Salt Hydrolysis Chemistry Questions with Solutions

Q-1: Which of the following statements about the degree of hydrolysis for strong base and weak acid is incorrect?

a) It decreases with dilution
b) It is dependent of dilution
c) It increases with increase in temperature
d) It increases with decrease in K_a of the bases

Answer: a) It decreases with dilution

Explanation: We know that for strong base and weak acid, degree of hydrolysis is given by

$$h = \sqrt{\frac{K_W}{c \times K_a}}$$

As a result of dilution, concentration decreases. The relationship clearly shows that the degree of hydrolysis is inversely proportional to concentration. As a result, as concentration decreases, the degree of hydrolysis increases. This means it gets stronger with dilution.

Q-2: Which of the salts undergoes cationic hydrolysis?
a) NaH_2PO_4
b) CH_3COONa
c) $GaCl_3$
d) Li_2CO_3

Answer: C) $GaCl_3$

Explanation: Cationic hydrolysis occurs in salts of strong acids and weak bases. Because $GaCl_3$ is a salt of both a weak base ($Ga(OH)_3$) and a strong acid (HCl), it will undergo cationic hydrolysis. Rest salts are salts of a strong base and a weak acid, so they will not undergo this type of hydrolysis.

Q-3: In which case both pH and hydrolysis constant are independent of the concentration of ions involved in hydrolysis?

a) WA+SB
b) SA+WB
c) WA+WB
d) SA+SB

Answer: c) WA+WB

Explanation: For a salt of weak acid(WA) and weak base(WB), the expression for pH is

$pH = ½(pK_W+pK_a-pK_b)$

And for hydrolysis constant, is

$K_h = K_W/(K_a \times K_b)$

We can clearly see that neither the hydrolysis constant nor the pH expressions contain concentration terms. This means that it is unaffected by the concentration of an ion involved in hydrolysis.

Q-4: The degree of hydrolysis of a salt of a weak acid and a weak base in 0.1M solution is found to be 30%. If the molarity of the solution is 0.2 M, the salt's percent hydrolysis should be

a) 90%
b) 30%
c) 65%
d) 10%

Answer: b) 30%

Explanation: The degree of hydrolysis of a weak acid and weak salt is independent of the concentration of the solution. Hence, when the molarity of the solution is 0.2 M, the percentage degree of hydrolysis will remain the same,that is, 30%.

Q-5: At 25 degrees Celsius, the sodium salt of a weak monobasic organic acid is hydrolyzed to a 3 percent extent in its 0.1M solution. Given that the ionic product of water at this temperature is 10^{-14}, what is the acid's dissociation constant?

Answer: Given % hydrolysis,h = 3% = 0.03

For a sodium salt of weak acid, formula for acid's dissociation constant(K_a) is

$K_a = K_W/K_h$
Where K_W is the ionic product of water and K_h is the hydrolysis constant.

$K_h = h^2c = 0.03^2 \times 0.1 = 9\times10^{-5}$

Substitute $K_w = 10^{-14}$ and $K_h = 9\times10^{-5}$ in the formula for K_a

$K_a = K_W/K_h$
$K_a = 10^{-14} / 9\times10^{-5}$
$= 10^{-10}$(approximately)

Q-6: Calculate the % hydrolysis in a 10^{-2} M solution of NaCN ($K_a = 6.2\times10^{-10}$).

Answer: NaCN is a salt of weak acid(HCN) and strong base(NaOH). The degree of hydrolysis(h) for such as salt can be calculated by using the following formulae:

$$h = \sqrt{\frac{K_W}{K_a \times C}}$$

$$h = \sqrt{\frac{10^{-14}}{6.2 \times 10^{-10} \times 10^{-2}}} = 0.0401$$

Thus, % hydrolysis = %h = 0.0401×100 = 4.0%

Q-7: NH_4Cl has a hydrolysis constant (K_h) of 5.6×10^{-10}.Calculate the pH at equilibrium for 0.1 M NH_4Cl solution.

Answer: NH_4Cl is a salt of weak base (NH_4OH) and strong acid (HCl). The hydrolysis constant for such a salt has the following formulae:

$$K_h = \frac{K_w}{K_b}$$

Substitute $K_w = 10^{-14}$ and $K_h = 5.6\times10^{-10}$ in the above formula and calculate for K_b.

$$5.6 \times 10^{-10} = \frac{10^{-14}}{K_b}$$

On solving, $K_b = 1.78 \times 10^{-5}$
$pK_b = -\log(K_b) = 4.74$

The pH for this salt can be calculated using the below equation:
$pH = ½[pK_w - pK_b - \log c] = ½ [14-4.74-\log(0.1)] = 5.13$

Q-8: Salt hydrolysis is a chemical reaction that occurs when salt reacts with _____

a) Acid
b) Base
c) Water
d) Salt

Answer: c) Water

Q-9: $AlBr_3$ is formed by the reaction of a strong acid and a weak base. What is the nature of the solution,when this salt dissociates?

a) Basic
b) Neutral
c) Basic and acidic
d) Acidic

Answer: d) Acidic

Q-10: Give the hydrolysis reaction for magnesium nitride.

