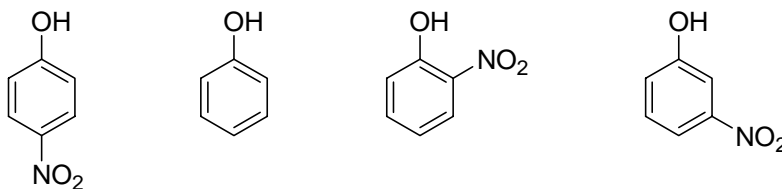
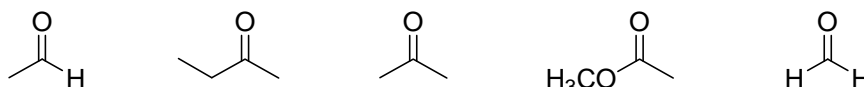




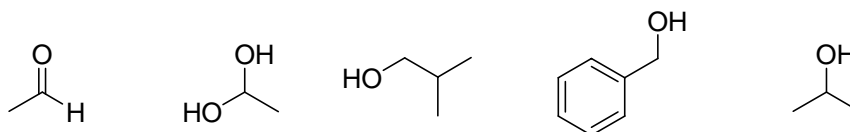
1a) Which of the following phenols is *least* acidic? Circle the correct choice (6 pts).



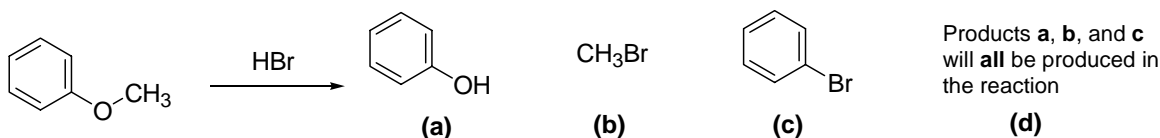
1b) Circle the compound in the following series that is *least* reactive towards nucleophilic addition by an organolithium reagent (3 pts).



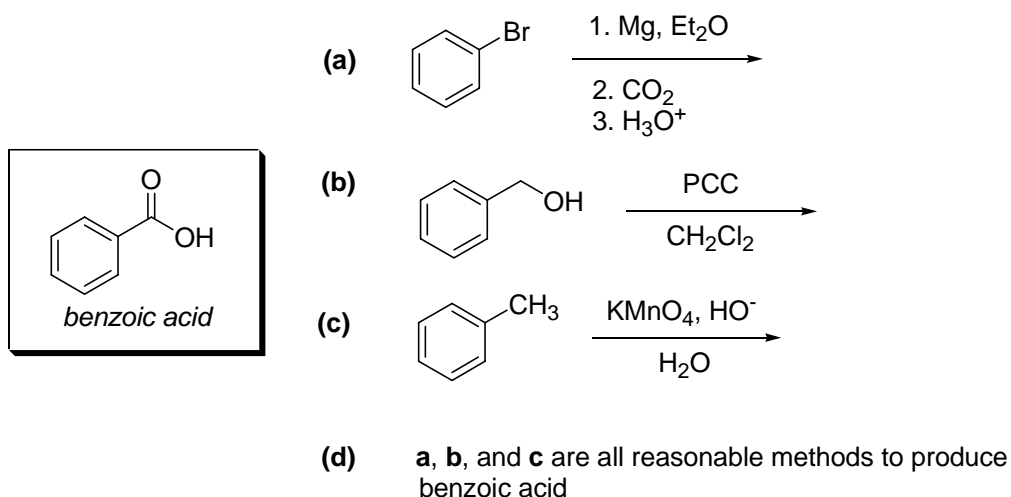
1c) Circle the compound in the following series that cannot be oxidized to a carboxylic acid using sodium dichromate, sulfuric acid and water (3 pts):



1d) Which of the following would *not* be a product from the reaction of phenyl methyl ether (shown at left) and HBr? Circle it (3 pts):



1e) Which of the following is *not* a possible synthesis of benzoic acid? Circle it (3 pts):



2. Indicate the conditions you would use to accomplish each of the following transformations by selecting the appropriate letter from this list. Write the letter above the reaction arrow. Only one enantiomeric product is shown here to save space. You may use some choices more than once, or not at all. Assume aqueous workup even if it's not explicitly written (20 pts).

