Equation |

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| Equimolar solutions of the following substances were prepared separately. Which one of these will record the highest value?  (2012) |
|  |
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|  |
|  |
| a |
| All other salts give acidic solution due to cationic hydrolysis |
| is a salt of strong acid and strong base . So, its aqueous solution is neutral with 7. All other salts give acidic solution due to cationic hydrolysis, so their pH is less than 7 .  Thus, pH value is highest for the solution of |
| Solubility product |

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| The compound whose aqueous solution has the highest is  (2010) |
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| c |
| Salt of weak base and strong acid, pH is less than 7. |
| The hydrolysis of gives neutral solution because it is salt of strong acid and strong base and hence, its is 7 . is salt of weak base and strong acid, so its pH is less than 7. is also acidic whereas is salt of strong base and weak acid, so its is more than 7. |
| Solubility product |

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| Find out the solubility of in . Given, that the ionic product of is .  (2020) |
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|  |
| d |
|  |
| lonic product is  =2×10-13 |
| Common ion effect |

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| In which of the following the solubility of will be minimum?  (2014) |
|  |
| Water |
|  |
|  |
| c |
| Common ion effect |
| In , the solubility of is minimum due to the phenomenon of common ion effect. The common ion effect occurs when the addition of an ion that is already present in a solution reduces the solubility or extent of ionization of a dissolved species. This effect is a result of the shift in equilibrium caused by the increase in the concentration of one of the ions involved in the equilibrium. |
| Common ion effect |