

Name (Please Print) _____

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

$$K_a K_b = K_w$$

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

$$pH = pK_a + \log [base]/[acid]$$

$$p\text{Anything} = -\log(\text{Anything})$$

$$pH + pOH = 14$$

Multiple Choice – 4 pts. each

- In the reaction $HF(aq) + OH^-(aq) \rightleftharpoons F^-(aq) + H_2O(l)$, the conjugate acid-base pairs are

<i>pair 1</i>	<i>pair 2</i>
A. HF and OH ⁻ ;	F ⁻ and H ₂ O.
☒ B. HF and F ⁻ ;	OH ⁻ and H ₂ O.
C. HF and H ₂ O ;	OH ⁻ and F ⁻ .
D. HF and H ₃ O ⁺ ;	OH ⁻ and F ⁻ .
E. H ₃ O ⁺ and OH ⁻ ;	HF and H ₂ O.
- For HNO₂, $K_a = 4.5 \times 10^{-4}$. An aqueous solution of NaNO₂ therefore would be

A. neutral ☒ B. basic C. acidic
- A titration of an acid and base to the equivalence point results in a noticeably basic solution. It is likely this titration involves

A. a strong acid and a weak base.
☒ B. a weak acid and a strong base.
 C. a weak acid and a weak base (where K_a equals K_b).
 D. a strong acid and a strong base.
- What is the pH at the equivalence point in the titration of 100 mL of 0.10 M HCl with 0.10 M NaOH?

A. 1.0 B. 6.0 ☒ C. 7.0 D. 8.0 E. 13.0
- Which of the following would decrease the molar solubility of BaSO₄?

A. Lowering the pH of the solution
 B. Adding a solution of PbI₂
☒ C. Adding a solution of Ba(NO₃)₂
 D. None of the above—the K_{sp} of a compound is constant at constant temperature.

6. Which of the following statement is true for a 0.10 M solution of a weak acid HA?

- A. The pH is 1.00
- B. The $[H^+] = 0.10 \text{ M}$
- C. The $[HA] = 0.10 \text{ M}$
- ☒ D. The pH is > 1.00
- E. None of the above

7. Which of the following accurately reflects the K_{sp} expression for a saturated CaF_2 solution ($\text{CaF}_2(s) \rightleftharpoons \text{Ca}^{2+}(aq) + 2\text{F}^-(aq)$)

- A. $K_{sp} = [\text{Ca}^{2+}][\text{F}^-]$
- B. $K_{sp} = [\text{Ca}^{2+}][\text{F}^-]/[\text{CaF}_2]$
- C. $K_{sp} = [\text{CaF}_2]/[\text{Ca}^{2+}][\text{F}^-]^2$
- ☒ D. $K_{sp} = [\text{Ca}^{2+}][\text{F}^-]^2$
- E. $K_{sp} = 1/[\text{Ca}^{2+}][\text{F}^-]^2$

Use this information to answer the following two questions.

Given the following K_a values: $\text{HF} = 7.1 \times 10^{-4}$, $\text{HNO}_2 = 4.5 \times 10^{-4}$, $\text{CH}_3\text{COOH} = 1.8 \times 10^{-5}$, $\text{HCN} = 4.9 \times 10^{-10}$

8. Which is the correct order of acid strength from *least* acidic to *most* acidic.

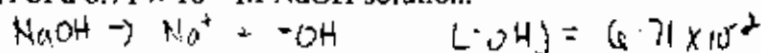
- ☒ A. $\text{HCN} < \text{CH}_3\text{COOH} < \text{HNO}_2 < \text{HF}$
- B. $\text{HF} < \text{HNO}_2 < \text{CH}_3\text{COOH} < \text{HCN}$
- C. $\text{HNO}_2 < \text{CH}_3\text{COOH} < \text{HCN} < \text{HF}$
- D. $\text{CH}_3\text{COOH} < \text{HCN} < \text{HF} < \text{HNO}_2$
- E. $\text{HCN} < \text{HF} < \text{HNO}_2 < \text{CH}_3\text{COOH}$

9. Which is the correct order of base strength from *least* basic to *most* basic.

- A. $\text{CN}^- < \text{CH}_3\text{COO}^- < \text{NO}_2^- < \text{F}^-$
- ☒ B. $\text{F}^- < \text{NO}_2^- < \text{CH}_3\text{COO}^- < \text{CN}^-$
- C. $\text{NO}_2^- < \text{CH}_3\text{COO}^- < \text{CN}^- < \text{F}^-$
- D. $\text{CH}_3\text{COO}^- < \text{CN}^- < \text{F}^- < \text{NO}_2^-$
- E. $\text{CN}^- < \text{F}^- < \text{NO}_2^- < \text{CH}_3\text{COO}^-$

Problems

1.(10) Calculate the pH of a 6.71×10^{-2} M NaOH solution.



