Final Exam Worksheet

Types of bonds

Ionic Bonding:

Covalent Bonding:

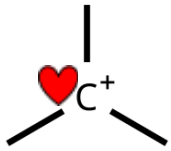
Polar Covalent:

What is the bonding type of each molecule below?

NaOH	HI	NH_3	H_2

Hybridization

Determine the hybridization of the hearted element:



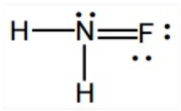
$CH_3CH_2NH_2$

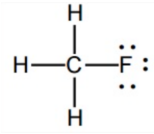
Lewis Structures

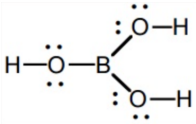
Draw the Lewis structure of the following compounds:

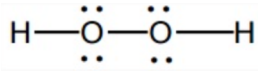
NI_3	CCl_4	CO_2	H_2CO

Which of the Lewis structures is wrong?





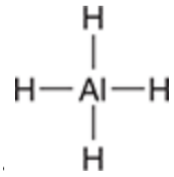


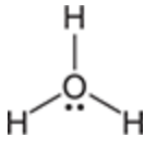


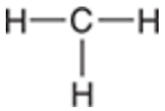
Formal Charge

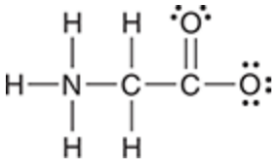
Assign each molecule a formal charge (if applicable)

Remember the equation:







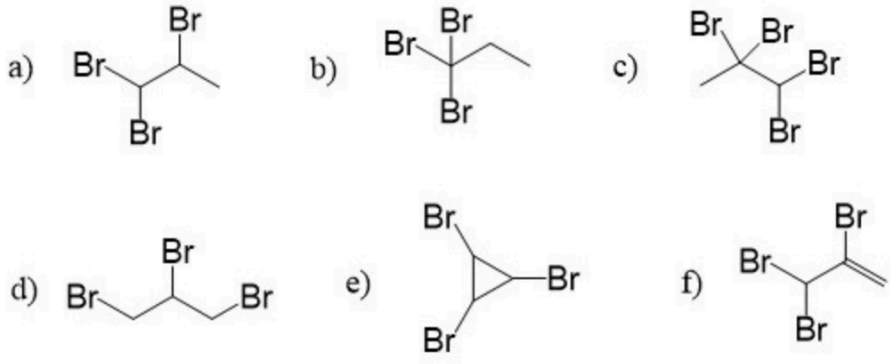


Constitutional Isomers

Draw all possible isomers of C_3H_7Cl

Draw all of the possible isomers of propanol

Identify the constitutional isomers of Molecule A

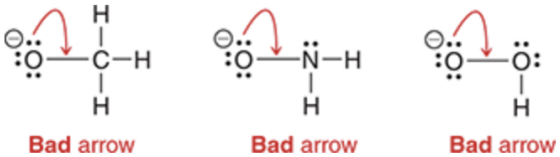


Resonance

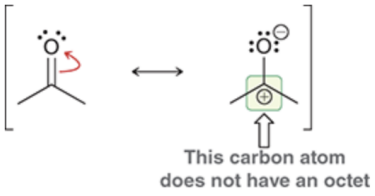
Rules

1. Avoid breaking a single bond

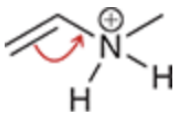
2. Never exceed an octet for second-row elements (C, N, O, F)

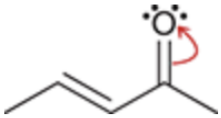


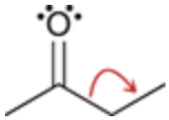
3. Less than the octet is okay



Do the following resonance arrows violate the octet rule? Are there any other rules being violated in the structures below?

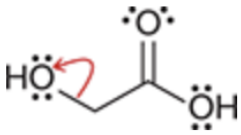




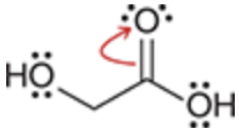


Which of the following arrows is valid?

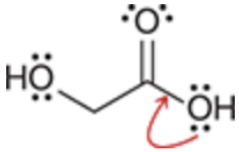
a.



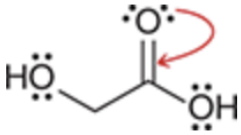
b.



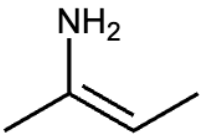
c.

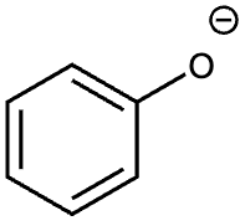


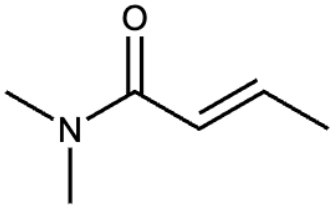
d.



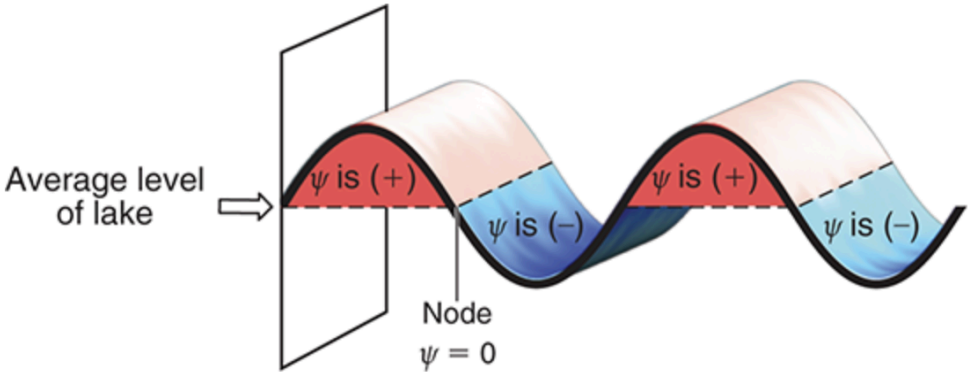
Draw all possible resonance structures in the following compounds:







MO theory/Quantum Mechanics

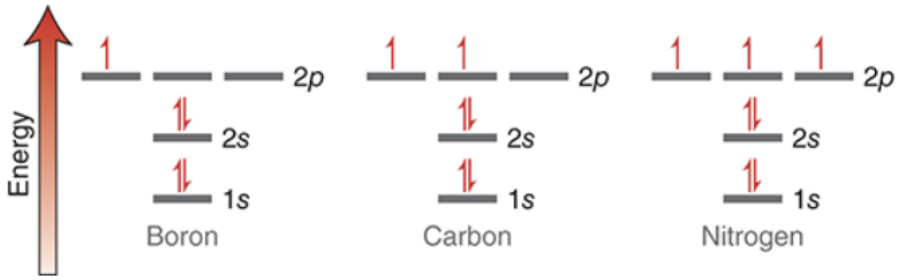


Follow these three principles of filling electron orbitals:

