



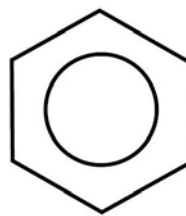
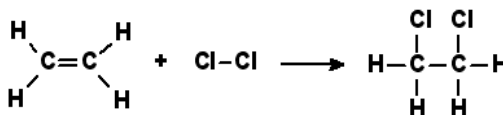


Organic Chemistry

methane CH ₄	$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{H} \\ \\ \text{H} \end{array}$	
ethane C ₂ H ₆	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	
propane C ₃ H ₈	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	
butane C ₄ H ₁₀	$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{H} \\ \quad \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \quad \text{H} \end{array}$	



1

Tables P/Q/R

Table P
Organic Prefixes

Prefix	Number of Carbon Atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10

Table Q
Homologous Series of Hydrocarbons

Name	General Formula	Examples	
		Name	Structural Formula
alkanes	C _n H _{2n+2}	ethane	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
alkenes	C _n H _{2n}	ethene	$\begin{array}{c} \text{H} \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \\ \text{H} \quad \text{H} \end{array}$
alkynes	C _n H _{2n-2}	ethyne	H-C≡C-H

n = number of carbon atoms

Table R
Organic Functional Groups

Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	-F (fluoro-) -Cl (chloro-) -Br (bromo-) -I (iodo-)	R-X (X represents any halogen)	CH ₃ CHClCH ₃ 2-chloropropane
alcohol	-OH	R-OH	CH ₃ CH ₂ CH ₂ OH 1-propanol
ether	-O-	R-O-R'	CH ₃ OCH ₂ CH ₃ methyl ethyl ether
aldehyde	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH}_2\text{C}-\text{H} \end{array}$ propanal
ketone	$\begin{array}{c} \text{O} \\ \\ -\text{C}- \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{R}' \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH}_2\text{CCH}_2\text{CH}_3 \end{array}$ 2-pentanone
organic acid	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{OH} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{OH} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH}_2\text{C}-\text{OH} \end{array}$ propanoic acid
ester	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{O}- \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{R}-\text{C}-\text{O}-\text{R}' \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH}_2\text{COCH}_3 \end{array}$ methyl propanoate
amine	-N-	$\begin{array}{c} \text{R}' \\ \\ \text{R}-\text{N}-\text{R}'' \end{array}$	CH ₃ CH ₂ CH ₂ NH ₂ 1-propanamine
amide	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{NH} \end{array}$	$\begin{array}{c} \text{O} \quad \text{R}' \\ \quad \\ \text{R}-\text{C}-\text{NH} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH}_2\text{C}-\text{NH}_2 \end{array}$ propanamide

R represents a bonded atom or group of atoms.

Organic Chemistry

- The study of _____ containing compounds.
- All atoms are bonded _____
- Why is Carbon so special?
 - Has ___ valence electrons
 - Can form ___ bonds with other elements or other ___ atoms
 - Large #'s of different _____ are possible when _____, _____ or _____ are formed
 - _____=when an atom bonds to other atoms of the same element to form a ring

