Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Regents Chemistry

 Based on Chapters 21, 22, 23 in the Textbook

NOTES: Organic Chemistry

**(adapted from Mr. Rosengarten (NYS Chemistry Teacher) and Ms. Johnston (MHS) Notes)**

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**TOPIC 1: Introduction to Organic Chemistry**

**Objective:** Review polar and nonpolar covalent bonds and molecules, identify properties of organic compounds and how they relate to covalent bonding and polarity of molecules, identify what the principle building block of organic compounds

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1. **Review of Polar and Nonpolar Covalent Bonds and Molecules**
* What is the difference between polar and nonpolar covalent **bonds**?
* **Polar Bonds**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (generally consist of: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
* **Nonpolar Bonds**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (generally consist of: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
* What is the difference between polar and nonpolar **molecules**?
* **Polar Molecules**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Example:**

* **Nonpolar Molecules**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Example**:

1. **Properties of Organic Compounds**
* **Organic Chemistry**: The study of \_\_\_\_\_\_\_\_\_\_\_\_\_\_ containing compounds. They occur extensively in nature because all living things are made of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ containing compounds.
* **Review of Carbon**
* Has **\_\_\_\_\_\_\_** unpaired valence electrons
* Forms **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** bonds with other nonmetals
* Forms \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (Two or more different structural forms giving it different properties)
* **Examples**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **Properties of Organic Compounds**
	+ - 1. Generally **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** molecules (held together by London Dispersion/Van der Waals

Waals forces – which are **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** intermolecular forces (IMF))

* + - 1. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** melting and boiling points
			2. Non-electrolytes – do not **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
			3. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** in water (because NONPOLAR molecules do NOT dissolve in POLAR solvents –REMEMBER “Likes dissolves likes)
			4. **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** – making them a primary source of energy

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**TOPIC 2: Naming and Writing Formulas for Organic Compounds**

**Objective:** Identify hydrocarbons, difference between saturated vs. unsaturated hydrocarbons, isomers, write the molecular formulas and structural formulas for alkanes, alkenes, and alkynes,

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1. **Molecular Formulas of Hydrocarbons**
* **Hydrocarbons**: Organic compounds consisting of ONLY \_\_\_\_\_ and \_\_\_\_\_



* **Naming Molecular Formulas of Hydrocarbons (See Tables \_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_)**

|  |  |  |
| --- | --- | --- |
| **Alkanes**Name ends in –aneCnH2n + 2 | **Alkenes**Name ends in –eneCnH2n | **Alkynes**Name ends in –yneCnH2n - 2 |
| CH\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_C2H\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_C4H\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | C**2**H\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_C**3**H\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_C4H\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | C**2**H\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_C**3**H\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_C4H\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. **Drawing and Naming Hydrocarbons**
2. **Structural Formulas of Alkanes**

|  |  |  |
| --- | --- | --- |
| **Methane (natural gas) \_\_\_\_\_\_** | **Propane (gas in grills) \_\_\_\_\_\_** | **Octane (gasoline) \_\_\_\_\_\_\_** |
| Condensed Structural Formula\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Condensed Structural Formula\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Condensed Structural Formula\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

\***NOTE**: Structural formulas can be written without the hydrogens bonded to the carbon. You just have lines coming off the carbon to indicate that hydrogen is bonded to it.

1. **Structural Formulas of Alkenes**
* NOTE: If there is a double or triple bond, we want to know where it is in the chain of carbons, so we put a number to indicate which carbon the double or triple bond is on (**USE THE LOWEST NUMBER POSSIBLE)**

|  |  |  |
| --- | --- | --- |
| **Ethene \_\_\_\_\_\_** | **Propene \_\_\_\_\_\_** | **Butene \_\_\_\_\_\_\_** |
| Condensed Structural Formula\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Condensed Structural Formula\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | 1-butene \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_2-butene \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

* **Isomers**: Molecules with the same **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** formulas, but different

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** formulas.

