

Acids & Bases

Name ANSWER KEY

Slyter Box 007

Hour Examination 4

March 20, 2003

General Chemistry (CHEM 122-01)

Acids & Bases

Dr. Bennett

Please do not open until instructed

*Acids & Bases*Notes:

* This exam consists of **5 questions on 5 pages** (including this cover page). Please check to make sure that you have a complete copy of the exam.

* *Please do not simply give me answers. Give me well-supported answers. Numerical answers that are not backed by supporting calculations will receive minimal credit.*

* Please write clearly; if I can't read your answer, I can't give you credit for your answer.

* Please note that different questions are worth different numbers of points. Plan your time accordingly.

* Remember to include units and significant figures where appropriate.

* No books or notes are to be used on this exam.

* Please do NOT share calculators; if you need a calculator but do not have one, please let me know!

* *If you feel that you would be better able to answer **any** question if you had additional information, please do not hesitate to ask for it.* I will happily provide any information that I feel will help you answer the question without compromising the efficacy and fairness of the test.

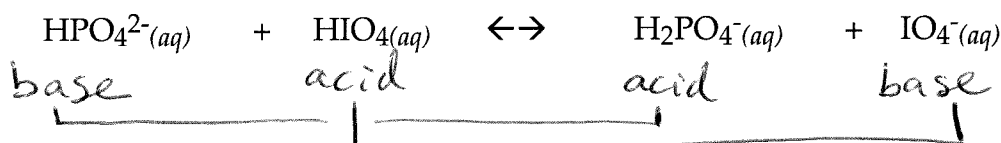
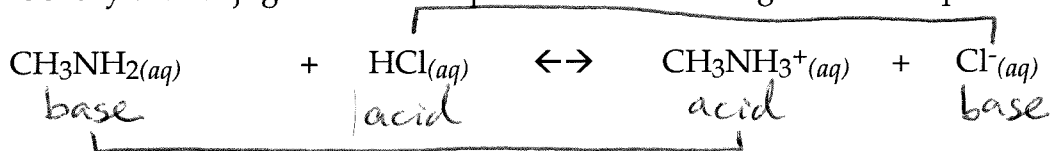
Question	Possible	Score
1	18	
2	14	
3	18	
4	10	
5	10	
TOTAL	70	
percent:		

The Quadratic Equation

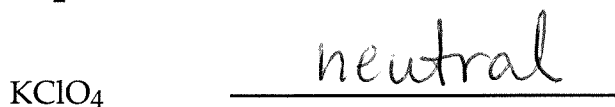
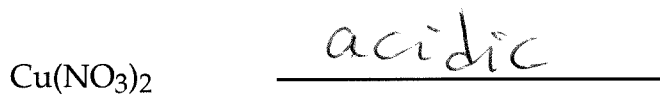
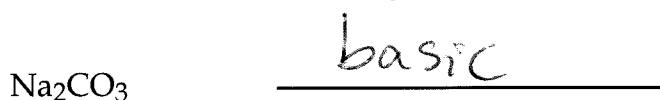
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

1. SHORT ANSWER

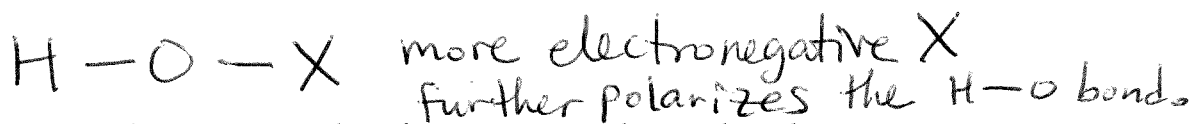
- 4 (a). Identify the conjugate acid-base pairs in the following chemical equations.



- 8 (b). Classify the solutions of the following salts as acidic, basic or neutral.



- 3 (c). Rank the following substances in order of increasing acidity and explain your reasoning:

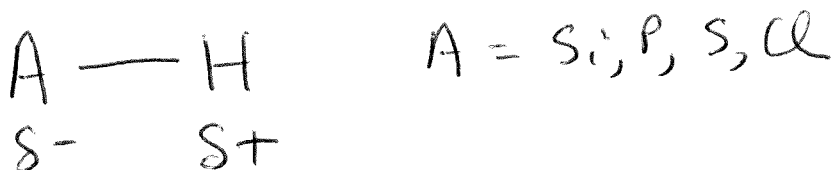


- 3 (d). Rank the following substances in order of increasing acidity and explain your reasoning:



—————→

the bonds in this direction
are more polarized:



2. (Potassium fluoride dissolves in water to give a solution that is basic.

(a) Write the chemical equation that illustrates why the solution is basic.



(b) For an 0.25 M solution of potassium fluoride, calculate the pH at equilibrium. Note $K_a(\text{HF}) = 6.8 \times 10^{-4}$.

