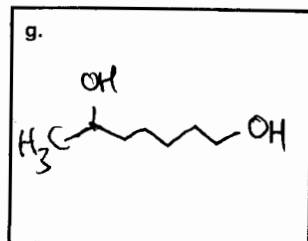
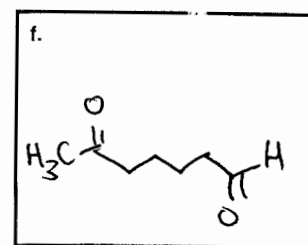
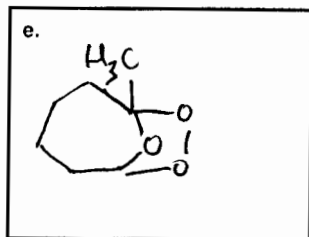
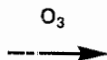
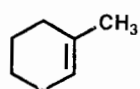
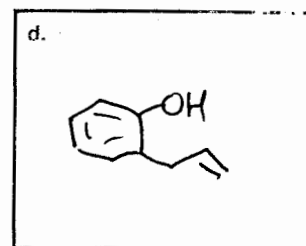
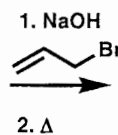
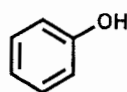
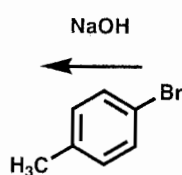
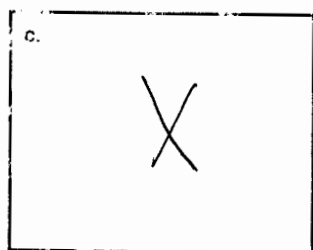
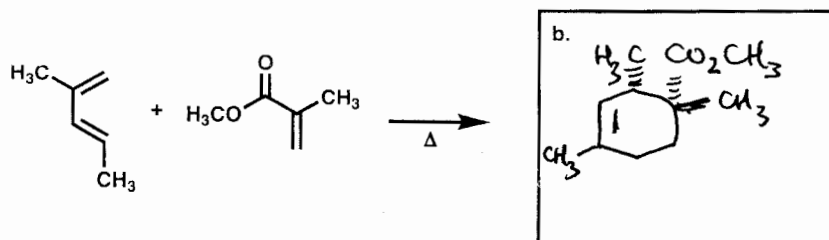
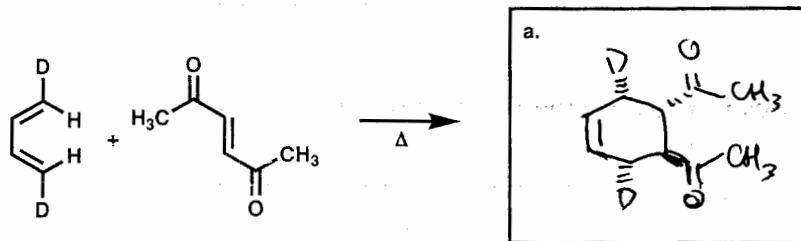
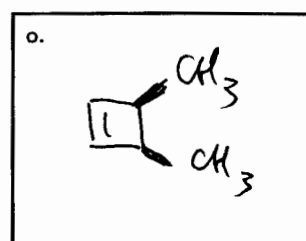
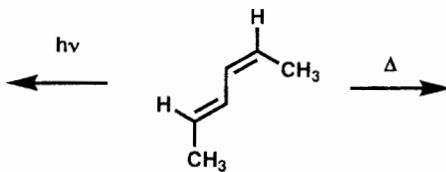
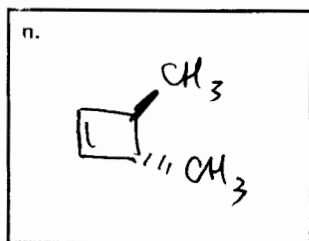
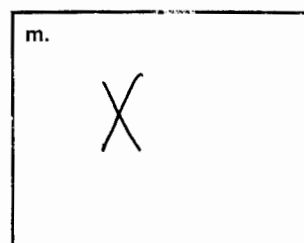
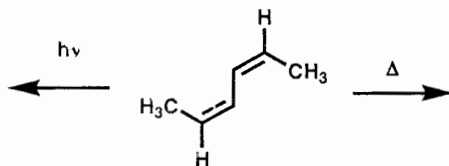
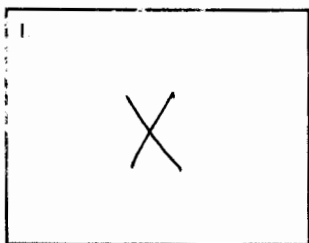
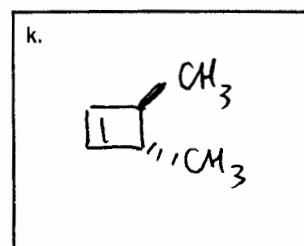
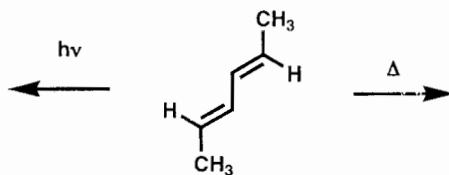
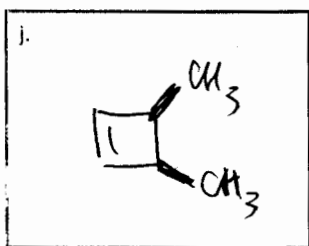
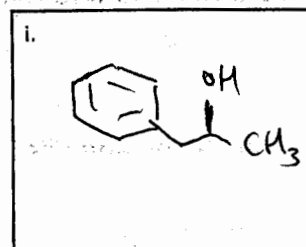
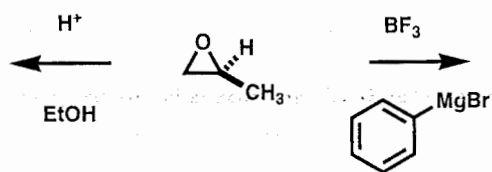
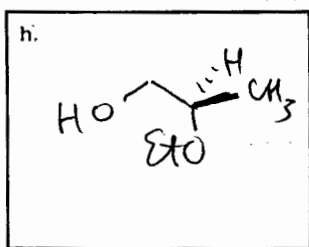


