

# Organic Reactions

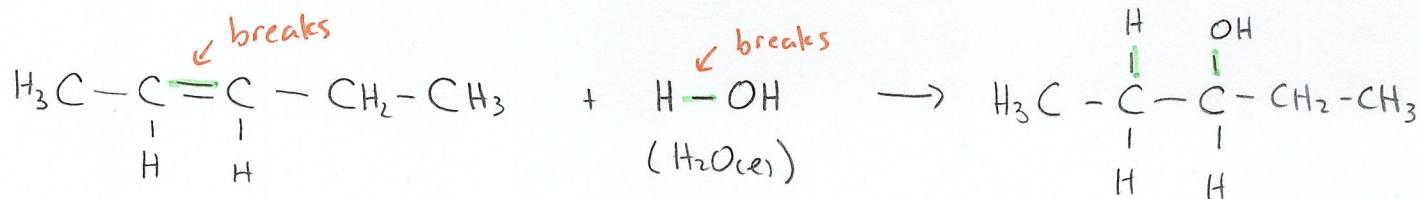
## ADDITION, ELIMINATION & SUBSTITUTION REACTIONS

- An **addition reaction** occurs when a double or triple bond is broken and other small molecule is added to the reactant/original organic molecule
  - Only alkenes and alkynes can undergo addition reactions
- In an addition reaction, the **small molecule** will **split** into two pieces and one or more of the **multiple bonds** will **break** allowing new bonds to form and incorporate the small molecule

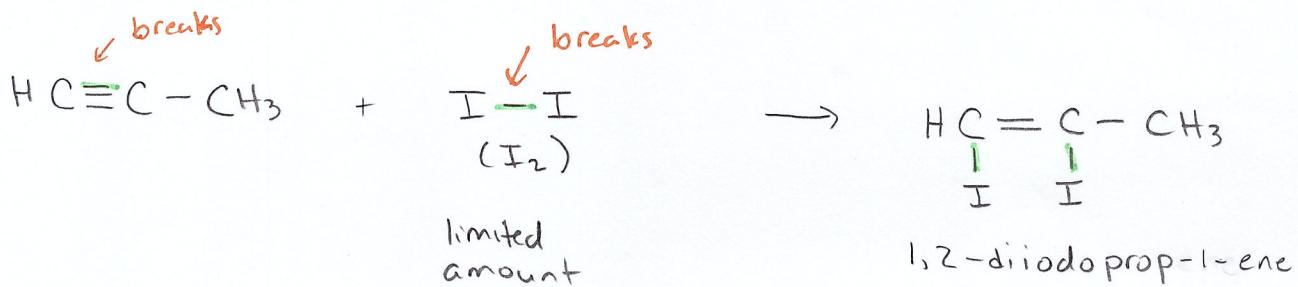
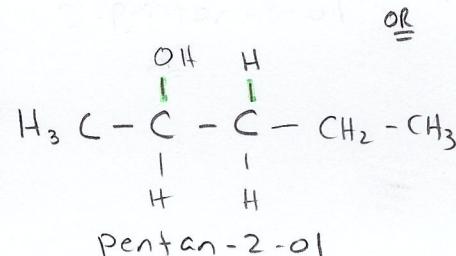
EXAMPLES: Predict the products of each reaction by writing/drawing the complete reaction.