Aufbau's:

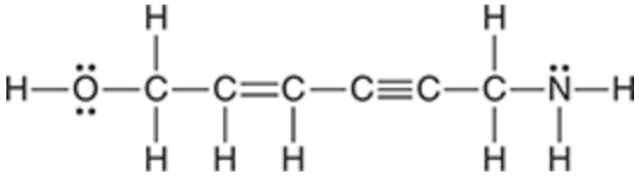
Pauli Exclusion:

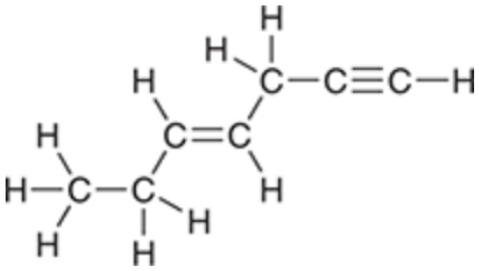
Hund's Rule:



Bonding

How many sigma and pi bonds are in the following molecules?





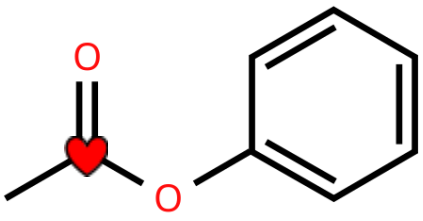
Which of the compounds has the longest and shortest carbon-carbon bond? CH_3CH_3 and HCCH

Order the compounds below in decreasing bond length: HI, HF, and HBr

Do the compounds below have an overall dipole moment?

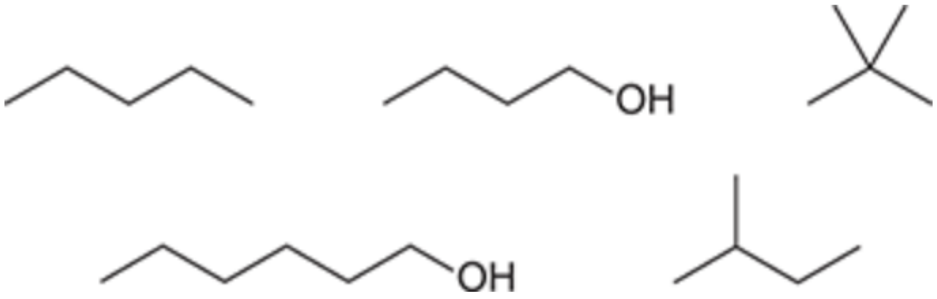
CH_4 NH_3 H_2O CO_2 CCl_4 CH_2Br_2

What is the carbon atom's Hybridization state, molecular geometry, and bond angle in the compound below?



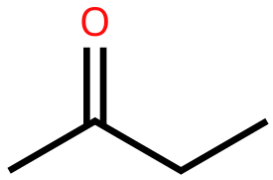
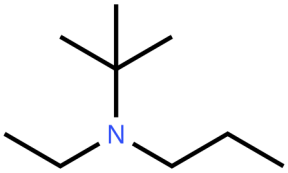
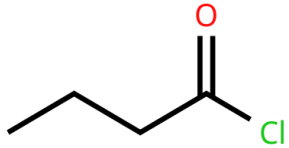
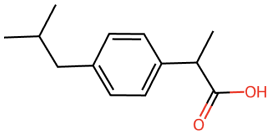
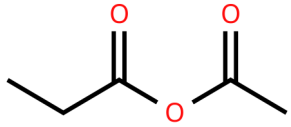
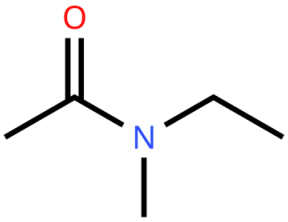
bonus What are the functional groups here?

Order the compounds in increasing boiling point:



Functional Groups

Identify the functional groups in the compounds (there can be more than 1):

Of the intermolecular forces listed, which is stronger? Weaker?

a. London-Dispersion
b. Dipole-Dipole
c. Hydrogen Bonding

What intermolecular force is present among all molecules?

Acids and Bases

Define Bronsted-Lowry acids/bases:

Define Lewis acids/bases:

Identify the acid, base, conj. acid, and conj. base of the reactions below:

$$HCl + NH_3 \rightarrow NH_4^+ + Cl^-$$

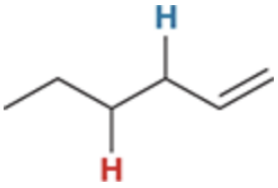
$$OH\text{-} + HCN \rightarrow H_2O + CN\text{-}$$

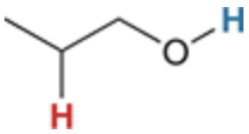
The _____the pKa value, the stronger the acid!

Rank the compounds in increasing order of basicity:

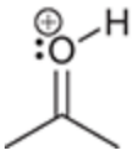
CH_3O^-, H_2O, NH_3, H_2N^-

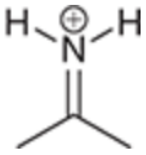
Circle the most acidic hydrogen:





Which of the compounds is more acidic? Why?





Nomenclature 101

Naming Alkanes:

Number of C atoms	Formula	Name
1	CH_4	methane
2	C_2H_6	ethane
3	C_3H_8	propane
4	C_4H_{10}	butane
5	C_5H_{12}	pentane
6	C_6H_{14}	hexane
7	C_7H_{16}	heptane
8	C_8H_{18}	octane
9	C_9H_{20}	nonane
10	$C_{10}H_{22}$	decane

1. If there is a competition of numbering chains of an equal length, number so that you get the _____amount of substituents

