

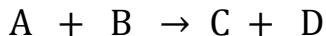
## SCH 4U

### PART 1: TYPES of ORGANIC REACTIONS

#### (1) ADDITION REACTIONS -- Add atoms to a double bond or triple bond



#### (2) SUBSTITUTION REACTIONS -- Usually alcohols, alkyl halides, aromatic compounds



#### (3) ELIMINATION REACTIONS



- Single bonds form double bonds
- Reactant heated in presence of a strong acid catalyst (eg.  $H_2SO_4$ )

#### (4) OXIDATION/REDUCTION REACTIONS

##### A. OXIDATION

From reactants to products, carbon has MORE bonds to oxygen & FEWER bonds to hydrogen. Reactions involve an “oxidizing agent”, represented by [O].

- **alcohol** + oxidizing agent  $\rightarrow$  aldehyde or ketone
- **aldehyde** + oxidizing agent  $\rightarrow$  carboxylic acid

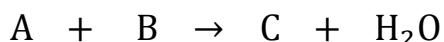
##### B. REDUCTION – [also addition reactions OR hydrogenation reactions]

From reactants to products, carbon has FEWER bonds to oxygen & MORE bonds to hydrogen. Reactions involve a “reducing agent”, represented by [H].

- **aldehyde or ketone** + reducing agent  $\rightarrow$  alcohols
- **alkenes or alkynes** + reducing agent  $\rightarrow$  alkanes

#### (5) ESTERIFICATION

##### A. CONDENSATION



Carb. acid + alcohol  $\rightarrow$  ester + water

##### B. HYDROLYSIS



Ester + water  $\rightarrow$  carb. Acid + alcohol

**EXAMPLES:**

1. ethene combined with hydrobromic acid.

2. 1-butyne with limited bromine

3. 1-propanol with hydrochloric acid

4. 2-bromobutane and ammonia

5. benzene with nitrous acid

6. 2-propanol with sulfuric acid catalyst

7. bromoethane with heat and a catalyst

8. 2-methyl-1-propanol + [O]

9. propyne + [H]

10. 3-nitropentanal + [O]

11. 2-methylcyclopentanone + [H]

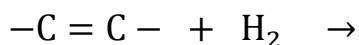
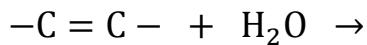
11. ethanoic acid + 3-methyl butanol

12. tert-butyl cyclopentanoate + water

## PART 2: REACTIONS OF FUNCTIONAL GROUPS

### ① ALKENES & ALKYNES

- **ADDITION REACTIONS** are common due to reactive double/triple bonds



### ALKENES

- **symmetrical** – identical groups on each side of double bond
- **asymmetrical** – different groups on each side of double bond
- **ADDITION SUBSTANCE** → symmetrical – eg.  $\text{Cl}_2$  --  $[\text{Cl} - \text{Cl}]$   
→ asymmetrical -- eg.  $\text{H}_2\text{O}$  --  $[\text{H} - \text{OH}]$

**IF either alkene or addition substance is symmetrical → ONLY 1 product**

**EG 1:** 2-butene + water →  
(symmetrical) (asymmetrical)

**EG 2:** 1-butene + chlorine →

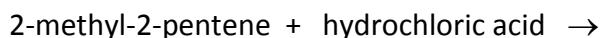
**IF both reactants are asymmetrical → MORE THAN 1 product**

**EG:** 1-butene + hydrobromic acid →

### **MARKOVNIKOV'S RULE:**

- Major & minor products are formed.
- **MAJOR PRODUCT:** The H of the **added substance** goes to the carbon with the **greater number of H atoms**; the rest of the added substance goes to the carbon with the fewer H atoms. This is a case of "The rich get richer!"

**EG:** Draw and label only the major product for the reaction:



### **ALKYNES**

- If addition substance is limited, alkyne  $\rightarrow$  alkene
- If addition substance is unlimited, alkyne  $\rightarrow$  alkane
- Follows Markovnikov's rule for asymmetrical reactants

**EG 1:** propyne +  $2 \text{ Br}_2 \rightarrow$

**EG 2:** 1-butyne + hydrobromic acid  $\rightarrow$

### **AROMATIC COMPOUNDS**

- ONLY Substitution reactions, NOT addition reactions

**EG:** benzene + bromine (with ferric bromide catalyst)

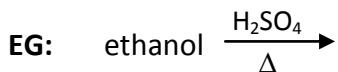
## ② ALCOHOLS

### [A] **SUBSTITUTION REACTIONS (with HX)**

EG: ethanol with hydrochloric acid

### [B] **ELIMINATION REACTIONS (forms alkenes)**

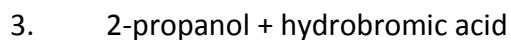
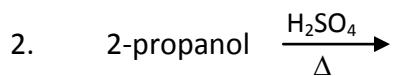
- Heated with strong acid catalyst



### [C] **OXIDATION REACTIONS (forms aldehyde or ketone)**

- $1^\circ$  alcohol + oxidizing agent  $\rightarrow$  aldehyde + oxidizing agent  $\rightarrow$  carb. acid
- $2^\circ$  alcohol + oxidizing agent  $\rightarrow$  ketone
- $3^\circ$  alcohol + oxidizing agent  $\rightarrow$  NR

**EXAMPLES:** Complete each reaction.



### ③ ALDEHYDES & KETONES

#### **[A] OXIDATION REACTIONS -- *only aldehydes, NOT ketones***

- Aldehyde + oxidizing agent → carb acid

#### **[B] REDUCTION REACTIONS -- *aldehydes and ketones***

- Aldehyde + reducing agent →  $1^{\circ}$  alcohol
- Ketone + reducing agent →  $2^{\circ}$  alcohol

**EXAMPLES:** Complete each reaction.

1. ethanal + [H]

2. propanone + [O]

3. butanone + [H]

4. pentanal + [O]

## (4) CARBOXYLIC ACIDS

### **[A] NEUTRALIZATION REACTIONS:**

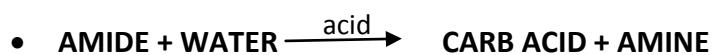
- CARB ACID with a BASE → SALT & WATER

### **[B] ESTERIFICATION REACTIONS (*special type of CONDENSATION REACTION*)**

- CARB ACID WITH ALCOHOL → ESTER & WATER

**⑤ ESTERS & AMIDES** -- undergo hydrolysis reactions

**[A] ACID HYDROLYSIS**



**[B] BASIC HYDROLYSIS**

