

CHEM 1032
Spring 2023
UNIT ASSESSMENT 3

SECTION: _____

NAME: Key

TUID:

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Before the Unit Assessment begins, read the rest of this page, and follow the instructions.

!!! Do not turn this page until given the signal to begin !!!

Put away everything besides pencil(s) and a scientific calculator.

- Non-programmable (scientific) calculators are permitted. Graphing calculators **are not permitted** (such as these models: TI-83, TI-84, TI-89, Casio FX-9750).
- Any other electronic devices - including cell phones, smart phones, and smart watches - **are not permitted**. If you are not sure what is permitted, ask *before* the exam begins.

When you are told to begin work, open the booklet and read the directions.

A periodic table and other useful information can be found on the next page.

Grading. Each question is graded by your instructor using the scale below.

1 - Excellent

- The student demonstrates a deep understanding of concepts and problem-solving techniques.
- Calculations are clear and legibly written.
- Any mistakes are minor or careless errors that do not indicate a major conceptual misunderstanding.

0.5 - Fair

- The student demonstrates a partial understanding of concepts and techniques.
- Calculations are clear and legibly written but contain errors.
 - The student may have started out correctly but gone on a tangent or not finished the problem.
 - The student may have used pattern matching to answer a different, more familiar question instead.

0 - Unsatisfactory/Incomplete

- The student did not demonstrate an understanding of the problem or has minimal understanding.
- Calculations are unclear, missing, or incomplete.
 - The student may have written some appropriate formulas or diagrams, but nothing further.
 - The student may have done something entirely wrong.
 - The student may have written almost nothing or nothing at all.

Unit Assessment Time: 50 minutes.

It is to your advantage to answer every question.

!!! Do not turn this page until given the signal to begin !!!

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
H 1.008																He 4.0066		
Li 6.94	Be 9.0122															Ne 20.180		
Na 22.990	Mg 24.315															Ar 39.948		
K 39.098	Ca 40.0784(4)															Kr 83.798(2)		
Rb 85.468	Ti 44.956	V 50.942	Cr 51.998	Mn 54.938	Fe 55.845(2)	Co 56.933	Ni 58.693	Cu 63.546(3)	Zn 65.389(2)	Ga 69.723	Ge 72.630(8)	As 74.922	Se 78.971(8)	Br 79.904		Xe 131.29		
Cs 132.91	Zr 87.62	Y 88.906	Nb 91.224(2)	Mo 92.906(2)	Tc 95.95	Ru 101.07(2)	Rh 102.91	Pd 106.42	Ag 107.87	Cd 112.41	In 114.82	Sn 118.71	Sb 121.76	Te 127.60(3)		At 126.90		
Fr 87	Ra 88	* 137.33	Lu 174.97	Hf 178.49(2)	Ta 180.95	W 183.84	Re 186.21	Os 190.23(2)	Ir 192.22	Pt 195.08	Au 196.97	Hg 200.59	Tl 204.38	Pb 207.2	Bi 208.98	Po 209.59	Rn 208.98	
	Lr 89-102		Rf 103	Db 104	Sg 105	Bh 106	Hs 107	Mt 108	Ds 109	Rg 110	Cn 111	Nh 112	Fl 113	Mc 114	Lv 115	Ts 116	Og 117	
	La 138.91	Ce 140.12	Pr 140.91	Nd 144.24	Pm 144.91	Sm 150.36(2)	Eu 151.96	Gd 157.28(3)	Tb 158.93	Dy 162.50	Ho 164.93	Er 167.26	Tm 168.93	Yb 173.05				
	Ac [227.03]	Th 232.04	Pa 231.04	U 238.03	Np [231.04]	Pu [238.03]	Am [231.04]	Cm [238.03]	Bk [231.04]	Cf [238.03]	Es [231.04]	Fm [238.03]	Md [231.04]	No [238.03]				

!!!! FOR CREDIT, BE CLEAR AND WRITE LEGIBLY !!!!

Acids and bases are found in our day to day lives and in the laboratory. Use the table below to answer all questions.
You may need to look up equilibrium values in the useful information section.

