

Semester 2

Organic Chem

Fractional Distillation

Organic chemistry

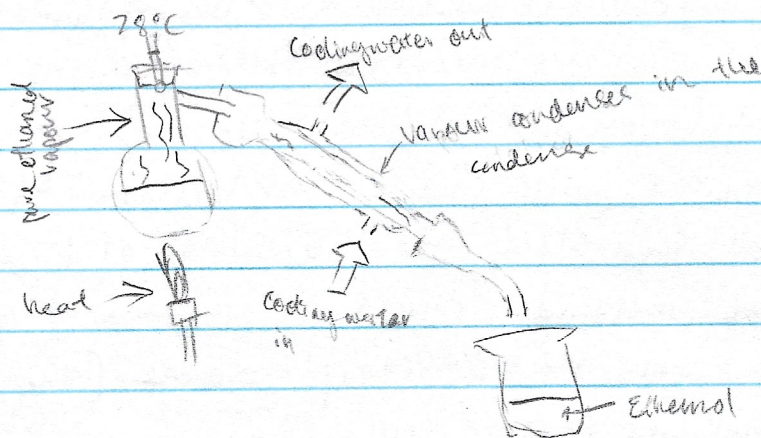
- Study of compounds of carbon
- 20 million known organic compounds
- Everything else = inorganic compounds
- 100,000
- Exceptions = carbonates, hydrogenocarbonates and oxides of carbon

Distillation

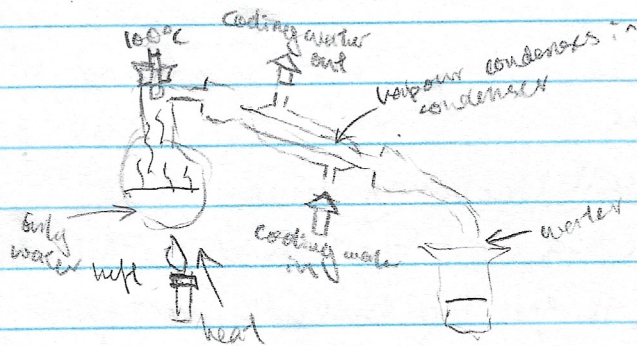
- Process to separate pure liquid from mixture of liquids
- Boiling points

Water and alcohol distillation

1. Water and ethanol solution are heated
2. Ethanol evaporates first, cools then condenses (78°C)



3. The water left cools then condenses



Sequence of events in distillation = heating \rightarrow evaporating \rightarrow cooling \rightarrow condensing

Alkanes

- Family of hydrocarbons
- Saturated hydrocarbons
- Can be arranged in straight lines or branched chain or ring

Naming Alkanes - straight chain

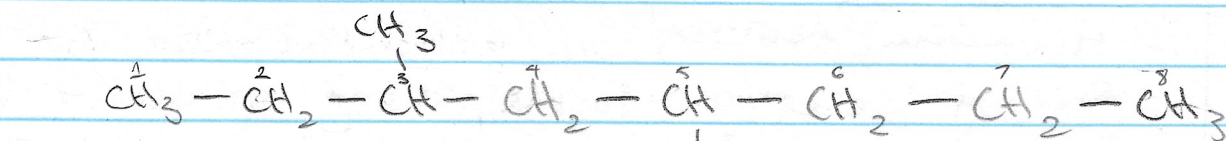
- All atoms arranged in straight line
- Meth, Eth, Prop, But, Pent, Hex, Hept, Oct
- -ane ending

Structural isomers

- Isomers - organic molecules in same molecular formula but diff. structural formulas
- Structural isomers have
 - Diff names
 - Diff chem properties
 - Diff shapes