1. pent-2-ene reacting with water

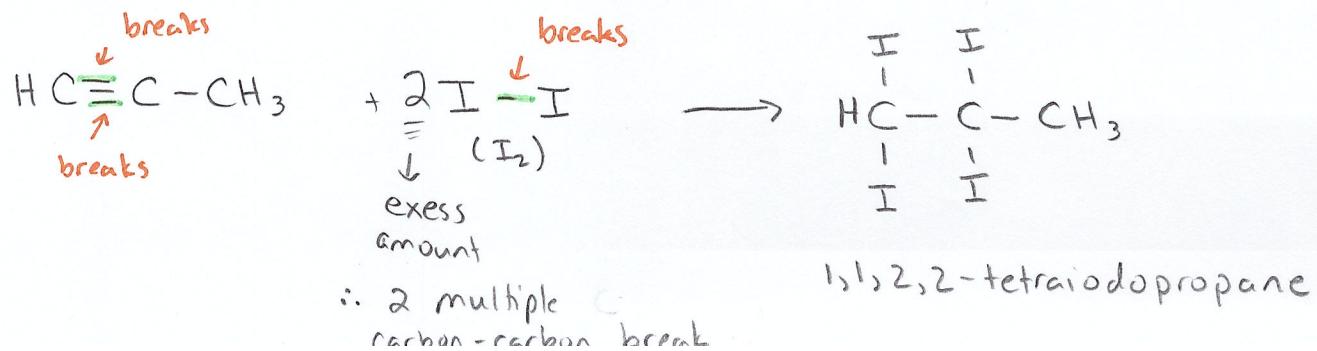
pentan-3-ol



2.  $\text{C}_3\text{H}_4 + \text{I}_2 \rightarrow$   
alkyne b/c  $\text{C}_n\text{H}_{2n-2}$



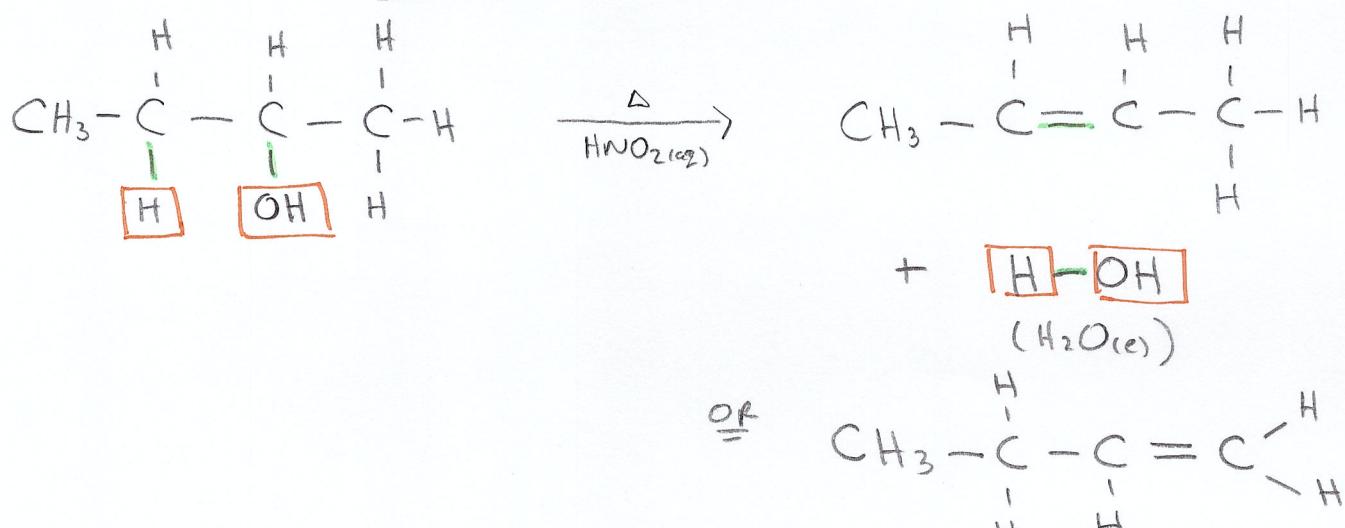
3.  $\text{C}_3\text{H}_4 + 2\text{I}_2 \rightarrow$



