Test 14: Organic Chemistry

1. **Properties of organic compounds**

* Generally nonpolar molecules (symmetric molecules)
* Held together by weak van der waals forces
* Low melting and boiling points
* Generally insoluble in water (remember water is a polar molecule)
* Generally nonelectrolytes (only organic acids can conduct electricity in solution)
* Slow reactions (molecular compounds react slower than ionic compounds)

1. **Isomers**

* Have the same molecular formula but different structures and properties.
* The greater the number of carbons the greater the number of possible isomers.
* Hydrocarbons must have atleast 4 carbon atoms in order to exist as isomers.
* Draw the structures of 1 butanol and 2 butanol below:
* Draw the structures of butane and methyl propane below:

1. **Homologous Series of Hydrocarbons: (table Q)**

**Aliphatic (straight or branch chains)**

* Contain only carbon and hydrogen
* Each member differs from the preceding member by one carbon and two hydrogens (increment)

|  |  |  |  |
| --- | --- | --- | --- |
|  | Alkanes | Alkenes | Alkynes |
| Bond | Single | Double | Triple |
| Saturated (single bonds)  Unsaturated (multiple bonds) | Saturated | Unsaturated | Unsaturated |
| General Formula | CnH2n+2 | CnH2n | CnH2n-2 |
| Examples: | C3H8 | C3H6  (n>1) | C3H4 (n>1) |
| Draw the structures |  |  |  |

* **Aromatic (benzene series):** alternating double and single bonds (resonance hybrids), unsaturated, CnH2n-6 (n>5), C6H6.  Draw the structure of benzene below:

1. **Naming and drawing organic compounds:**

* Refer to tables P and Q
* Name the longest chain first
* Number the carbons left to right or right to left where the double or triple bond gets the smallest number. If an alkane the attachment would get the smallest number.
* Attached group names CH3 (methyl), C2H5 (ethyl), etc.
* Prefixes are used to indicate the number of side groups. Di is 2, tri is 3, tetra is 4, penta is 5 etc.
* Draw the structure formula for 2,3 dichlorobutane:

1. **Functional groups:**

* A functional group is an atom or group of atoms that replace hydrogen in a hydrocarbon.
* Functional groups give the compound distinctive physical and chemical properties.
* Remember when classifying, naming or drawing organic compounds with functional groups refer to table R. Listed in the table are functional groups, general formulas and examples.

1. **Halides:**

* Functional groups are: -F (fluoro), -Cl (chloro), -Br (bromo), -I (iodo)
* The alkane chain is numbered to show the location of the halogen.

1. **Alcohol:**

* Functional group is –OH (hydroxyl)
* Nonelectrolytes (not a base because it does not start with a metal)
* Polar molecule
* Soluble in water (because water is polar)
* To name: name the alkane drop the “e” and replace with “ol”
* The alkane chain is numbered to show the location of the OH

1. **Ether:**

* Functional group is -O-
* To name: name the groups alphabetically on either side of the oxygen and end with the word “ether”

1. **Aldehyde:**

* Functional group is –CHO
* To name: name the alkane drop the “e” and replace with “al”

1. **Ketone:**

* Functional group is –CO
* To name: name the alkane drop the “e” and replace with “one”. The alkane chain is numbered to show the location of the ketone group.

1. **Organic Acid:**

* Functional group is –COOH (carboxyl)
* Weak electrolytes (acetic acid is CH3COOH—listed on table K)
* Soluble in water
* Turns litmus red and phenolphthalein colorless
* To name: name the alkane drop the “e” and replace with “oic acid”

1. **Ester:**

* Functional group is –COO
* To name: Name the carbon chain attached to the single bond oxygen first. Use the appropriate prefix from table P followed by the letters “yl”. (comes from the name of the alcohol). Name the carbon chain attached to the double bond oxygen second. The part of the name will end in the letters with “oate”.

1. **Amine:**

* Functional group is –N-
* Formed when one or more hydrogen atoms of ammonia are replaced by an alkyl group such as methyl or ethyl.
* To name: name the alkane drop the “e” and replace with “amine”. The alkane chain is numbered to show the location of the amine group.

1. **Amide:**

* Functional group is –CO and –NH
* Also called a peptide
* Formed by the combination of two amino acids by a condensation reaction
* To name: name the alkane drop the “e” and replace with “amide”

1. **Amino Acid:**

* Functional group is –COOH (carboxylic group) and –N (amine group)
* The amine group is attached to the C atom that is adjacent to the –COOH
* Amino acids are the building blocks of proteins.

1. **Organic Reactions:**

* Generally occur more slowly than inorganic reactions
* You should be able to identify reaction type and or determine a missing reactant or product in a balanced equation.

1. **Substitution:**

* Occurs with saturated hydrocarbons (alkanes)
* Two reactants yield two products
* For example: C2H6  + Br2→ C2H5Br + HBr

1. **Addition:**

* Occurs with unsaturated hydrocarbons (alkenes and alkynes)
* Double or triple bonds become a single bond
* Two reactants yield one product
* For example: C2H4 + Cl2→C2H4Cl2

1. **Esterification:**

* The reaction is: alcohol + acid → ester + water
* To name an ester use the alkyl name of the alcohol followed by the acid group modified to end in “oate”
* For example: C2H5 OH + HCOOH → HCOOC2H5 + H20

Ethanol + methanoic acid → ethyl methanoate + water

1. **Saponification:**

* The reaction is: ester + base → glycerol + soap
* For example: C3H5(C17H35COO)3 + 3NaOH→ C3H5(OH)3 + 3C17H35COONa

Fat (ester) + base → glycerol + soap

1. **Fermentation:**

* The reaction is: sugar → alcohol + CO2
* Yeast is needed to secrete the enzyme zymase
* For example: C6H12O6 → 2C2H5OH + CO2

1. **Cracking:**

* The reaction is: large molecules→small molecules

1. **Polymerization:**

* The reaction is: small molecules (monomers)→ large molecules (polymer)
* Naturally occurring polymers include proteins, starches and cellulose
* Synthetic polymers include plastics such as nylon, rayon and polyethylene.
* Adding together monomers is called addition polymerization. (no byproduct)

For example: n(C2H4)→(C2H4)n

* Polymers formed by reactions that remove water is called condensation polymerization

1. **Combustion:**

* Almost all organic compounds will burn
* When sufficient oxygen is present a hydrocarbon will react with oxygen to form carbon dioxide and water in complete combustion.
* When there is insufficient oxygen carbon monoxide may be produced instead of carbon dioxide.