Answer: The hydrolysis reaction for magnesium nitride(Mg_3N_2) is shown below:

$$Mg_3N_2 + 6H_2O \rightarrow 3Mg(OH)_2 + 2NH_3$$

Q-11: Which nitrogen oxides are formed on the hydrolysis of N_2O_3?

A) N_2O + NO
B) NO_2 + N_2O
C) N_2O + NO_2
D) None of the above

Answer: A) N_2O + NO

Q-12: The compound with highest pH among the following is

a) CH_3COONH_4
b) Na_2CO_3
c) NH_4Cl
d) $NaNO_3$

Answer: b) Na_2CO_3

Explanation: The basic salt has the highest pH. Na_2CO_3 is the salt of NaOH (a strong base) and H_2CO_3 (weak acid). Overall, the salt will be basic, resulting in the highest pH.

Q-13: K_b for NH_4OH is 1.8 $\times 10^{-5}$ and K_a for CH_3COOH is 1.8×10^{-5}. Ammonium acetate's pH will be

a) 7.08
b) 6.75
c) 7.0
d) Between 6 and 7

Answer: c) 7.0

Explanation: Ammonium acetate is a salt of weak acid and weak base. For a salt of weak acid(WA) and weak base(WB), pH can be calculated using the below formula:

$pH = ½(pK_W + pK_a - pK_b)$

We can see K_b and K_a values are the same, it means their pK_a and pK_b values are also the same.

$pH = ½(pK_W) = 14/2 = 7$

Q-14: The pH of a 0.02 M solution of pyridinium hydrochloride is 3.44. Calculate the pyridine's ionisation constant.

Answer: Pyridinium hydrochloride is a weak base and strong acid(HCl) salt. We need to calculate ionisation constant(K_b).

The pH formula for this salt is shown below:
$pH = ½[pK_w - pK_b - \log c]$
$3.44 = ½[14 - pK_b - \log(0.02)]$

$pK_b = 8.82$

$pK_b = -\log K_b$
$K_b = 1.51 \times 10^{-9}$

Q-15: The hydrolysis of weak acid and strong base is called

a) Cationic hydrolysis
b) Anionic hydrolysis
c) Non ionic hydrolysis

d) Amphoteric hydrolysis

Answer: b) Anionic hydrolysis

Practise Questions on Salt Hydrolysis

Q-1: HX is a weak acid($K_a = 10^{-5}$).When it reacts with caustic soda, it forms the salt NaX(0.1 M). The degree of hydrolysis of NaX is

a) 0.1%
b) 0.000001%
c) 0.01%
d) 0.5%

Answer: a) 0.01%

Explanation:

Step-1: Calculate the hydrolysis constant
$K_h = K_W/K_a$
$= 10^{-14}/ 10^{-5}$
$= 10^{-9}$

The degree of hydrolysis can be calculated using the below formula:

$$h = \sqrt{\frac{K_h}{C}}$$

$$h = \sqrt{\frac{10^{-9}}{0.1}} = 10^{-4}$$

% hydrolysis = 0.01%

Q-2: Determine whether the following salts' aqueous solutions are acidic, basic, or neutral.

a) NH_4F
b) Na_2HPO_4
c) NH_4Cl

Answer:

a) NH_4F is a salt of a weak base (NH_4OH) and a weak acid (HF). Because both salts are weak, they will not be able to completely cancel out each other's effects. As a result, the solution will be slightly acidic, with a pH slightly less than 7.
b) Na_2HPO_4 is a salt of NaOH, a strong base, and H_3PO_4, a weak acid. Because the effect of strong substances is always considered, the salt will be overall basic.
c) NH_4Cl is a salt of weak base NH_4OH and strong acid HCl. Since the effect of strong substances is always taken into account, therefore the salt will be overall acidic.

Q-3: A salt hydrolysis reaction occurs when

a) Salts dissociate in any liquid solvent to produce proton and hydroxide ions.
b) Salt dissociates in water to produce acidic and basic solutions.
c) The salt releases anions and cations, resulting in acidic solutions.
d) The salt releases anions and cations, resulting in basic solutions.

Answer: b) Salt dissociates in water to produce acidic and basic solutions.

Q-4: Which of the following salt's degree of hydrolysis is independent of solution concentration?

a) NH_4CN
b) CH_3COONa
c) $(NH_4)_2SO_4$
d) None of these

Answer: a) NH_4CN

Explanation: Those salts which are made up of weak acid and weak base are independent of the concentration of solution.

NH_4CN is a salt of weak acid(HCN) and weak base (NH_4OH). Therefore is independent of the concentration of solution.

Q-5: The pH of 0.4M aqueous NaCN solution will be (Given pK_b of CN^- = 4.70)

a) 2.548
b) 3.513
c) 10.213
d) 11.450

Answer: d) 11.450

Explanation: NaCN is salt of weak acid(HCN) and strong base(NaOH). The formula used for the calculation of pH for weak acid and strong base is

$pH = ½(pK_W + pK_a + \log C)$

$pK_a = pK_w - pK_b = 14 - 4.70 = 9.3$

Substitute, C= 0.4 M and pK_a =9.3 in the formula of pH.
$pH = ½(14 + 9.3 + \log 0.4) = 11.45$

Hence **pH = 11.45**