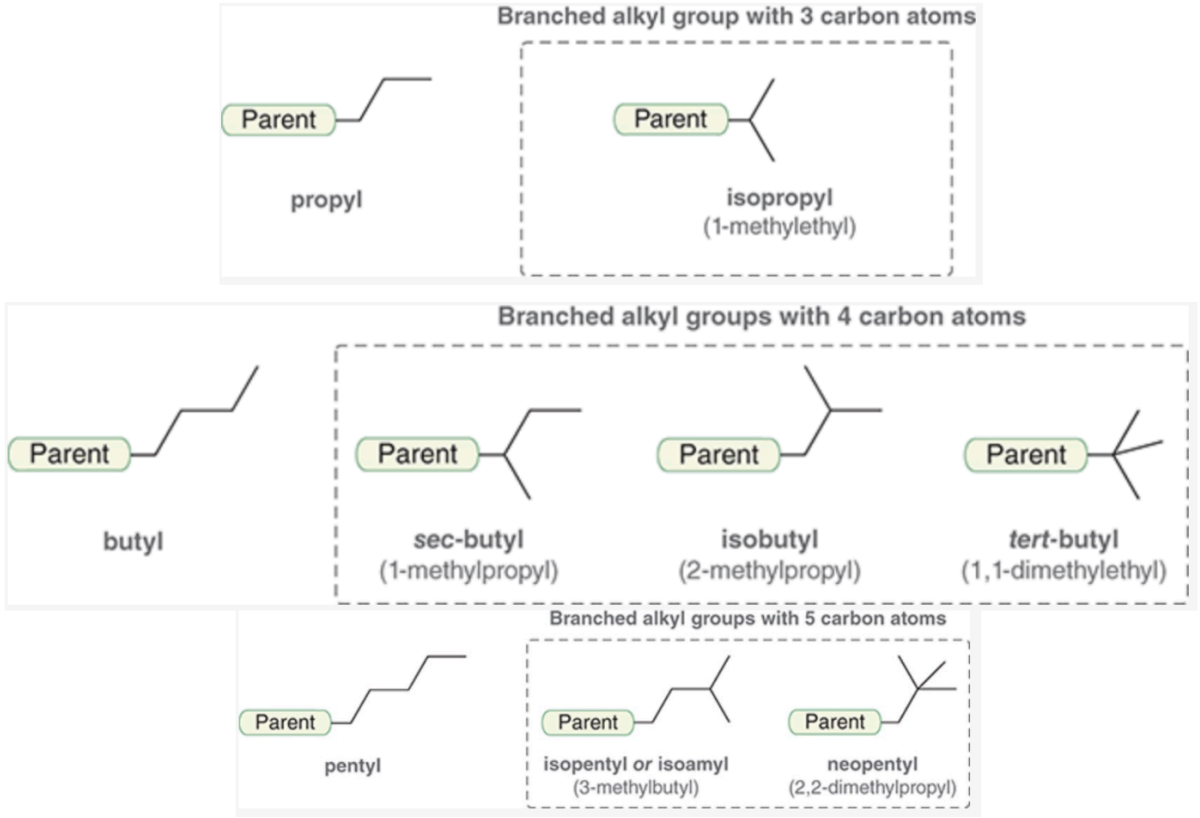
2. Use _____ to indicate a ring

3. To name alkyl substituents_____+_____

4. Number the parent chain and assign substituents the _____number possible according to IUPAC rules

5. To put names together, _____ substituents and combine using _____

Common names of alkyl groups (memorize)



When a substituent appears more than once in a molecule:

# of functional groups:	Prefix:
2	Di-
3	Tri-
4	Tetra-
5	Penta-
6	Hexa-

<u>Naming Alkyl Halides</u>

1. Halogen is treated as a _____

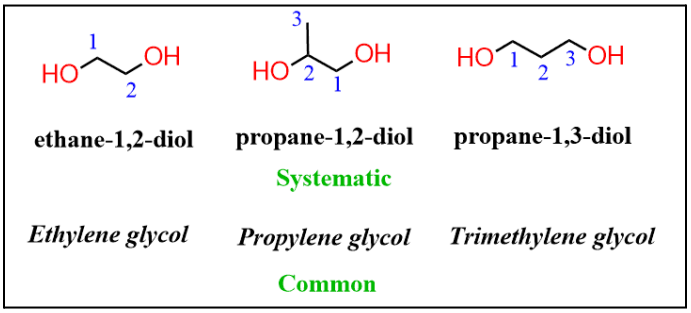
<u>Naming Alcohols</u>

1. Number the chain that includes the _____ group
2. Ends in _____

3. Alcohol gets_____(for the purposes of this class)

Naming Diols

1. Similar to alcohols just make sure you indicate the prefix of multiple alcohols
2. Remember the _____ of basic diols



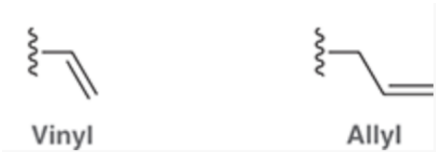
Bicyclic Compounds

1. Find total _____
2. Use _____
3. Find _____
4. Order paths going_____

Naming Alkenes

1. Ends in _____
2. Use the longest chain that _____
3. Pi bond is assigned _____

Allyl and Vinyl groups



Naming Alkynes

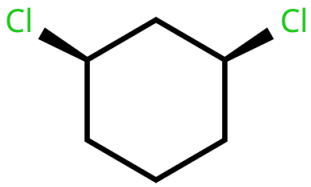
1. Use _____
2. The triple bond should be assigned _____

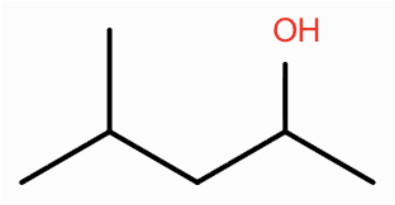
Alkenes and Alkynes: Which Takes Priority?

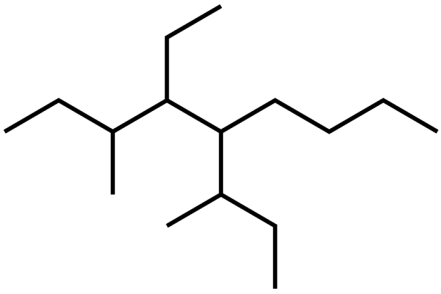
A molecule containing an alkene and alkyne with *no* higher-ranking substituents

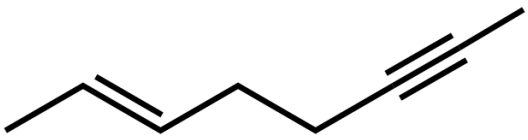
- will be **numbered** so as to provide the lowest set of locants
- will be **named** so as to arrange the ene/yne **alphabetically**

Name the compounds:









Draw the compound based on the name:

Trans-1,3-dimethylcyclohexane

(Z)- 2-bromo-2-butene

3-methylcyclopentene

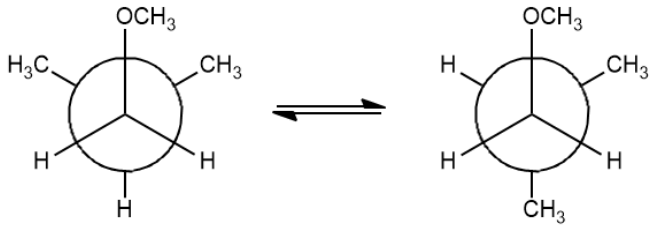
2,5-dimethyl-3-hexyne

10-ethyl-2-methylbicyclo[3.3.2]decane

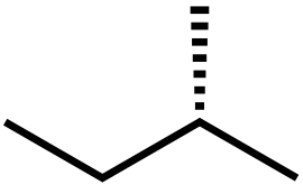
2-methylpentene

Conformational Analysis

Identify the most stable Newman projection of the molecule below:

