Base & Ksp Test 2019 v1 Name: Answers.

ent adds some hydrochloric acid, $HCl_{(aq)}$, to water and finds the resulting solution to e a pH of 3.50. **What is the hydroxide ion concentration $[OH^-_{(aq)}]$ of this solution?**

14 − 3.5 = 10.5 $[H^+] = 10^{-10.5} = 3.16 \times 10^{-11}$

A) 3.16×10^{-11} mol/L
B) 2.86×10^{-15} mol/L
C) 10.5 mol/L
D) 3.16×10^{-4} mol/L

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

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

Acid	K_a
Carbonic acid, H_2CO_3	4.4×10^{-7}
Hydroselenic acid, H_2Se	1.7×10^{-4}
Acetic acid, CH_3COOH	1.8×10^{-5}
Nitrous acid, HNO_2	5.1×10^{-4}

Which is the strongest acid?

A) H_2CO_3 B) H_2Se C) CH_3COOH D) HNO_2

4 **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 & 3 B) 1 & 4 C) 2 & 5 D) 3, 4 & 5

5 The ionization constant for water at 25°C is 1.0×10^{-14} & at 100°C it is 5.13×10^{-13}. **What is the pH of water at 100°C?**

A) 1.00×10^{-7} B) 7.16×10^{-7} C) 6.14 D) 7.00

$5.13 \times 10^{-13} = [H^+][OH^-] = x^2$

$\sqrt{5.13 \times 10^{-13}} = x$

$7.16 \times 10^{-7} = x = [H^+]$ → $-\log(7.16 \times 10^{-7}) = 6.14$

Q	A
1.	A
2.	D
3.	D
4.	A
5.	C

/10

Acid-Base & Ksp Test 2019 v2 Name: Answers

1 A student adds some hydrochloric acid, $HCl_{(aq)}$, to water and finds the resulting solution to have a pH of 3.50. **What is the hydroxide ion concentration $[OH^-_{(aq)}]$ of this solution?**

A) 3.16×10^{-4} mol/L
B) 2.86×10^{-15} mol/L
C) 10.5 mol/L
D) 3.16×10^{-11} mol/L

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3

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Which is the strongest acid?

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1. The Ka value is very large.
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3. $[H^+] > [OH^-]$.
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5. The K_a value is very small.

A) 1 & 3 B) 1 & 4 C) 2 & 5 D) 3, 4 & 5

5 The ionization constant for water at 25°C is 1.0×10^{-14} & at 100°C it is 5.13×10^{-13}. **What is the pH of water at 100°C?**

A) 1.00×10^{-7} B) 6.14 C) 7.16×10^{-7} D) 7.00

$K_w = (H^+)(OH^-)$

$5.13 \times 10^{-13} = x^2$

$7.16 \times 10^{-7} = x$

Q	A
1.	D
2.	C
3.	D
4.	A
5.	B

/10

6. Give the "Acid name" for the following compounds. (3)

A) hydrogen bromide (HBr) hydrobromic acid

B) hydrogen carbonate (H_2CO_3) carbonic acid

C) hydrogen sulphite (H_2SO_3) sulphurous acid.

1/3

Show all you work for the following problems. Show formulae & provide units. 4 pts each

7. 25.56 g of NH_3 (a strong base) is dissolved into 2.00 L of water. The base ionizes completely as shown in the equation below: $NH_{3(g)} + H_2O_{(l)} \rightarrow NH_4^+{}_{(aq)} + OH^-{}_{(aq)}$

Calculate the pH of this solution?

$\frac{1\,mol}{x} = \frac{17.04\,g}{25.56}$ $x = 1.500\,mol\,NH_3 = 1.500\,mol\,OH^-$

$[OH^-] = \frac{1.500\,mol\,OH^-}{2.00\,L} = 0.750\,M$

$pOH = -\log[OH^-]$

$= -\log(0.750)$

$pOH = 0.125$

$14 - pOH = pH$

$pH = 14 - 0.125$

$\boxed{pH = 13.9}$

8. Carbonic acid, H_2CO_3, is a weak acid. $H_2CO_{3(aq)} \leftrightarrow H^+_{(aq)} + HCO_3^-{}_{(aq)}$ $K_a = 4.3 \times 10^{-7}$

5.00×10^{-4} moles of carbonic acid are placed into 500 mL of distilled water.

