Organic Chemistry 2
Third Examination
April 14, 2006
Prof. Malachowski

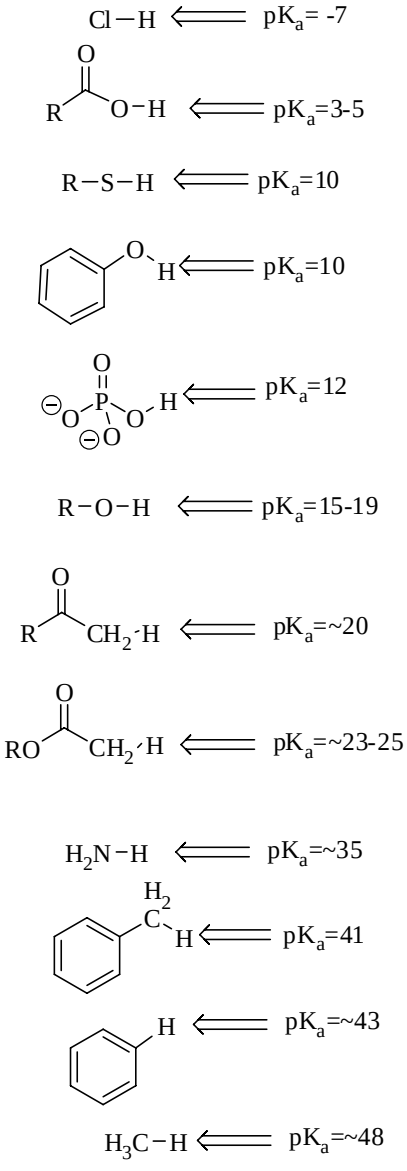
Name:_____

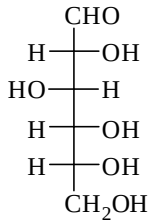
The examination has seven questions on four pages. The point values for each question are found with the question. Partial credit where appropriate will be given.

Read each question carefully before answering. Be certain you understand everything the question is requesting. Do the easy questions first. If questions appear confusing or exceedingly complex , then you may need to rethink the question. Keep in mind the intended examination topics.

In organic chemistry, hand-drawn pictures convey specific information. Be sure the drawing you have made conveys the essential information required to answer the question. Make certain that three-dimensional pictures display the correct atom arrangements. Don't forget to include lone pairs of electrons and formal charges when appropriate.

pK_a information:

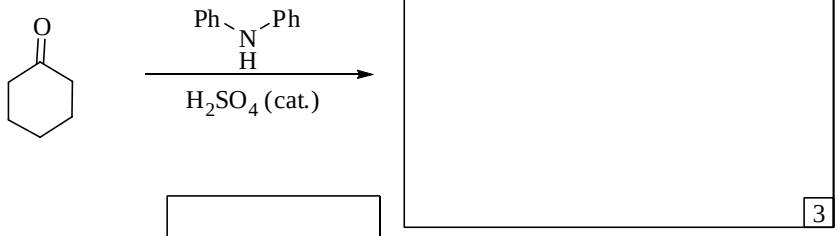




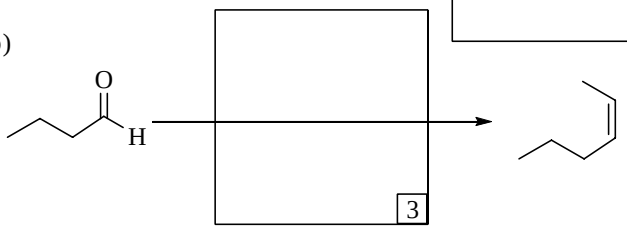
D-glucose

1. Complete the following reactions by providing the necessary information: starting material, reagent or major product. (points listed in corner of box)

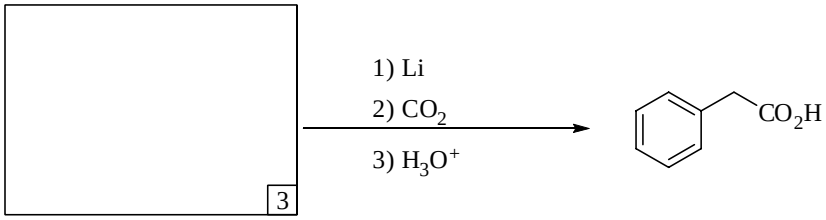
a)