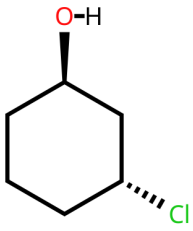


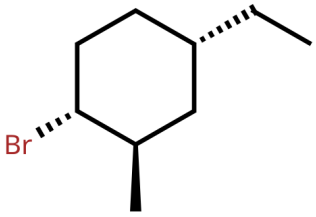
Draw the Newman projections:

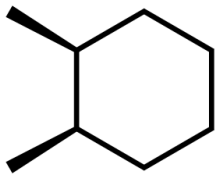


2,3-dibromobutane looking down the C2-C3 bond:

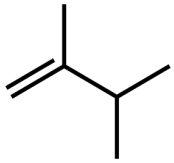
Draw the chair conformation of the compounds below:

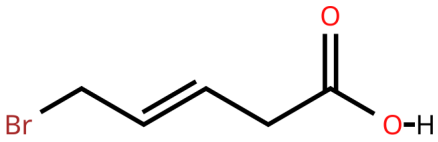


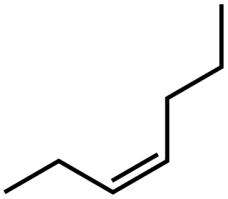




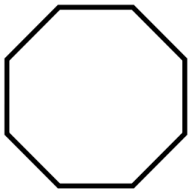
Label the compounds as cis, trans, or non-isomeric

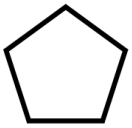






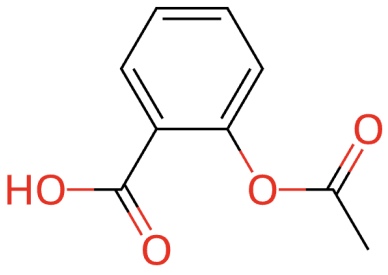
Which of the compounds has the greatest amount of ring strain:

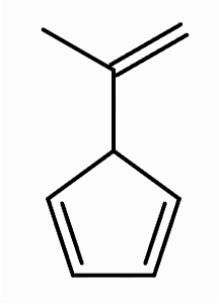




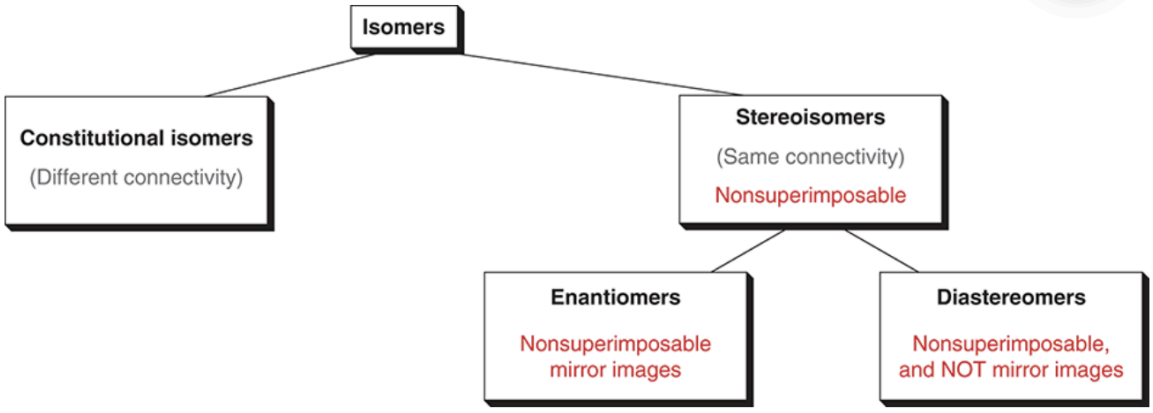
What is the hydrogen deficiency index of the compounds below:

$$\text{Degrees of Unsaturation} = \frac{(2 \times \#\text{carbons}) + 2 + \#\text{nitrogens} - \#\text{hydrogens} - \#\text{halogens}}{2}$$

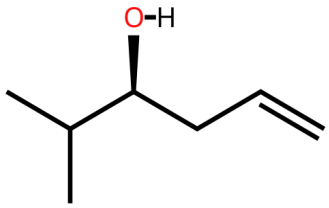


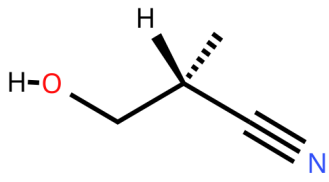


Stereochemistry

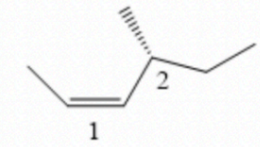


Designate the configuration on the following compounds:

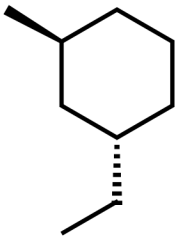




Designate sequentially (1,2) the stereochemistry at the numbered sites in the molecule shown below:



Name the compound with the R & S configuration:

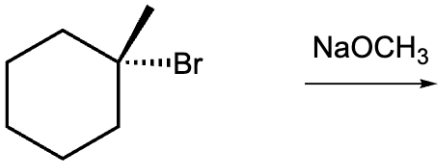


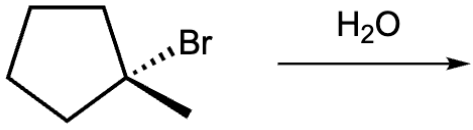
Substitution and Elimination Reactions

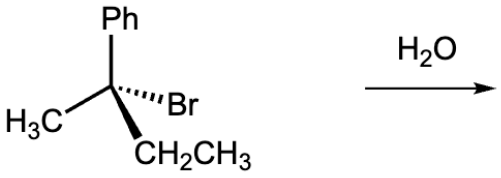
MEMORIZE THIS TABLE!!!