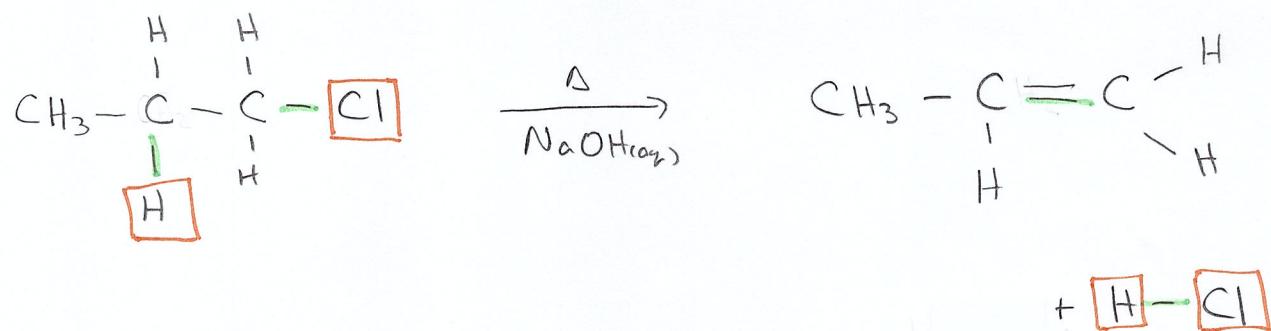
- An **elimination reaction** occurs when atoms from an organic molecule are removed causing a double bond to form between the two carbon atoms from which the atoms were removed
  - An elimination reaction is the reverse process of an addition reaction
- There are two groups of organic molecules that can undergo elimination reactions when certain chemical and physics conditions are met
  - \* 1.) Alcohols undergo elimination reactions when the alcohol is heated ( $\Delta$ ) in the presence of a strong acid (any of the top six acids)
  - \* 2.) Alkyl halides can also undergo elimination reactions when heated ( $\Delta$ ) in the presence of a strong base (ie. NaOH or NaOCH<sub>2</sub>CH<sub>3</sub>)

EXAMPLES: Predict the products of each reaction by writing/drawing the complete reaction.

1. butan-2-ol heated in the presence of nitric acid



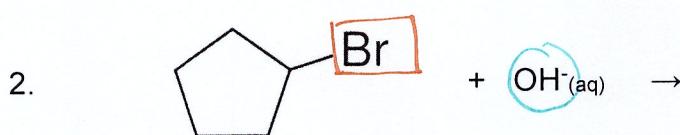
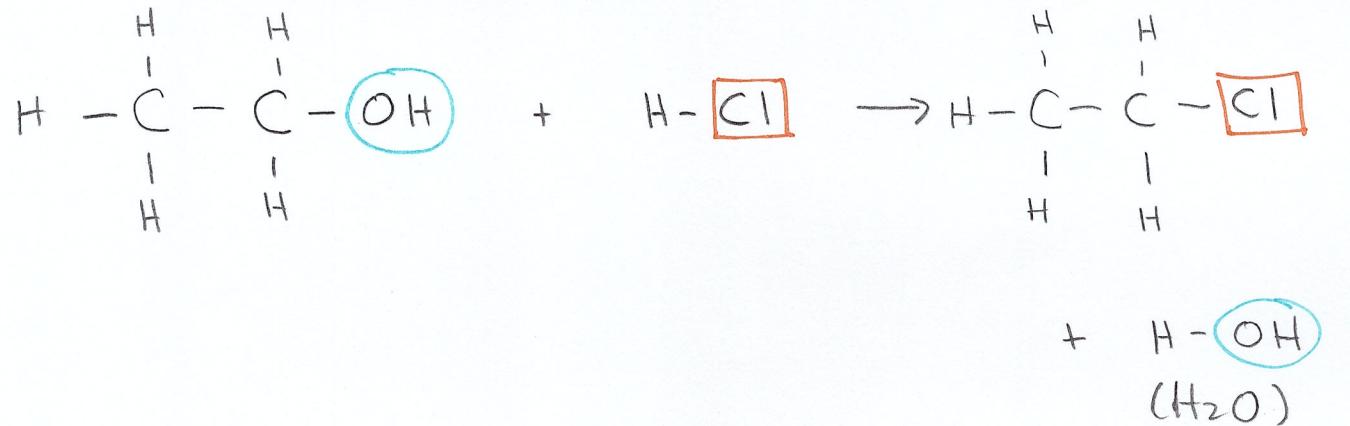
2.