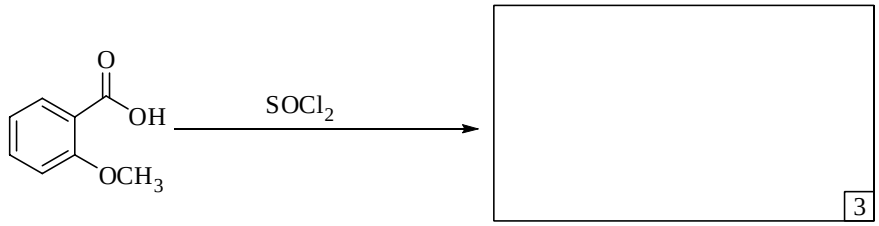
b)



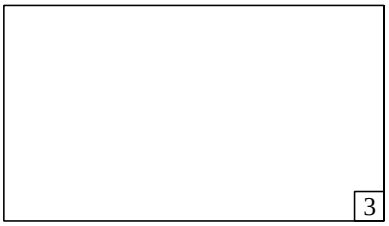
c)



d)

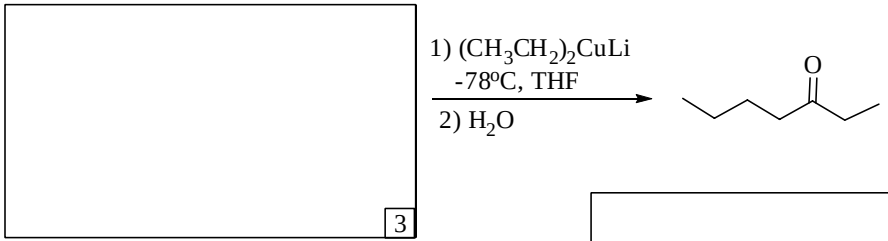


e) $Br-CH_2CH_2CH_2CH_2\cdot CO_2H$ $\xrightarrow[\text{acetone}]{K_2CO_3}$

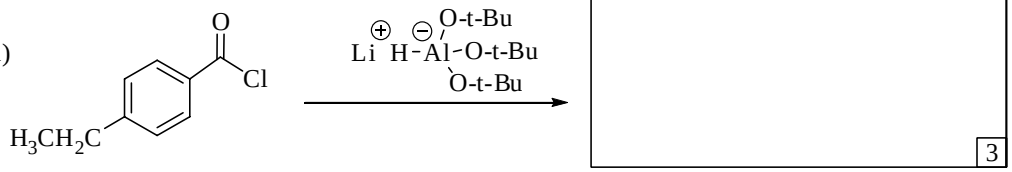


f) $CH_3(CH_2)_{18}CO_2CH_2CH_3$ → $CH_3(CH_2)_{18}CO_2Na$

g)

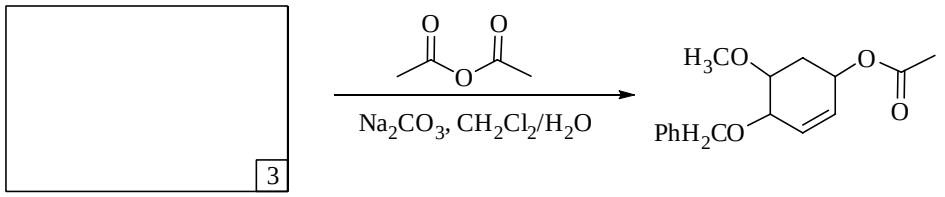


h)



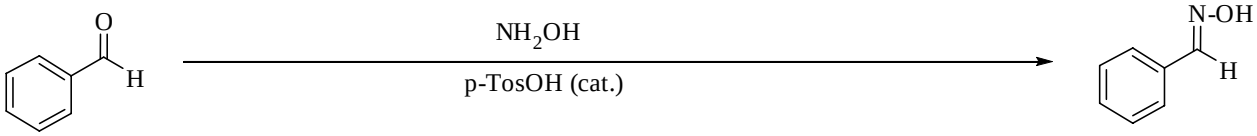
24 total pts.

i)



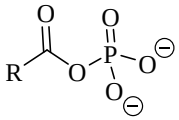
j)

2. Draw the curved-arrow electron flow mechanism of the following reaction. (10 pts.)



3. Nature can not use acid chlorides and acid anhydrides as acylating agents because they are too reactive; instead nature uses thioesters and acid phosphates.

a) Provide two reasons why acid phosphates are less reactive than acid chlorides. (8 pts.)



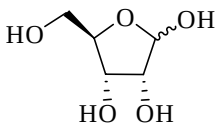
acid phosphate

b) If the acid phosphate is behaving as an acylating agent, is it an electrophile or a nucleophile in this process? Circle one. (2 pts.)

electrophile nucleophile

26 total pts.