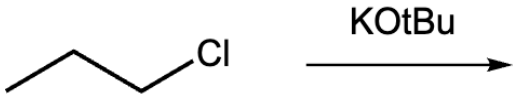
	Strong Base/ Weak Nucleophile	**Strong base/ Strong Nucleophile**	**Weak base/ Strong Nucleophiles**	**Weak base/ Weak nucleophile**
1°				
2°				
3°				

Predict the products of the following reactions and identify what kind of reaction is happening:



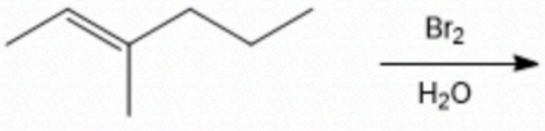




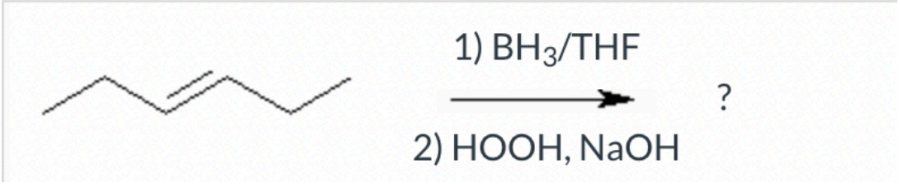


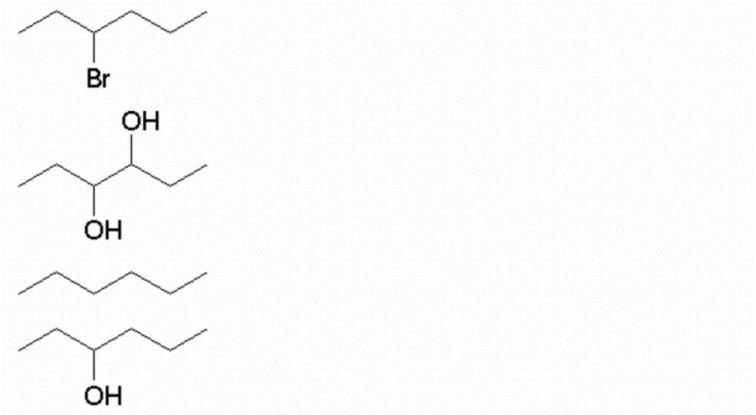
Reactions of Alkenes and Alkynes

Predict the major product of the following reaction.



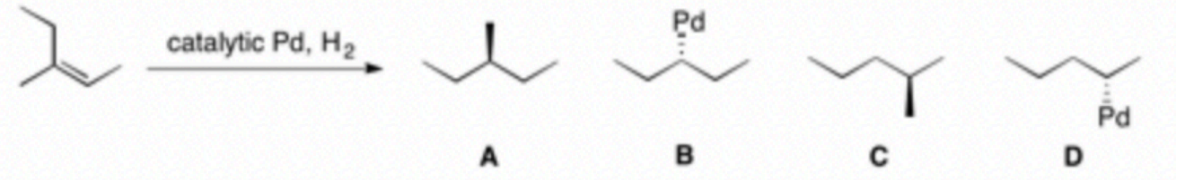
Give the major organic product of the following reaction.



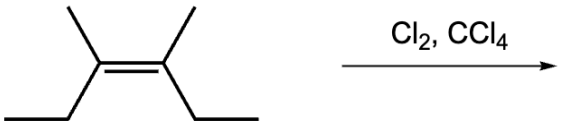


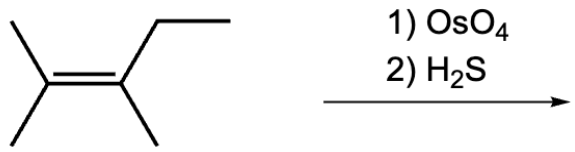
There is no reaction under these conditions or the correct product is not listed here.

Which product would form under the conditions given below?

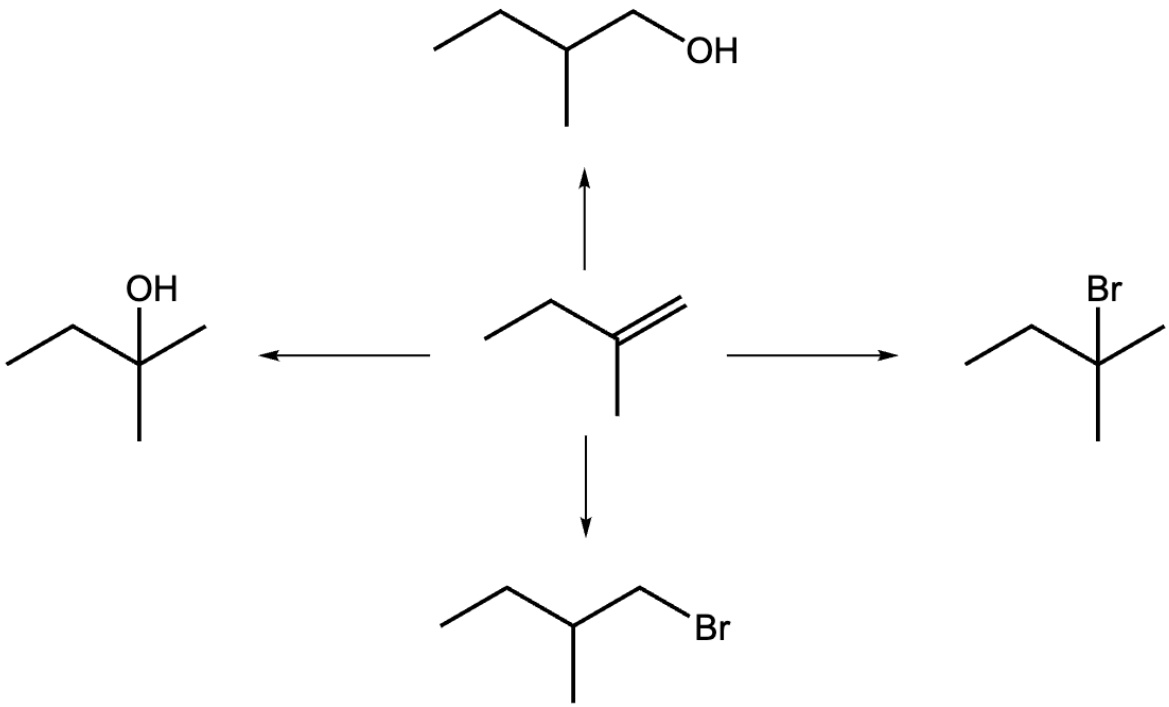


Give the major product in the reactions below:

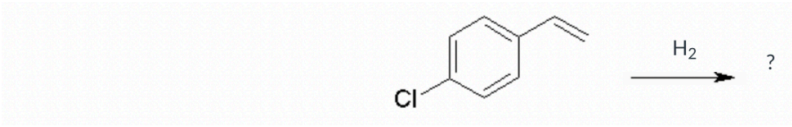


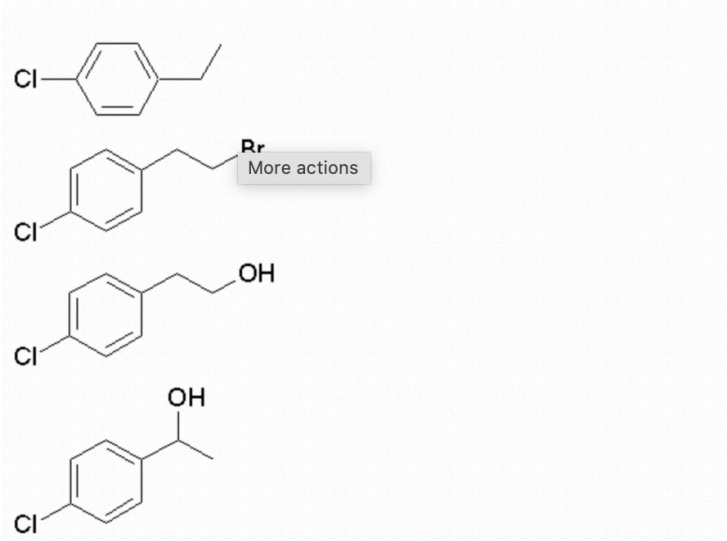


Fill in the missing reagents and identify the reaction being done:



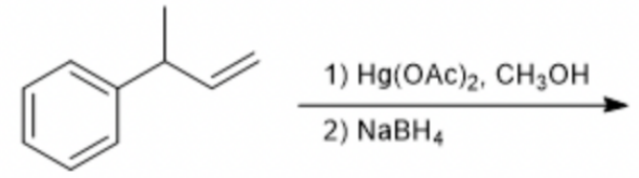
Circle the major product:

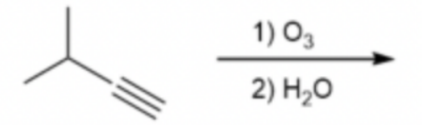


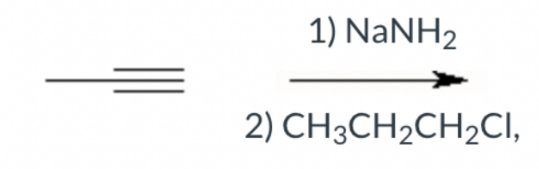


There is no reaction under these conditions or the correct product is not listed here.

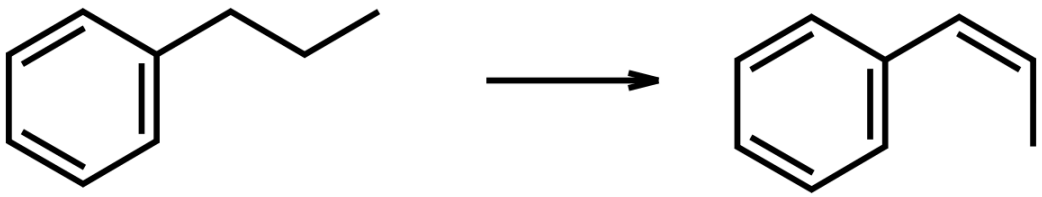
Predict the products:



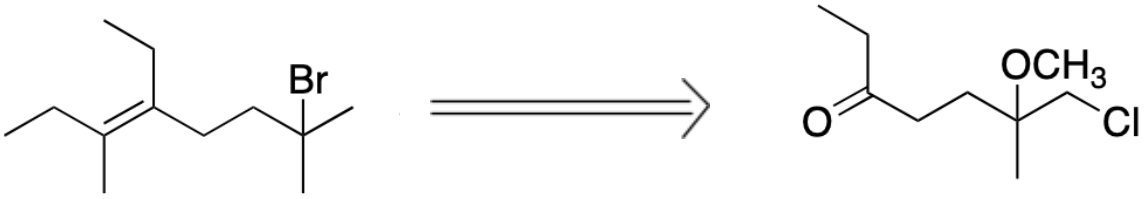




Multi-step Synthesis

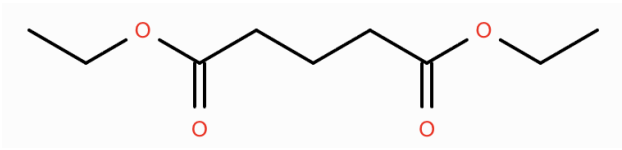


Retrosythesis

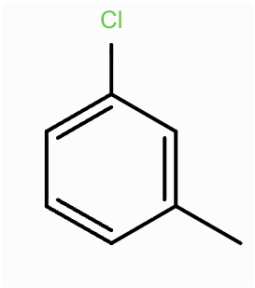


NMR

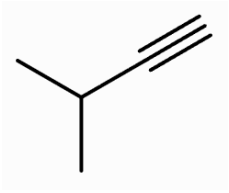
How many H NMR peaks will you expect to see in the compounds below?

1. 

A) 7
B) 3
C) 1
D) 4
E) 5

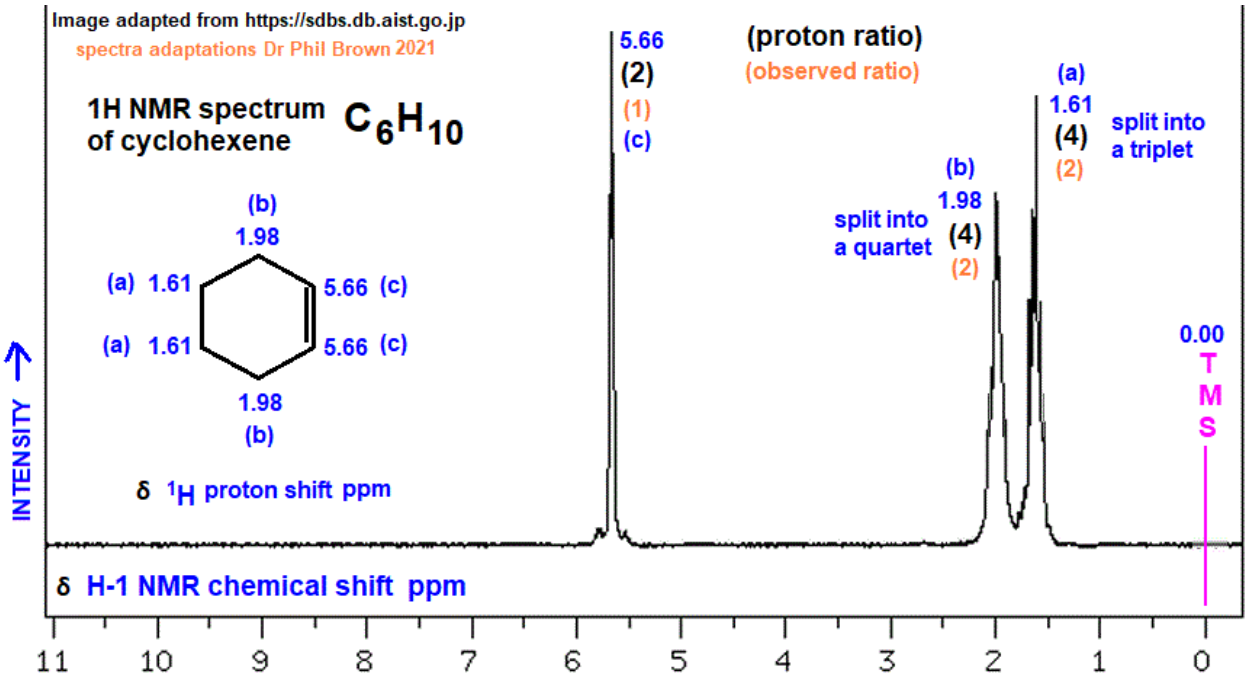
2. 