- A **substitution reaction** occurs when a hydrogen atom or a functional group is replaced by a different functional group.
  - \* o In a substitution reaction two compounds react to form two different compounds.
  - \* o Recall that in an addition reaction, two compounds react to form one product and in an elimination reaction, one compound reacts to form two products.
- Alcohols and alkyls halides commonly undergo substitution reactions
  1. Alcohols need to react with an acid containing a halogen. The halogen in the acid switches places with the hydroxyl group in the alcohol
  2. Alkyl halides need to react with a hydroxide ion (ie. a strong base) to produce an alcohol in a substitution reaction. Essentially, the hydroxide ion switches places with the halide.

EXAMPLES: Predict the reactants or products of each reaction by writing/drawing out the complete organic reaction.

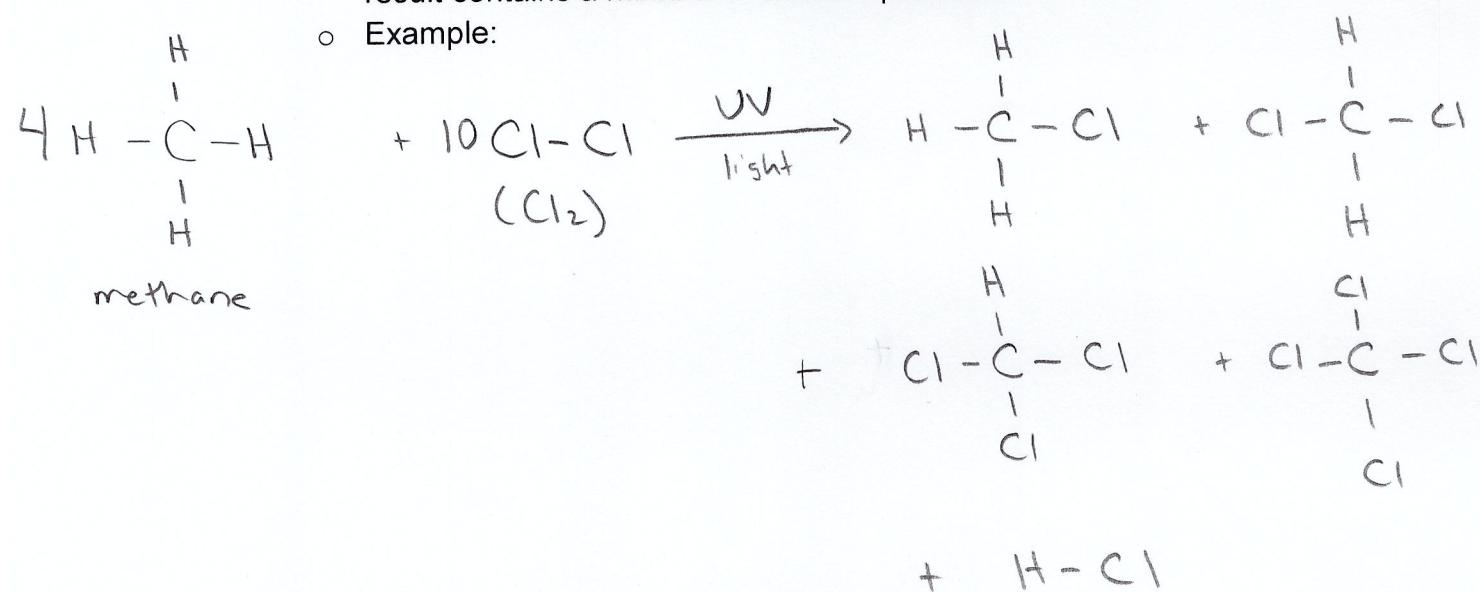
1. ethanol reacting with hydrochloric acid