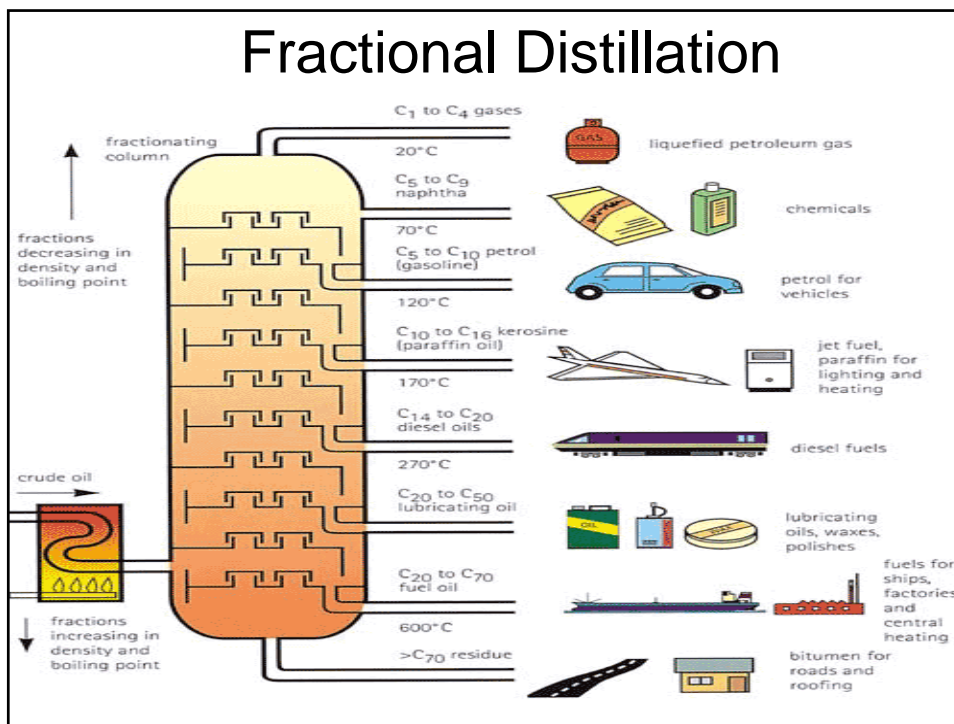
3

You use organics in your everyday lives

- Naturally occurring: _____, _____, _____, plant and animals, olive oil, citric acid etc.
- Synthetic: _____, _____, paraffin (____)
 - Come from petroleum in a process called _____
 - crude oil is separated into many parts based on _____
 - Split into hydrocarbon products such as methane, propane, butane, oils, kerosene, gasoline, etc.

4

Fractional Distillation



Properties of Organics

- Saturated: compound with all _____ bonds
- Unsaturated: compound containing 1 or more _____ bond (_____ or _____ bond)
- Solubility: generally _____ (when saturated)
 - Soluble in _____ solvents, or other organics
 - Ex. gasoline is _____ in water
- Conductivity: generally _____ conductors of electricity
 - Some organic acids are _____ conductors

Properties of Organics continued

- Melting Point: relatively _____ due to weak intermolecular forces (below 300°C)
 - As molecule size ↑, the MP/BP ___ due to ___ vanderwaals force between molecules
- Reactivity: generally _____
 - High _____ required to start rxn
 - _____ organics are more reactive than saturated ones

7

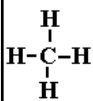
Properties of Organics continued

- Hydrocarbons: compounds/chains with only _____ and _____ bonds
- Homologous series: Where adjacent members vary by a constant _____ (1 extra CH₂ for alkanes).
 - These compounds have similar structures and properties
 - Alk____, alk____ and alk____ series

8

Alkanes: Saturated with all single bonds

- Also called the methane or paraffin series
- General formula \rightarrow _____ (n= # of C atoms)
 - Ex. CH __, C₂H __, C₃H __
 - What is the formula for a compound with 22C atoms or one with 38H atoms
- Structural formula \rightarrow shows all _____ and _____ within a molecule
- Condensed structural formula \rightarrow does _____ show all the bonds, but is similar to a structural formula
 - Ex. #1 \rightarrow _____
 - Ex. #2 \rightarrow _____



9

Alkanes: (C_nH_{2n+2}) all single bonds

- Nomenclature (naming alkanes)
- number of C atoms \rightarrow prefix from table P
- ending added is -ane
 - Ex. 5 carbons would be _____ane
 - Formula \rightarrow C₅H __
 - Ex. 7 carbons would be _____ane
 - General formula \rightarrow C₇H __

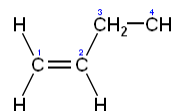
10

Alkenes: (C_nH_{2n})

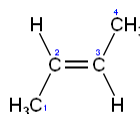
- contain 1 (or more) _____ bond
- number of C atoms → prefix from table P
- ending added is - _____
- Double bond does not have to exist at the end of a chain