Weak base
ionization

	F^-	$+ \text{H}_2\text{O}$	$\xrightleftharpoons{K_b}$	HF	$+ \text{OH}^-$	
I	0.25			0	0	
C	-x			+x	+x	
E	(0.25-x)			x	x	

$K_b = \left(\frac{K_w}{K_a} \right)$

$$K_b = \frac{[\text{HF}][\text{OH}^-]}{[\text{F}^-]} = \frac{x^2}{(0.25-x)} = \frac{10^{-14}}{6.8 \times 10^{-4}}$$

} this is K_b ;
 $K_b = 1.47 \times 10^{-11}$

$$x^2 = 3.68 \times 10^{-12}$$

$$x = [\text{OH}^-] = 1.92 \times 10^{-6} \text{ M}$$

pOH = 5.71

pH = 8.29

(c) Calculate the pOH at equilibrium.

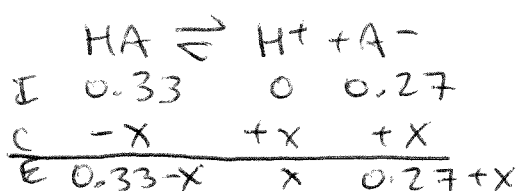
3. Ascorbic acid, $C_5H_7O_4COOH$, also known as Vitamin C, is an essential nutrient for all mammals. In lab it can also be used to make buffers. The K_a of ascorbic acid is 7.9×10^{-5} .

- (a) Calculate the pH of a buffer solution which is made by mixing 0.250 moles of ascorbic acid and 0.200 moles of the conjugate base sodium ascorbate in a total volume of 0.750 liters.

$$[HA] = \frac{0.250 \text{ mol HA}}{0.750 \text{ L sol'n}} = 0.33 \text{ M}$$

$$[A^-] = \frac{0.200 \text{ mol } A^-}{0.750 \text{ L sol'n}} = 0.27 \text{ M}$$

$$\boxed{\text{pH} = 4.0}$$



$$K_a = 7.9 \times 10^{-5} = \frac{(x)(0.27+x)}{(0.33-x)}$$

$$x = [H^+] = 9.88 \times 10^{-5}$$

- (b) Calculate the hydroxide ion concentration ($[OH^-]$) of this solution.

$$\text{pOH} = 10.0$$

$$[OH^-] = 1 \times 10^{-10} \text{ M}$$

- (c) Calculate the pH of the ascorbic acid/ascorbate buffer solution after 0.100 moles of nitric acid (HNO_3) is added (assume no volume change).

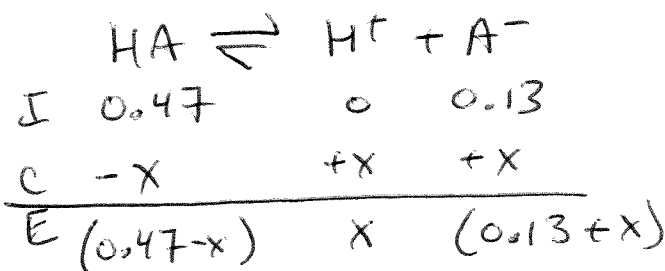
moles of HA becomes 0.350 moles HA } because
 moles of A^- becomes 0.100 moles A^- } $A^- + H^+ \xrightarrow{100\%} HA$

molarities: $[HA] = 0.47 \text{ M}$

$$[A^-] = 0.13 \text{ M}$$

$$K_a = \frac{(x)(0.13+x)}{(0.47-x)} = 7.9 \times 10^{-5}$$

$$x = [H^+] = 2.86 \times 10^{-4} \text{ M}$$



$$\boxed{\text{pH} = 3.5}$$

4. What is the pH of the solution that results from mixing 350.0 mL of 0.600 M HBr with 225.0 mL of 0.500 M KOH? (The volume of the new solution is 575.0 mL.)

strong acid and base: how many moles of each are present?

$$\text{moles } \text{H}^+ = 0.350 \text{ L} \times 0.600 \text{ M} = 0.21 \text{ moles}$$

$$\text{moles } \text{OH}^- = 0.225 \text{ L} \times 0.500 \text{ M} = 0.11 \text{ moles}$$

An excess of H^+ means OH^- will be totally consumed, leaving 0.10 mol of H^+ in a volume of 0.575 L. $[\text{H}^+] = \frac{0.10 \text{ mol } \text{H}^+}{0.575 \text{ L}} = 0.174 \text{ M}$

$$\boxed{\text{pH} = 0.76}$$

5. In many medical applications, the value of K_w at 37 °C (body temperature) may be more appropriate than the 25 °C value of 1.0×10^{-14} . At 37 °C, the pH of pure water is 6.80. Calculate K_w , pOH and $[\text{OH}^-]$ at 37 °C.

pure H_2O : $[\text{H}^+] = [\text{OH}^-]$ b/c they both only come from $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$

$$\text{so, } [\text{OH}^-] = [\text{H}^+] = 10^{-6.80}$$

$$\boxed{[\text{OH}^-] = 1.58 \times 10^{-7} \text{ M}}$$

$$\boxed{\text{pOH} = 6.8}$$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$= (1.58 \times 10^{-7})(1.58 \times 10^{-7})$$

$$\boxed{K_w = 2.5 \times 10^{-14}}$$