Ka in Chemistry Questions with Solutions

Q1. What is the concentration of hydronium ions in a solution if the hydroxide ion concentration is 6.6×10^{-6} M?

a) 6.6×10^{-6}M
b) 6.6×10^{8} M
c) 1.5×10^{-8} M
d) 1.5×10^{-9} M

Correct Answer: (d) 1.5×10^{-9} M
Explanation: For every acidic or basic solution, the product of the hydroxide ion concentration and the hydronium ion concentration will be equal to 1×10^{-14}, the dissociation constant for water.

Q2. What property distinguishes a strong acid from a weak acid?

a) A strong acid will dissociate completely in water and have a high Ka value.
b) A strong acid will dissociate completely in water and have a low Ka value.
c) A weak acid will dissociate completely in water and have a low Ka value.
d) A weak acid will fail to dissociate completely in water and have a high Ka value.

Correct Answer: (a) A strong acid will dissociate completely in water and have a high Ka value.
Explanation: The acid dissociation constant (Ka) is used to differentiate between strong and weak acids. Strong acids have a very high Ka value.
The Ka value is determined by examining the equilibrium constant for acid dissociation. The acid dissociates more readily as the Ka increases. As a result, strong acids must dissociate more readily in water. A weak acid, on the other hand, is less likely to ionise and release a hydrogen ion, resulting in a less acidic solution.

Q3. What is Ka of acetic acid?

Answer. Acetic acid is a weak acid with an acid dissociation constant Ka = 1.8×10^{-5}.

Q4. Do strong acids have a high ka?

Answer. A high Ka value indicates a strong acid because it indicates that the acid has been partially dissociated into its ions. A high Ka value also indicates that the formation of products in the reaction is encouraged. A low Ka value indicates that little of the acid dissociates, resulting in a weak acid.

Q5. Fill in the blank.
Strong acids have a ____ pH value.

Answer. Strong acids have a lower pH value. At equilibrium, the larger the Ka, the stronger the acid and the higher the H^+ concentration.

Q6. State true or False. The equilibrium constant can be zero.

Answer. False. The equilibrium constant cannot be equal to zero. This is due to the fact that at equilibrium, the concentration of products is equal to zero.

Q7. Does Ka determine the absolute strength?

Answer. The acid dissociation constant is denoted by the symbol Ka. However, it does not determine absolute acid strength, only relative acid strength (to the solvent),

Q8. Why is Ka important?

Answer. It tells chemists how strong an acid is quantitatively without requiring them to conduct an experiment. Furthermore, it is extremely useful in calculations involving titrations or other analyses of weak acids that we cannot assume dissociate completely upon solvation.

Q9. Is it possible for the equilibrium constant to be negative?

Answer. The equilibrium constant, on the other hand, can never be negative. The equilibrium constant is a ratio of product concentrations to reactant concentrations, or of reactant partial pressures to product partial pressures.

Q10. What is Ka?

Answer. The acid ionisation constant, Ka, is the equilibrium constant for chemical reactions involving weak acids in an aqueous solution. Ka's numerical value is used to predict the magnitude of acid dissociation.

Q11. What is the unit in which Ka is expressed?

Answer. The acid and base dissociation constants are commonly expressed in moles per litre (mol/L). Ka is the acid dissociation constant. This constant's -log is essentially pKa.

Q12. Calculate Ka for a dibasic acid if its concentration is 0.05N and hydrogen ion concentration is 1×10^{-3} mol L^{-1}.

Answer. $H_2A \rightleftharpoons 2H^+ + A^{2-}$
Initial Concentration $H_2A = C$
Equilibrium Concentration $H_2A = C\alpha$, $2H^+ = 2C\alpha$, $A^{2-} = C\alpha$

C = 0.05/2 = 0.025M

$$Ka = \frac{[H^+]^2\,[A^-]}{H_2A} = \frac{[2C\alpha]^2\,[C\alpha]}{[C - C\alpha]} = \frac{4C^2\alpha^3}{1}$$

$[H^+] = 2C\alpha = 0.05\alpha = 10^{-3}$
α = 0.02
So, $Ka = 4C^2\alpha^3 = 4(0.025)^2\,(0.002)^3 = 2 \times 10^{-8}$.

Q13. How will you convert from pKa to Ka?

Answer. The conversion of pKa to Ka is given below.
pKa = – log Ka
= – pKa = – log Ka
= $10^{-(pKa)}$ = Ka
= Ka = $10^{-(pKa)}$

Q14. Calculate the Ka of HClO if the given pH of 0.100 M HClO is 4.23.