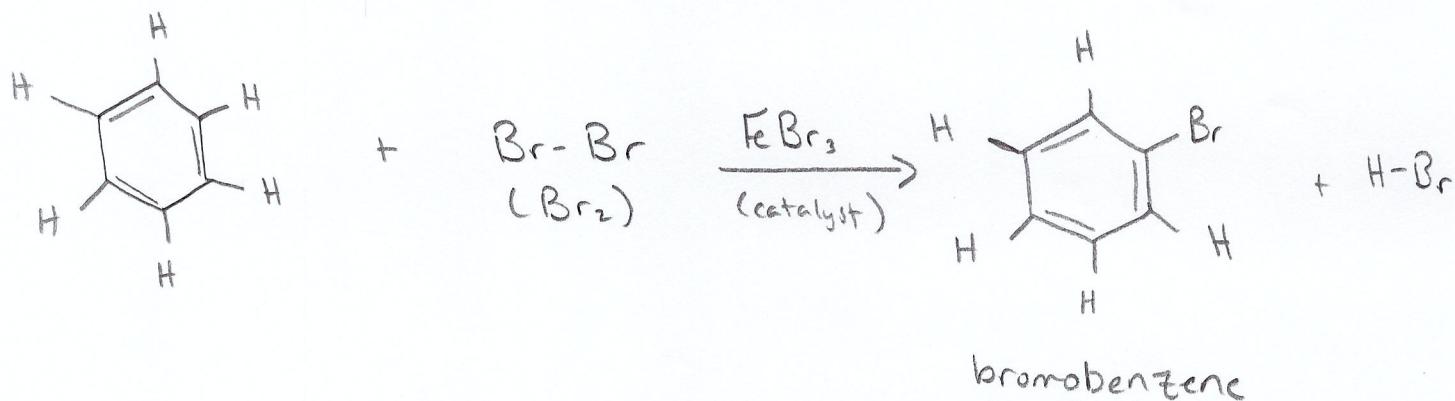
1-bromocyclopentane

cyclopentanol

- Alkanes and aromatic hydrocarbons can undergo substitution reactions as well but since both organic molecules are very stable and relatively un-reactive, the reactions need to be forced
- Alkanes can undergo substitution reactions when considerable amounts of energy (ie. UV light) are put into the reactions.
  - Substitution reactions with alkanes are not too useful because the end result contains a mixture of different products
  - Example:



- Aromatic compounds will undergo a substitution reaction with  $\text{Cl}_2$  or  $\text{Br}_2$  only in the presence of a catalyst
  - Example:

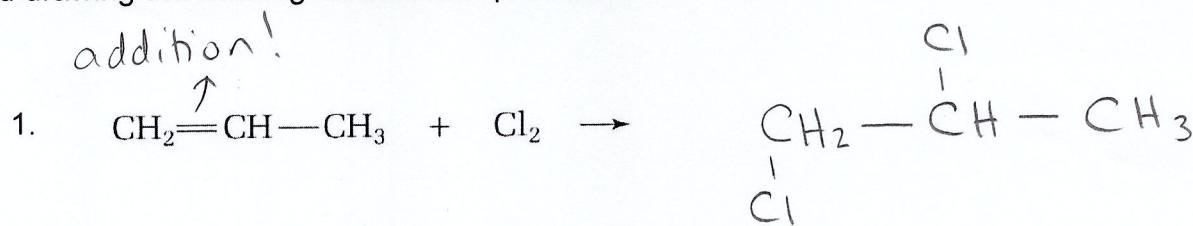


\* X = halogen

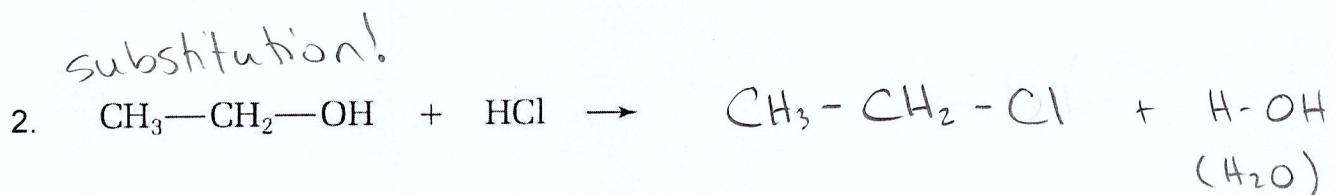
- Bringing it all together

ORGANIC REACTION	# OF REACTANTS	TYPE OF REACTANTS	# OF PRODUCTS	TYPE OF PRODUCTS	REQUIRED CONDITIONS
ADDITION	2	alkene	1	single bond	—
	2	alkyne	1	double bond single bond	— limited — excess
ELIMINATION	1	alcohol	2	alkene + water	heat & strong acid
	1	alkyl halide	2	alkene + H-X	heat & strong base
SUBSTITUTION	2	alcohol + acid w/ halide	2	alkyl halide + H <sub>2</sub> O	—
	2	alkyl halide + strong base	2	alcohol + X(g)	—
	2	alkane + X <sub>2</sub>	many	alkyl halide	UV light
	2	benzene + X <sub>2</sub>	many	halogenated benzene	catalyst
HYDROCARBON COMBUSTION	2	C <sub>n</sub> H <sub>y</sub> + O <sub>2</sub>	2	H <sub>2</sub> O + CO <sub>2</sub>	—

