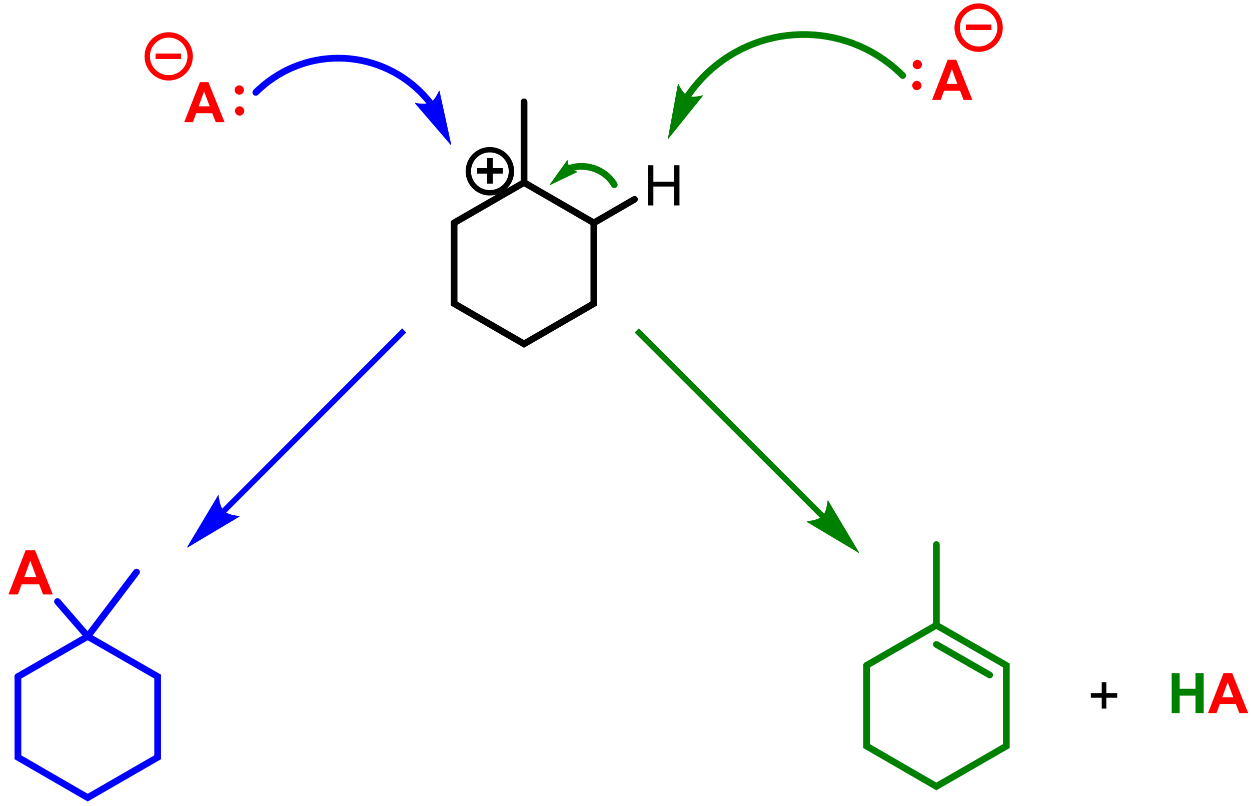
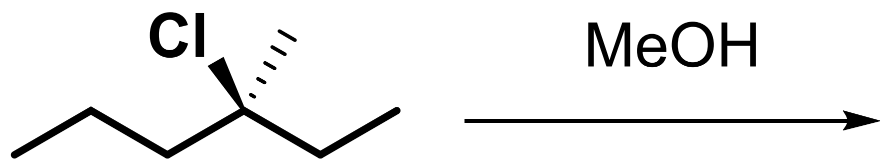


S_N1 when A acts as a *nucleophile*.

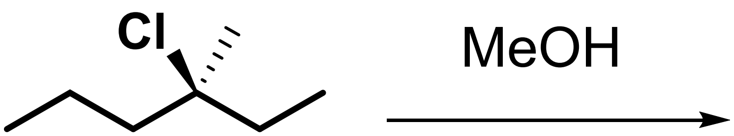
E1 when A acts as a *base*.

Problem 9

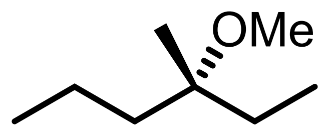
Predict the major substitution product(s):



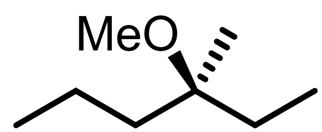
Problem 9



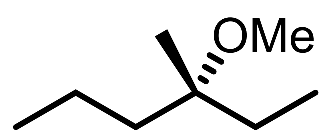
A



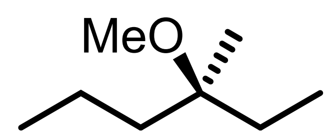
B



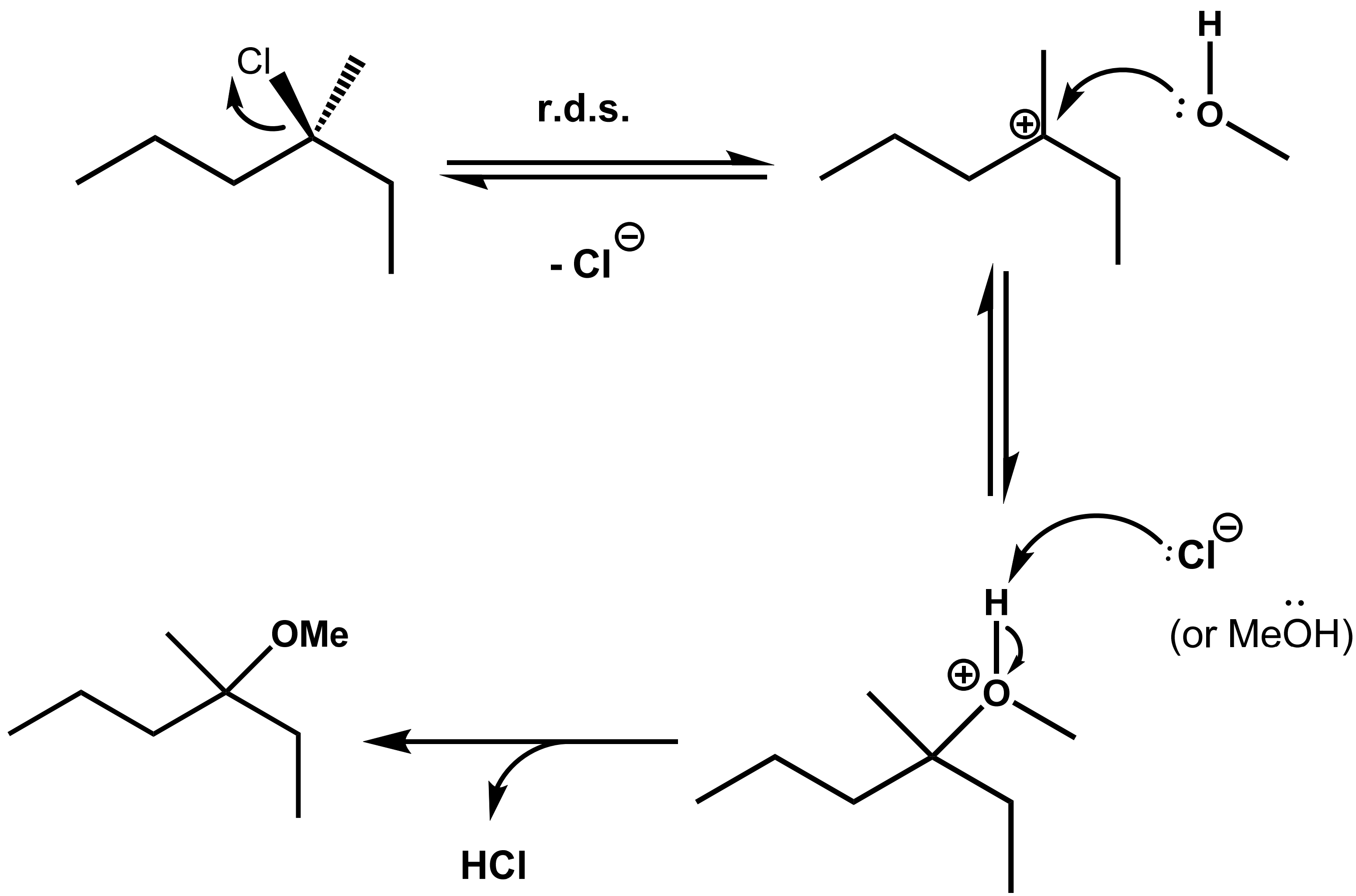
C



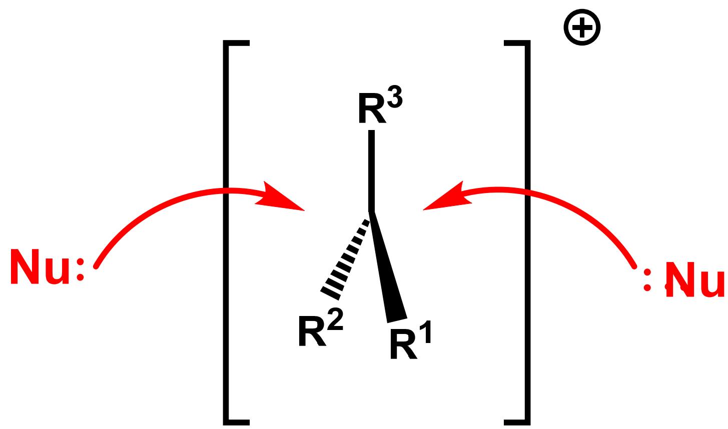
and



Mechanism

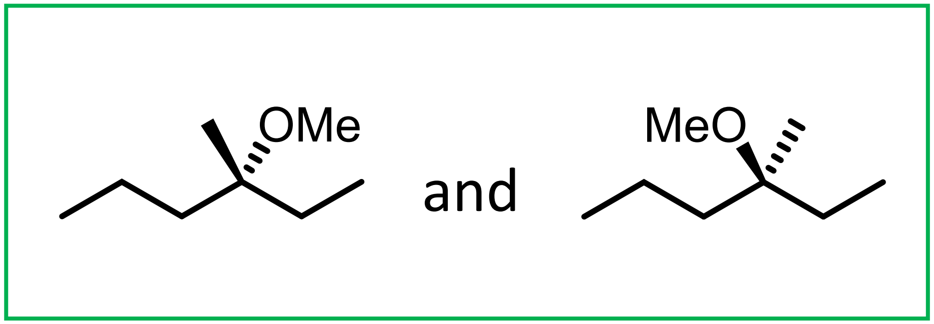


S_N1 - stereochemistry

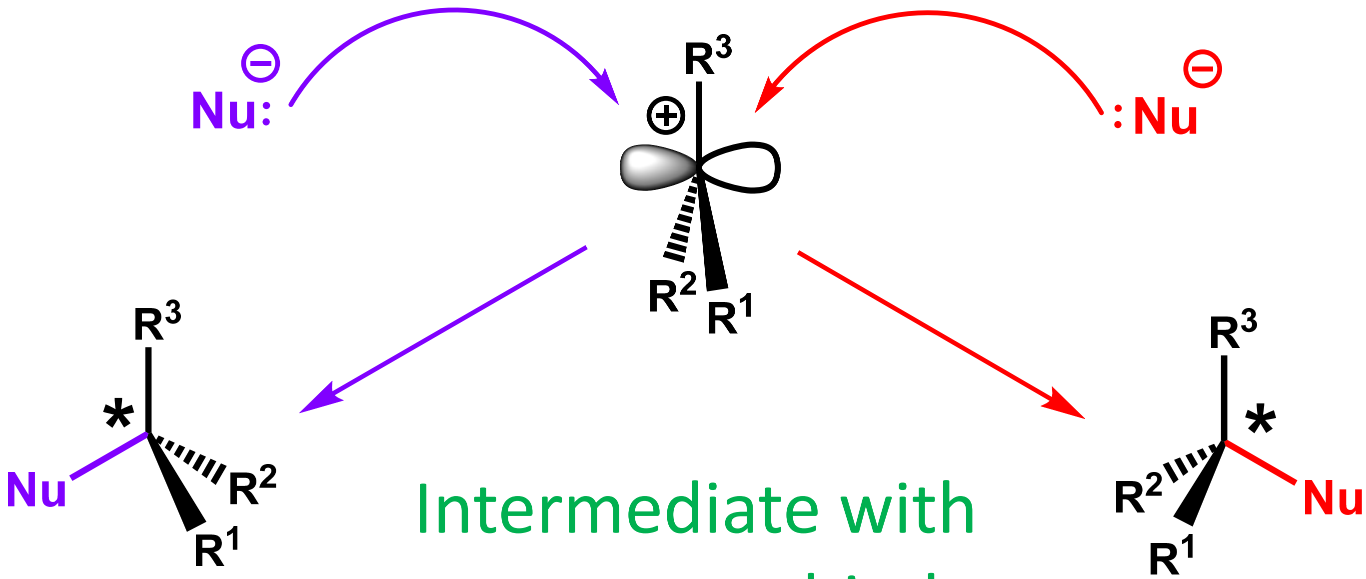


Equal chance of attack from either face

- Stereochemical info is lost when carbocation forms
- Racemic product mixture (±)

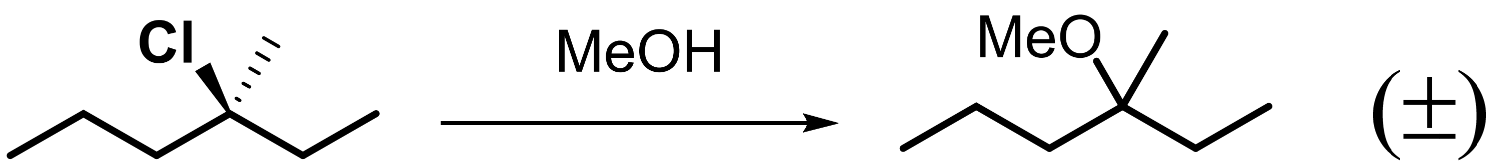


S_N1 - stereochemistry



Problem 9 - solution

Predict the major substitution product(s):

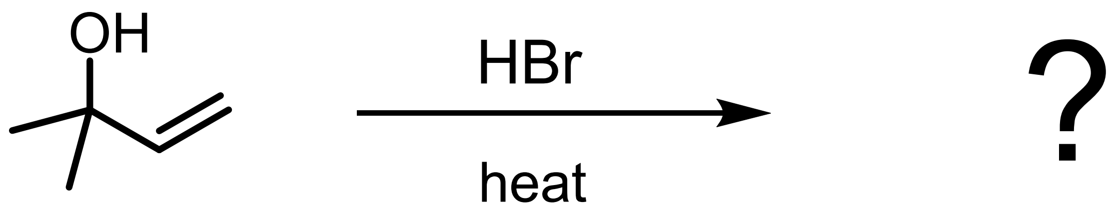


Concepts:

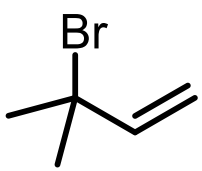
- **S_N1** mechanism
- Stereochemistry - racemization

Problem 10

Draw the S_N1 product(s) and propose a mechanism:

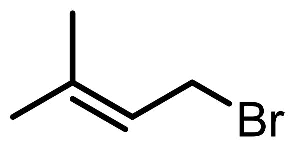


A



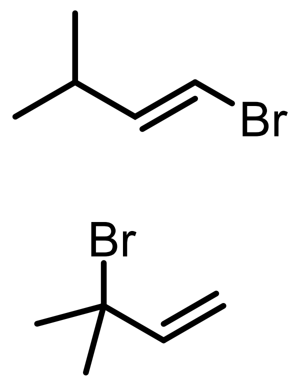
only

B

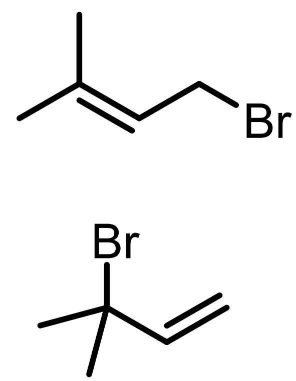


only

C

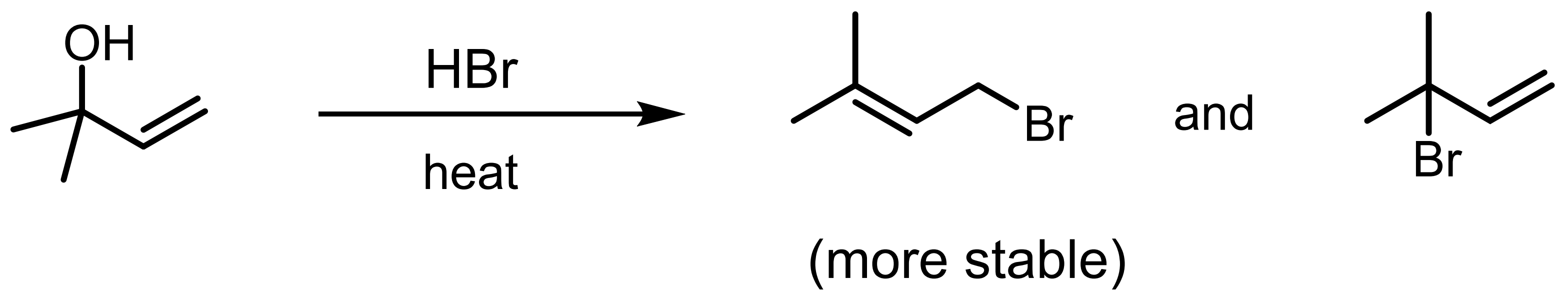


D



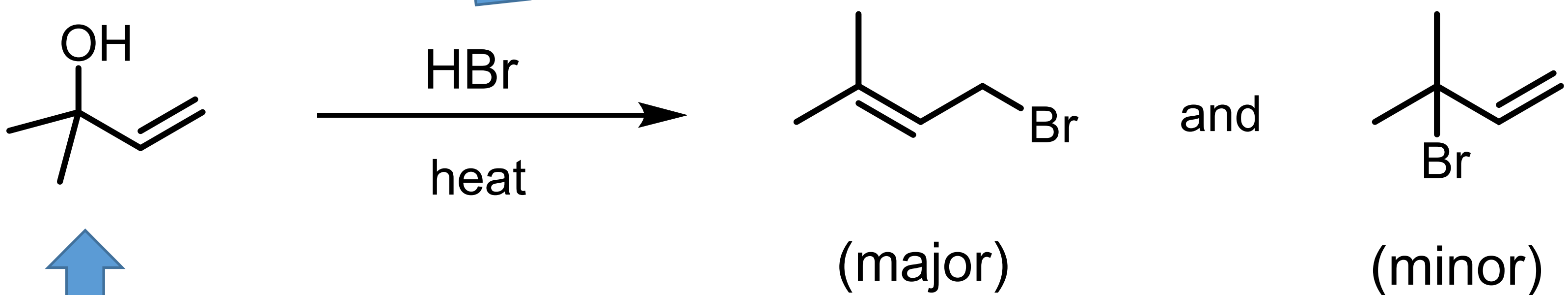
Problem 10

Propose a mechanism for the following:



