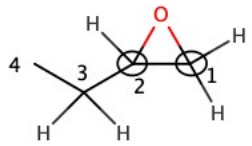
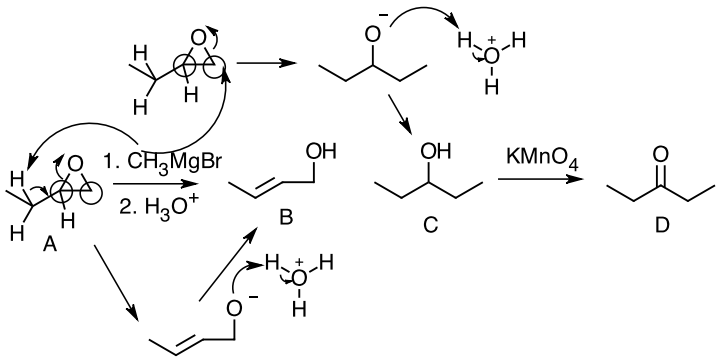
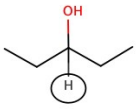
MOQ 1 solutions:
This reaction sequence makes Compound D, which is used as a solvent in paint and precursor for Vitamin E.
a. Circle the alpha carbon(s) in Compound A. Draw in all of the H's on beta carbons in Compound A.




Each carbon is labeled with a number.
C-1 and C-2 are alpha carbons in the epoxide ring.
Alpha carbon C-1 (primary C) is bonded to one beta carbon (C-2).
Alpha carbon C-2 (secondary C) is bonded to two beta carbons (C-1 and C-3).
Note: a beta carbon can also be an alpha carbon.
C-1 is bonded to 2 H's. C-2 is bonded to 1 H. C-3 is bonded to 2 H's.
b. Compound A reacts with $CH_3MgBr/H_3O^+$ to form Compounds B and C. Use curved arrows to show how Compound B is produced.



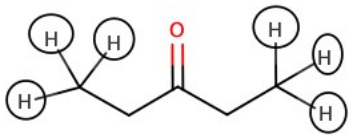

c. Compound C forms in a substitution reaction. The H NMR spectrum of Compound C shows 4 peaks with the following intensity ratio and splitting (multiplicity) = 6 (triplet): 4 (quartet/doublet): 1 (quintet): 1 (singlet).
(i) Draw the structure of Compound C. In your structure of Compound C, draw in the H or H's and circle the H or H's that is responsible for the H NMR peak that splits into a quintet.



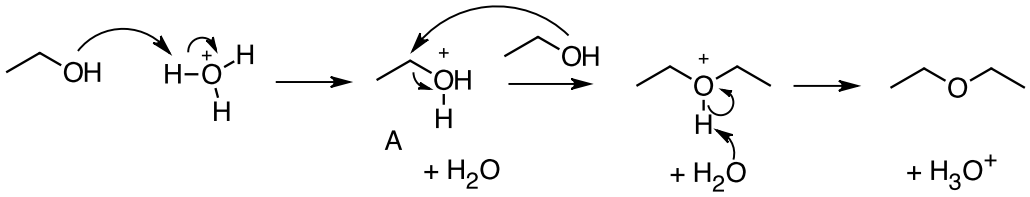

3-pentanol has a role as a pheromone.
The H on C-3 (circled) has 4 H's on two adjacent C's (C-2 and C-4) so n + 1 = 5 → quintet.

(ii) C NMR can be used to distinguish between Compound B and Compound C because the C NMR spectrum of Compound B shows 4 peaks and the C NMR spectrum of Compound C shows 3 peaks.
Blank 1: answer "can" or "cannot". Blanks 2 and 3: give a number only.
(iii) IR can be used to distinguish between Compound B and Compound C because the IR spectrum of Compound B shows a peak at 1620 $cm^{-1}$, which represents a C=C bond, whereas the IR spectrum of Compound C does not show this peak.
Blank 1: answer "B" or "C". Blank 2: give the bond type. Blank 3: answer "B" or "C".
d. Compound C reacts with $KMnO_4$ to form Compound D. The H NMR of Compound D shows two peaks with the following intensity ratio and splitting (multiplicity) = 3 (triplet): 2 (quartet).

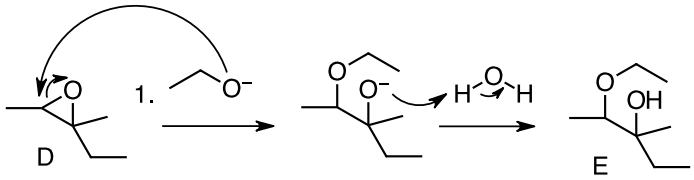
Draw the structure of Compound D. In your structure of Compound D, draw in the H or H's and circle the H or H's that is responsible for the H NMR peak that splits into a triplet.
Compound C (3-pentanol) is a 2° alcohol. $KMnO_4$ is an oxidizing agent.
A 2° alcohol is oxidized to a ketone so 3-pentanol is oxidized to 3-pentanone.
3-pentanone is used as a solvent in paints and is a precursor to Vitamin E.
2 H's on C adjacent to circled H's so n + 1 = 3 → triplet.



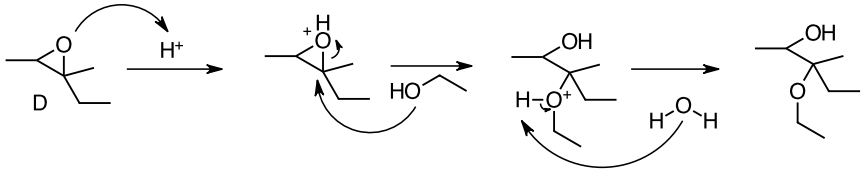
Quiz 3 Solutions:
1. Diethyl ether is a common organic solvent. It can be made from ethanol.
a. Draw the structure of Compound A. Why does Compound A need to form? To make a better leaving group
b. Use curved arrows to show how Compound A reacts with ethanol to form diethyl ether.



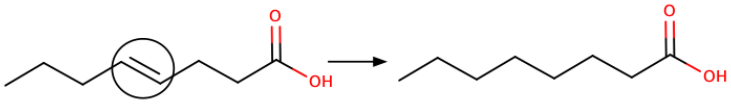

2. a. Compound D has 2 alpha carbons. The O in Compound D does not have to be protonated first because ___.
The epoxide ring is very strained (compare 60° ring angle to ideal 109° tetrahedral angle) so opening the ring by reacting at the alpha C is favored energetically.
Blank 1: give a number only. Blank 2: give reasons.
b. Draw Compound E. Use curved arrows to show E forms.




c. Compound D reacts with $H^+$ and $C_2H_5OH$. Will Compound E form? If not, draw the structure of the product that forms.
Compound E will not form. $H^+$ protonates epoxide O. The nucleophile reacts at the more substituted 3° carbon (electronic effect compared to steric effect for 1° and 2° carbons).

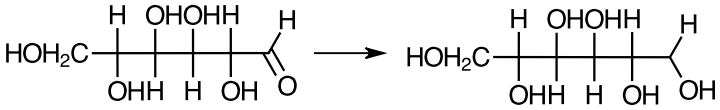



Quiz 2 solutions
1. a. Identify the reaction as an oxidation or reduction. Circle the carbon(s) at which oxidation or reduction occurs.



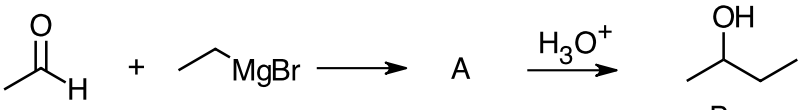
Reduction: alkene → alkane involves gain (addition) of 2 H's.

b. Identify the reaction as an oxidation or reduction. How many H's and O's are gained or lost in this reaction?



Reduction: aldehyde → alcohol involves gain of 2 H's (1 H on C and 1 H on O) and loss of 1 O (treat C=O double bond like two C-O single bonds).

2. Consider the reaction.

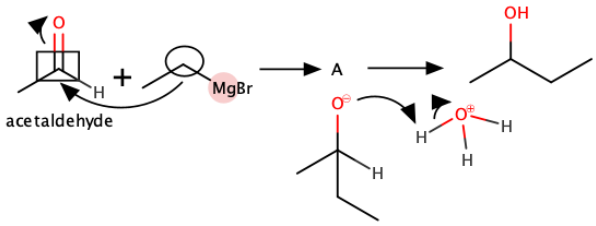


acetaldehyde

a. Circle the nucleophilic atom and box the electrophilic atom in the reactants.

b. Use curved arrows to show how Compound A forms. Draw the structure of Compound A.

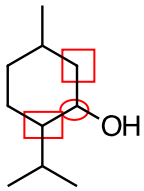
c. Use curved arrows to show how Compound A reacts with $H_3O^+$ to form Compound B. Is the reaction of acetaldehyde to Compound B an oxidation or reduction?



Quiz 1 solutions

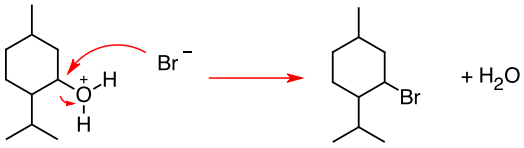
Menthol is the chemical that gives a cool sensation in our mouth and skin.

a. Alpha C is the C bonded to the OH leaving group. Beta C is adjacent to the alpha C.

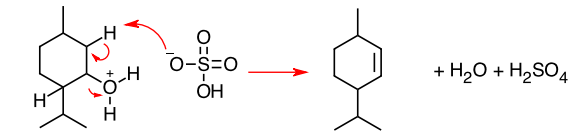


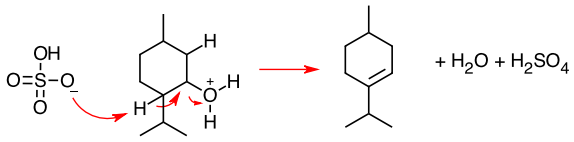
b. Reagent B = HCl, HBr, $H_2SO_4$, or any acid that is strong enough to react with ROH.

c.



d. At least two elimination products can form:




e. The ethoxide ion is a base and reacts with the acidic H on the alcohol to form: