

Recitation Worksheet 10: Acid and Bases (14.7 – 14.9/Structure and Properties of Organic Acids)

Name:

MyID:

Instructions:

1. Please enter your first and last name as it appears on the eLC classlist (do not use a nickname).
2. Your UGA myID is a combination of letters and numbers (example: Dr. Abdelrahman MyID is ema88805).
Do not use your 81x number.
 - a. If you do not have access to a printer, type your answers in the worksheet PDF and then upload it to **Gradescope** by Friday, April 7th at 11:59 pm. Write your work on separate sheets of paper, convert to a PDF and upload to the "Recitation Worksheet 10 Dropbox" on eLC.
 - b. If you are using an app to annotate the worksheet, make sure the pages are in the correct order and have the same layout as the original or Gradescope will not be able to read it.
 - c. If you have access to a printer, print out the worksheet, write your answer in the answer boxes, and show your work on it when appropriate. Then convert it to a PDF and upload to **Gradescope** by Friday, April 7th at 11:59 pm. You do not need to upload anything to eLC. The pages must be in the correct order and have the same layout as the original, or Gradescope will not be able to read it.
 - d. There is a **Gradescope App** available for both iOS and Android devices that allows you to scan and submit your printed work or you can submit your fillable PDF directly. Detailed instructions on how to access and use the app can be found on your CHEM 1212 class eLC page under content → Welcome module → Gradescope → Gradescope new mobile app.
3. Answers must be written in the corresponding answer box, or no credit will be awarded.
4. The instructions for uploading worksheets to Gradescope can be found in the Content area of eLC in the Welcome Module.
1. Which of the pairs below has the **stronger acid** listed **first**? Select all that apply. Insert letters without spaces in the answer box, example **ABCD**.

- A. HClO_2 and HClO_3
- B. H_3PO_4 and H_2SiO_3
- C. $\text{I}_3\text{CCH}_2\text{CH}_2\text{COOH}$ and $\text{CH}_3\text{CH}_2\text{CCl}_2\text{COOH}$
- D. H_2PO_4^- and HPO_4^{2-}
- E. CF_3COOH and CH_3COOH

2. Which of the choices represents the correct order of the acids below in order of **strongest to weakest**?

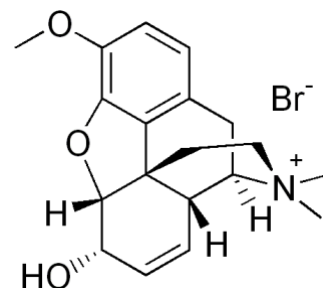
HBr, CHCl_2COOH , $\text{CH}_3\text{CH}_2\text{COOH}$, $\text{CH}_3\text{F}_2\text{CCOOH}$, $\text{I}_2\text{CHCH}_2\text{COOH}$

- A. $\text{HBr} > \text{CHCl}_2\text{COOH} > \text{CH}_3\text{F}_2\text{CCOOH} > \text{I}_2\text{CHCH}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{COOH}$
B. $\text{CH}_3\text{CH}_2\text{COOH} > \text{I}_2\text{CHCH}_2\text{COOH} > \text{CH}_3\text{F}_2\text{CCOOH} > \text{CHCl}_2\text{COOH} > \text{HBr}$
C. $\text{HBr} > \text{CH}_3\text{F}_2\text{CCOOH} > \text{CHCl}_2\text{COOH} > \text{I}_2\text{CHCH}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{COOH}$
D. $\text{HBr} > \text{I}_2\text{CHCH}_2\text{COOH} > \text{CH}_3\text{F}_2\text{CCOOH} > \text{CHCl}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{COOH}$
E. $\text{CHCl}_2\text{COOH} > \text{CH}_3\text{F}_2\text{CCOOH} > \text{I}_2\text{CHCH}_2\text{COOH} > \text{CH}_3\text{CH}_2\text{COOH} > \text{HBr}$

3. You were asked to prepare an aqueous solution of pH ~ 8.5 and you are provided with a list of salts below. Which of these salts would you use? ($K_{a1} \text{H}_3\text{PO}_4 = 7.08 \times 10^{-3}$, $K_{a2} \text{H}_2\text{PO}_4^- = 6.31 \times 10^{-8}$, $K_{a3} \text{HPO}_4^- = 4.47 \times 10^{-13}$).