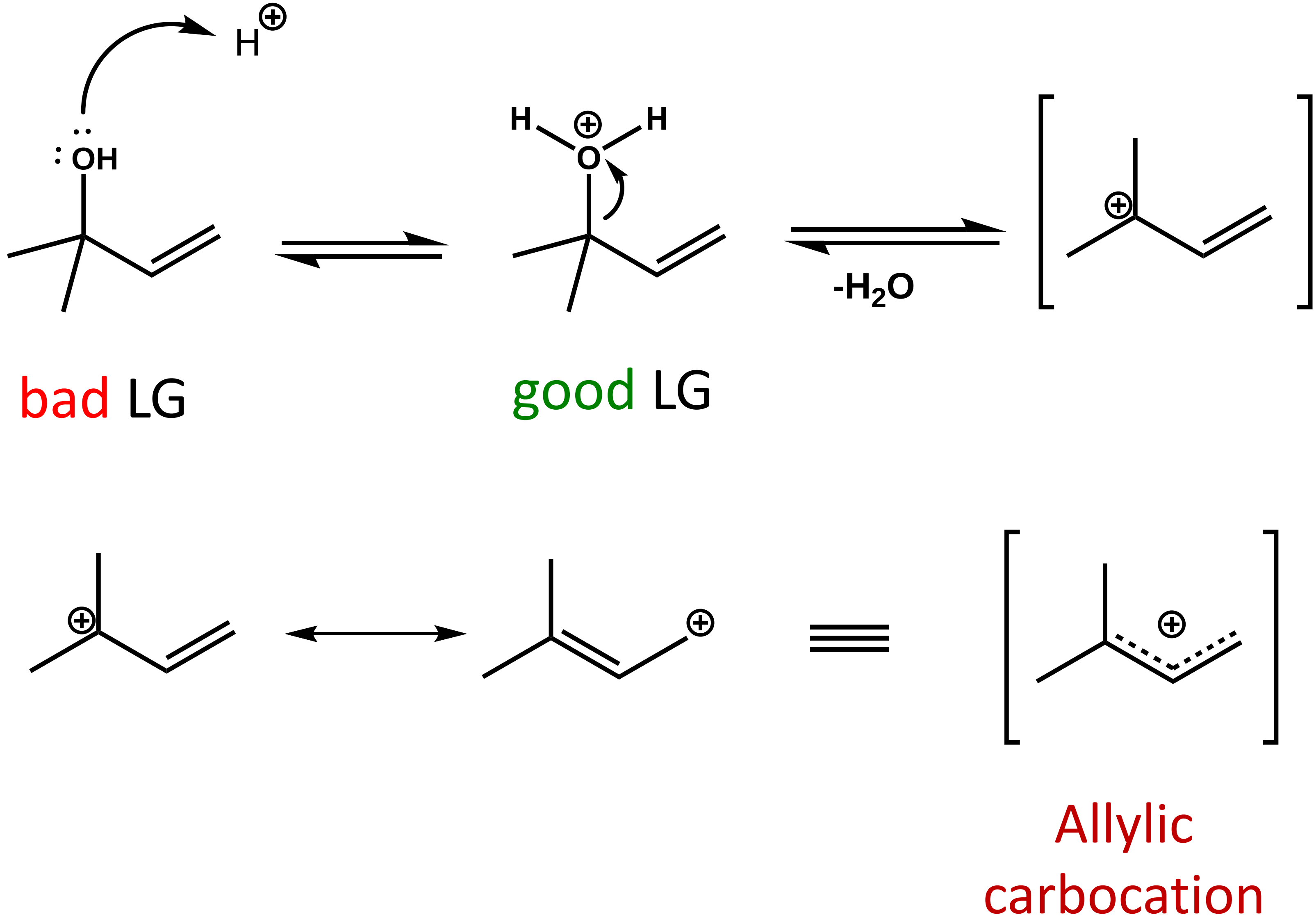
Problem 10 - analysis

- Strong acid
- Bromide - nucleophilic

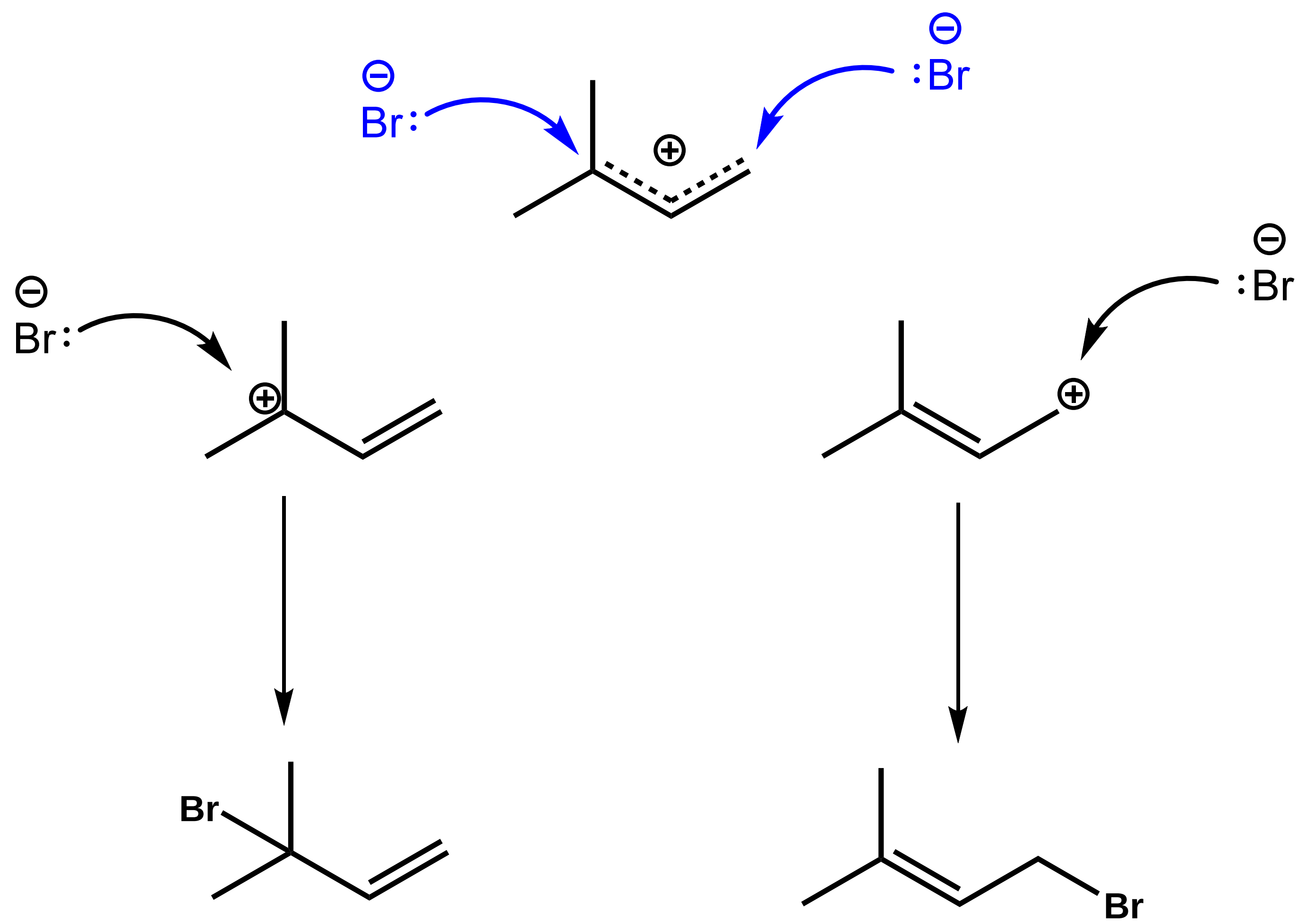


- Tertiary alcohol
- Allylic alcohol

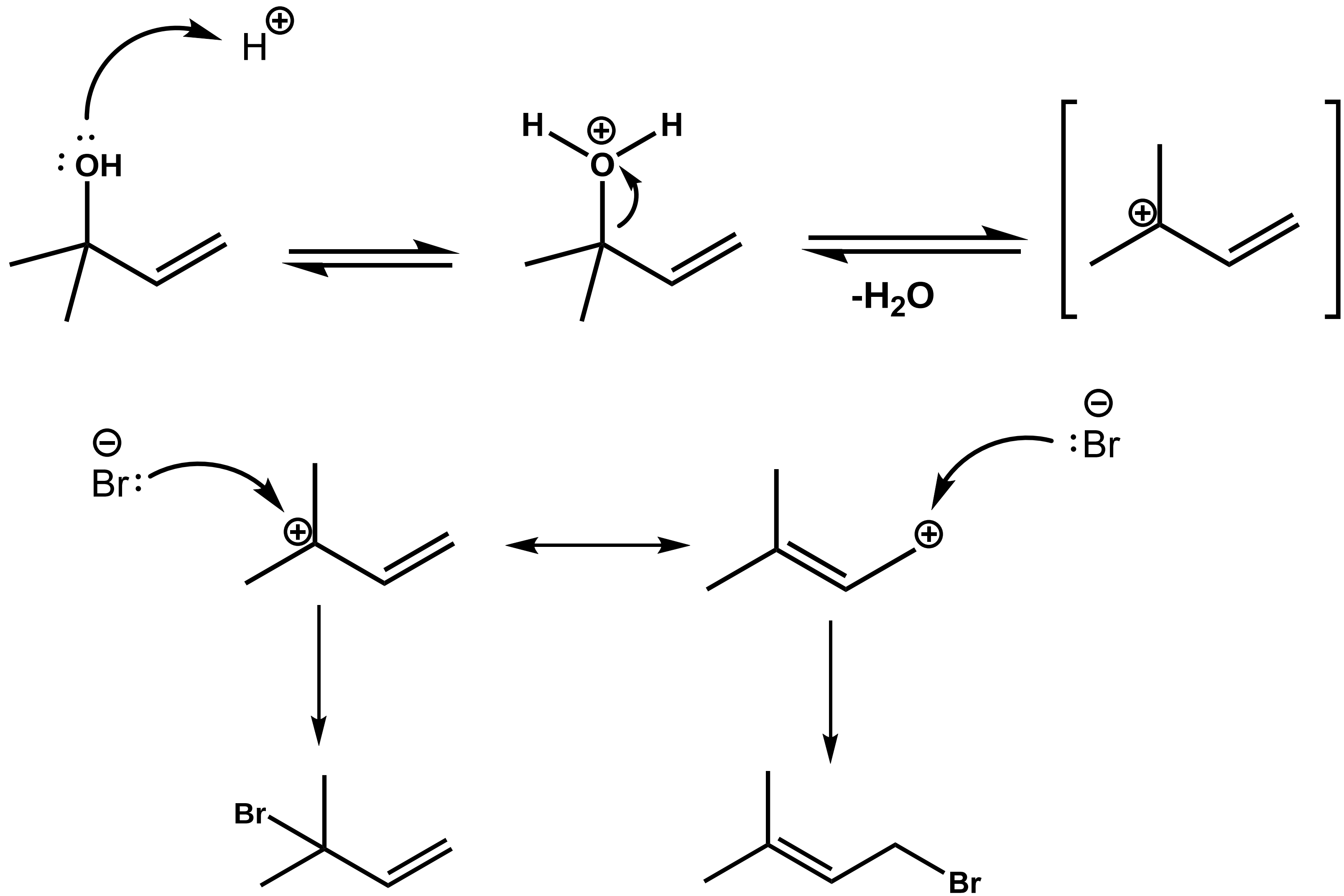
Substitution products (via S_N1)



