9:07 – 9:22

15 min

Chemistry 534 Acids and Bases and Salts Oh My!!

Name: Answer Key

All Questions Worth 4 Marks

= A pH < 7 — pH

1 The pH of an acetic acid solution, $CH_3COOH_{(aq)}$, 1.0 mol/L is 2.4.

What is the concentration of hydroxide ions, $OH^-_{(aq)}$, in this solution?

$pH = -\log[H^+] = 3.98 \times 10^{-3}\ M$

2.4

$\frac{1 \times 10^{-14}}{3.98 \times 10^{-3}\ M} = [OH^-] =$

Answer: $2.51 \times 10^{-12}\ M$

2 Refer to the acid-base system below:

A B CB CA

$$HNO_{2(aq)} + HCO^{-1}{}_{3(aq)} \leftrightarrow NO^{-1}{}_{2(aq)} + H_2CO_{3(aq)}$$

Given that the equilibrium favors the formation of products, which of the following statements is true?

A) HCO_3^{-1} is a stronger acid than H_2CO_3.

B) HCO_3^{-1} is a stronger acid than HNO_2.

C) H_2CO_3 is a stronger acid than HNO_2.

D) HNO_2 is a stronger acid than H_2CO_3.

3 Which of the following are **TRUE** characteristics of a strong acidic solution?

1. The Ka value is very large. ✓
2. It does not conduct electricity. ✗
3. $[H^+] > [OH^-]$. ✓
4. pH > 7.
5. The K_a value is very small.

A) 1 and 3

B) 1 and 4

C) 2 and 5

D) 3, 4 and 5

4 During an experiment, you are asked to compare the strength of two different acids of known concentrations.

You decide to measure the pH of the two acids using Universal Indicator and obtain the following results:

Acid	Concentration (mol/L)	Volume (mL)	Colour with Universal Indicator
	same		
X	2.0×10^{-2}	10.0	Pale Orange same
Y	2.0×10^{-4}	10.0	Pale Orange same pH

Which of these acids is the weakest? Justify your answer. 4 points only Nodo!!!!!

- ~~At the same~~ diff conc [Y] > [X]
- same pH bec same colour
- same [H+] but diff [HA]
- the lower conc X had same [H+] = more ionization than Y

5 Hydrogen cyanide gas, HCN, a powerful respiratory inhibitor, is highly toxic. It is a weak acid when dissolved in water, as shown by the equation below.

$$HCN_{(aq)} \leftrightarrow \overset{x}{H^+_{(aq)}} + \overset{x}{CN^-_{(aq)}} \qquad [HCN]$$

An aqueous solution of hydrogen cyanide, with a concentration of 0.23 mol/L, is prepared. It only ionizes 0.005 %.

What is the ionization constant (K_a) of this acid?

$$K_A = \frac{[H^+][CN^-]}{[HCN]}$$

$$= \frac{(1.15 \times 10^{-5})^2}{0.23}$$

$$=$$

Answer: 5.75×10^{-10}

$$\% \text{ ion} = \frac{[H^+]}{[HCN]} \times 100$$

$$\frac{\% \times [HCN]}{100} = [H^+]$$

$$\frac{(0.005\%)(0.23)}{100} = [H^+]$$

$$1.15 \times 10^{-5} M$$

6 The following table shows the relative strength, K_a, of certain acids.

Acid	K_a
1. $H_2CO_{3(aq)}$	4.4×10^{-7}
2. $H_2S_{(aq)}$	1.0×10^{-7}
3. $HSO_{3\,(aq)}^-$	6.2×10^{-8}

Which of the following sequences shows the acids arranged in order of increasing ability to donate a proton?

Weak → Stronger
Low K_A → High K_A

A) 1, 2, 3

B) 1, 3, 2

C) 3, 1, 2

D) 3, 2, 1

7 A 1.00-L volumetric flask contains 600 mL of distilled water to which a student adds 0.40 g of sodium hydroxide, $NaOH_{(s)}$. Once the $NaOH_{(s)}$ has dissolved, he adds distilled water until the flask is filled, keeping the temperature at 25.0 °C. He then seals the flask.

What is the pH of the resulting solution?

$$\frac{0.40\,g\,NaOH}{1\,L} \times \frac{1\,mol\,NaOH}{40\,g} = 0.01\,M$$

$NaOH \rightleftharpoons Na^+ + OH^-$

$0.01\,M$

$1 \times 10^{-2}\,M \rightarrow [H^+] = 1 \times 10^{-12}\,M$

Answer: pH 12

8 Consider the following reaction involving the ionic dissociation of oxalic acid:

$$HCO_2COOH_{(aq)} \leftrightarrow HCO_2COO^-_{(aq)} + H^+_{(aq)}$$

The initial concentration of the acid was 0.3 mol/L. At equilibrium, it had a pH of 1.