1. (64 points total, 4 points each) In each box below, draw the structure of the major product of the reaction. Indicate relative stereochemistry where appropriate. If no reaction occurs, put a large X in the box. (Note: "D" = deuterium,  $^2\text{H}$ )

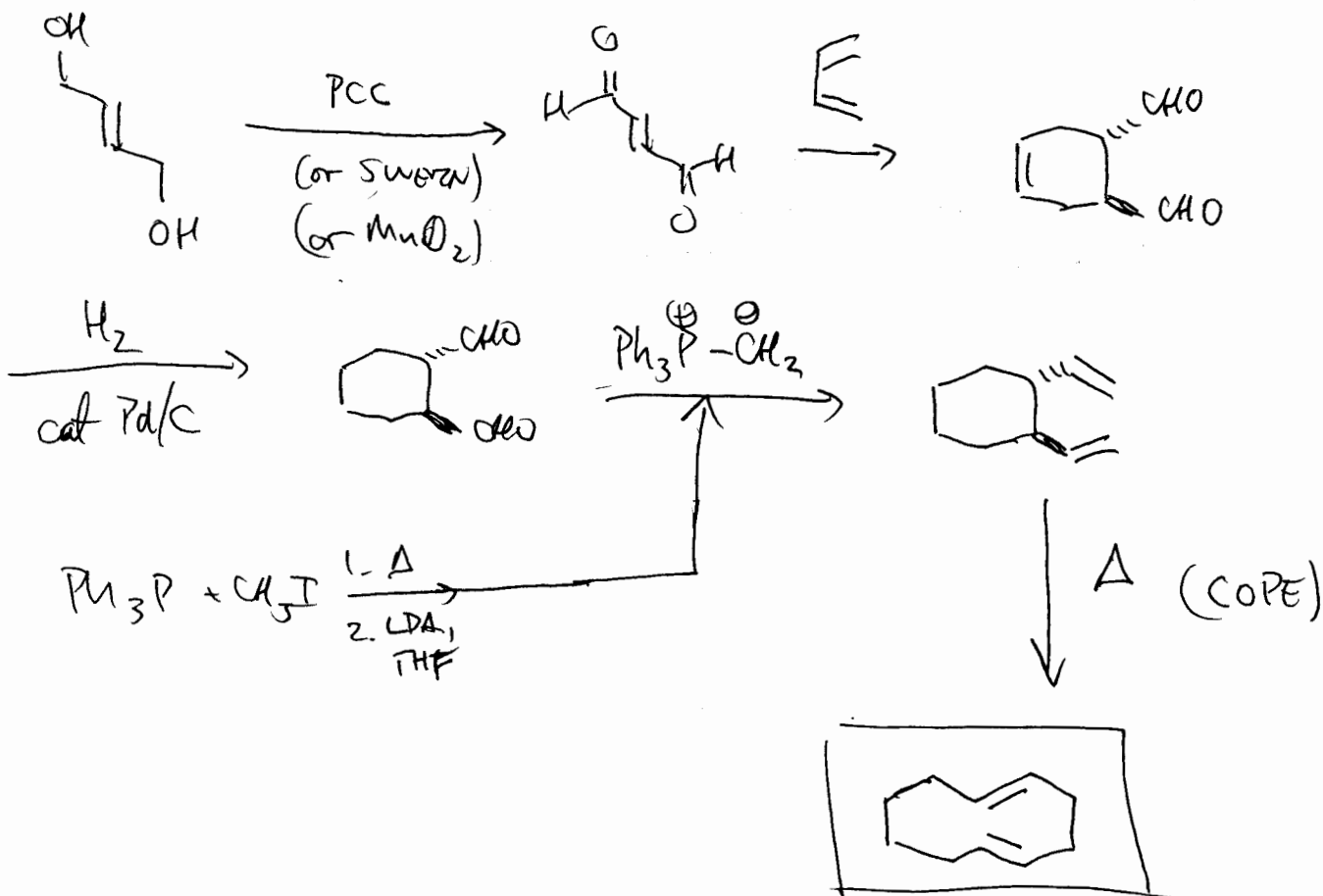
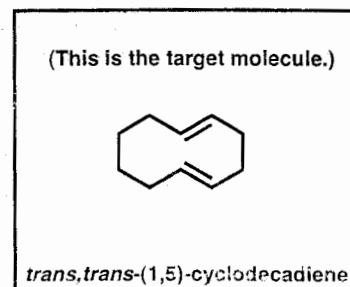
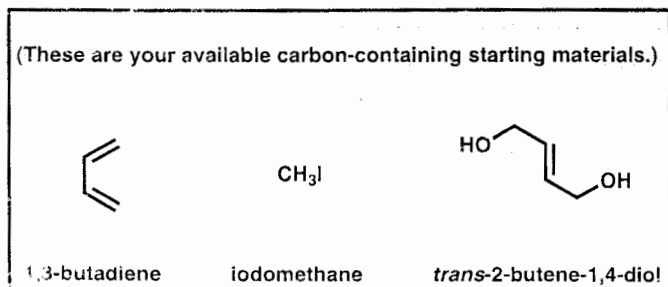


(1., continued – see previous page for directions)



2. (18 points) Propose a synthesis of *trans,trans*-(1,5)-cyclodecadiene. You may use **only** 1,3-butadiene, iodomethane, and *trans*-2-butene-1,4-diol as the source(s) of **all the carbon atoms** in the target molecule, but you may use each of these three starting materials as many times as necessary. You may also use **any other reagents**, as long as their carbon atoms (if any) **don't** end up in the target molecule.

Write your synthesis in the forward direction (not retrosynthetic analysis), with the reagents (if any) required for each step above each arrow.



3. (18 points) The relative energy levels of the molecular orbitals for the **cyclopropenyl cation, anion, and radical** can be derived using **Frost's Circle ("Polygon Rule")** (below).
- (3 points) Clearly draw the "zero energy" line on all three diagrams below, i.e. for all three species (cation (A.), anion (B.), radical (C.)).
  - (3 points) In the **box next to the energy level** for each orbital, write "bonding", "non-bonding", or "anti-bonding", as appropriate.
  - (6 points) **Populate** the orbitals (**bold horizontal lines**) of each species (cation (A.), anion (B.), radical (C.)) with the appropriate number of electrons to indicate the **ground state configuration** (lowest energy) in each case.
  - (6 points) In the **shaded, rounded box to the right of each diagram**, indicate whether the species is **aromatic, anti-aromatic, or neither**, as defined by Hückel's rule.