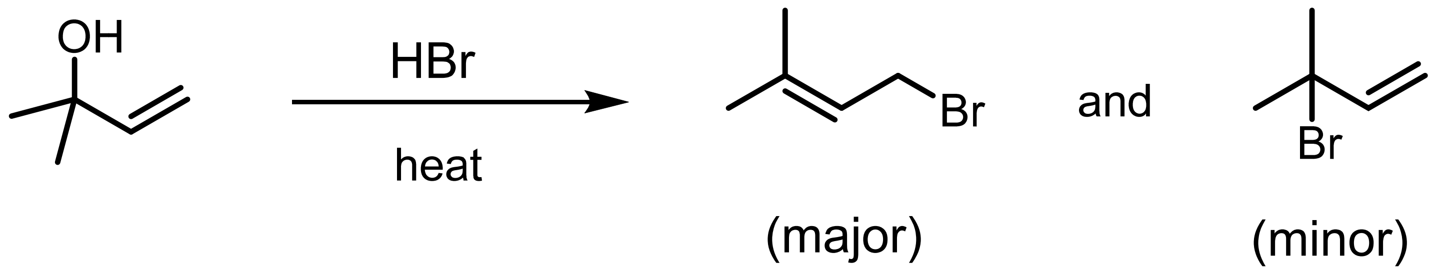
H
OH
H
O
H
-H2O
bad LG
good LG
Allylic
carbocation


Br
Br
Br
Br
Br
Br

Problem 10 - answer



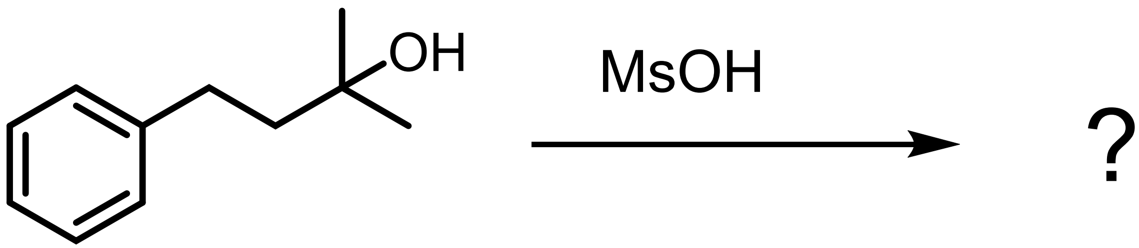
Problem 10 - concepts

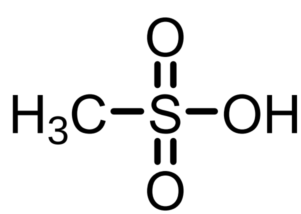


- Acid-base
- Carbocations
- Resonance structures (i.e. allylic)
- **S_N1** reactions

Problem 11

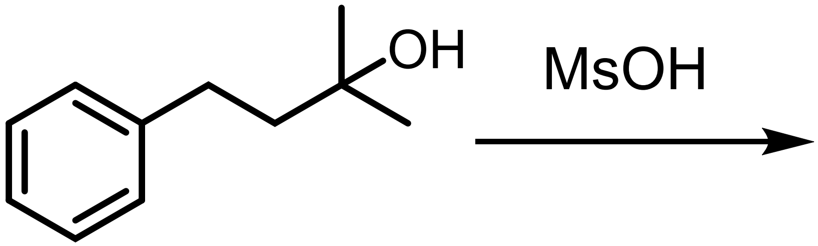
Predict the major product(s):



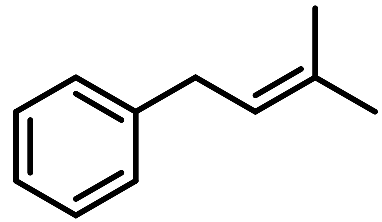
MsOH = 

Methanesulfonic acid
(Ms = mesyl)

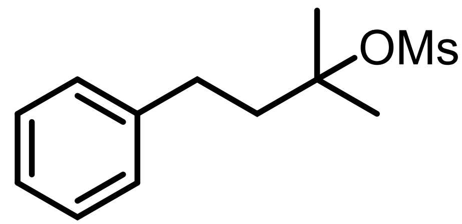
Problem 11



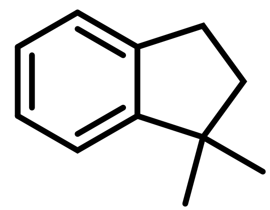
A



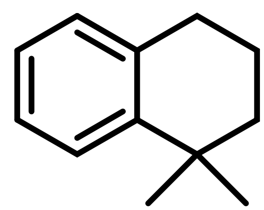
B



C

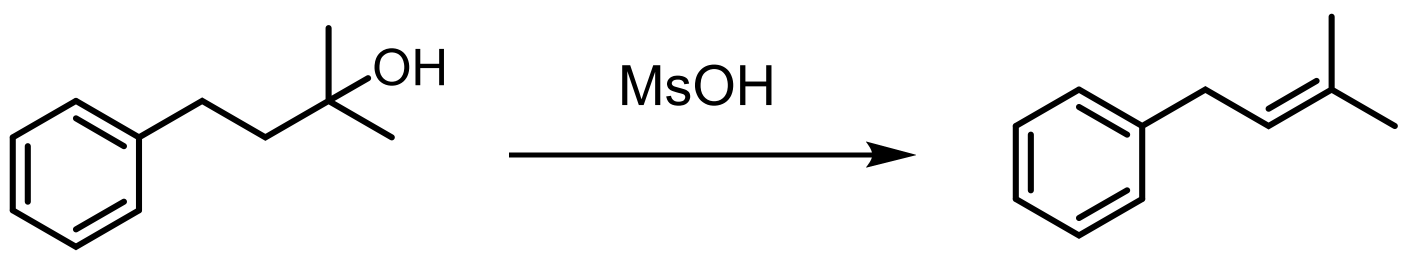


D



Problem 11

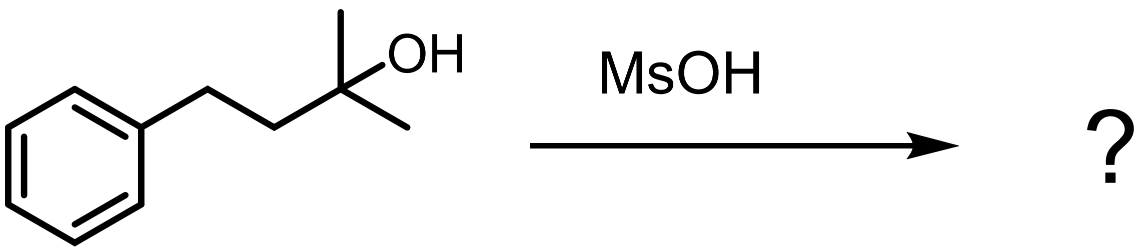
Predict the major product(s):



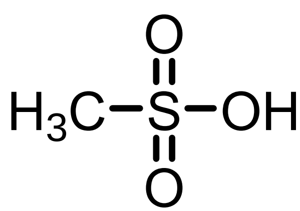
Possible product, but not the major one

Problem 11 - analysis

- Tertiary alcohol (potential 3˚ carbocation)

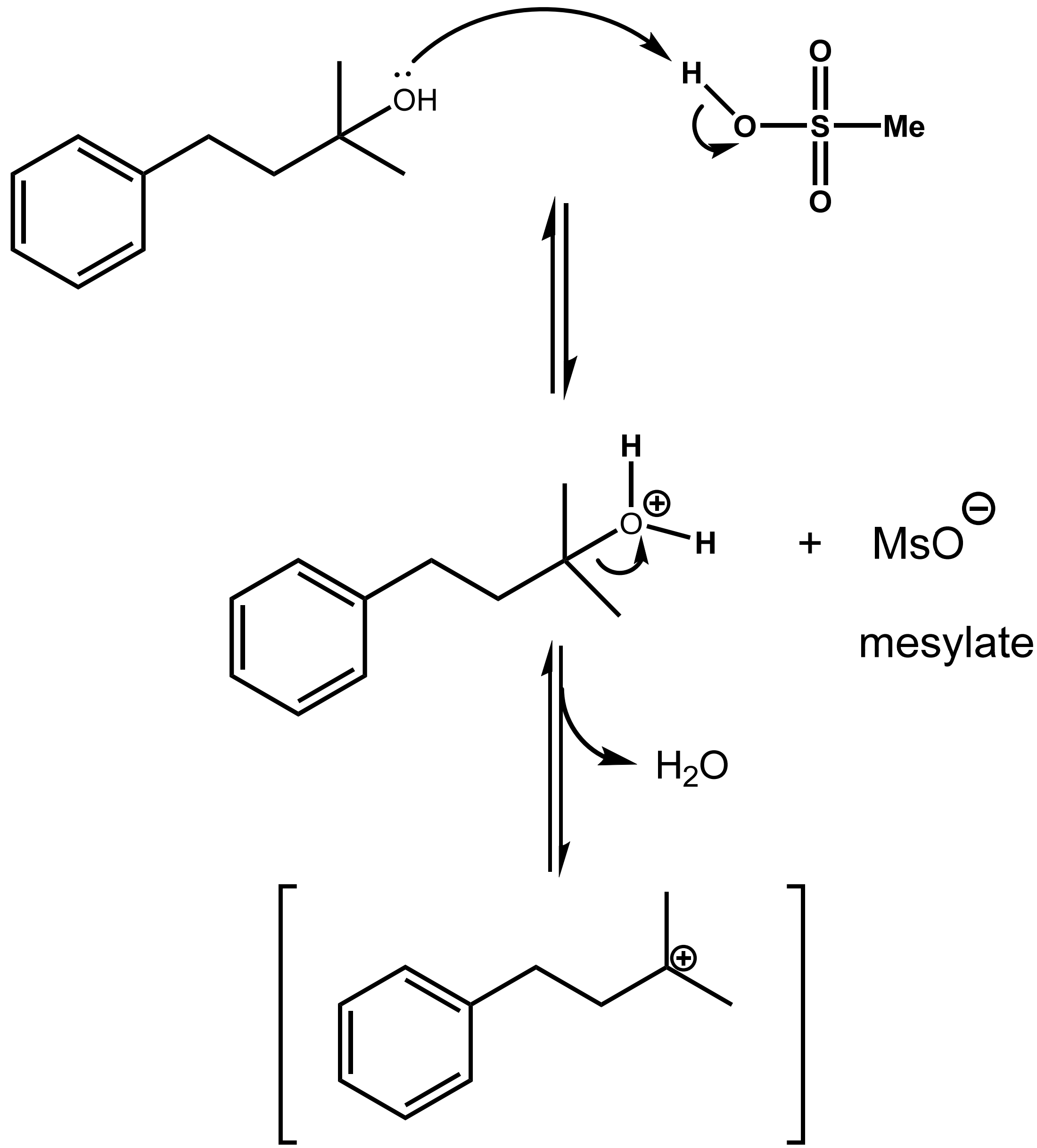


MsOH =

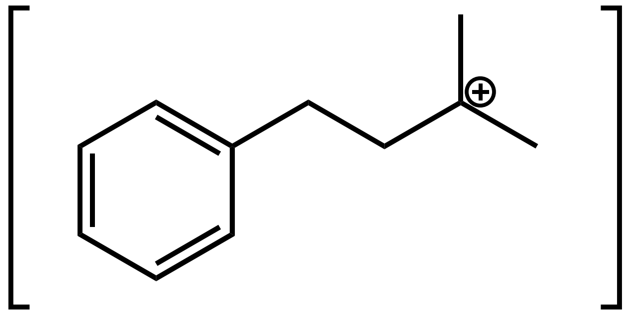


methanesulfonic acid

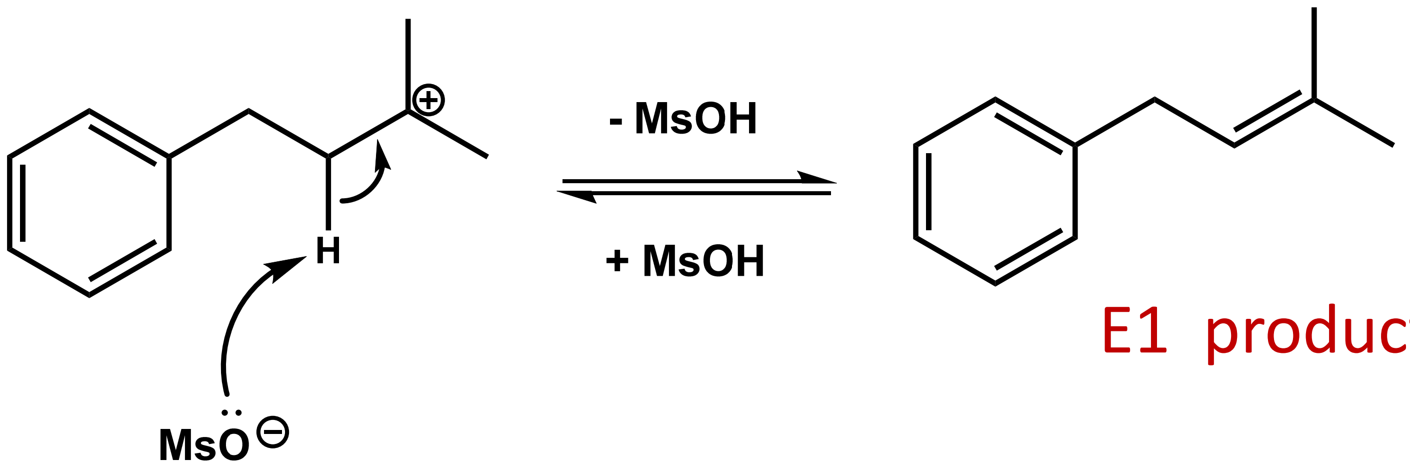
- Strong acid
- Non-nucleophilic anion



OH
H
O
S
Me
O
O
H
O
H
+
MsO
mesylate
H_2O



3˚ carbocation



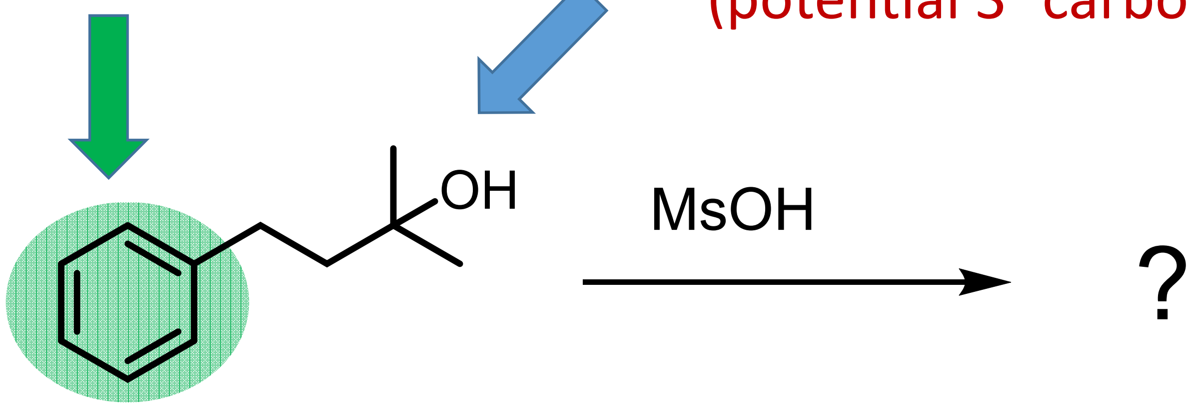
E1 product

is reasonable, but ***not the best*** option.

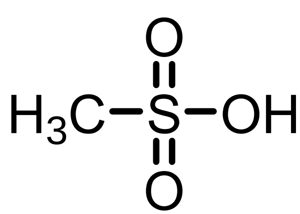
Problem 11 - analysis

This can be a nucleophile!

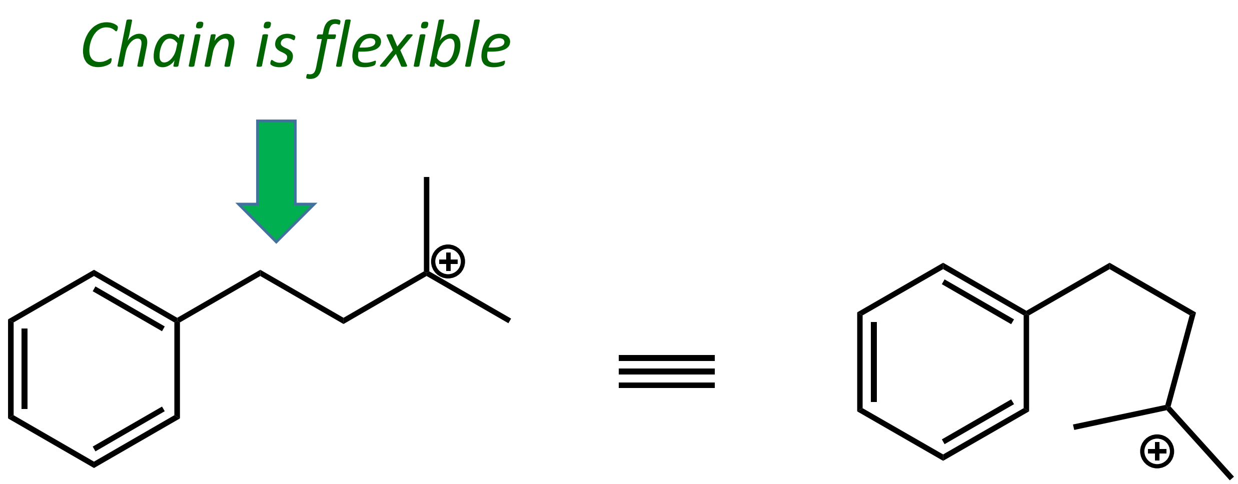
- Tertiary alcohol (potential 3˚ carbocation)

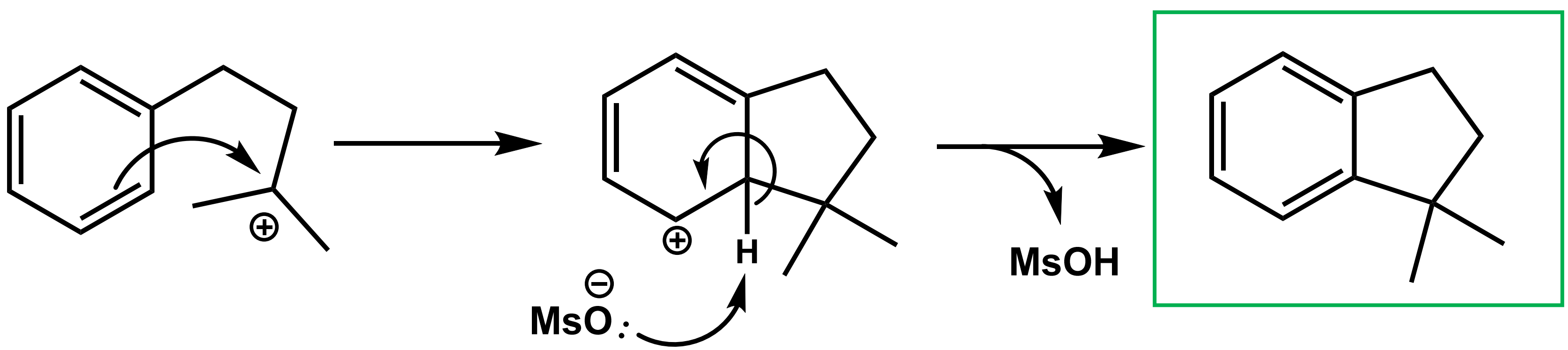


MsOH =



- Strong acid
- Non-nucleophilic anion



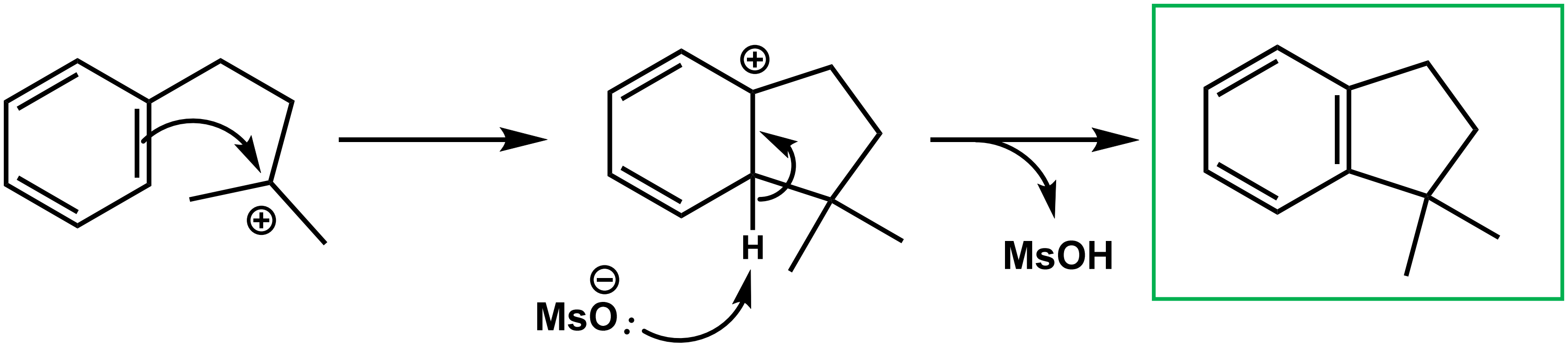


Benzene: undergoes electrophilic aromatic substitution

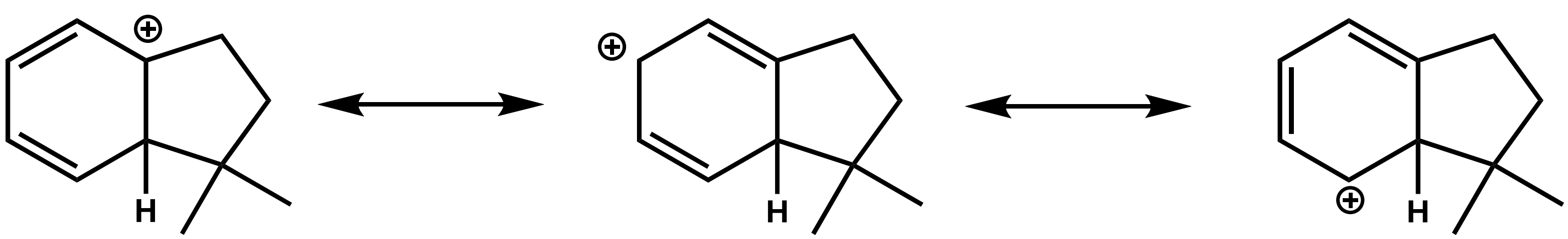
In case <u>you had drawn your benzene ring double bonds differently</u>...

..your mechanism (equivalent) would look like this:

arenium ion



The different representations are related by resonance:



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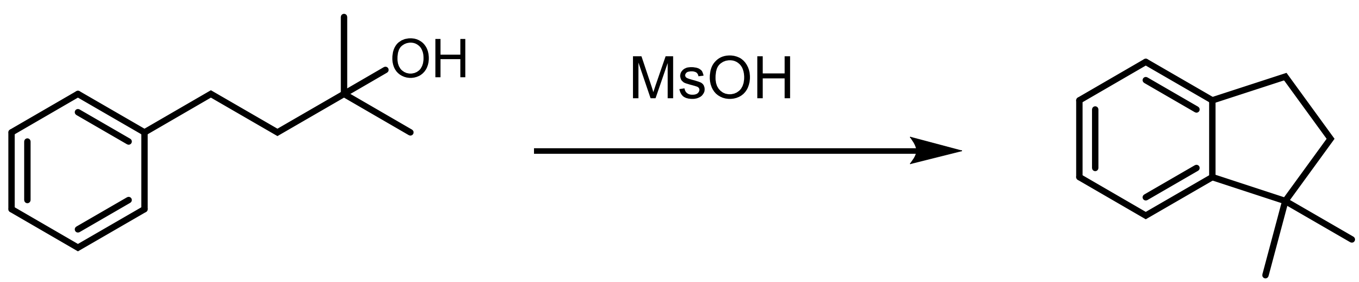
Problem 11 - solution

Predict the major product(s):

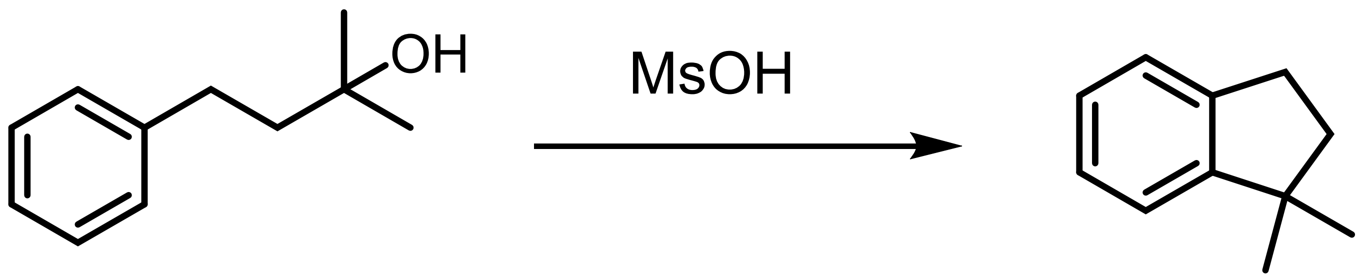


Benzene: underwent electrophilic aromatic substitution, **S_EAr**

Alcohol: underwent **S_N1** reaction

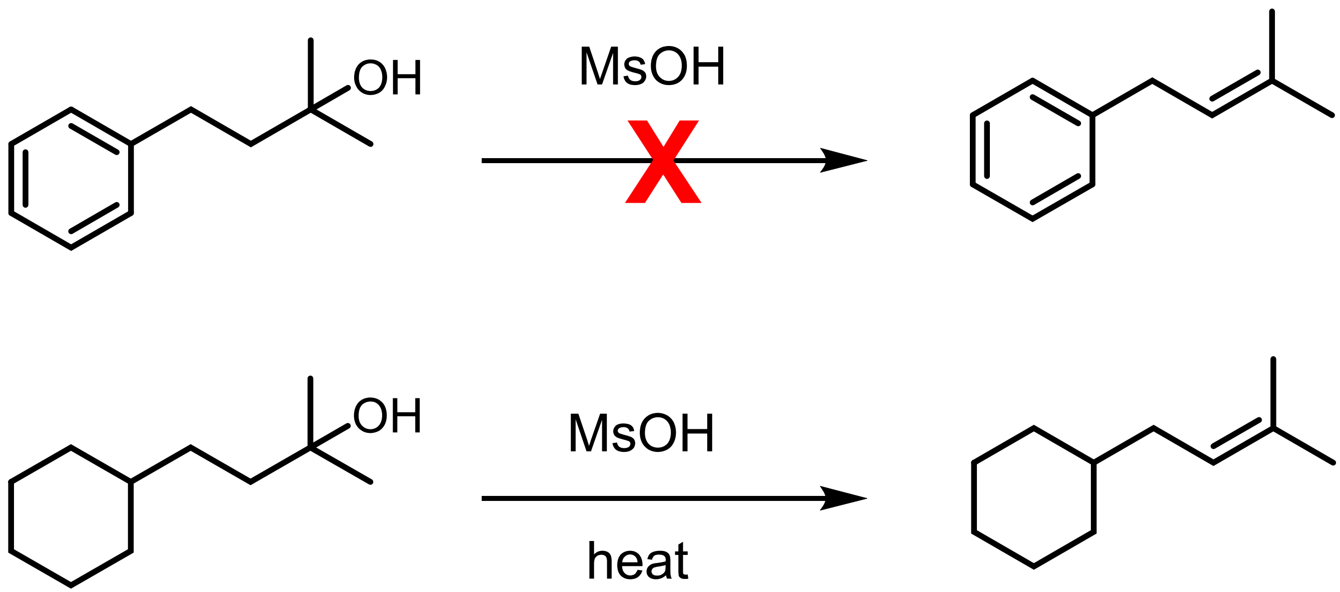
Problem 11 - concepts

Predict the major product(s):