* To name an isomer of alkene:
	+ - 1. Look where the double bond is located
			2. Put a number to indicate which carbon the double or triple bond is on (**USE THE LOWEST NUMBER POSSIBLE)**

|  |  |  |
| --- | --- | --- |
| **1-pentene \_\_\_\_\_\_\_\_\_** | **2-pentene \_\_\_\_\_\_\_** | **3-pentene \_\_\_\_\_\_\_\_\_** |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. **Structural Formulas of Alkynes**
* **NOTE**: Follow the same rules as naming alkenes (use a number to indicate where the triple bond is)

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| **Ethyne \_\_\_\_\_\_\_\_\_** | **Propyne \_\_\_\_\_\_\_** | **Hexyne \_\_\_\_\_\_\_\_\_** |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | 1-hexyne \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_2-hexyne \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

1. **Aromatic Hydrocarbons**
* Hydrocarbons that are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and exhibit \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **Resonance**: Double bonds that move through the molecule
* **Example**: Benzene –
1. **Network Structures of Hydrocarbons**
* Carbon can make different network structures (these are all allotropes of carbon)
* **Example**: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* **Other examples of network structures**: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
1. **Saturated vs. Unsaturated Hydrocarbons**
* **Saturated Hydrocarbons**: hydrocarbons with **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* **Family Name**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **Example**: Butane
* **Unsaturated Hydrocarbons**: hydrocarbons with **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* **Family Names**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **Example**: 2-Butene

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**TOPIC 3: Branched (Substituted) Hydrocarbons**

**Objective:** Draw structural formulas of branched hydrocarbons from their names, write the names of branched hydrocarbons from their structural formulas, identify isomers of branched hydrocarbons\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. **Molecular Formulas of Hydrocarbons**
* Hydrocarbons can have other atoms or groups of atoms added or substituted onto a hydrocarbon chain.
1. **Alkyl Groups**: **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** molecules with their a H removed, allowing it to have another hydrocarbon chain attached to it
	* + 1. **Methyl Group**: \_\_\_\_ hydrocarbon branch attached

Example: 2-methylpentane

 Example: 2, 2-dimethylpropane

* + - 1. **Ethyl Group**: \_\_\_\_ hydrocarbon branch attached

Example: 3-ethylhexane

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The next groups are called Functional Groups (found on Table \_\_\_\_). The atom or group of atoms are bonded to a chain of hydrocarbons to give it specific properties. We use the **IUPAC** (**I**nternational **U**nion for **P**ure and **A**pplied **C**hemistry) naming system to identify/name organic compounds.

1. **Halide Groups**: a **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** atom or atoms that are on the

chain in place of a hydrogen. See Table \_\_\_\_\_

|  |  |
| --- | --- |
| **1-chloroethane** | **2-bromobutane** |
|  |  |
| **2,3-dichlorobutane** | **1 chloro 2,3-dibromo pentane** |
|  |  |

1. **Hydroxyl Groups (Alcohol)**: a **\_\_\_\_\_\_\_\_\_** attached to the end carbon (primary,1st), a

middle carbon (secondary, 2nd), or tertiary carbon (3rd).

* **Properties**:
1. Small alcohols are **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** and will **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
2. **Naming** – Position of OH- (prefix for # of C) - anol

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| **Methanol (wood alcohol)** | **Ethanol (grain alcohol)** | **1,2 ethandiol (antifreeze)** |
|  |  |  |
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1. **Organic Acids:** General Formula \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Acid strength increases as number of carbons **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* **Naming** – (prefix for # of C) - anoic acid

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| --- | --- |
| **Methanoic acid (formic acid)** | **Ethanoic acid (vinegar)** |
|  |  |
|  |  |

1. **Esters:** General Formula \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Used to make **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* **Naming** – (R2 prefix) - yl (R1 + C prefix) \_\_\_ anoate

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| **Ethyl pentanoate (apple)** | **Pentyl ethanoate (banana)** |
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1. **Amines:** General Formula \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* -NH2 is always on the 1st carbon
* Used in dyes and medications
* **Naming** - \_\_(prefix for # of C) - anamine