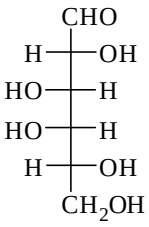
4. Depictions of carbohydrates will frequently show a squiggly line for one of the hydroxyl groups. One such example is for the D-ribofuranose shown below. Explain why this carbon might be shown without a clear R or S stereochemical configuration. (6 pts.)



D-ribofuranose

5. A recent article in the journal Nature (**2006**, *440*, 435) described why the avian flu virus has a more difficult time spreading from one human to another. The reason appears to be a preference in the avian flu virus for binding to 3-O-(sialic acid)-D-galactose carbohydrates over 6-O-(sialic acid)-D-galactose carbohydrates. In humans, the 3-O-(sialic acid)-D-galactose carbohydrates are found on the surface of cells in the lower respiratory tract, not the upper. With an infection deep in the lungs, the virus is less likely to be expelled (and spread) during coughing or sneezing.

a) Draw the chair structure of β-D-galactopyranose. (6 pts.)



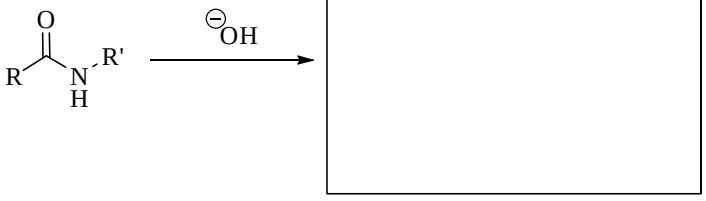
D-galactose

b) Label the two different points of attachment for sialic acid described in the preceding text. You can use the labels '3-O-Sia' and '6-O-Sia' and an arrow to the appropriate positions on the galactose ring. (4 pts.)

c) Circle the carbon that determines whether the galactose is D or L. Draw an arrow to this carbon and label it with a 'D'. (2 pts.)

6. Most HIV protease inhibitors contain a secondary alcohol as their key functional group responsible for inhibiting the enzyme, HIV protease, which then arrests the progression of AIDS. Answer the following questions to understand why a secondary alcohol can inhibit the enzyme.

a) Protease enzymes essentially catalyze the hydrolysis of an amide bond in a peptide with hydroxide ion. Draw the tetrahedral intermediate of an amide bond reaction with hydroxide ion in the box below. Include the curved electron flow arrows that lead to the tetrahedral intermediate that you have drawn. (4 pts.)



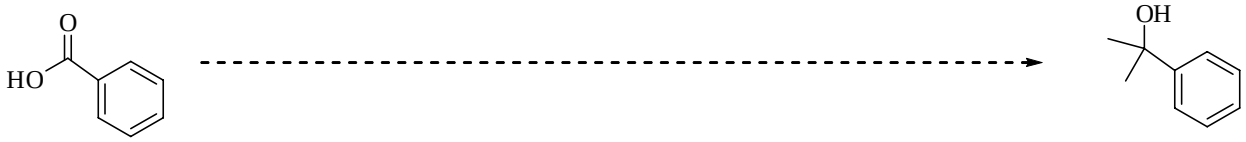
tetrahedral intermediate

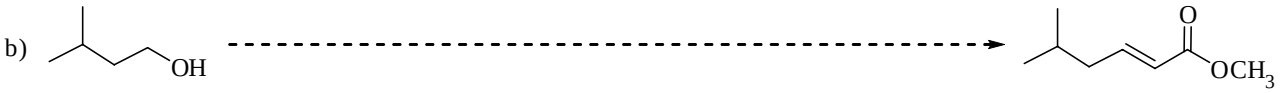
b) Draw a secondary alcohol. (3 pts.)

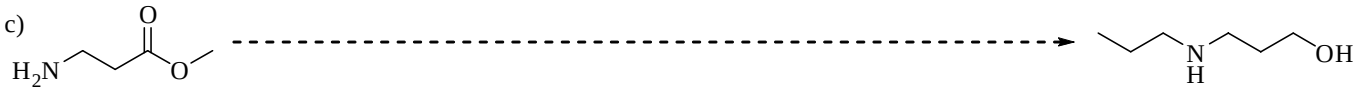
c) As described in class, protease enzymes catalyze nucleophilic acyl substitution reactions by binding and stabilizing the tetrahedral intermediates (or transtition states) on the way to the product. In comparing the tetrahedral intermediate (part a) and the secondary alcohol (part b), which features are the same and therefore might explain why the enzyme HIV protease might mistake the secondary alcohol for the tetrahedral intermediate? (4 pts.)

29 total pts.

7. Devise a synthesis for the product on the right from the starting material on the left. You may use any inorganic or organic reagents. (7 pts. each)

a) 

b) 

c) 

21 total pts.