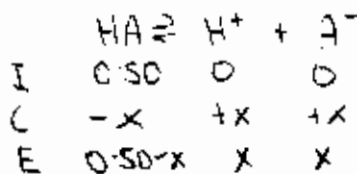
$$\text{pOH} = -\log(6.71 \times 10^{-2}) = 1.17$$

$$\text{pH} + \text{pOH} = 14$$

$$\text{pH} = 14 - \text{pOH} = 14 - 1.17$$

$$\text{pH} = 12.83$$

2.(10) Calculate the pH of a 0.50 M solution of ascorbic acid (Vitamin C, $K_a = 8.0 \times 10^{-5}$)



$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]} = 8.0 \times 10^{-5}$$

$$8.0 \times 10^{-5} = \frac{(x)(x)}{0.50-x} \quad \text{if } x \ll 0.50 \text{ then}$$

$$8.0 \times 10^{-5} = \frac{x^2}{0.50}$$

$$(8.0 \times 10^{-5})(0.50) = x^2$$

$$6.32 \times 10^{-3} = x = [\text{H}^+]$$

$$\frac{6.32 \times 10^{-3}}{0.50} \times 100 = 1.3\% \checkmark$$

$$\text{pH} = -\log(6.32 \times 10^{-3}) = 2.20$$

3.(10) Calculate the pH of a 0.25 M solution of caffeine ($K_b = 4.1 \times 10^{-4}$)

If B = caffeine: $B + H_2O \rightleftharpoons BH^+ + ^-OH$

	I	0.25	-	0	0
K_b	C	-x	-	+x	+x
	E	0.25-x		x	x

$$K_b = 4.1 \times 10^{-4} = \frac{(x)(x)}{0.25-x} \quad \text{if } x \ll 0.25 \text{ then}$$

$$\frac{1.01 \times 10^{-2}}{0.25} \times 100 = 4\% \checkmark$$

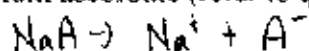
$$4.1 \times 10^{-4} = \frac{x^2}{0.25}; \quad (4.1 \times 10^{-4})(0.25) = x^2$$

$$1.01 \times 10^{-2} = x = (^-OH)$$

$$pOH = -\log(1.01 \times 10^{-2}) = 2.0$$

$$pH = 14 - 2.0 = 12.0$$

4.(10) In pills, Vitamin C is often administered as sodium ascorbate. Calculate the pH of a 0.25 M solution of sodium ascorbate (refer to question 2 for important information).



$$K_a = 8.0 \times 10^{-5} \quad (\text{ascorbic acid})$$

$$K_b = \frac{1 \times 10^{-14}}{8.0 \times 10^{-5}} = 1.25 \times 10^{-10}$$

	I	0.25	-	0	0
	C	-x		+x	+x
	E	0.25-x		x	x

$$K_b = 1.25 \times 10^{-10} = \frac{(HA)(^-OH)}{(A^-)} = \frac{(x)(x)}{0.25-x}$$

$$\text{if } x \ll 0.25 \text{ then}$$

$$1.25 \times 10^{-10} = \frac{x^2}{0.25}$$

$$(1.25 \times 10^{-10})(0.25) = x^2; \quad 5.59 \times 10^{-6} = x = (^-OH)$$

$$pOH = -\log(^-OH) = -\log(5.59 \times 10^{-6}) = 5.25$$

$$pH = 14 - pOH$$

$$pH = 14 - 5.25 = 8.75$$

- 5.(14) Calculate the pH of a 1 liter solution which contains 0.50 M ascorbic acid and 0.25 M sodium ascorbate. A Buffer

$$pH = pK_a + \log \frac{[ascorbate]}{[ascorbic\ acid]}$$

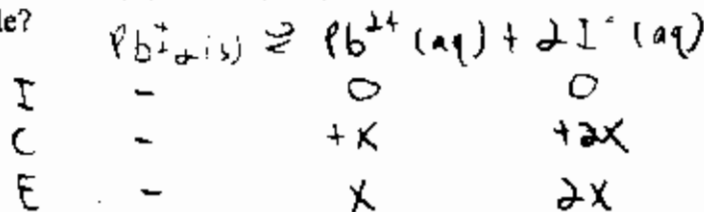
$$pK_a = -\log K_a = -\log 8.0 \times 10^{-5} = 4.10$$

$$pH = 4.10 + \log \left(\frac{0.25}{0.50} \right)$$

$$pH = 4.10 + \log 0.5$$

$$pH = 3.80$$

- 6.(10) The K_{sp} value for lead(II) iodide (PbI_2) is 1.4×10^{-8} . What is the molar solubility of lead(II) iodide?



$$K_{sp} = 1.4 \times 10^{-8} = (Pb^{2+})(I^{-})^2$$

$$1.4 \times 10^{-8} = (X)(2X)^2$$

$$1.4 \times 10^{-8} = 4X^3$$

$$\left(\frac{1.4 \times 10^{-8}}{4} \right)^{\frac{1}{3}} = X$$

$$1.5 \times 10^{-3} = X \quad \text{which is the molar solubility of } PbI_2$$