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| **Methanamine** | **Butanamine** |
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1. **Amides:** General Formula \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* -CONH2 is always on the 1st carbon
* Used in rubber and plastic manufacturing
* **Naming** - \_\_(prefix for # of C) - anamide

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| **Ethanamide** | **Pentanamide** |
|  |  |
|  |  |

1. **Ethers:** General Formula \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* A single oxygen atom between two alkyl groups
* Used in anesthetics
* **Naming** - \_\_(prefix for #C in R1) - yl (prefix for #C in R2) - yl ether

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| **Dimethyl ether (methyl methyl ether)** | **Ethyl butyl ether** |
|  |  |
|  |  |

1. **Aldehyde:** General Formula \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* -CHO is on the first carbon
* Used in preservatives
* **Naming** - \_\_(prefix for #C) - anal

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| --- | --- |
| **Methanal** | **Ethanal** |
|  |  |
|  |  |

1. **Ketones:** General Formula \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Used to make Nonpolar solvents
* **Naming** – (CO position) – (#C prefix) - anone

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| --- | --- |
| **2-propanone (acetone-nail polish remover)** | **2-butanone** |
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**TOPIC 4: Organic Reactions**

**Objective:** Determine what kind of reaction is required to make the desired organic product, complete simple organic reactions, and identify the reaction that is proceeding based on structural formulas or molecular formulas

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1. **Seven Types of Organic Reactions**
* In general, these are slower than inorganic reactions because bonds need to be broken
* Frequently involve only the functional groups of the molecule, the majority of the molecule remains unchanged
	+ - 1. **Substitution Reactions:**
* Involves \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ hydrocarbons (**\_\_\_\_\_\_\_\_\_\_\_\_\_\_**)
* One of the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** are removed (usually on the end)
* It is replaced with an atom of **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**. HA is the by-product

|  |
| --- |
| **Example**:  CH4 + Cl2 🡪 |
| **Example**:  CH3CH3 + Br2 🡪 |

* + - 1. **Addition Reactions:**
* Involve \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ hydrocarbons (**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**)
* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** bond is broke to form a **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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| --- |
| **Example**:  CH3CH2CHCH2 + Br2 🡪 |
| **Example**:  CH2CH2 + I2 🡪 |

* + - 1. **Combustion (Burning):**
* General Equation: Organic compound + O2 🡪 \_\_\_\_\_\_+ \_\_\_\_\_\_ + \_\_\_\_\_\_\_
* **Example:** \_\_\_\_ CH4 + \_\_\_\_ O2 🡪
* **Incomplete Combustion:** occurs when there is \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

present, therefore, the products that are made contain \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Products are \_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_ or \_\_\_\_\_ and \_\_\_\_\_\_\_
* **Examples:** 1) C6H14 + O2 🡪

2) C4H10 + O2 🡪

* + - 1. **Fermentation (making ethanol):**
* **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** anaerobically digested by yeast or enzyme
* Products are **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* When the concentration of ethanol reaches 14%, the yeast dies in its own waste products (ethanol and CO2)
* **Examples:** 1) C11H22O11 🡪

 2) C6H12O6 🡪

* + - 1. **Saponification (making soap):**
* Occurs when a **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** is broken apart by a **\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* Products are **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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 🡪

* + - 1. **Esterification (making esters):**
* Occur when an **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** reacts with an **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* Occurs by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Products are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **Example: Methanoic acid + ethanol 🡪**
	+ - 1. **Polymerization (making polymers):**
* **Polymer**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **Monomer**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Synthetic Examples: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Natural Examples: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
1. **Addition Polymerization**
* Occurs with a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ hydrocarbon
* The double or triple bond is… **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

* The product is a **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
* **Example**: vinyl chloride 🡪 polyvinyl chloride
1. **Condensation Polymerization**
* Occurs by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and always

produces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* **Example**: