

Name (Please Print) _____

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

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

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

$$pH + pOH = 14$$

$$K_a K_b = K_w$$

$$pH - pK_a = \log [\text{base}]/[\text{acid}]$$

Multiple Choice – 4 pts. each

- In the reaction $\text{HSO}_4^-(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons \text{SO}_4^{2-}(\text{aq}) + \text{H}_2\text{O}(\text{l})$, the conjugate acid-base pairs are

<i>pair 1</i>	<i>pair 2</i>
☒ A. HSO_4^- and SO_4^{2-} ;	H_2O and OH^- .
B. HSO_4^- and H_3O^+ ;	SO_4^{2-} and OH^- .
C. HSO_4^- and OH^- ;	SO_4^{2-} and H_2O .
D. HSO_4^- and H_2O ;	OH^- and SO_4^{2-} .
E. HSO_4^- and OH^- ;	SO_4^{2-} and H_3O^+ .
- For HNO_2 , $K_a = 4.5 \times 10^{-4}$. An aqueous solution of NaNO_2 therefore would be

A. neutral	☒ B. basic	C. acidic
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- A titration of an acid and base to the equivalence point results in a noticeably acidic 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
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- Which of the following would decrease the molar solubility of PbI_2 ?

A. Lowering the pH of the solution
B. Adding a solution of $\text{Ba}(\text{NO}_3)_2$
☒ C. Adding a solution of KI
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 $[H^+] = 0.10$ M
- C. The $[HA] = 0.10$ 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 ($CaF_2(s) \rightleftharpoons Ca^{2+}(aq) + 2F^-(aq)$)

- A. $K_{sp} = [Ca^{2+}][F^-]$
- B. $K_{sp} = [Ca^{2+}][F^-]/[CaF_2]$
- C. $K_{sp} = [CaF_2]/[Ca^{2+}][F^-]^2$
- ☒ D. $K_{sp} = [Ca^{2+}][F^-]^2$
- E. $K_{sp} = 1/[Ca^{2+}][F^-]^2$

Use this information to answer the following two questions.

Given the following K_a values: $HF = 7.1 \times 10^{-4}$, $HNO_2 = 4.5 \times 10^{-4}$, $CH_3COOH = 1.8 \times 10^{-5}$, $HCN = 4.9 \times 10^{-10}$

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

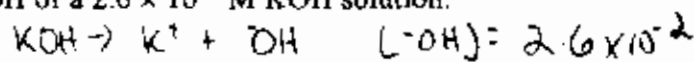
- A. $HCN > CH_3COOH > HNO_2 > HF$
- ☒ B. $HF > HNO_2 > CH_3COOH > HCN$
- C. $HNO_2 > CH_3COOH > HCN > HF$
- D. $CH_3COOH > HCN > HF > HNO_2$
- E. $HCN > HF > HNO_2 > CH_3COOH$

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

- ☒ A. $CN^- > CH_3COO^- > NO_2^- > F^-$
- B. $F^- > NO_2^- > CH_3COO^- > CN^-$
- C. $NO_2^- > CH_3COO^- > CN^- > F^-$
- D. $CH_3COO^- > CN^- > F^- > NO_2^-$
- E. $CN^- > F^- > NO_2^- > CH_3COO^-$

Problems

1.(10) Calculate the pH of a 2.6×10^{-2} M KOH solution.



$$\text{pOH} = -\log (2.6 \times 10^{-2}) = 1.6$$

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

$$\text{pH} + 1.6 = 14$$

$$\text{pH} = 14 - 1.6 = 12.4$$

2.(10) Calculate the pH of a 0.25 M solution of ascorbic acid (Vitamin C, $K_a = 8.0 \times 10^{-5}$)

	$\text{HA} \rightleftharpoons \text{H}^+ + \text{A}^-$		
I	0.25	0	0
C	-x	+x	+x
E	0.25-x	x	x

$$K_a = 8.0 \times 10^{-5} = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]} = \frac{(x)(x)}{0.25-x}$$

$$\text{if } x \ll 0.25 \text{ then } 8.0 \times 10^{-5} = \frac{x^2}{0.25}$$

$$(8.0 \times 10^{-5})(0.25) = x^2$$

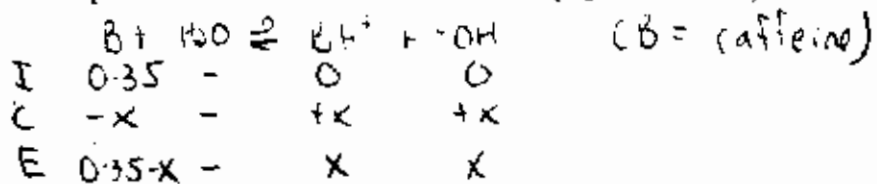
$$4.47 \times 10^{-3} = x = [\text{H}^+]$$

$$\text{pH} = -\log [\text{H}^+] = -\log (4.47 \times 10^{-3})$$

$$\text{pH} = 2.35$$

$$\frac{4.47 \times 10^{-3}}{0.25} \times 100 = 1.8\% \checkmark$$

3.(10) Calculate the pH of a 0.35 M solution of caffeine ($K_b = 4.1 \times 10^{-4}$)



$$K_b = 4.1 \times 10^{-4} = \frac{(BH^+)(OH^-)}{[B]} = \frac{(x)(x)}{0.35-x}$$

if $x \ll 0.35$ then $4.1 \times 10^{-4} = \frac{x^2}{0.35}$

$$(4.1 \times 10^{-4})(0.35) = x^2$$

$$1.20 \times 10^{-4} = x = [OH^-] \quad \frac{1.20 \times 10^{-2}}{0.35} \times 100 \approx 3\% \checkmark$$

$$pOH = -\log(1.20 \times 10^{-2}) = 1.9$$

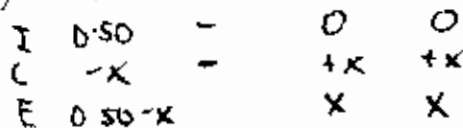
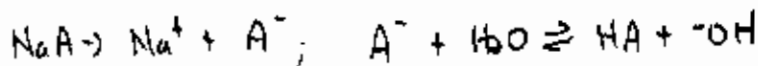
$$pH = 14 - pOH$$

$$pH = 14 - 1.9 = 12.1$$

4.(10) In pills, Vitamin C is often administered as sodium ascorbate. Calculate the pH of a 0.50 M solution of sodium ascorbate (refer to question 2 for important information).

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

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



$$K_b = 1.25 \times 10^{-10} = \frac{(x)(x)}{0.50-x} \quad \text{if } x \ll 0.50 \text{ then}$$

$$1.25 \times 10^{-10} = \frac{x^2}{0.50}$$

$$(1.25 \times 10^{-10})(0.50) = x^2$$

$$7.9 \times 10^{-6} = x = [OH^-] \checkmark$$

$$pOH = -\log(7.9 \times 10^{-6}) = 5.1$$

$$pH = 14 - 5.1 = 8.9$$

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

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

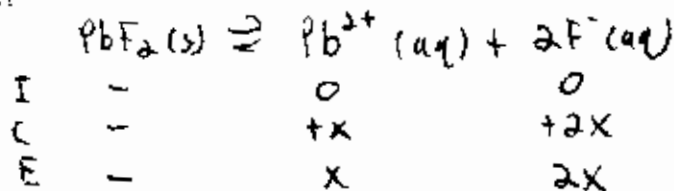
$$pH = pK_a + \log \frac{[\text{ascorbate}]}{[\text{ascorbic acid}]}$$

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

$$pH = 4.10 + \log 2$$

$$pH = 4.40$$

- 6.(10) The K_{sp} value for lead(II) iodide (PbI_2) is 4.1×10^{-8} . What is the molar solubility of lead(II) fluoride?



$$K_{sp} = (Pb^{2+})(F^{-})^2 = 4.1 \times 10^{-8}$$

$$(x)(2x)^2 = 4.1 \times 10^{-8}$$

$$4x^3 = 4.1 \times 10^{-8}$$

$$x = \left(\frac{4.1 \times 10^{-8}}{4} \right)^{1/3}$$

$$x = 2.2 \times 10^{-3} \text{ which is the molar solubility of } PbF_2$$