– Ex. 4 carbons would be _____ene

- C₄H₈ _____
– 1-butene



- C₄H₈ _____
– 2-butene



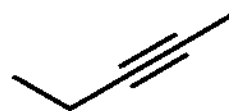
11

Alkynes: (C_nH_{2n-2})

- or the acetylene series
- contain 1 (or more) _____ bond
- number of C atoms → prefix from table P
- ending added is - _____
- Triple bond does not have to exist at the end of a chain

– Ex. 5 carbons would be _____

- C₅H₈ CH₃CCCH₂CH₃
– 2-pentyne



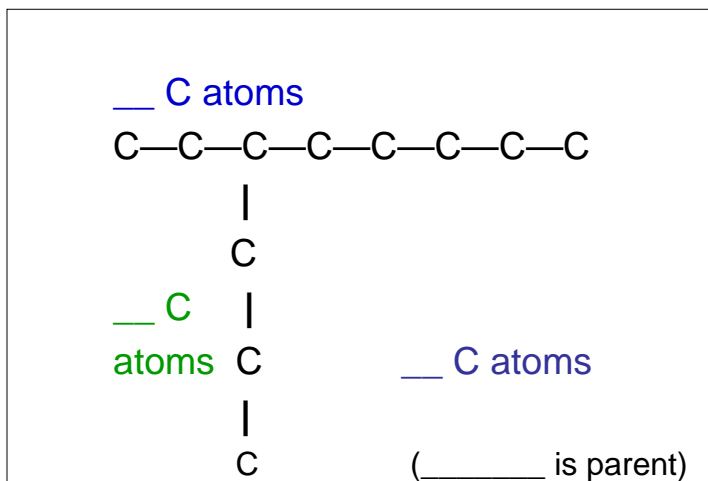
- C₅H₈ CHCCH₂CH₂CH₃
– 1-pentyne



12

Naming Hydrocarbons

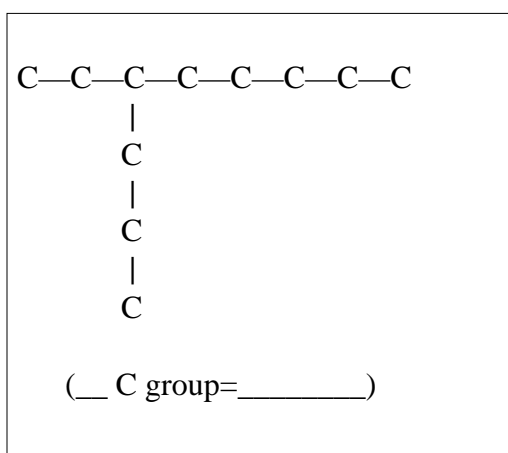
Longest chain of carbons = parent or backbone



13

Naming Hydrocarbons continued

Short branched chains listed at a prefix

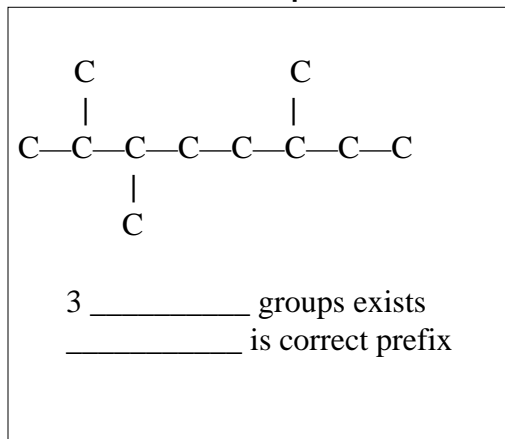


Branches use
same prefixes
for 1-10 and
end in yl

14

Naming Hydrocarbons continued

If more than 1 of the same type of branch exists, another prefix is needed



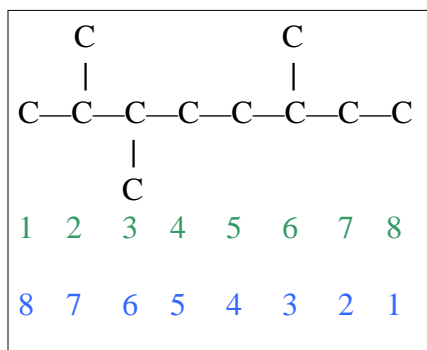
2=____
3=____
4=____

15

Naming Hydrocarbons continued

Number 'C' atoms so that the branches will occur at the _____ numbered carbons of a chain

- Is it best to have branches at the 2nd, 3rd and 6th carbons or 3rd, 6th and 7th carbons?
- **Green group** is best choice= 2,3,6-trimethyloctane



16

Naming Hydrocarbons continued

- If a chain has ____ branches, it is known as '___' or '_____',
 - Ex. _____ = or _____

17

Naming Alkenes

- Longest chain = parent
- Number 'C' atoms so that the double bond starts at the lowest #C possible
 - 1-hexene → _____
 - 2-hexene → _____
 - 3-hexene → _____
 - 4-hexene → _____
 - Branches are listed _____ the double bond has been given a number, but are listed at the _____ of the name

18

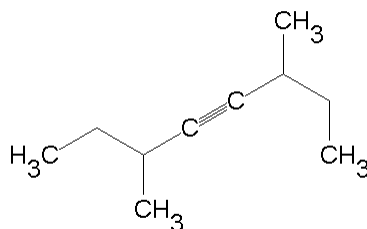
Naming Alkynes

- Same rules as Alkenes

– 1-butyne → _____

– 2-butyne → _____

– 3-butyne → _____



19

Functional Groups

- An arrangement of a few _____ that give characteristic _____ to an organic molecule
– See Table R
- An 'H' or hydrogen atom is typically _____ with an atom from another element

Table R
Organic Functional Groups

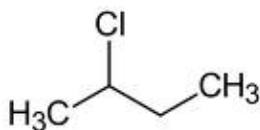
Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	-F (fluoro) -Cl (chloro) -Br (bromo) -I (iodo)	$R-X$ (X represents any halogen)	$CH_3CHClCH_3$ 2-chloropropane
alcohol	-OH	$R-OH$	$CH_3CH_2CH_2OH$ 1-propanol
ether	-O-	$R-O-R'$	$CH_3OCH_2CH_3$ methyl ethyl ether
aldehyde	$\begin{array}{c} O \\ \\ -C-H \end{array}$	$\begin{array}{c} O \\ \\ R-C-H \end{array}$	$\begin{array}{c} O \\ \\ CH_3CH_2C-H \end{array}$ propanal
ketone	$\begin{array}{c} O \\ \\ -C- \end{array}$	$\begin{array}{c} O \\ \\ R-C-R' \end{array}$	$\begin{array}{c} O \\ \\ CH_3CCH_2CH_2CH_3 \end{array}$ 2-pentanone
organic acid	$\begin{array}{c} O \\ \\ -C-OH \end{array}$	$\begin{array}{c} O \\ \\ R-C-OH \end{array}$	$\begin{array}{c} O \\ \\ CH_3CH_2C-OH \end{array}$ propanoic acid
ester	$\begin{array}{c} O \\ \\ -C-O- \end{array}$	$\begin{array}{c} O \\ \\ R-C-O-R' \end{array}$	$\begin{array}{c} O \\ \\ CH_3CH_2COCH_3 \end{array}$ methyl propanoate
amine	$\begin{array}{c} \\ -N- \end{array}$	$\begin{array}{c} R' \\ \\ R-N-R'' \end{array}$	$CH_3CH_2CH_2NH_2$ 1-propanamine
amide	$\begin{array}{c} O \\ \\ -C-NH \end{array}$	$\begin{array}{c} O \\ \\ R-C-NH \end{array}$	$\begin{array}{c} O \\ \\ CH_3CH_2C-NH_2 \end{array}$ propanamide

R represents a bonded atom or group of atoms.

20

Alkyl Halides or Halogenides (group 17 elements)

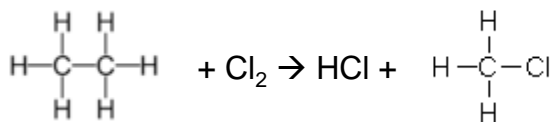
- Typical formula R-X (where X is a _____)
- Naming → Longest chain is the parent
 - halogen listed as _____
 - 'ine' ending of halogen dropped, '____' added
 - ex. Iodine → _____/Chlorine → _____



21

Alkyl Halides continued

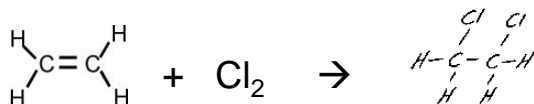
- ___ methods to form these molecules
 - Substitution Rxn: _____ of a hydrogen, in a _____ hydrocarbon, with a halogen
 - $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{HCl} + \text{CH}_3\text{Cl}$ (_____ formed)



22

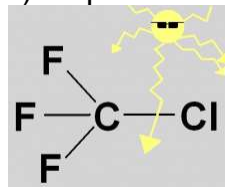
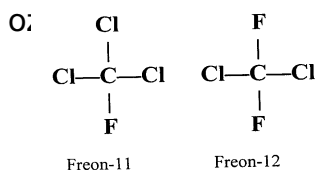
Alkyl Halides continued

- Addition Rxn: _____ halogens at the site of a multiple bond of an unsaturated hydrocarbon



- _____ plus chlorine yields _____

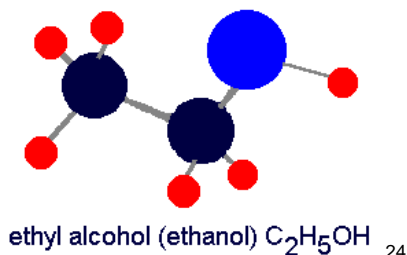
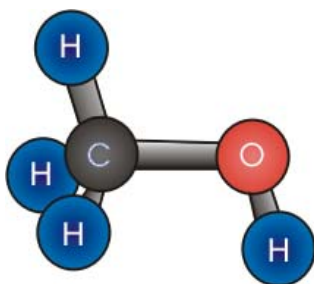
- CFC's (Chlorofluorocarbons) responsible for some



23

Alcohols

- Alcohols → _____ group attached
- Primary (1°): O-H is attached at the _____ of a chain of carbons
 - This 'C' has only _____ other carbon bonded to it
 - R-OH (where R=rest of the molecule/branch)

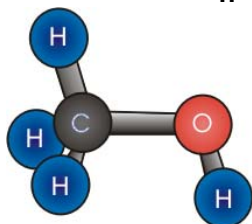


24

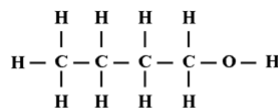
Alcohols continued

- Naming
 - Parent= longest 'C' chain
 - Drop 'e' ending and add 'ol'
 - diagram (i) would be _____
 - » also known as _____ alcohol
 - diagram (ii) would be _____
 - » also known as _____ alcohol

i



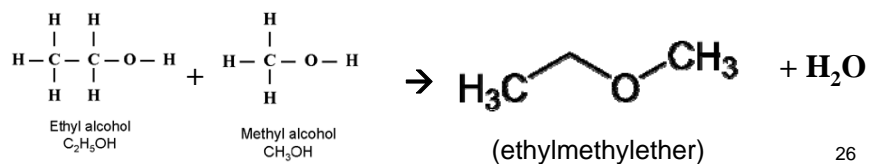
ii



25

Ethers

- 2 carbon chains connected by an _____ atom
- _____
- Formed by the addition of _____
 - Process known as _____
 - Sometimes called a _____ rxn as water is a byproduct



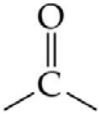
26

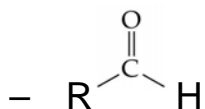
Naming Ethers

- Both _____ groups listed alphabetically
 - Followed by term '_____'
 - If alkyl groups are _____ = di prefix used
 - Ex. dipropyl ether → C-C-C-O-C-C-C
- You may also also see ethers named in order of branch size (not alphabetical)
 - Both can be correct
 - Ex. C-C-C-C-O-C-C could be _____ ether or _____ ether

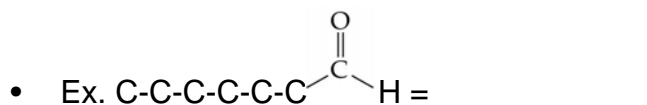
27

Carbonyl Groups: Aldehydes

- Contain a C=O double bond (carbonyl)
- Aldehyde: Carbonyl is at the _____ of a  chain



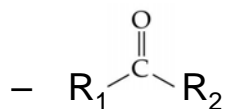
- Naming: drop 'e' of parent and add '____'



28

Carbonyl groups continued: Ketones

- Ketone: Carbonyl is on an _____ 'C' atom



- Naming: drop 'e' of parent and add '____'

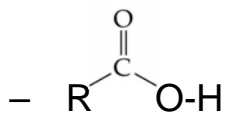
- # the placement of the $\overset{\text{O}}{\parallel}{\text{C}}$



29

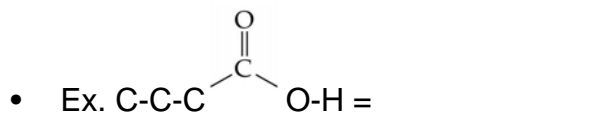
Carbonyl groups continued: Organic or Carboxylic Acids

- Contain a carbonyl and an OH group at the end of a chain



- Naming: drop 'e' of parent and add '____'

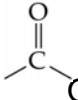
- If more than one= _____ acid etc.



30

Organic Acids continued

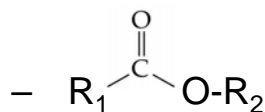
- These are _____ acids
 - Acetic acid (vinegar)
 - citric acids (fruits)
 - _____ (muscle's in regards to cramping during anaerobic respiration/fermentation)
- _____ electrolytes when dissolved in water

-  is a polar end, thus they are miscible in water

31

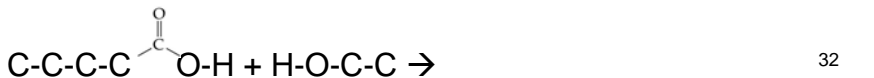
Carbonyl groups continued: Esters

- Ester: Similar to the acid, but end 'H' has been replaced with another Carbon chain



- Esterification: process used to make them

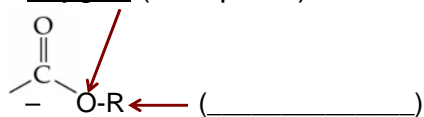
- A form of _____
- _____ + _____ → _____ + _____

- 

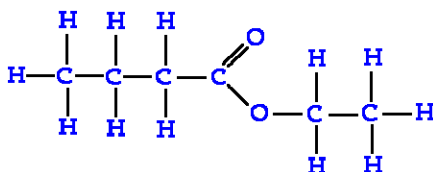
32

Esters continued

- Pleasing fragrances/aromas released
 - pineapple, wintergreen etc
- Naming: Drop 'oic acid' and add '_____'
 - Add alkyl group that is attached to the non-carbonyl oxygen (as a prefix)



- What would this be called?




33

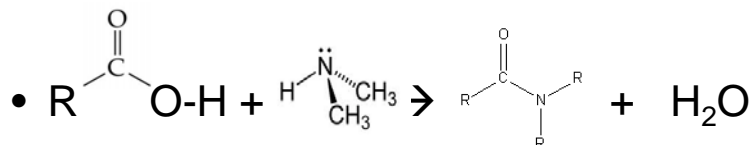
Carbonyl groups continued: Amines

- Amines: Ammonia (NH₃) derivatives where hydrogen has been replaced with an _____
- Naming: branches listed _____ (di, tri etc)
 - Ending of 'amine'
 - 1°, 2° and 3° amines based on the # of alkyl groups present
- (trimethylamine=3°) (dimethylamine=2°)
- (ethylmethyl amine=2°)
- Are weak _____ in aqueous solutions
- Found in _____ and associated with breakdown of _____ in animals

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Carbonyl groups continued: Amides

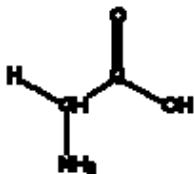
- Amides: contain a  bond in the chain
- results from a _____ reaction between an amine and an organic acid
- Naming: 'oic acid' dropped '_____' added
- Acid + Amine → Amide + water



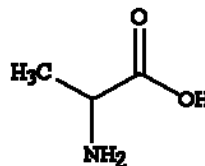
35

Carbonyl groups continued: Amino Acids

- Amino Acids: Contain an _____ and _____
- Are building blocks of _____
- Molecules will bond together to form long _____



- Ex. Glycine



Alanine

36

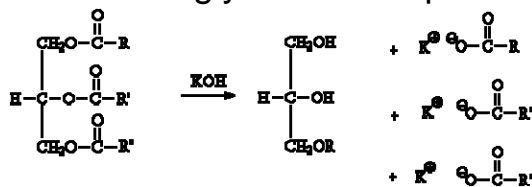
Organic Reactions:

- Substitution: replacement of an _____ in a _____ compound
 - $\text{CH}_4 + \text{Cl}_2 \rightarrow \text{_____} + \text{_____}$
- Addition: adding atoms to an _____ compound
 - $\text{CH}_2\text{CH}_2 + \text{Br}_2 \rightarrow \text{_____}$
 - Adding 'H' to an unsaturated = _____
 - Changing oil (liquid) into fat (solid)
- Condensation/Dehydration synthesis: two molecules combine with loss of _____

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Organic Reactions continued

- Combustion: organic _____ in presence of _____
 - Complete: _____ and _____ are products
 - Incomplete: _____, _____, _____ and _____ result
 - _____ gas furnace, vehicles etc
- Saponification: addition of an _____ and an _____ to form a soap and glycerol
 - Ester + Base \rightarrow glycerol + soap



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Organic Reactions continued

- Fermentation: decomposition of _____ in the presence of yeast (enzyme = zymase) to produce ethanol and CO_2
 - $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow$ _____ + _____
- Cracking: large molecule _____ due to _____ being applied (more useful molecule made)
 - $\text{C}_{20}\text{H}_{40} \rightarrow$ _____

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Organic Reactions continued

- Polymerization:
 - Monomer: _____ unit
 - Polymer: _____ made of joined monomers
 - Addition polymers: _____ occurring between _____ with _____.
 - ethene \rightarrow polyethene (polyethylene)
 - reaction can be _____ many times

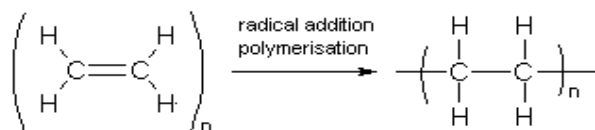
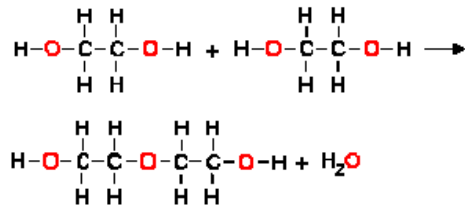


Fig 1: The polymerisation of ethene into poly(ethene)

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Polymerization continued


- Condensation polymers: removal of _____ to form a polymer (_____)
- may be co-polymers (_____ monomers together)
- Dimer: when two monomers join




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Polymerization continued

- Natural Polymers: _____, _____, _____
- Man-made: _____, _____, _____
- Three possible structures of polymer chains
 - Linear, branched, cross-linked(network)

 – Linear= HDPE; high density polyethylene (#1,2 recyclables)

 – Branched=LDPE; low density polyethylene (trash bags)

– Cross-Linked/network= CDPE; cross-linked polyethylene (sturdy crates)



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