Solution	W	X	Y	Z
Compound	NaOH	KCHOO	CHOOH	HBr
Concentration	0.125 M	0.180 M	0.010 M	0.090 M

Part I – Multiple Choice Questions (1 pt each)

Excellent Answer = 1 pt

Fair Answer = 0.5 pts

Unsatisfactory Answer = 0 pts

B

1. Which compound contains a weak base?

 - A. NaOH - strong base
 - B. KCHOO - weak base
 - C. CHOOH - weak acid
 - D. HBr - strong acid

A

2. What is the pH of **solution Z**?

A. 1.04 HBr - strong
B. 2.31
C. 7.52
D. 12.96

pH = $-\log [H_3O^+]$

4

3. A 50.0 mL sample of **solution Z** is titrated with **solution W**. How much titrant is required to reach the equivalence point?

$$(50.0 \text{ mL})(0.090 \text{ M}) = (x)(0.125 \text{ M})$$

$$x = 37.50 \text{ mL}$$

- A. 36.0 mL
- B. 50.0 mL
- C. 86.0 mL
- D. There is

C

4. Which solutions contain ions that do not affect the pH of the solution?

 - A. Solutions X and Z
 - B. Solutions W and X
 - C. Solutions W, X, and Z
 - D. Solutions W, X, Y, and Z

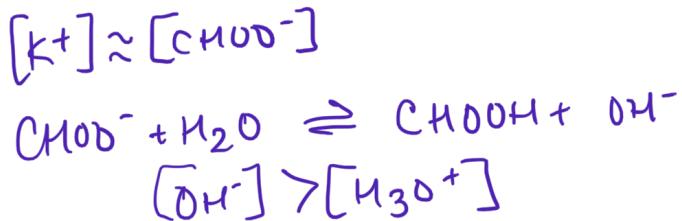
W X Y
↓ ↓ ↓
Na⁺ OH⁻ K⁺ CH₃O⁻ CH₃O⁻ H⁺
↑ ↑ ↑

$$\begin{array}{cccc}
 W & X & Y & Z \\
 \downarrow & \downarrow & \downarrow & \downarrow \\
 \text{Na}^+ & \text{K}^+ & \text{CH}_3\text{O}^- & \text{H}^+ \\
 \uparrow & \uparrow & \uparrow & \uparrow \\
 \text{OH}^- & \text{CH}_3\text{OH} & \text{Br}^- & \text{H}_3\text{O}^+
 \end{array}$$

0

5. Which species has the lowest concentration in **Solution X**?

- A. K^+
- B. CHOO^-
- C. H_3O^+
- D. OH^-



Solution	W	X	Y	Z
Compound	NaOH	KCHOO	CHOOH	HBr
Concentration	0.125 M	0.180 M	0.010 M	0.090 M