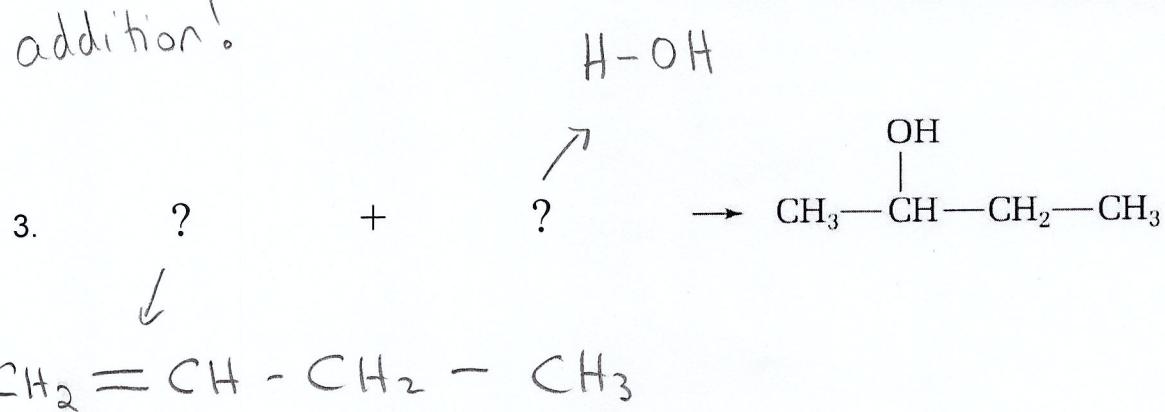
EXAMPLES: Complete the chemical equations by identify the reaction type and naming and drawing the missing reactants or products.



1,2-dichloropropane



addition!