Answer. $HClO \rightleftharpoons H^+ + ClO^-$
$Ka = [H^+][ClO^-]/[HClO]$

ICE	HClO	H^+	ClO^-
Initial Concentration	0.1	0	0
Change in Concentration	-x	+x	+x
Equilibrium Concentration	0.1 - x	x	x

$[H^+] = 10^{-pH} = 10^{-4.83}$
$x = 5.89 \times 10^{-5}$
Therefore,

$$Ka = \frac{(5.89 \times 10^{-5})^2}{(0.1 - 5.89 \times 10^{-5})} = 3.47 \times 10^{-8}$$

Q15. Calculate the Ka value of a 0.2 M aqueous solution of propionic acid ($CH_3CH_2CO_2H$) with a pH of 4.88.

$CH_3CH_2CO_2H + H_2O \rightleftharpoons H_3O^+ + CH_3CH_2CO_2^-$

Answer.

ICE	$CH_3CH_2CO_2H$	H_3O^+	$CH_3CH_2CO_2^-$
Initial Concentration	0.2	0	0
Change in Concentration	-x	+x	+x
Equilibrium Concentration	0.2 - x	x	x

According to the definition of pH

$-\text{pH} = \log[H_3O^+] = -4.88$
$[H_3O^+] = 10^{-4.88}$
$= 1.32\times10^{-5}$
$= x$
According to the definition of Ka

$Ka = [H_3O^+][CH_3CH_2CO_2^-] / [CH_3CH_2CO_2H]$

$= x^2 / (0.2-x)$

$= (1.32 \times 10^{-5})^2 / (0.2-1.32\times10^{-5})$

$= 8.69 \times 10^{-10}$

Practise Questions on ka

Q1. Suppose a nanotechnological innovation allows every single charged ion to be precisely identified and removed from a small volume of water. Which of the following describes Ka for the water at the end of the process, assuming that the filtered water is given adequate time to re-equilibrate?

a) 10^{-14}
b) 0
c) 1
d) 10^{-7}

Correct Answer: (a) 10^{-14}
Explanation: Water autoionization occurs naturally as a result of attractive forces between the constituents of water molecules.

Even if all ions (including hydronium ions) are removed from a sample of water, the water will re-ionize after a short time until it reaches an equilibrium concentration of ions.
Ka = Kw = 10^{-14} in equilibrium.

Q2. Which of the following is what determines the strength of an acid?

a) The Ka
b) The Kb
c) Its physical state
d) Electronegativity values

Correct Answer: (a) The Ka
Explanation: Since the Ka is the acid dissociation constant, it determines how strong the acid is. Stronger acids dissociate more readily, resulting in lower pH values.

Q3. Write the formula of Ka for the reaction: HCl+ $H_2O \rightarrow H_3O^+ + Cl^-$

Answer. The formula of Ka for the reaction: HCl+ $H_2O \rightarrow H_3O^+ + Cl^-$ is-

$$Ka = \frac{[H_3O^+]\,[Cl^-]}{HCl}$$

Q4. Determine the equilibrium concentration of CH_3COO^- ions in a .00270M CH_3COOH solution. Given Ka = 1.76 × 10^{-5}.

Answer. Ka = 1.76 × 10^{-5} = $\frac{[H^+]\,[CH_3COO^-]}{CH_3COOH}$
Set up an ICE table

ICE	H^+	CH_3COO^-	CH_3COOH
Initial Concentration	0	0	0.0027
Change in Concentration	x	x	-x
Equilibrium Concentration	x	x	0.0027 - x

Ka = 1.76 × 10^{-5} = $\frac{[x]\,[x]}{[0.0027 - x]}$
$x^2 + 1.76 \times 10^{-5}\,x - 4.75 \times 10^{-8} = 0$
Using quadratic formula:

x = 2.09×10^{-4}
$[CH_3COO^-] = 2.09 \times 10^{-4}$ M

Q5. Determine the equilibrium concentration of IO_3^- ions in a 0.00450M HIO_3 solution. Given Ka = 0.16

Answer.

Ka = 0.16 = $\frac{[H^+][IO_3^-]}{HIO_3}$

Set up an ICE table

ICE	H^+	IO_3^-	HIO_3
Initial Concentration	0	0	0.0045
Change in Concentration	x	x	-x
Equilibrium Concentration	x	x	0.0045 - x

Ka = 0.16 = $\frac{[x][x]}{[0.0045 - x]}$
$x^2 + 0.16x - 0.00072 = 0$
Using quadratic formula:
x = 0.00438
$[IO_3^-]$ = 0.00438 M.