Part II – Open Answer Questions – See Page 1 for full grading details

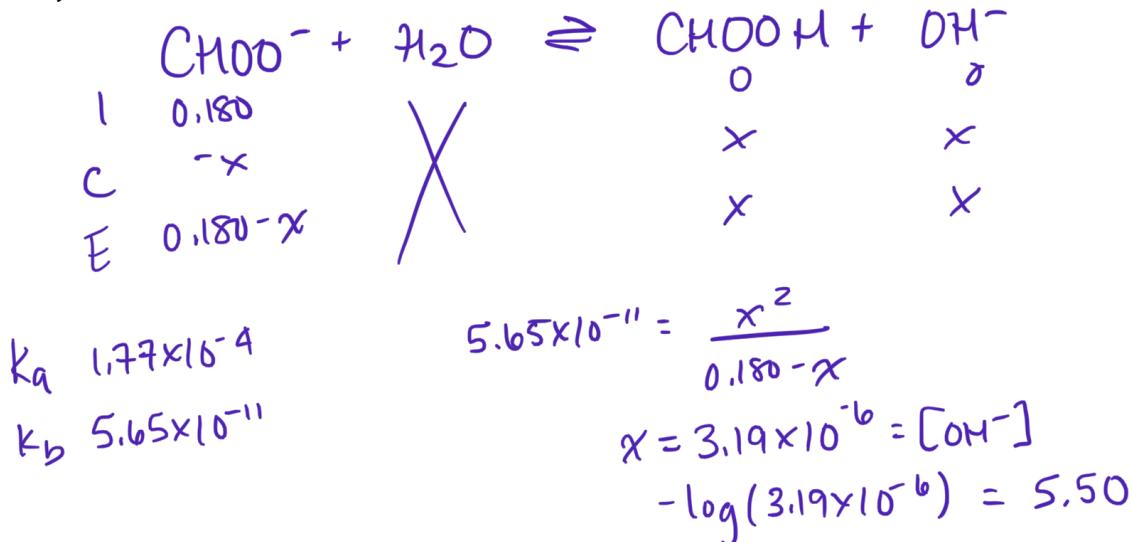
Excellent Answer = 1 pt

Fair Answer = 0.5 pts

Unsatisfactory Answer = 0 pts

6. Calculate the pOH of **solution X**.

Show your work in this box.



WRITE pOH HERE → Write value here... **5.50**

7. You want to make a buffer with the highest capacity possible. You start with 500.0 mL of **Solution X**. To that you add 250.0 mL of one of the other solutions. Write your solution choice below and calculate the pH of the buffer.

Solution Choice:

Solution Z is best choice.

Show your work in this box.

Solution X is a weak base, need conjugate acid either by adding directly or generating by strong acid. $[\text{solution Y}] < [\text{solution Z}]$ so Z is best choice.

$$0.180 \text{ M} = \frac{x}{0.500 \text{ L}} \quad x = 0.09 \text{ moles}$$

$$0.090 \text{ M} = \frac{x}{0.250 \text{ L}} \quad x = 0.0225$$

$$\begin{array}{r} 0.09 \\ - 0.0225 \\ \hline 0.0675 \text{ moles base} \end{array} \quad \begin{array}{r} 0.0225 \text{ moles} \\ + 0 \\ \hline 0.0225 \text{ moles acid} \end{array}$$