**A** 1. MCPBA; 2. NaOMe, MeOH

**B** 1. MCPBA; 2. NaOH, H<sub>2</sub>O

**C** 1. MeLi, Et<sub>2</sub>O; 2. H<sub>3</sub>O<sup>+</sup>

**D** OsO<sub>4</sub>, t-BuOOH, H<sub>2</sub>O

**E** NaOH, H<sub>2</sub>O

**F** NaH, then H<sub>3</sub>O<sup>+</sup>

**G** 1. LAH, Et<sub>2</sub>O; 2. H<sub>3</sub>O<sup>+</sup>

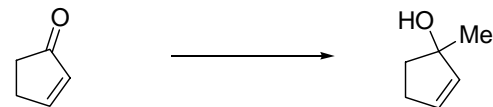
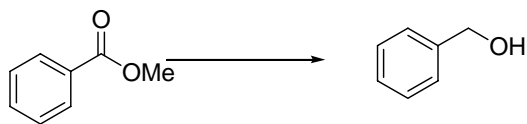
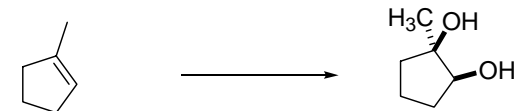
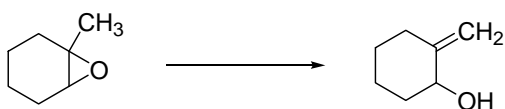
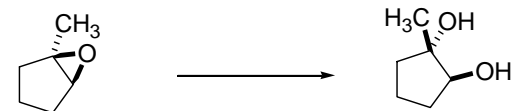
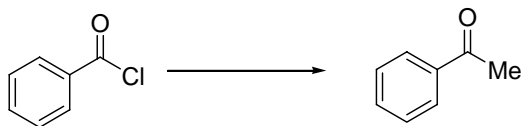
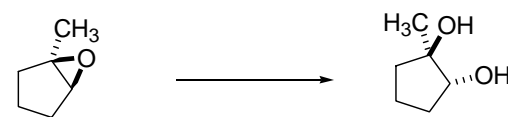
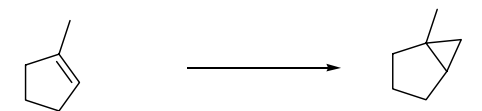
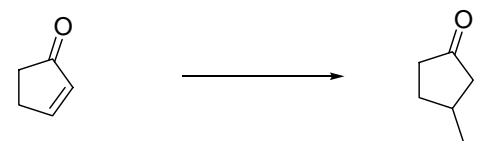
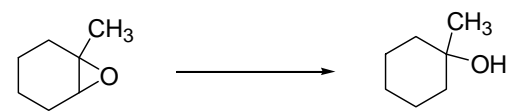
**H** 1. Me<sub>2</sub>CuLi, Et<sub>2</sub>O; 2. H<sub>3</sub>O<sup>+</sup>

