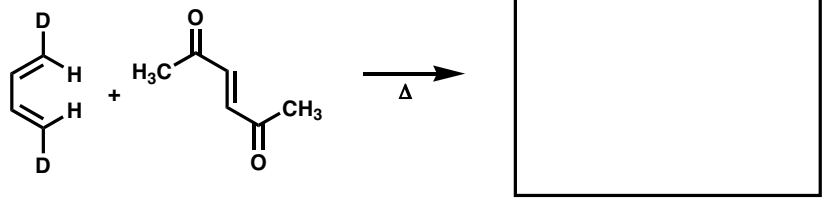
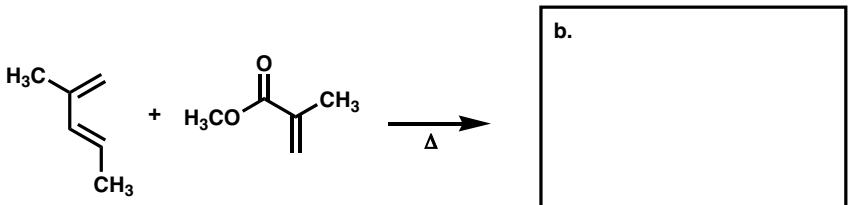
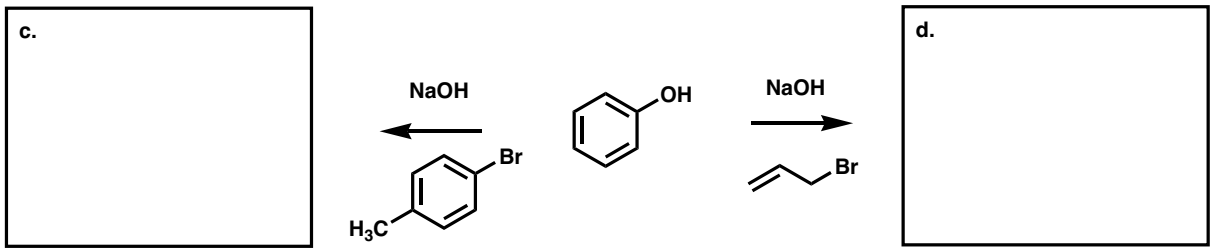
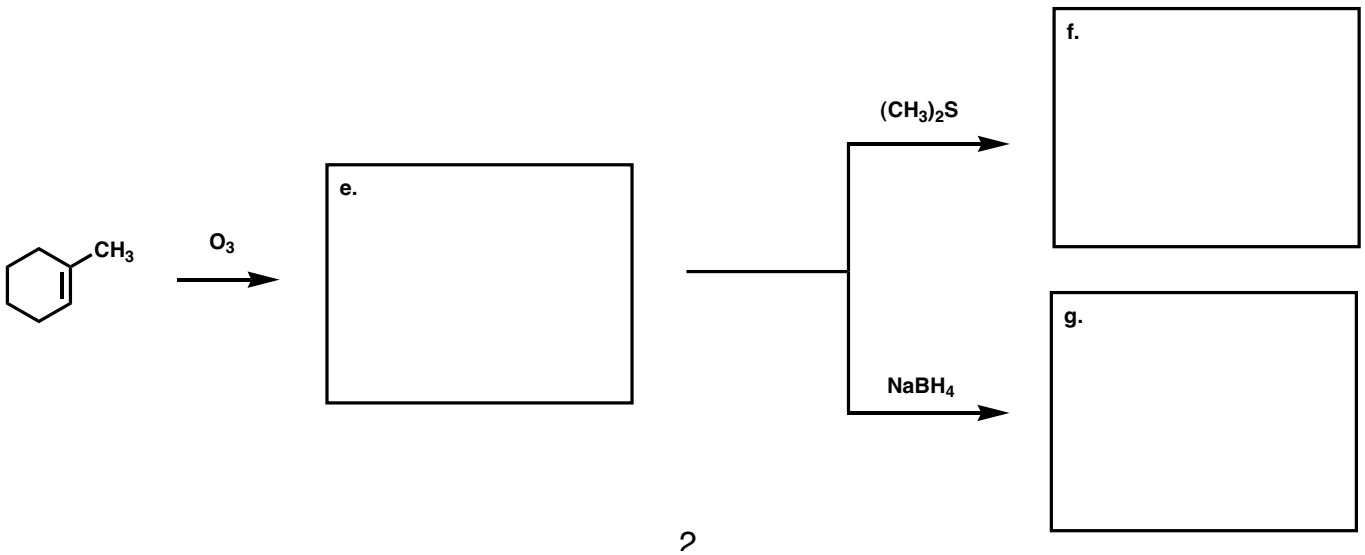
1. (**64 points total, 4 points each**) In each box below, draw the structure of the **major** product of the reaction. **Indicate** relative **stereochemistry** where appropriate. If **no reaction** occurs, put a large **X** in the box. (Note: "D" = deuterium, ^2H)



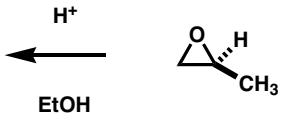


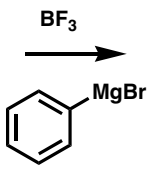




(1., continued – see previous page for directions)

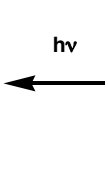
h.

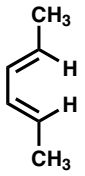


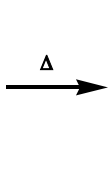


i.

j.

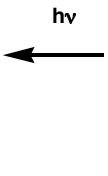


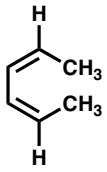


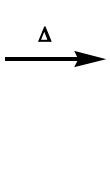


k.

l.

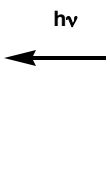


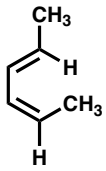


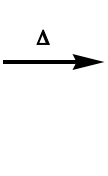


m.

n.

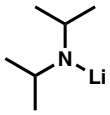






o.

2. (**18 points**) Using ***only*** **lithium diisopropylamide (LDA), 1,3-butadiene, iodomethane, fumaric dialdehyde, triphenylphosphine,** and any other **inorganic reagents**, propose a synthesis of *trans,trans*-(1,5)-cyclodecadiene. Write your synthesis in the forward direction (not retrosynthetic analysis), with the reagents (if any) required for each step above each arrow.

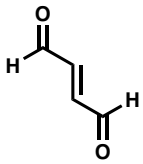


LDA

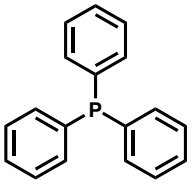
1,3-butadiene

CH_3I

iodomethane

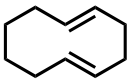


fumaric dialdehyde



triphenylphosphine

(This is the target molecule.)



***trans,trans*-(1,5)-cyclodecadiene**

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).

a. **(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.)).

b. **(3 points)** In the ***box next to*** the **energy level for each orbital**, write "bonding", "non-bonding", or "anti-bonding", as appropriate.

c. **(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.

d. **(6 points**) In the ***shaded, rounded box to the right of* each** diagram, indicate whether the species is **aromatic** or **anti-aromatic** as defined by Hückel's rule.