# CHEM 3331 (Richardson) Final Exam – Dec. 20, 2023

Your Name: _____

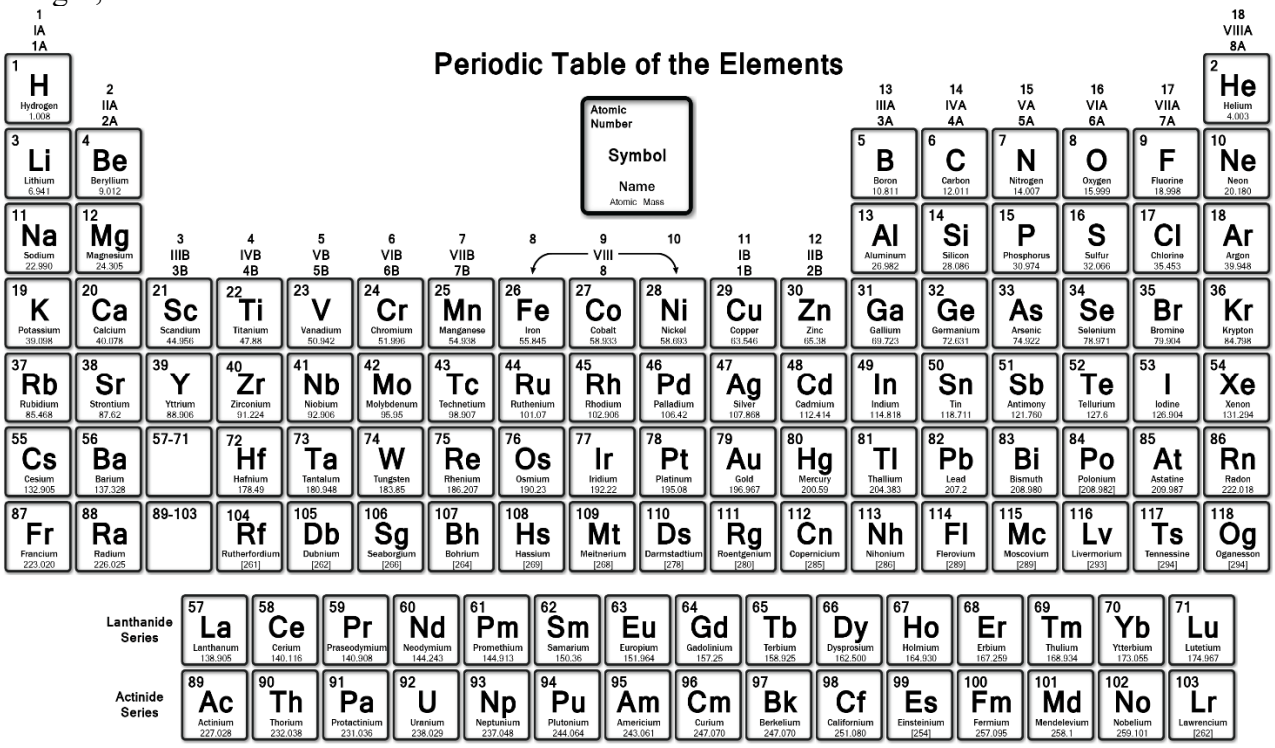
Student ID: _____

Recitation TA (fill in one circle):

O 134 (Alec Kolodziejczyk) O 142 (Kajal)
O 135 (Alec Kolodziejczyk) O 143 (Kajal)
O 136 (Lukas Gardner) O 144 (James Greenwood)
O 137 (Lukas Gardner) O 147 (Lukas Gardner)
O 141 (Kyle Fisch)

| Question | Score | Out of |
|---|---|---|
| 1 | | 30 |
| 2 | | 30 |
| 3 | | 40 |
| 4 | | 30 |
| 5 | | 40 |
| 6 | | 30 |
| 7 | | 20 e.c. |
| Total | | 200 |

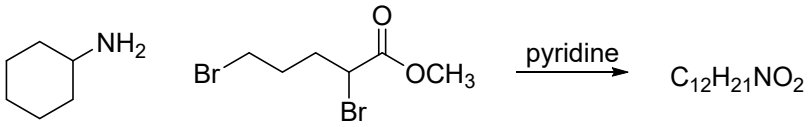
This is a closed-book exam, except for two double-sided sheets of 8.5 x 11" paper. The use of calculators or cell phones will not be allowed during the exam. You may use models sets brought in a clear bag. Use the backs of the pages for scratch work. If your final answer is not clearly specified, you will lose points. For mechanisms, show all intermediates including correct formal charges, but do not show transition states.