Calculate the pH of this solution?

$[H_2CO_3] = \frac{5.00\times10^{-4}}{0.500\,L} = 1.00\times10^{-3}\,M$

H_2CO_3	H^+	HCO_3^-
0.001	0	0
$-x$	$+x$	$+x$
$0.001-x$	x	x

$K_a = \frac{[H^+][HCO_3^-]}{[H_2CO_3]}$

$4.3\times10^{-7} = \frac{(x)(x)}{0.001 - x}$

$4.3\times10^{-7} = \frac{x^2}{0.001}$

$4.3\times10^{-10} = x^2$ $x = 2.1\times10^{-5}$

$[H^+] = 2.1\times10^{-5}$

$-\log[H^+] = pH$

$\boxed{pH = 4.7}$

9. The initial concentration of an acid (HX) is 2.70 M. **Calculate the dissociation constant (K_a) for this acid if the pH is 1.3.**

$pH = 1.3$

$[H^+] = 10^{-1.3} = 0.05 = x$

$K_a = \frac{[H^+][X^-]}{[HX]}$

$= \frac{(x)(x)}{2.70 - x}$

$= \frac{(0.05)^2}{2.70 - 0.05}$

$K_a = \frac{0.0025}{2.65} = \boxed{9.5\times10^{-4}}$

(accept 9.4×10^{-4})

/15

10. Solid barium phosphate ($Ba_3(PO_4)_2$) dissolves into its respective ions at 25°C. Given that $[Ba^{2+}] = 0.015$ M, find the value of Ksp.

$Ba_3(PO_4)_{2(s)} \rightarrow 3Ba^{2+} + 2PO_4^{-3}$

$[Ba] = \frac{0.015}{3} = \frac{3x}{3}$

$0.005 = x$

$[PO_4^{-3}] = 2x = 0.010$

$K_{sp} = [Ba^{2+}]^3 [PO_4^{-3}]^2$

$= (3x)^3 (2x)^2$

$= (0.015)^3 (0.010)^2$

$= 3.375 \times 10^{-10}$

$K_{sp} = 3.4 \times 10^{-10}$

11. What is the concentration of a HCl solution if it takes 180 mL of a 1.40 M solution of $Al(OH)_3$ to titrate 235 mL of HCl.

$3HCl + Al(OH)_3 \rightarrow AlCl_3 + 3H_2O$

$\frac{M_A V_A}{n_A} = \frac{M_B V_B}{n_B}$

$\frac{M_A (235)}{3} = \frac{(1.40)(180)}{1}$

$\frac{235 M_A}{235} = \frac{756}{235}$

$M_A = 3.22$ M

12. 400 mL of 1.50 M HCL was combined with 800 ml OF 0.625 M NaOH. What is the pH of the resulting solution?

$1.50 \text{ mol/L} \times 0.400 \text{ L} = 0.600 \text{ mol } H^+$

$0.625 \text{ mol/L} \times 0.800 \text{ L} = 0.500 \text{ mol } OH^-$

$0.600 \text{ mol } H^+ - 0.500 \text{ mol } OH^- = 0.100 \text{ mol } H^+ \text{ left}$

$[H^+] = \frac{0.100 \text{ mol } H^+}{1.200 \text{ L}} = 0.083 \text{ M}$

$pH = -\log [H^+]$

$= -\log 0.083$

$pH = 1.08$

/12

$$pH + pOH = 14$$

$$[H^+] = 10^{-pH} \qquad pH = -\log [H^+]$$

$$[OH^-] = 10^{-pOH} \qquad pOH = -\log [OH^-]$$

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

$$K_w = 1 \times 10^{-14}$$

$$K_w = K_a \cdot K_b$$

$$\frac{M_A V_A}{n_A} = \frac{M_B V_B}{n_B}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$