1. **Combustion (p. 340)**
   - all hydrocarbons and most derivatives undergo combustion
   - products of complete combustion are $CO_{2(g)}$ and $H_2O_{(g)}$

General Equation: hydrocarbon + $O_{2(g)}$ ➜ $CO_{2(g)}$ + $H_2O_{(g)}$

eg. $\mathbf{CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(g)}}$

Practice:

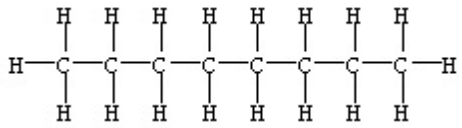
____ $CH_3CH_{3(g)}$ + ____ $O_{2(g)}$ ➜ ____ $CO_{2(g)}$ + ____ $H_2O_{(g)}$

____ $C_2H_5OH_{(l)}$ + ____ $O_{2(g)}$ ➜ ____ $CO_{2(g)}$ + ____ $H_2O_{(g)}$

____ $C_6H_{6(g)}$ + ____ $O_{2(g)}$ ➜ ____ $CO_{2(g)}$ + ____ $H_2O_{(g)}$

2. **Cracking & Reforming**
   - **cracking** occurs when a large hydrocarbon is broken into smaller hydrocarbons.
   - $H_{2\ (g)}$ is needed for cracking.

eg.



+ $H_{2\ (g)}$ ➜ pentane + propane

   - **reforming** occurs when smaller hydrocarbons combine to form larger hydrocarbons.
   - $H_{2\ (g)}$ is produced by reforming.

eg. ethane + butane ➜ hexane + $H_{2\ (g)}$

   - there are many possible isomers for both cracking and reforming reactions.
   - both reactions may be initiated by high temperature (**thermal**) or by use of special chemicals (**catalytic**)

Practice:

decane + $H_{2\ (g)}$ ➜

nonane + $H_{2\ (g)}$ ➜

propane + butane ➜ + $H_{2\ (g)}$

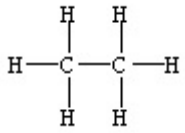
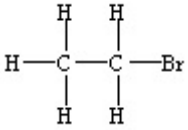
methane + hexane ➜ + $H_{2\ (g)}$

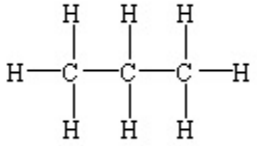
3. **Substitution (pp. 344, 362)**
   - happens in *alkanes* and *aromatics*
   - occur in the prescence of light ($h\nu$)
   - a H atom is replaced by a halogen atom

General Equation: R-H + X_2 $\xrightarrow{h\nu}$ R-X + HX

Organic halide

Hydrogen halide

eg.  + Br_2 $\xrightarrow{h\nu}$  + HBr

 + Br_2 $\xrightarrow{h\nu}$ 2 possible isomers + HBr

1-bromopropane OR
2-bromopropane

U do:

$CH_4 + I_2 \xrightarrow{h\nu}$

benzene + Br_2 $\xrightarrow{h\nu}$

fluorobenzene + F_2 $\xrightarrow{h\nu}$

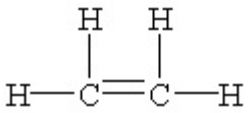
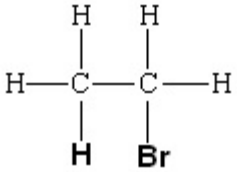
(draw 3 possible isomers)

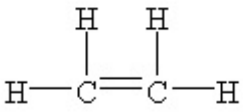
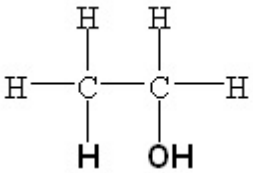
$C_5H_{12} + Br_2 \xrightarrow{h\nu}$

(NAME only 2 organic isomers)

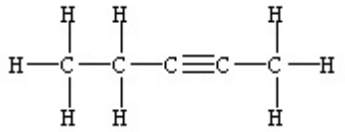
4. **Addition (p. 349)**
   - occur in alkenes and alkynes
   - a molecule adds *'across'* a double or triple bond
   - the new molecule has fewer multiple bonds
     (ie. a double bond is changed to a single bond)

General Equation: $CH_2{=}CH_2 + X\text{-}Y \rightarrow CH_2(X)\text{-}CH_2(Y)$

eg.  + H-Br → 

 + H-OH → 

Ewe Dew: $CH_3CH{=}CH_2 + H_2 \rightarrow$

 + H-Cl ➜

(draw 2 possible isomers)

1-butene + F-Br ➜

(NAME 2 possible isomers)

$CH_3CH{=}CH_2$ + H-Br ➜

(draw 2 possible isomers)

5. **Esterification (p. 410)**
   - reaction between an alcohol and a carboxylic acid
   - an acid catalyst (H_2SO_4 or H^+) and heat(Δ) is needed for the reaction to occur

General Equation: Carboxylic acid + alcohol $\xrightarrow[\Delta]{H^+}$ ester + water

eg. **propanoic acid + ethanol** $\xrightarrow[\Delta]{H^+}$ **ethyl propanoate + water**

Use structural formulas to complete the following:

butanoic acid + 1-propanol $\xrightarrow[\Delta]{H^+}$

pentanoic acid + methanol $\xrightarrow[\Delta]{H^+}$

6. **Elimination (p. 390)**
   - occur in alcohols
   - water is removed using heat (Δ) and an acid catalyst (H_2SO_4 or H^+)

General Equation: alcohol $\xrightarrow[\Delta]{H^+}$ alkene + H_2O

eg. $CH_3CH_2OH \xrightarrow[\Delta]{H^+} CH_2{=}CH_2 + H_2O$

U do:

$CH_3\text{-}CH_2\text{-}CH_2OH \xrightarrow[\Delta]{H^+}$

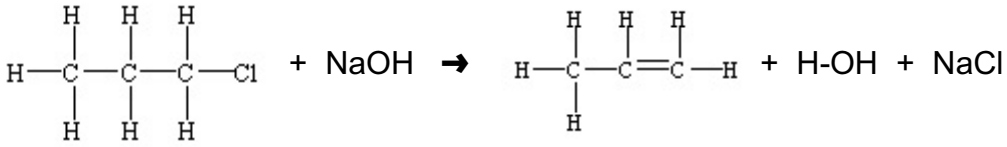
$CH_3\text{-}CH_2\text{-}CHOH\text{-}CH_3 \xrightarrow[\Delta]{H^+}$

(draw 2 possible isomers)

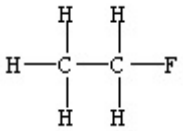
7. Elimination (p. 390)

- occur in alkyl halides
- a metal hydroxide is needed to remove the halogen atom

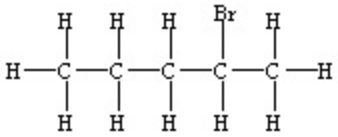
eg.



Your turn:



+ KOH ➜



+ NaOH ➜

(draw 2 possible isomers)

1-bromobutane + LiOH ➜

2-iodohexane + NaOH ➜

(draw two possible isomers)