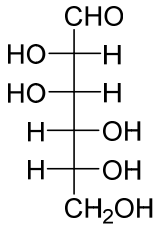

## pKa Values

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| HI | -10 | $CH_3COOH$ | 4.7 | ArOH | 10 | HC≡CH | 26 |
| HBr | -8 | $HN_3$ | 4.7 | RSH | 10-12 | $H_2$ | 35 |
| HCl | -6 | $H_2S$ | 7.0 | $H_2O$ | 15.7 | $NH_3$ | 36 |
| $H_3O^+$ | -1.7 | $NH_4^+$ | 9.3 | ROH | 16-18 | $H_2C{=}CH_2$ | 45 |
| HF | 3.2 | HCN | 9.4 | O=C-CH | 9-25 | $CH_4$ | 60 |

1) You perform the reaction below, which proceeds by two $S_N2$ reactions and some proton transfers. Show a reasonable mechanism and the product for this reaction. (30 pts)




2) One enantiomer of mannose is shown below. (30 pts)




a. Circle the terms that describe this compound: **L**, **D**, aldose, ketose, pentose, hexose. (6 pts)

Draw the following structures for this compound (you don't need to show stereochemistry on parts that are outside the ring). (6 pts each)

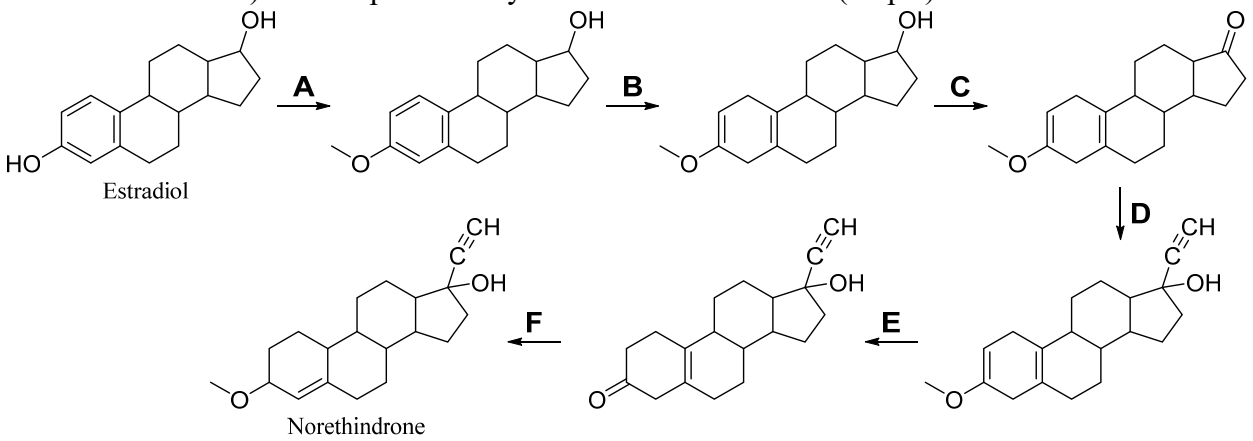
b. Haworth projection for β-furanose form

c. Haworth projection for α-pyranose form

d. One chair conformation for α-pyranose form

e. The other chair conformation for α-pyranose form

3) The synthesis shown below was invented by Carl Djerassi, the "Father of the Pill", to convert estradiol (extracted from the Mexican yam) into norethindrone (a popular contraceptive for several decades). The steps of this synthesis are labeled **A-F**. (40 pts)




What reagents would you need for each step? (8 pts each)

**A:**

**B:**

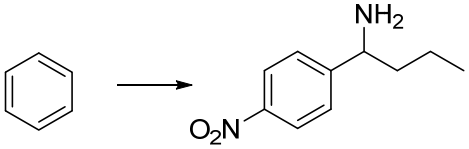
**C:**

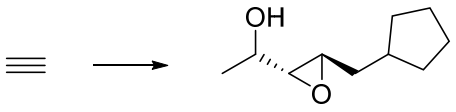
**D:**

**E:** (hint: if you hydrolyze the ether at the far left to an alcohol, what would the molecule look like?)

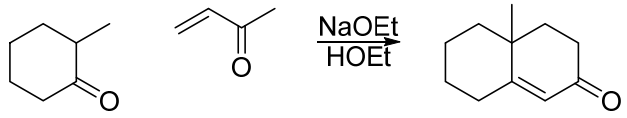
4) Most naturally-occurring carbohydrates are **D**, but weirdly, **L**-arabinose is more commonly found than **D**-arabinose, and is a component of biopolymers such as pectin (used for thickening jam). You are attempting to figure out the structure of **L**-arabinose, which you know is an aldopentose. You oxidize both ends of **L**-arabinose to carboxylic acids and find that the product is optically active. You also know that **L**-arabinose is one of two sugars that can be made by performing the Kiliani-Fischer synthesis on **L**-erythrose, an aldotetrose. When **L**-erythrose is oxidized at both ends, its product is optically inactive. What is the structure of **L**-arabinose? (30 pts)

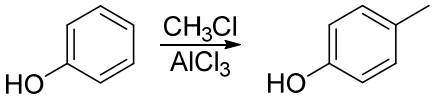
5) Find a way to synthesize the desired product from the given starting material plus any other reagents containing at most six carbon atoms, or triphenylphosphine, or any transition metal-based catalyst. (40 pts; 20 pts each)

a. 


b. 

6) Write out the mechanisms for these reactions, including any major resonance forms for intermediates. (30 pts; 15 pts each)

a. 


b. 


7) Extra credit! Describe each of the structures below as aromatic, nonaromatic, or antiaromatic. Assume each structure is planar. (20 pts e.c.)