- A. KNO_2
B. NH_4Cl
C. NaNO_3
D. KH_2PO_4
E. $\text{CH}_3\text{NH}_3\text{Cl}$
F. FeCl_3

4. The salt of codeine, codeine bromide ($C_{18}H_{21}O_3NH^+Br^-$) has analgesic and antitussive properties. Calculate the pH of a 0.324 M codeine bromide solution. pK_b of $C_{18}H_{21}O_3N$ is 7.95. Keep your answer to 3 decimal places.



5. Which of the following ionic compounds when dissolved in water produce a solution with the highest pH?

- A. $CaBr_2$
- B. NH_4I
- C. N_2H_5Cl
- D. $Sr(NO_3)_2$
- E. $C_6H_5CH_2COONa$

6. Use the picture below to answer the following questions

A blank periodic table grid with 18 columns and 7 rows. The grid is divided into blocks: a small block of 2x3 cells at the top left, a large block of 16x6 cells in the middle, and a small block of 10x2 cells at the bottom. The cells are empty, except for a few cells in the middle block which are labeled A, B, C, and D.

- A. Of the elements indicated on the periodic table shown above, which forms the strongest binary acid, H_2X or HX , where $\text{X} = \text{A, B, C, or D}$?

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- B. Of the elements indicated on the periodic table shown above, which forms the weakest binary acid, H_2X or HX , where $\text{X} = \text{A, B, C, or D}$?

- C. Of the elements indicated on the periodic table shown above, which forms the strongest oxoacid acid with the formula H_2XO_3 or HXO_3 , where X = A, B, C, or D?

- D. Of the elements indicated on the periodic table shown above, which forms the weakest oxoacid acid with the formula H_2XO_3 or HXO_3 , where X = A, B, C, or D?

7. Which of the following will be the strongest acid?

- A. $\text{CH}_3\text{CH}_2\text{OH}$
- B. $\text{CH}_3\text{CH}_2\text{NH}_2$
- C. $\text{CH}_3\text{CH}_2\text{SH}$
- D. $\text{CH}_3\text{CH}_2\text{CH}_3$
- E. All the above acids have the same strength

8. You are given the two sets of acids and each set consists of two acids:

Set I: a) HIO_3 and b) HClO_2 **Set II:** a) H_3PO_4 and b) H_3AsO_4 ,

Use the two sets of acids to answer the question below:

Which of the acids is the **weaker acid** in each set?

Set I

Set II

9. Calculate the pH of a sulfuric acid (H_2SO_4 , $K_a \text{ HSO}_4^- = 1.2 \times 10^{-2}$) solution that has a concentration of:

A. 5.00 M (Keep your answer to 3 decimal places).

B. 0.075 M (Keep your answer to 2 decimal places).

10. What is the $[\text{H}_3\text{O}^+]$, $[\text{SO}_3^{2-}]$, and pH of 0.054 M H_2SO_3 ? ($K_{\text{a}1} = 1.54 \times 10^{-2}$, $K_{\text{a}2} = 1.02 \times 10^{-7}$)

A. $[\text{H}_3\text{O}^+]$ (Keep your answer to 2 significant figures).

B. $[\text{SO}_3^{2-}]$ (Keep your answer to 3 significant figures).

C. pH (Keep your answer to 2 decimal places).

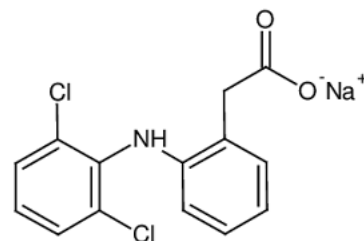
11. Using the table below for the relative acid strength, arrange the following species in order of **decreasing** relative **base strength**: ClO_2^- , Br^- , H_2O , OCl^- , $\text{C}_6\text{H}_5\text{O}^-$

Formula	Name	Value of K_a^*
HSO_4^-	Hydrogen sulfate ion	1.2×10^{-2}
HClO_2	Chlorous acid	1.2×10^{-2}
$\text{HC}_2\text{H}_2\text{ClO}_2$	Monochloroacetic acid	1.35×10^{-3}
HF	Hydrofluoric acid	7.2×10^{-4}
HNO_2	Nitrous acid	4.0×10^{-4}
$\text{HC}_2\text{H}_3\text{O}_2$	Acetic acid	1.8×10^{-5}
$[\text{Al}(\text{H}_2\text{O})_6]^{3+}$	Hydrated aluminum(III) ion	1.4×10^{-5}
HOCl	Hypochlorous acid	3.5×10^{-8}
HCN	Hydrocyanic acid	6.2×10^{-10}
NH_4^+	Ammonium ion	5.6×10^{-10}
HOC_6H_5	Phenol	1.6×10^{-10}