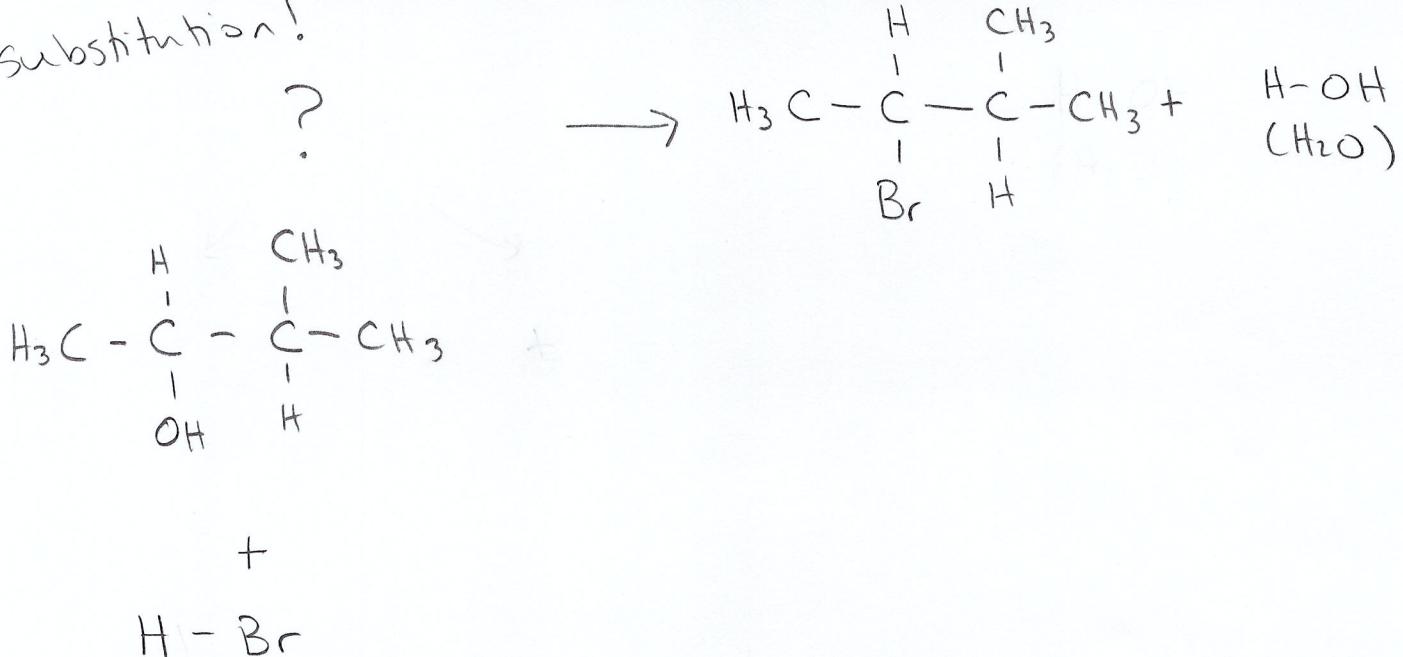


OR



4. 2-bromo-3-methylbutane and water are the products of an organic reaction

Substitution!



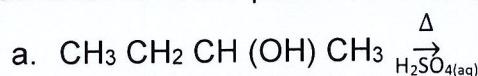
\*\*\*Now try pg. 596 #1 (omit b), 2 (omit e), 3(omit e), 4, 6 & pg. 602 #1 (omit b), 2 (omit b, g)

## Practice Problems

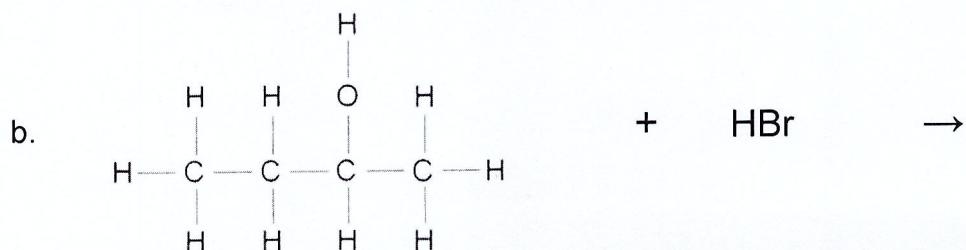
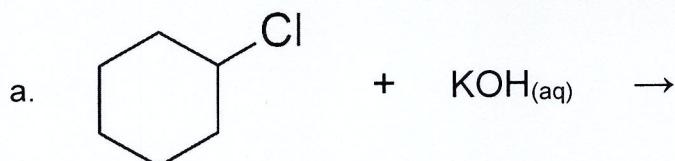
1. Draw and name the products for each addition reaction.



2. Draw and name the products for each elimination reaction.



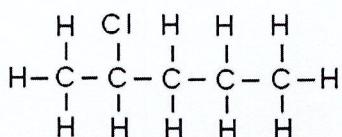
3. Draw and name the products for each substitution reaction.



## Answers

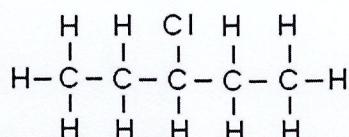
1.

a. 2-chloropentane

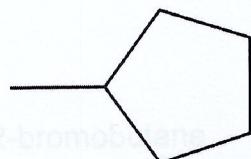


OR isomer

3-chloropentane

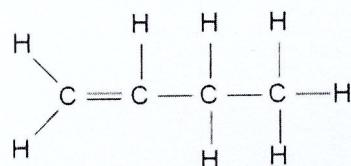


b. methylcyclopentane



2.