A) 4
B) 2
C) 5
D) 1
E) 3

3. 

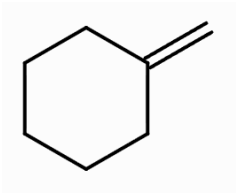
A) 1
B) 2
C) 3
D) 4
E) 5

Integration explained a little more for molecules with complete symmetry:



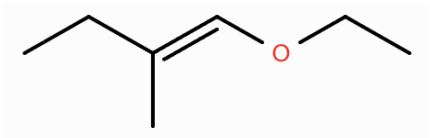
How many C NMR peaks will you see in the compounds below?

1.



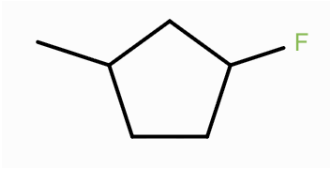
A) 1
B) 5
C) 4
D) 2
E) 6

2.



A) 6
B) 12
C) 4
D) 2
E) 7

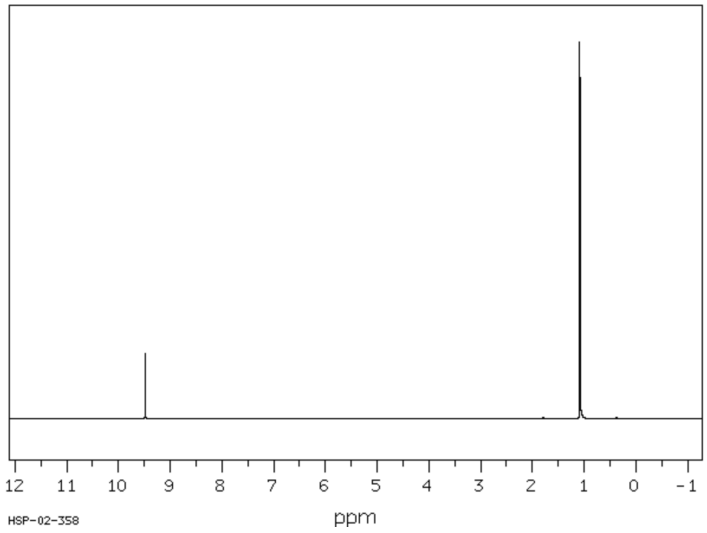
3.

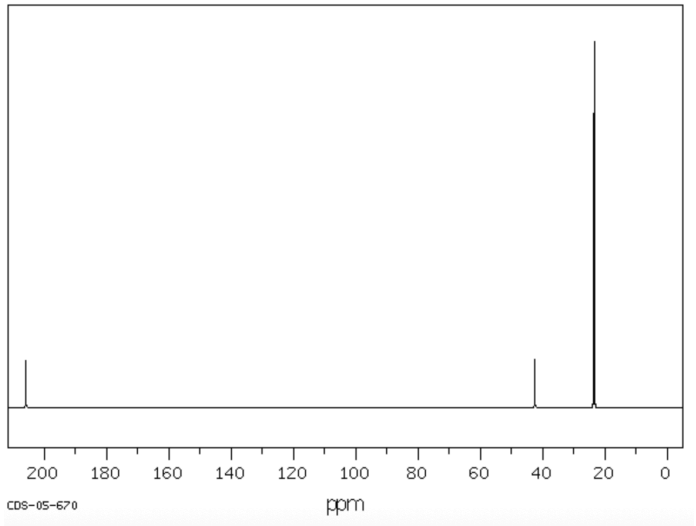


A) 5
B) 3
C) 1
D) 6
E) 2

Given the molecular formula, H NMR and C NMR, propose a structure:

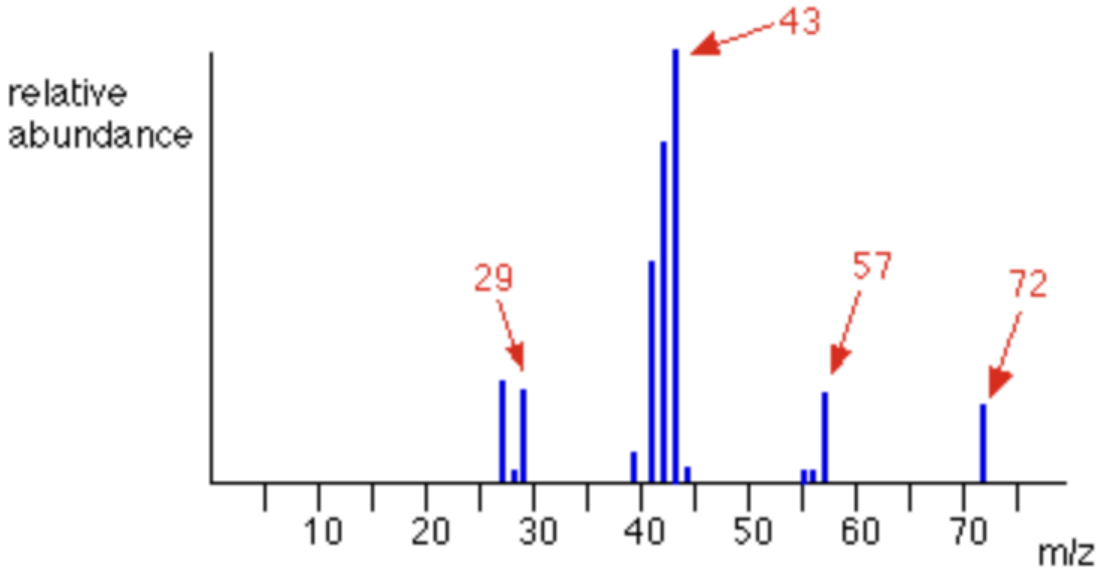
$C_5H_{10}O$





Mass Spectrometry

Given the mass spec of pentane and its prominent peaks, determine the base peak and molecular ion peak.