↑
Increasing acid strength

- A. $\text{C}_6\text{H}_5\text{O}^- > \text{OCl}^- > \text{ClO}_2^- > \text{H}_2\text{O} > \text{Br}^-$
 B. $\text{Br}^- > \text{H}_2\text{O} > \text{ClO}_2^- > \text{OCl}^- > \text{C}_6\text{H}_5\text{O}^-$
 C. $\text{ClO}_2^- > \text{OCl}^- > \text{Br}^- > \text{H}_2\text{O} > \text{C}_6\text{H}_5\text{O}^-$
 D. $\text{OCl}^- > \text{Br}^- > \text{ClO}_2^- > \text{C}_6\text{H}_5\text{O}^- > \text{H}_2\text{O}$
 E. $\text{H}_2\text{O} > \text{OCl}^- > \text{Br}^- > > \text{C}_6\text{H}_5\text{O}^- > \text{ClO}_2^-$

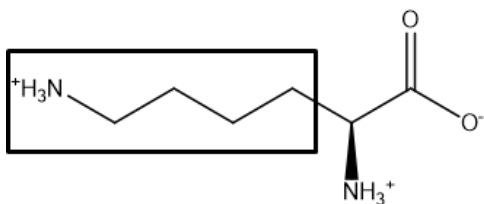
12. Diclofenac sodium is the active ingredient in Voltaren[®], is a non-steroidal anti-inflammatory drug used in a gel form for arthritis pain relief. Calculate the pH of 0.435 M diclofenac sodium ($\text{C}_{14}\text{H}_{11}\text{Cl}_2\text{NO}_2^-\text{Na}^+$) solution. pK_a of $\text{C}_{14}\text{H}_{11}\text{Cl}_2\text{NO}_2\text{H}$ is 4.15. Keep your answer to 3 decimal places.



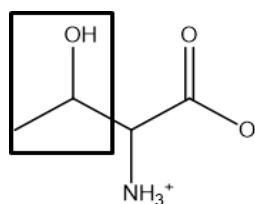
13. Which amino acid would have the **lowest pK_a** for its side chain, which is emphasized by the black box?
(Only compare the part of the molecule in the black box).



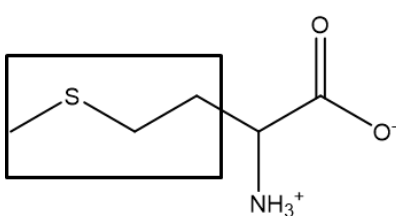
A.



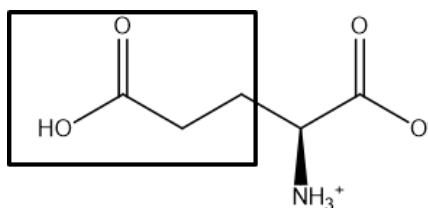
C.



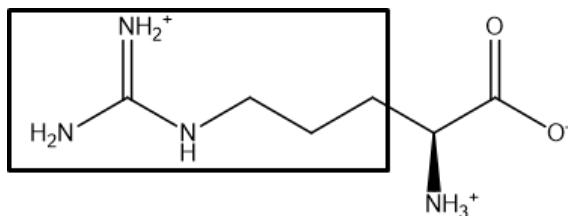
B.



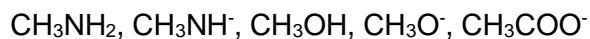
D.



E.



14. Rank the following species from **strongest to weakest base**. Select an answer choice from A-E.



- A. $\text{CH}_3\text{NH}^- > \text{CH}_3\text{O}^- > \text{CH}_3\text{COO}^- > \text{CH}_3\text{NH}_2 > \text{CH}_3\text{OH}$
- B. $\text{CH}_3\text{OH} > \text{CH}_3\text{COO}^- > \text{CH}_3\text{NH}_2 > \text{CH}_3\text{O}^- > \text{CH}_3\text{NH}^-$
- C. $\text{CH}_3\text{NH}^- > \text{CH}_3\text{O}^- > \text{CH}_3\text{NH}_2 > \text{CH}_3\text{COO}^- > \text{CH}_3\text{OH}$
- D. $\text{CH}_3\text{O}^- > \text{CH}_3\text{NH}^- > \text{CH}_3\text{COO}^- > \text{CH}_3\text{NH}_2 > \text{CH}_3\text{OH}$
- E. $\text{CH}_3\text{NH}_2 > \text{CH}_3\text{NH}^- > \text{CH}_3\text{O}^- > \text{CH}_3\text{OH} > \text{CH}_3\text{COO}^-$