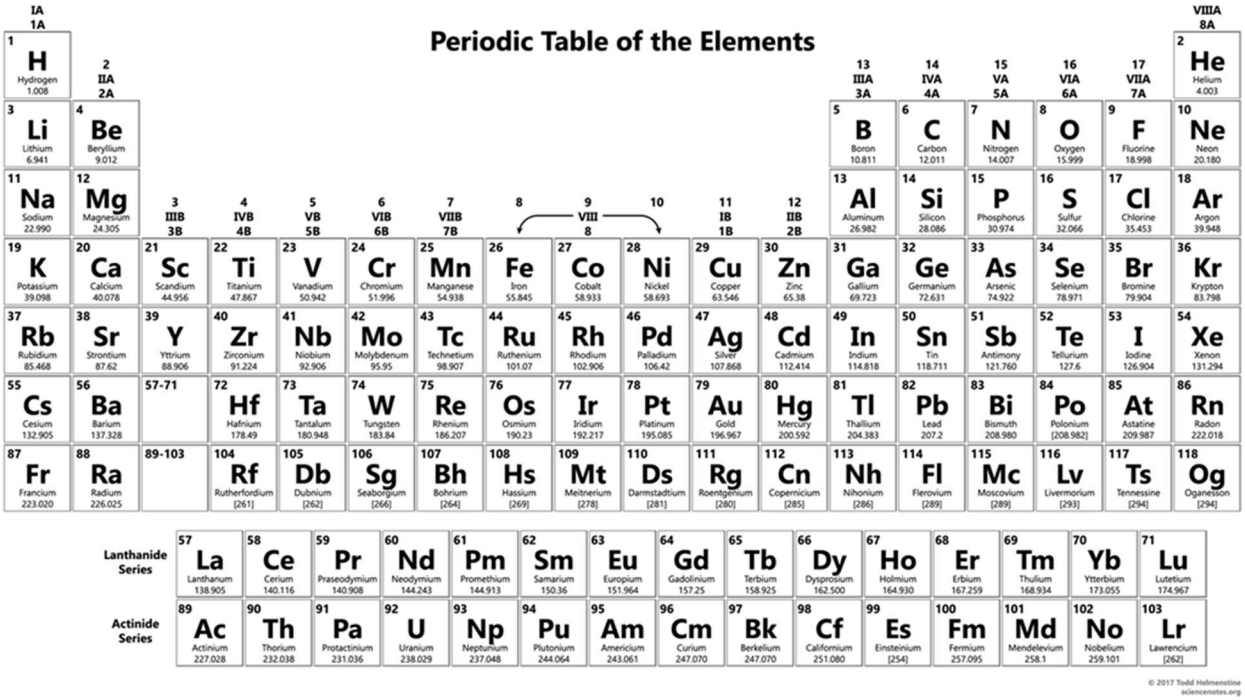
CHEM 222 Exam 3

- You may access the exam between 8:00 and 9:30 AM Friday, April 3.
- You may use your book, notes, or online resources**, but you MAY NOT receive assistance from anyone other than Dr. Lamp.**
- Complete five (5) of the six problems on separate paper. There is no need to print out the exam. You must show your work to receive credit for problems requiring math. Report your answers with the appropriate number of significant figures. For discussion problems, be concise in your answers.
- Once you have completed the exam, scan your work as pdf and upload it to Blackboard.
- Submission of your work is your pledge that the exam was completed in an ethical manner! Any unethical work will result in a grade of zero on the exam and the Student Affairs office will be notified.
- **Your exam materials must be uploaded by 9:30 AM**. You may turn the exam in earlier if you wish.

Possibly Useful Information

$K_w = 1.0 \times 10^{-14} = [H^+][OH^-]$	$K_aK_b = K_w$
$\alpha_{A^{2-}} = \frac{K_{a1}K_{a2}}{[H^+]^2 + [H^+]K_{a1} + K_{a1}K_{a2}}$	$\alpha_{H_2A} = \frac{[H^+]^2}{[H^+]^2 + [H^+]K_{a1} + K_{a1}K_{a2}}$
$pH = pK_a + \log\frac{[\text{conjugate base}]}{[\text{weak acid}]}$	$pH = \frac{1}{2}(pK_{a1} + pK_{a2})$
$[H^+] = \sqrt{\frac{K_{a1}K_{a2}F + K_{a1}K_w}{K_{a1} + F}} \approx \sqrt{K_{a1}K_{a2}}$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$



Complete five (5) of the following problems. 16 points each

1. Solution A was prepared by dissolving 0.0134 grams potassium hydroxide (molar mass 56.10 g/mol) in water and diluting to a total volume of 1000.0 mL. Next, 1.00 mL of solution A was transferred into a 3.000 L volumetric flask and diluted to the mark to prepare solution B. Calculate the pH of solution A and calculate the pH of solution B.

2. You need to prepare a pH 3.50 buffer with a total concentration of 100.0 mM. Any of the following monoprotic acid/conjugate base combinations could be used to prepare the buffer.
    a. Choose which of the three combinations you feel is the best option,
    b. justify your choice in a sentence or two, and,
    c. calculate the masses of acid and conjugate base needed to prepare the buffer.

Acid, HA (molar mass)	Conjugate Base, NaA (molar mass)	K_a
Butanoic acid (88.106 g/mol)	Sodium butanoate (110.088 g/mol)	1.52×10^{-5}
Formic acid (46.025 g/mol)	Sodium formate (68.007 g/mol)	1.80×10^{-4}
Pyruvic acid (88.06 g/mol)	Sodium Pyruvate (110.044 g/mol)	3.30×10^{-3}

3. Malonic acid is a weak, diprotic acid of the form H_2A with $K_{a1} = 1.42 \times 10^{-3}$ and $K_{a2} = 2.01 \times 10^{-6}$. What volume, in milliliters, of 0.489 M hydrochloric acid must be added to 250.0 mL of a 0.105 M solution of disodium malonate (Na_2A) to prepare a solution with pH 2.50?

4. Consider arsenic acid (H_3AsO_4, represented as H_3A), a triprotic acid with acid dissociation constants of 5.8×10^{-3}, 1.1×10^{-7}, and 3.2×10^{-12}. Describe the process you would use to determine the pH where the concentration of H_2A^- is at its maximum. You **do not need to calculate the pH**, but explain the relationship(s) that would be useful and how they could be used to find the pH.

5. Consider the titration below. Calculate the pH at any **three** of the following points along the titration, 0.00 mL, 10.00 mL, 20.00 mL, 40.00, 60.00 mL titrant added. Sketch the titration curve you would expect. Clearly label your graph.

Analyte in flask	Titrant in buret
20.0 mL 0.100 M oxalic acid ($pK_{a1} = 1.25$, $pK_{a2} = 4.27$)	0.100 M KOH

6. You are attempting to determine the identity of a **dibasic** weak base by titrating with standardized hydrochloric acid. You believe the base is either hydrazine ($C_2N_2H_4$), ethylendiamine ($C_2N_2H_8$), or piperazine ($C_4N_2H_{10}$). You weigh out 0.145 grams of the weak base, dissolve it in 50.00 mL water and titrate with 0.105 M HCl. If it requires 32.06 mL of titrant to reach the endpoint, what is the identity of the weak base? (*hint: dibasic is analogous to diprotic when describing an acid)*