1. A prominent (M•-18) peak suggests that the compound might be a(n):

   A) Alkane
   B) Alcohol
   C) Ether
   D) Ketone
   E) Primary amine

2. Mass spectrometry detects:

   I. Radicals
   II. Radicals and radical cations
   III. Radical cations
   IV. Cations and Anions

   A) I and II
   B) III only
   C) IV only
   D) I, II, and III
   E) II and IV

3. What is the criterion for using mass spectrometry?

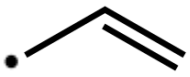
A) To find the composition of the sample
B) To find the relative mass of atoms
C) To find the concentration of elements in the sample
D) To find the properties of the sample

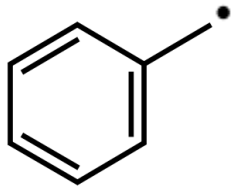
Radical Reactions

Radical Stability:

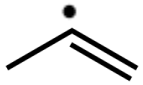
Resonance in radicals:

Allylic radicals are _____ and are more stable





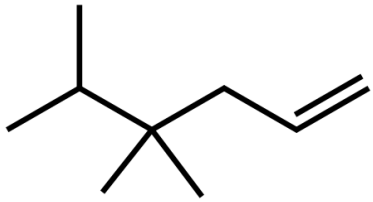
Vinylic radicals _____and are less stable



Identifying the weakest bond:

The weakest C-H bond comes from the _____

Start by drawing all possible radicals and compare stability:



The radical mechanism patterns:

1. Homolytic cleavage

2. Addition to a pi bond

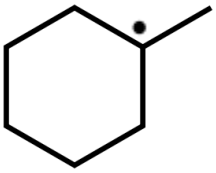
3. Hydrogen Abstraction

4. Halogen Abstraction

5. Elimination

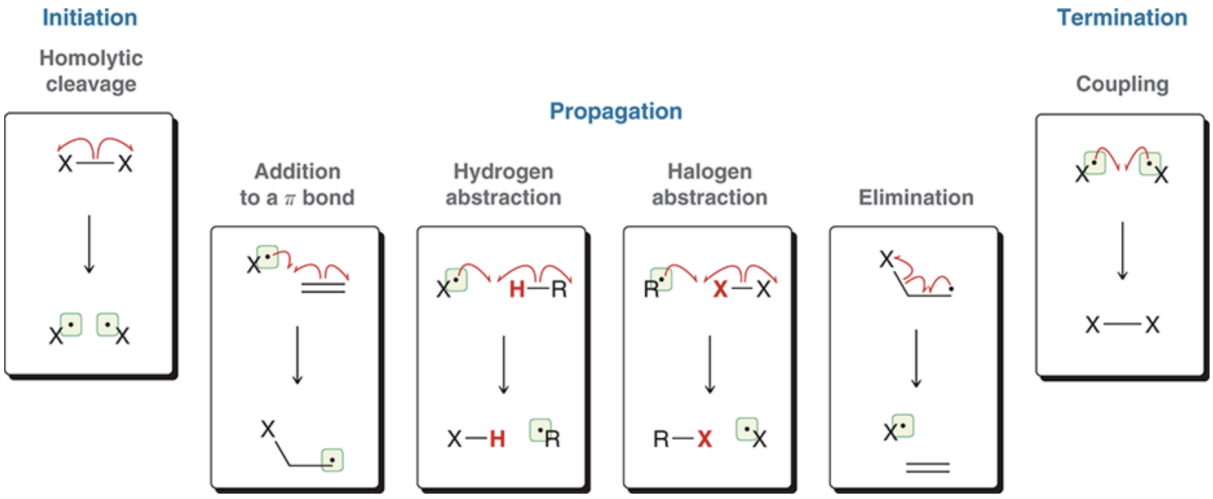
6. Coupling

Name the radical mechanism and draw the arrow pushing:



Br — Br

Patterns can be grouped into 3 categories, _____, _____,_____

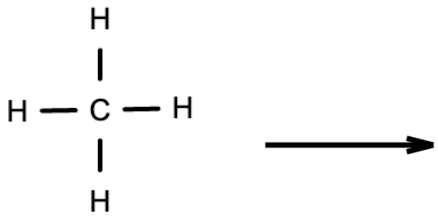


When doing radical reactions remember: when a new _____ is formed or

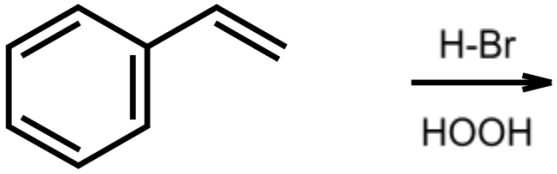
when adding to an existing _____, a _____ will form!

Chlorination is _____ while bromination is _____

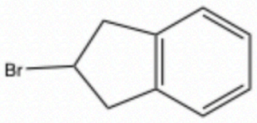
Draw the radical mechanism below, and name the mechanism being used in each step:

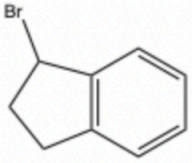


Draw the mechanism and label:

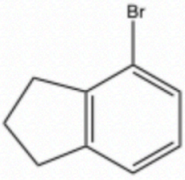


Give the major product of the following reaction.

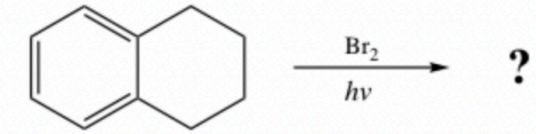


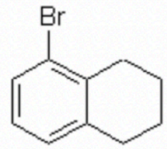


There is no reaction under these conditions or the product is not listed here.

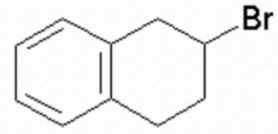


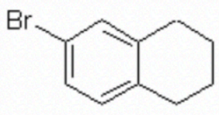
Give the major product of the following reaction.

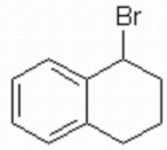


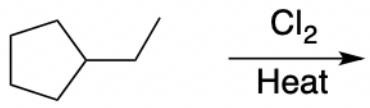


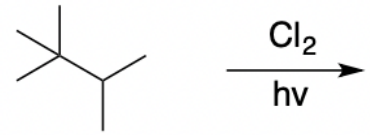
There is no reaction under these conditions or the product is not listed here.

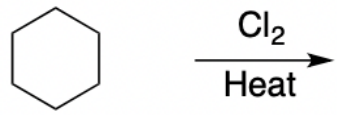







Cl_2
Heat


Cl_2
hv


Cl_2
Heat

Draw the products of this reaction: