

Name: _____

Student #: _____

Section or TA's name: _____

Chem 162

Midterm 2

Do not start the exam until you are instructed to begin!

1. Please clear the memory of your calculator.
2. You may only use the notes on the 3" x 5" card you have brought as discussed in the syllabus.
3. This is a 50 minute exam, and is worth a total of 100 pts.
4. Please show all work.
5. A subset of the examinations will be xeroxed to guard against academic fraud. By taking this examination, you acknowledge that your exam may be xeroxed and used as evidence of fraud should this become an issue.

Potentially Useful Information:

$$R = 8.314 \text{ J/mol.K or } 0.0821 \text{ l.atm/mol.K}$$

$$N_a = 6.022 \times 10^{23} \text{ molec./mol}$$

$$1 \text{ liter} = 10^3 \text{ ml}$$

1. (3 pts. each) Multiple guess and/or short answer. Circle the answer you believe is correct.

a) The autoionization constant for water is:

A: 10^{-7} B: 10^7 C: 1 D: 10^{-14}

b) If the K_a for CH_3COOH is 1.8×10^{-5} , the K_b for CH_3COO^- is

A: 5.55×10^{-6} B: 5.55×10^{-10} C: 1.8×10^{-5} D: 10^{-14}

c) The pH of an aqueous solution of 0.01 M NaOH is:

A: 2 B: 7 C: 12 D: 11

d) When OH^- is the conjugate base in an acid/base pair, the acid is:

A: H_2O B: H_3O^+ C: O_2^- D: OH^-

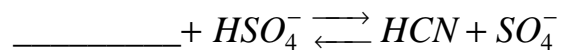
e) Given the K_a table attached to this exam, which of the following weak acids has the strongest conjugate base:

A: HNO_2 B: H_2CO_3 C: HF D: HClO

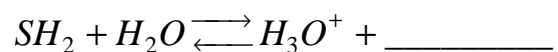
_____ (15 pts)

2. (5 pts. each) Complete each of the following reactions and indicate whether reactants or products are favored at equilibrium:

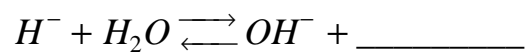
a)



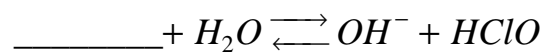
b)



c)



d)



_____ (20 pts)

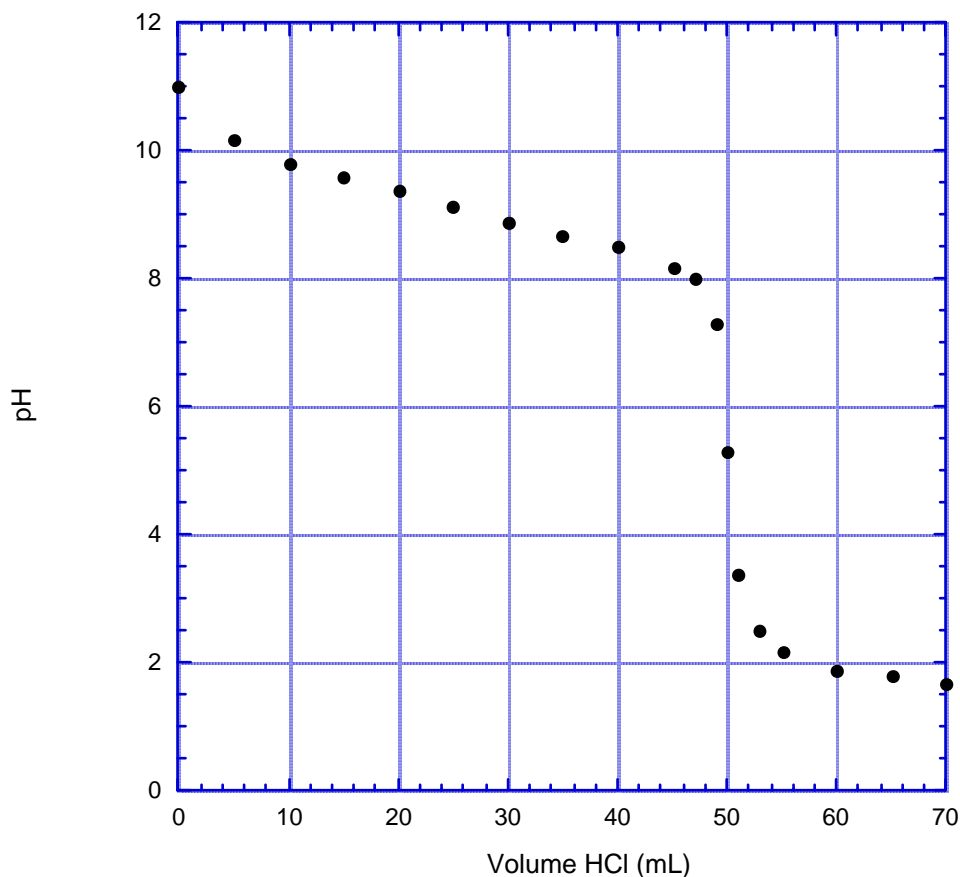
3. (25 pts.) Ascorbic acid, H_2A is a weak diprotic acid ($K_{a1} = 1 \times 10^{-5}$, $K_{a2} = 5 \times 10^{-12}$). What are the concentrations of all species in a solution that is initially 0.05 M in H_2A ? (Note: If you're stuck, treat the acid as monoprotic and work through the first deprotonation step only....you'll receive partial credit).

_____ (25 pts)

4. (20 pts.) A buffer solution is prepared by adding 5.15 g of NH_4NO_3 (MW = 80 g/mol) and 0.1 L of 0.15 M NH_3 (MW = 17 g/mol) What is the pH of this buffer?

_____ (20 pts)

5. (20 pts.) You are presented with the following titration curve of 50 mL of a 0.1-M weak base solution using 0.1 M HCl:



Unfortunately, the person who did the titration doesn't remember which weak base was used, but presents you with a choice between:

- ClO^- ($K_b = 2.9 \times 10^{-7}$)
- NH_3 ($K_b = 1.8 \times 10^{-5}$)
- HS^- ($K_b = 1 \times 10^{-7}$)
- NaOH ($K_b = 1$)

Knowing what you know about titrations, you're able to determine the identity of the weak base using two "methods" involving separate features of the above graph. On the following page, provide a numerical description of these methods.

a) (9 pts.) Method 1:

b) (9 pts.) Method 2:

c) (2 pts.) The weak base is: _____

_____ (20 pts)

Acid Name	Formula	K_a
Perchloric Acid	HClO_4	Large
Sulfuric Acid	H_2SO_4	Large
Hydrochloric Acid	HCl	Large
Nitric Acid	HNO_3	~20
Hydronium Ion	H_3O^+	1
Sulfurous Acid	H_2SO_3	1.2×10^{-2}
Hydrogen Sulfate	HSO_4^-	1.2×10^{-2}
Phosphoric Acid	H_3PO_4	7.5×10^{-3}
Hydrofluoric Acid	HF	7.2×10^{-4}
Nitrous Acid	HNO_2	4.5×10^{-4}
Formic Acid	HCOOH	1.8×10^{-4}
Benzoic Acid	$\text{C}_6\text{H}_5\text{COOH}$	6.3×10^{-5}
Acetic Acid	CH_3COOH	1.8×10^{-5}
Propanoic Acid	$\text{C}_2\text{H}_5\text{COOH}$	1.4×10^{-5}
Carbonic Acid	H_2CO_3	4.2×10^{-7}
Hydrogen Sulfide	H_2S	1×10^{-7}
Dihydrogen Phosphate	H_2PO_4^-	6.2×10^{-8}
Hydrogen Sulfate	HSO_3^-	6.2×10^{-8}
Hypochlorous Acid	HClO	3.5×10^{-8}
Ammonium	NH_4^+	5.6×10^{-10}
Hydrocyanic Acid	HCN	4.0×10^{-10}
Hydrogen Carbonate	HCO_3^-	4.8×10^{-11}
Hydrogen Phosphate	HPO_4^{2-}	3.6×10^{-13}
Water	H_2O	1×10^{-14}
Hydrogen Sulfide	HS^-	1×10^{-19}
Hydrogen	H_2	Very Small
Methane	CH_4	Very Small