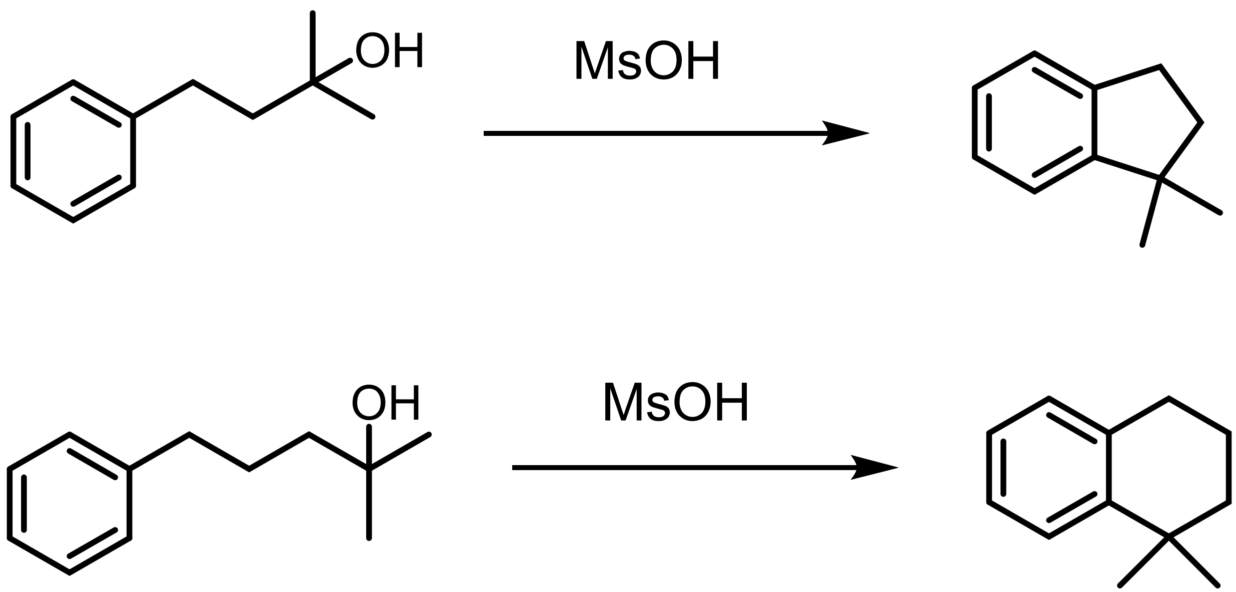
- Acid-base
- Carbocations
- S_N1 reaction (intramolecular)
- S_EAr reaction (intramolecular)

Problem 11 - pitfalls



Incomplete analysis of **starting material** in the first case leads to wrong conclusion.

Note on cyclizations

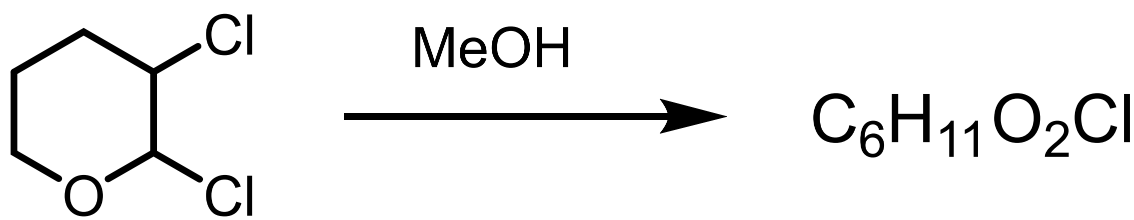


In general, 5- and 6-membered ring formations are favorable

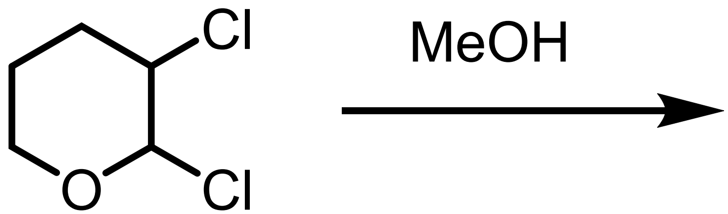
Problem 12

(i) Propose a structure for the product

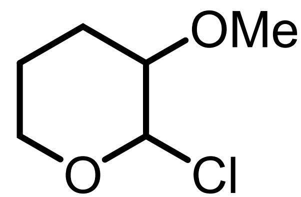
(ii) Draw a mechanism for its formation



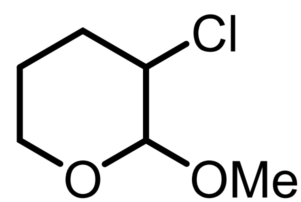
Problem 12



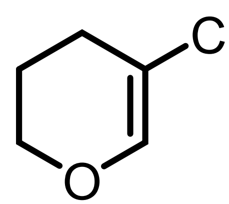
A



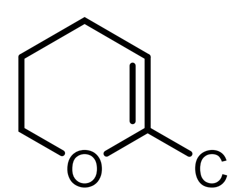
B



C

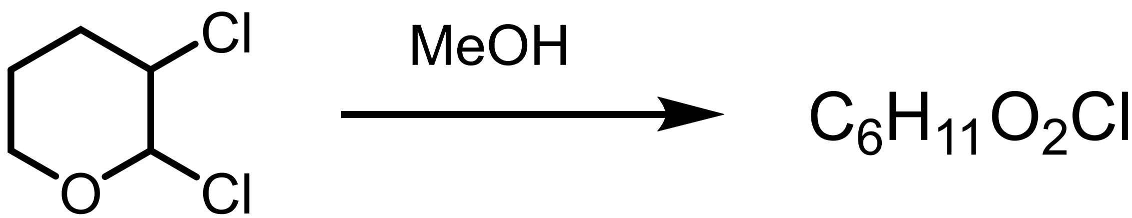


D



Problem 12 - analysis

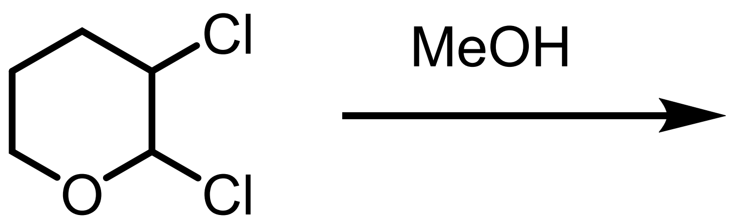
- Polar protic solvent
- Potential nucleophile



- Secondary halide
- Cl^- – good LG

Structure?

Problem 12 - analysis



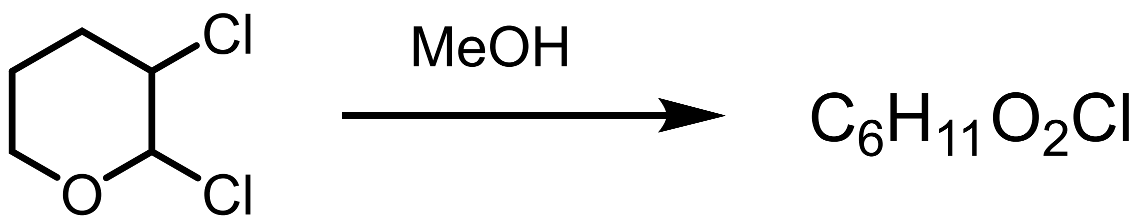
$C_6H_{11}O_2Cl$

Count atoms: $C_5H_8OCl_2$

- Gain 1 carbon
- Gain 3 hydrogens
- Gain 1 oxygen
- Lose 1 chlorine

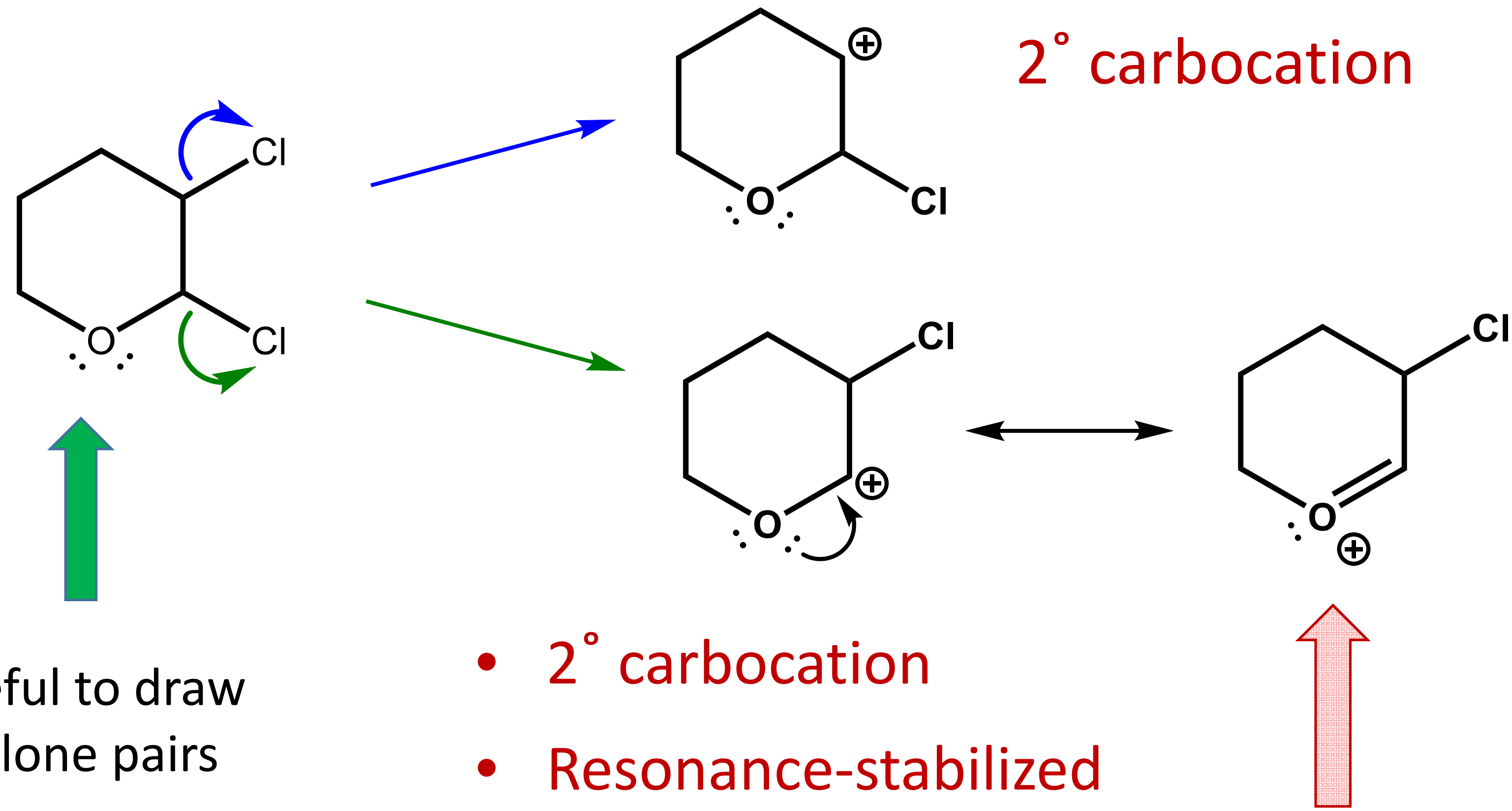
★ Gain CH_3O and lose Cl - **substitution**