Calculate the acid dissociation constant, K_a.

$[H^+] = 1 \times 10^{-1}$

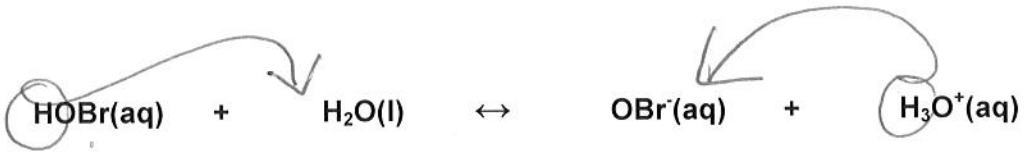
$\%\ ion = \frac{1 \times 10^{-1} M}{0.3M} \times 100 = 33\%\ ion$

R	HA	⇋	A^-	+	H^+
I	0.3		0		0
C	−.1		+.1		+.1
E	0.2		0.1		0.

$K_A = \frac{[H^+][A^-]}{[HA]} = \frac{(0.1)^2}{(0.2)}$

Answer: 0.05

Label the acid base conjugate pairs:



A B CB CA

10 The ionization equation for water can be written as:

$$HE + H_2O_{(l)} \leftrightarrow H^+_{(aq)} + OH^-_{(aq)}$$

This reaction is endothermic.

The temperature is increased to 70°C.

Using Le Chatelier's principle, which of the following could be the pH value of water at 70°C?

$K_W = [H^+][OH^-]$

$1 \times 10^{-14} = [H^+][OH^-]$

1×10^{-12} 1×10^{-7}

$[H^+]$

neutral

$[H^+] = [OH^-]$

6 6

A) 6.4

B) 7.0

C) 7.5

D) 14

mol/L

11 6.50 mL of 0.15 $Mg(OH)_2$ solution is required to neutralize 10.00mL of hydrochloric acid.

What is the concentration of the acid?

BCE: $Mg(OH)_{2(aq)} + 2HCl_{(aq)} \rightleftharpoons MgCl_{2(aq)}^{2+\ 1-} + 2H_2O_{(l)}$

$$6.50mL^{B} \times \frac{0.1 mol\ B}{1L} \times \frac{2 mol\ A}{1 mol\ B} \times \frac{1}{10.00mL\ A} = 0.13\ M$$

0.195 M

Answer: 0.~~13~~ M HCl

12 Which of the following is an acidic salt? SA + ~~SB~~ B

A) Na_2CO_3 BS

B) K_2SO_4 NS

C) $Al_2(SO_4)_3$ SA

D) $NaHCO_3$ BS

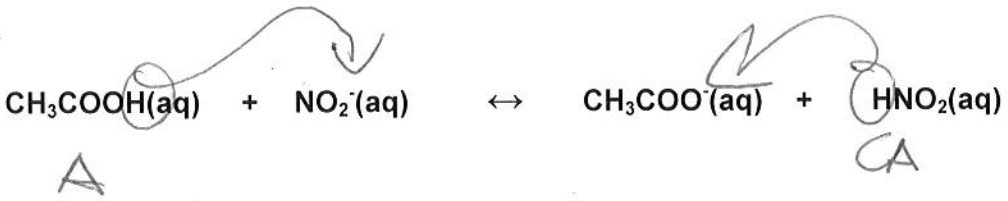
13 What is the conjugate acid of C_5H_5N? Justify your response somehow.

$C_5H_5N + H^+ \rightleftharpoons C_5H_5NH^+ + OH^-$

$+H_2O$

Answer: $C_5H_5NH^+$

14 Which way does the following equilibrium lie? Justify using math!



$$K_{eq} = \frac{K_A\ A}{K_A\ CA} = \frac{K_A\ CH_3COOH}{K_A\ HNO_2} =$$

Answer: **The equilibrium lies to the** L/R **because** Keq > or <

1

15 Citric acid $C_6H_8O_7$ is a weak organic acid which is a natural preservative. It is also used to add an acidic or sour taste to foods and soft drinks. In biochemistry it is important as an intermediate in the citric acid cycle and therefore occurs in the metabolism of virtually all living things. It can also be used as an environmentally benign cleaning agent.

How would one go about buffering a soft drink made with citric acid?

$NaC_6H_7O_7$

$C_6H_8O_7 \leftrightharpoons C_6H_7O_7^- + H^+$

certain M certain M

depending on desired pH