$$pK_a = -\log(1.77 \times 10^{-4}) = 3.75$$

$$\text{pH} = 3.75 + \log\left(\frac{0.0675}{0.0225}\right)$$

$$\text{pH} = 4.23$$

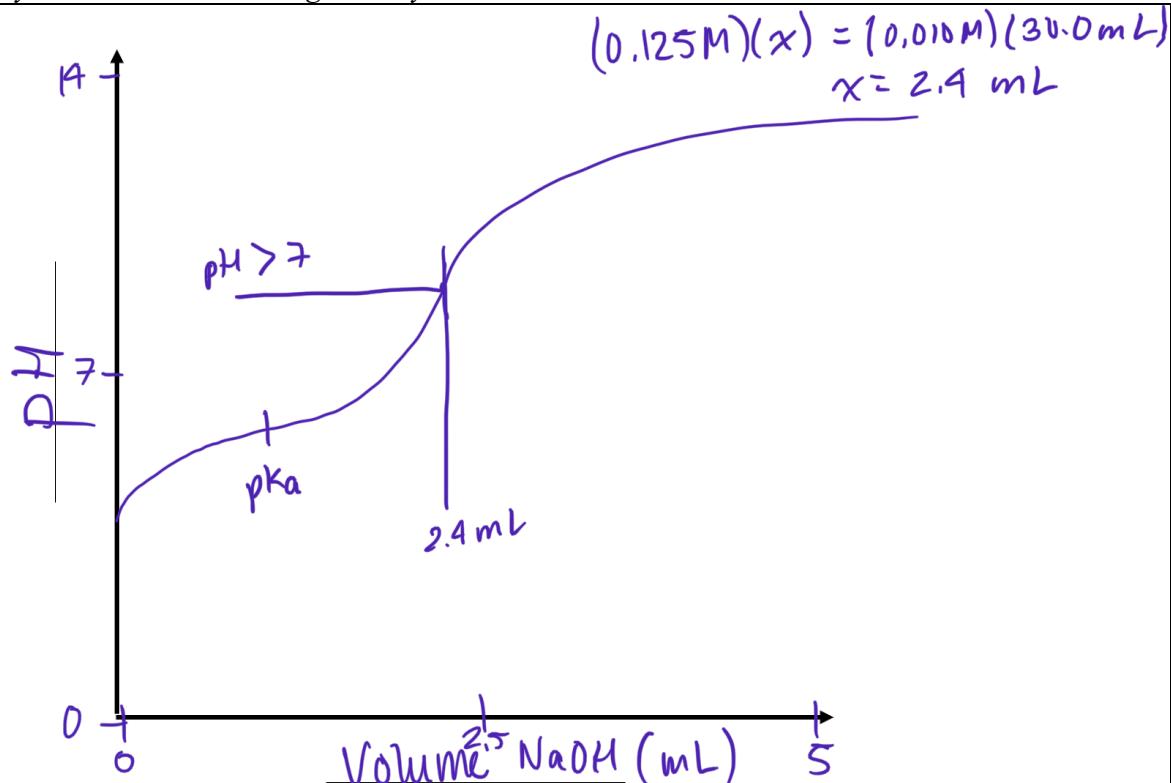
WRITE pH HERE →

4.23

Solution	W	X	Y	Z
Compound	NaOH	KCHOO	CHOOH	HBr
Concentration	0.125 M	0.180 M	0.010 M	0.090 M

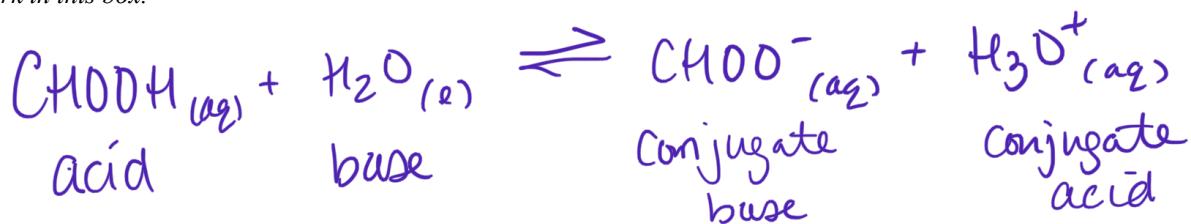
8. A 30.0 mL sample of **Solution Y** is titrated by **Solution W**. Draw an accurate titration curve labeling the pKa, volume at the equivalence point, and both axes (with units). You do not need to solve for pH at the equivalence point explicitly but you do need to have it generally correct.

Sketch curve here....