Problem 12 - analysis



- One of two Cl to be lost
- 2° chlorides, polar protic solvent
- **S_N1** is strongly indicated

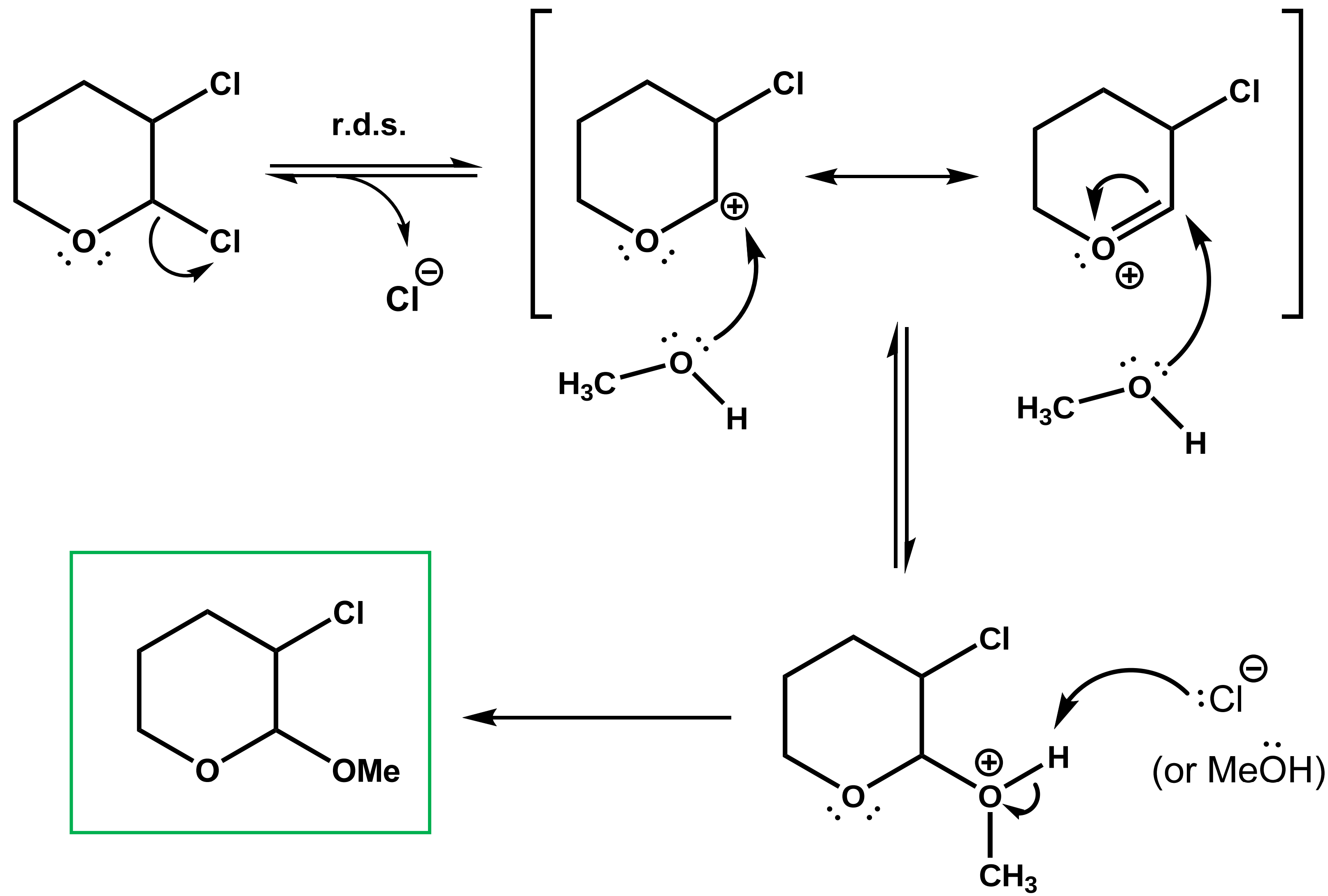
Problem 12 - first steps



2° carbocation

Useful to draw in lone pairs

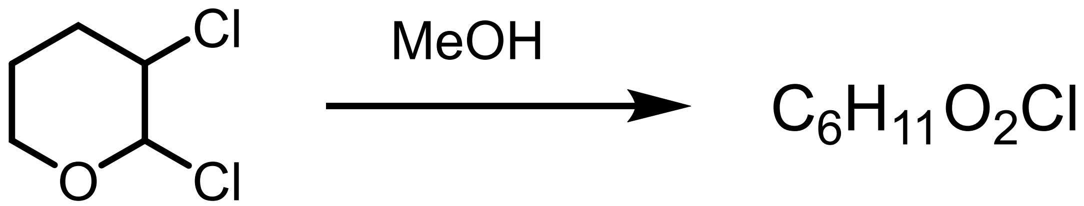
- 2° carbocation
- Resonance-stabilized
- RHS structure: <u>every atom has an **octet**</u>



Cl
Cl
r.d.s.
Cl
Cl
Cl
H3C
H
H3C
H
Cl
OMe
Cl
H
:Cl
(or MeOH)
CH3

Problem 12 - concepts

(i) Propose a structure for the product
(ii) Draw a mechanism for its formation



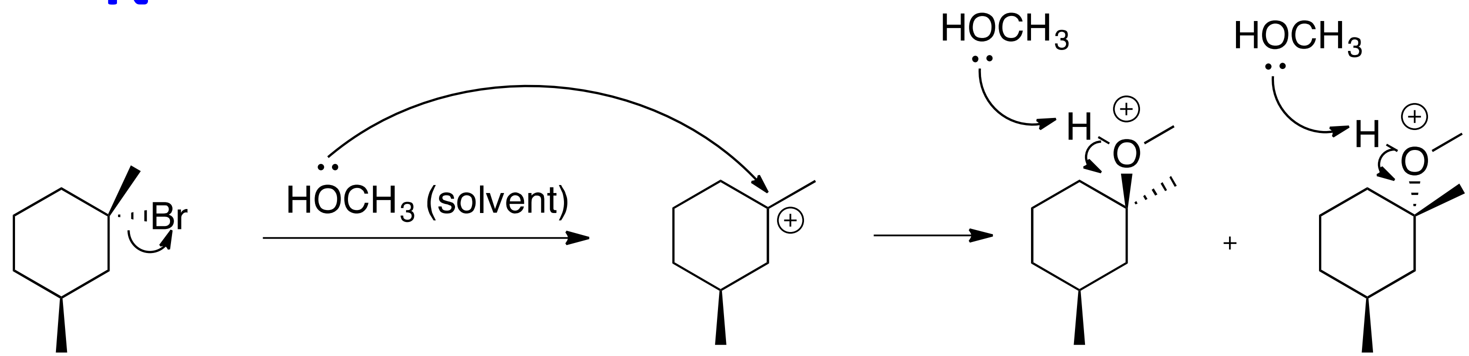
- Leaving groups
- Resonance-stabilized carbocations
- **S_N1** mechanism
- **Key**: knowing which Cl to substitute

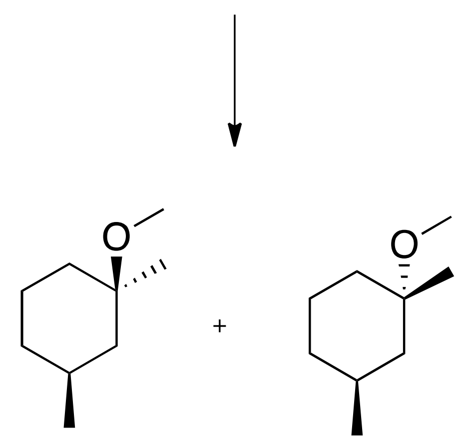
Problem 12 - Feedback

Many students answered **(A)** instead of **(B)**. You might have been concerned that the inductive effect of the electronegative O would destabilize your carbocation?

It thus helps to draw out any lone pairs. Then it can be seen that the resulting carbocation is **(i)** resonance-stabilized, and **(ii)** has a contributing structure in which all atoms have octets. These two factors would outweigh any inductive effect arguments that might favor (A).

S_N1 - summary





- **α carbon**: 3° or resonance-stabilized > 2° >> 1°
- **Leaving group**: weak base is best
- **Nucleophile**:
  - Weak nucleophiles favour **S_N1**
  - Usually the solvent
- **Solvent**:
  - Polar, protic
  - Stabilize the TS of the RDS
- **Regiochemistry**: Substitution at α-carbon
- **Stereochemistry**: Get a mixture of stereoisomers
- Watch for **rearrangements**