**I** ICH<sub>2</sub>ZnI, Et<sub>2</sub>O

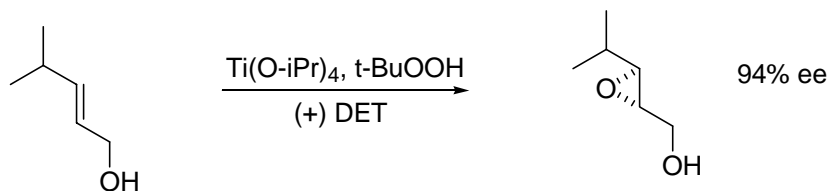
**J** H<sub>3</sub>O<sup>+</sup>

**K** CHBr<sub>3</sub>, t-butoxide

**L** This transformation cannot be carried out using any of the choices given.



3. (12 pts) The Sharpless asymmetric epoxidation is another example of a reaction that uses a chiral catalyst to effect an enantioselective transformation. Here, an allylic alcohol is transformed to a 2,3-epoxy alcohol; in other words, an epoxide is installed. The chiral catalyst in this example is formed from one stereoisomer of a molecule called diethyl tartrate, “DET”. Titanium isopropoxide,  $\text{Ti}(\text{O-iPr})_4$ , and *tert*-butyl hydroperoxide combine with the DET to form the epoxide.



\_\_\_\_\_ The allylic alcohol starting material shown above is (put correct letter on line):

- prochiral
- achiral
- chiral
- a & b
- none of the above

\_\_\_\_\_ If you treated the allylic alcohol with MCPBA in  $\text{CH}_2\text{Cl}_2$ , you would get:

- a single enantiomer
- an achiral molecule
- a racemic mixture
- none of the above

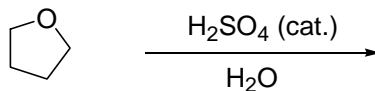
\_\_\_\_\_ If you treated the allylic alcohol with the same conditions shown here *except* you used the other enantiomer of DET, (-) DET, the reaction would produce:

- the same product as shown above
- the enantiomer of the product shown above
- a racemic mixture
- none of the above

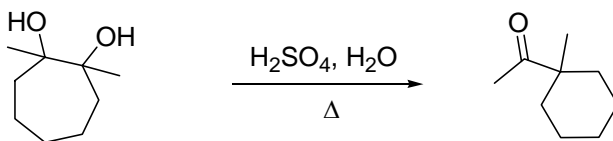
\_\_\_\_\_ The reaction shown above produces both enantiomers of the product, though only one is shown. Which statement is true about *this reaction as written above*?

- The transition states for the two pathways are equal in energy and enantiomeric.
- The transition states for the two pathways are unequal in energy and enantiomeric.
- The transition states for the two pathways are equal in energy and diastereomeric.
- The transition states for the two pathways are unequal in energy and diastereomeric.

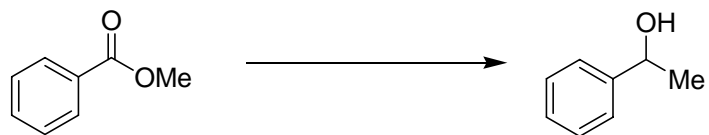
4a) Predict the product and draw an arrow-pushing mechanism for the following transformation. Show all bonds, arrows, formal charges and necessary lone pairs clearly to receive full credit (8 pts).



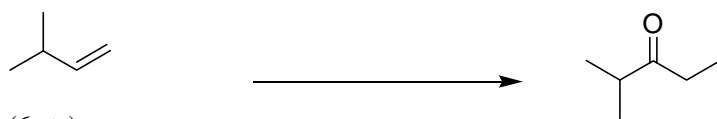
4b) Draw an arrow-pushing mechanism for the following transformation. Show all bonds, arrows, formal charges and necessary lone pairs clearly to receive full credit (12 pts).



5. For each of the following, outline a synthesis of the target compound from the indicated starting material and any organic or inorganic reagents. For full credit, show the reagents and the product of each step. (30 pts)



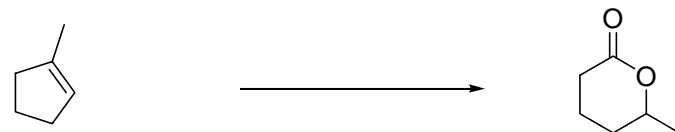
(6 pts)



(6 pts)



(6 pts)



(12 pts)