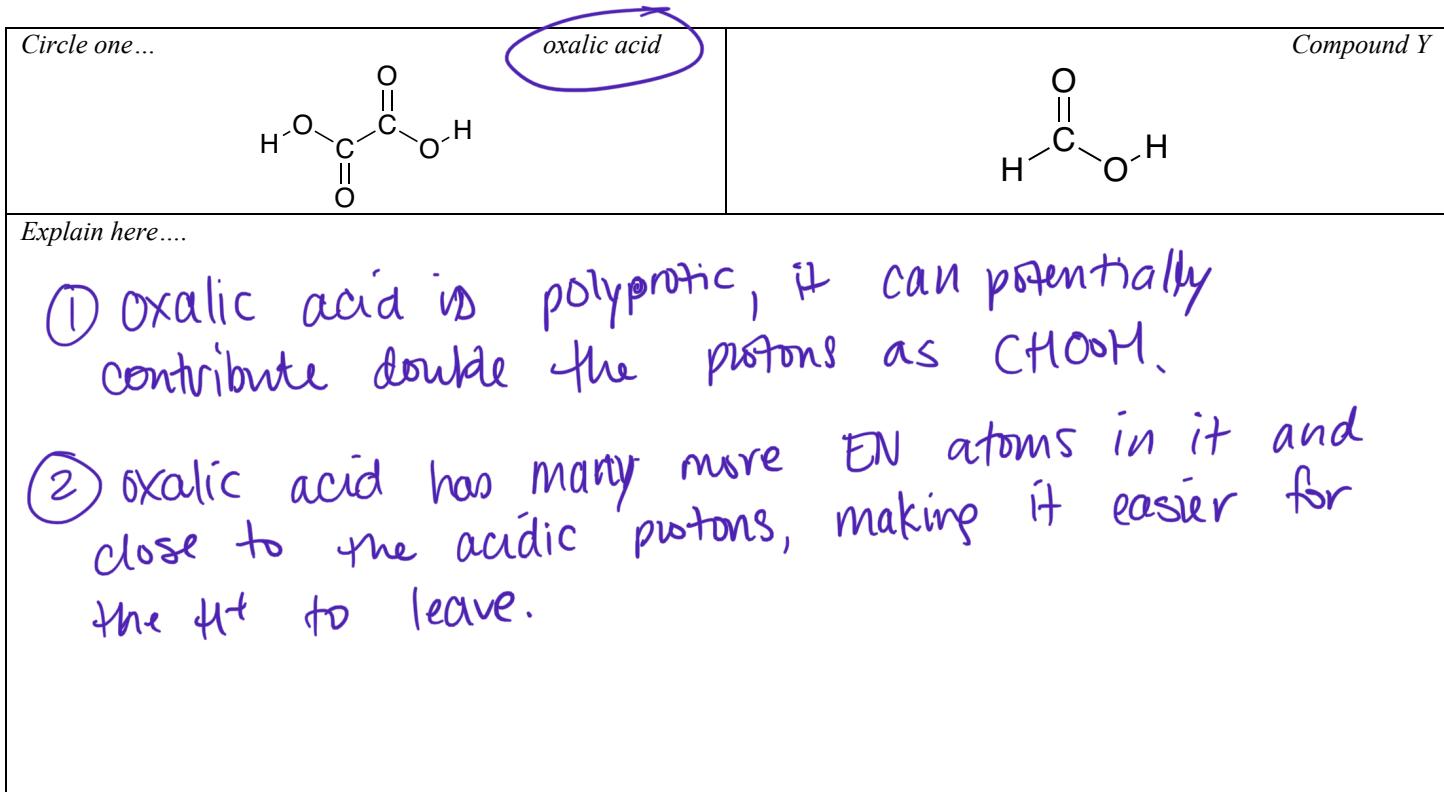
9. Clearly write the chemical equation for the reaction of **Compound Y** with water. Label the acid, base, conjugate acid, and conjugate base. Is the reaction reactants favored or products favored? Explain why.

Show your work in this box.



Based on the K_a of 1.77×10^{-4} , the $K \ll 1$, so the reaction is reactants favored. Very few products will form. $\frac{\# \text{products}}{\# \text{reactants}} \leq \text{small \#}$

10. Oxalic acid (HOOCCOOH) contains the same elements as **Compound Y** (CHOOH). If equal concentrated aqueous solutions of each compound were made, which solution would you expect to have a lower pH? Circle one and explain giving **two** reasons why.



END OF EXAM
!!! DON'T FORGET TO CHECK YOUR WORK !!!

Useful information:

$$1 \text{ atm} = 760 \text{ mmHg} = 101.3 \text{ kPa}$$

$$R = 8.314 \frac{\text{J}}{\text{mol} \cdot \text{K}} = 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$$

$$0^\circ\text{C} = 273 \text{ K}$$

$$K_a K_b = K_w$$

$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

$$\text{pOH} = -\log[\text{OH}^-]$$

$$\text{At } 25^\circ\text{C}: K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = 1.0 \times 10^{-14} \quad \text{pH} + \text{pOH} = 14.00 \quad pK_a + pK_b = 14.00$$

$$\text{pH} = pK_a + \log\left(\frac{[\text{base}]}{[\text{acid}]}\right)$$

$$K_a \text{ CHOOH } 1.77 \times 10^{-4}$$

USE THIS PAGE FOR SCRAP. IT WILL NOT BE GRADED.

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