a. but-1-ene

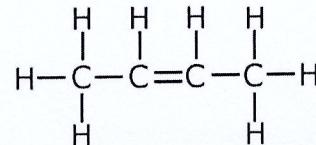


+

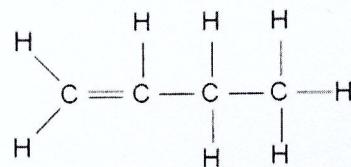
$\text{H}_2\text{O}_{(l)}$

OR isomer

but-2-ene



b. but-1-ene

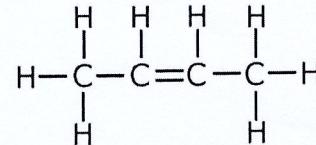


+

$\text{HBr}$

OR isomer

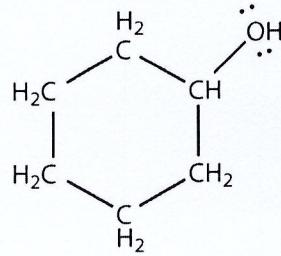
but-2-ene



3.

a. cyclohexanol

+  $\text{KCl}$



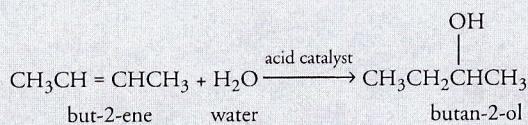
## **Section 15.1 Review Answers**

### **Student Textbook pages 602**

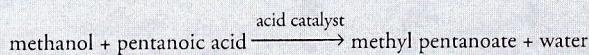
1. (a) addition  
(b) esterification  
(c) elimination  
(d) substitution

**2.** Students should produce answers similar to the following:

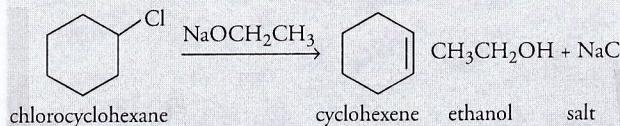
- (a) Addition reaction**



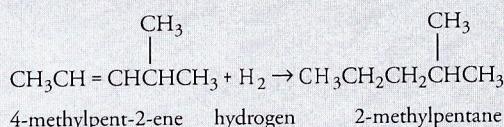
- (b) Esterification reaction**



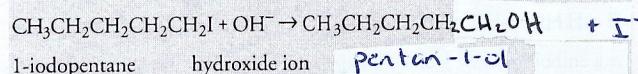
- (c) Elimination reaction**



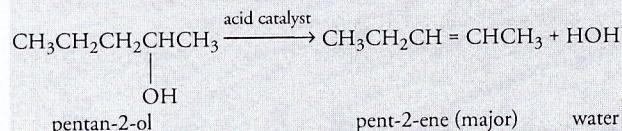
- (d) Addition reaction**



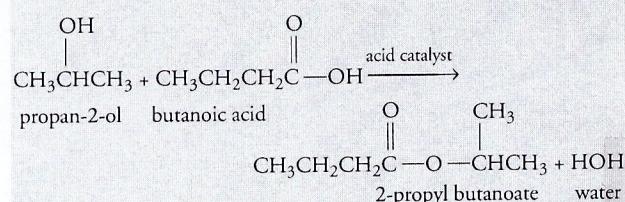
- (e) Substitution reaction



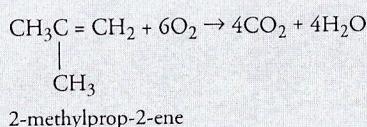
- (f) Elimination reaction**



- (g) Esterification reaction**

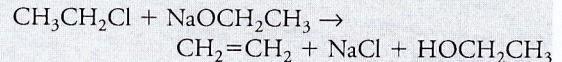


- (h) Combustion reaction**

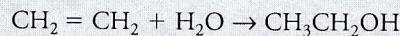


- 3.** Examples of possible answers are listed below.

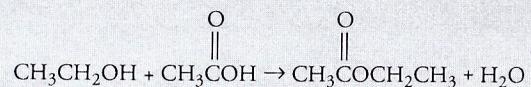
- (a) Elimination reaction**



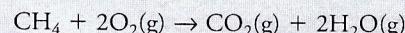
- (b) Addition reaction**



- (c) Esterification reaction**



- (d) Combustion reaction



- (e) Substitution reaction**