Naming Alkanes - branched

1. Find parent chain - longest continuous chain of carbons
2. Number carbon atoms



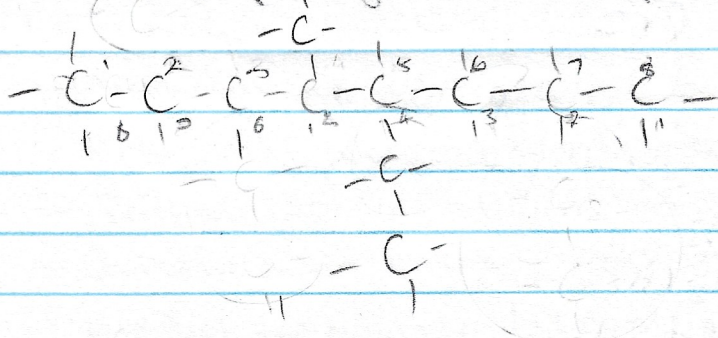
3. Substituents

- Atoms attached to parent chain
- Same prefix as alkanes } Methyl, Ethyl, Propyl
- -yl suffix
- Called Alkyl group
- Named by putting carbon number from parent chain in front of substituents
 - 3-methyl and 5-ethyl

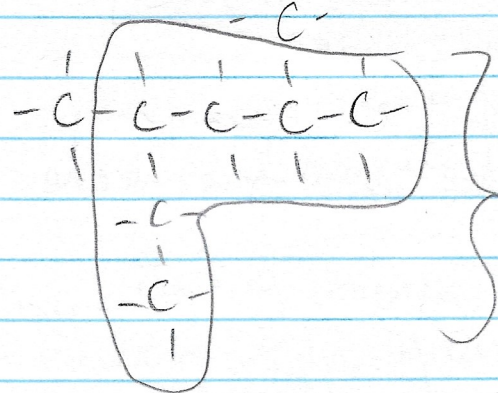
4. If more than 1 of same substituent in structural formula, use di-, tri-, tetra prefix
- If methyl in groups 2 and 4 the 2,4-dimethyl

* Priority

- To decide if we name left to right or right to left
- + Each group of FGs are different priorities, and within the groups they have their priorities going bottom to top



Since ethyl has priority over methyl, we count from the right and call it 4-ethyl, 5-methyl

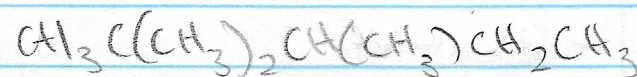
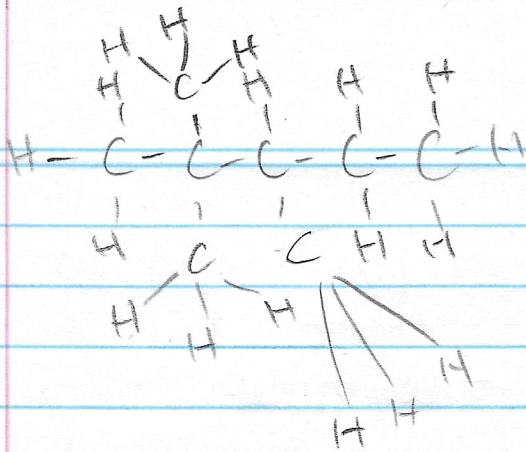


this is the parent chain
2,4-dimethyl

5. When we order them by name, it's alphabetical and you ignore the prefixes from step 4
- dibutyl, ethyl, trimethyl then pentyl
 - In first example, name them as 5-ethyl, 3-methyl

6. Commas to separate numbers

- Hyphens between numbers and substituents
- Parent name directly after last substituent with no space
- IUPAC naming system
- 5-ethyl-3-methylhexane



Physical properties

Melting & Boiling points of Alkanes

- Low melting & boiling.
- Weak intermolecular forces
- Meth, eth, prop - all are gas
- Pentane \rightarrow C6 = liquid
- Carbon chain longer = attraction increases - more energy needed to overcome forces of attraction
- Branched alkanes have lower melt & boiling points
 - Branches prevent molecules getting close = cannot attract so strongly

Viscosity of alkanes

- Increases as no. of carbons increase
- Cos increase in intermolecular forces of increasing sized molecules

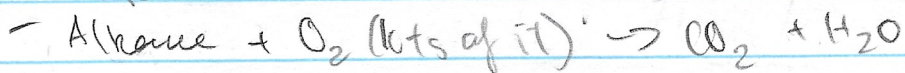
Volatility of alkanes

- High
- Low boiling point
- = weak intermolecular forces
- Fewer carbons in straight chain = higher volatility

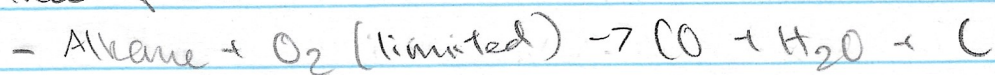
Combustion

- Flammable

- Complete combustion:

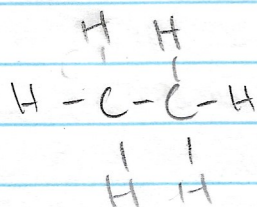


- Incomplete combustion

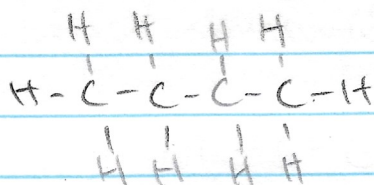


Practice Qs

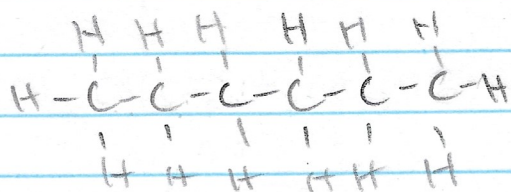
Ethane



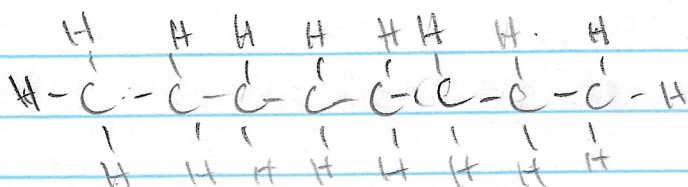
Butane



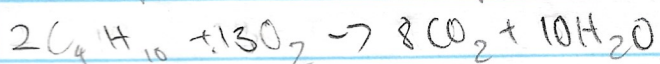
Hexane



Octane



Complete combustion of butane



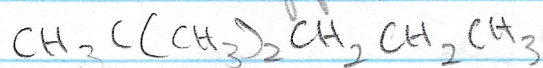
Methylbutane



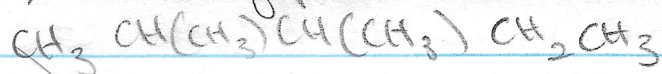
↳ Don't need numbers cos only 1 possible formula

2, - writing numbers gets you marked down

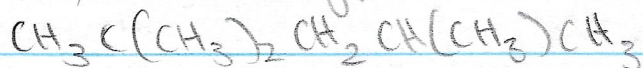
2,2-dimethylpentane



2,3-dimethylpentane



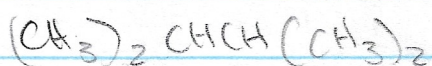
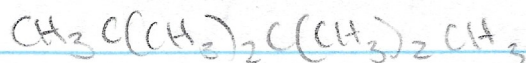
2,2,4-trimethylpentane



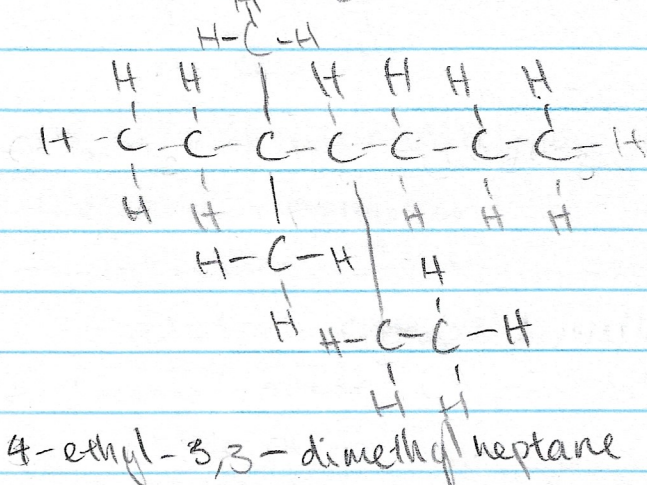
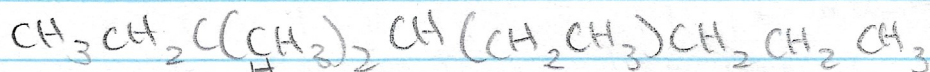
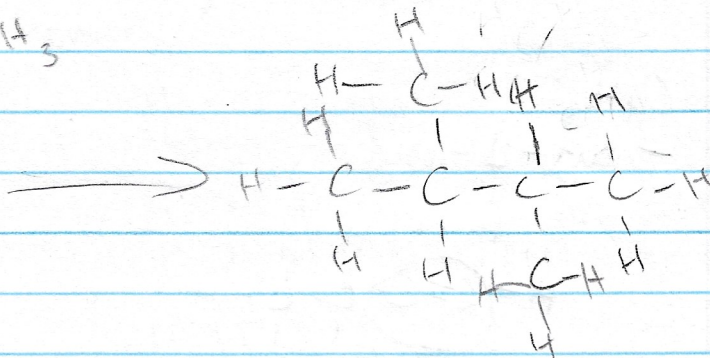
3-ethylhexane



Tetramethylbutane



2,3-dimethylbutane



4-ethyl-3,3-dimethylheptane

Alkenes

Alkenes

- At least one double bond between carbon atoms
- Unsaturated hydrocarbons
- $C=C$

Naming alkenes - straight chain

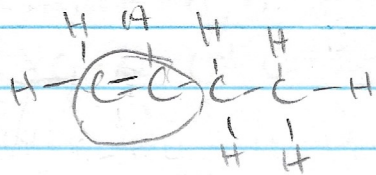
- Retain prefixes from alkanes
 - Note how meth- won't exist
- Parent compound = longest chain with $C=C$
- Number from end that gives $C=C$ lowest number
- Suffix -ene
 - Ethene
 - Octene

Naming alkenes - structural isomerism

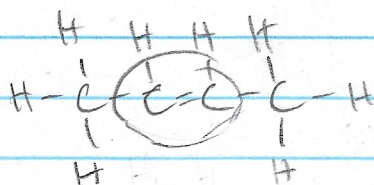
- Structural isomers occur in alkenes with 4+ carbons
- Where the $C=C$ is placed in different spots

C_4H_8

- But-1-ene



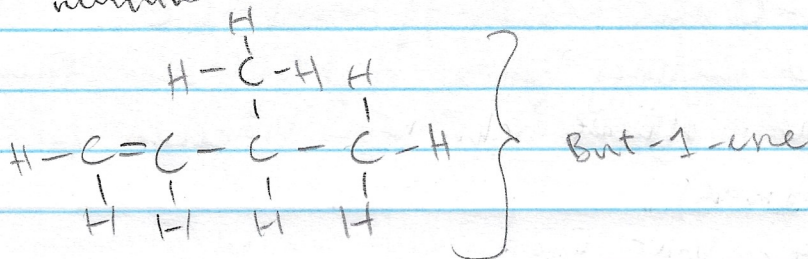
- But-2-ene



↳ But n-ene for the different isomers

Naming Alkenes - Branched

1. Find parent chain with C=C
2. Number Cs in order that will give C=C lowest number

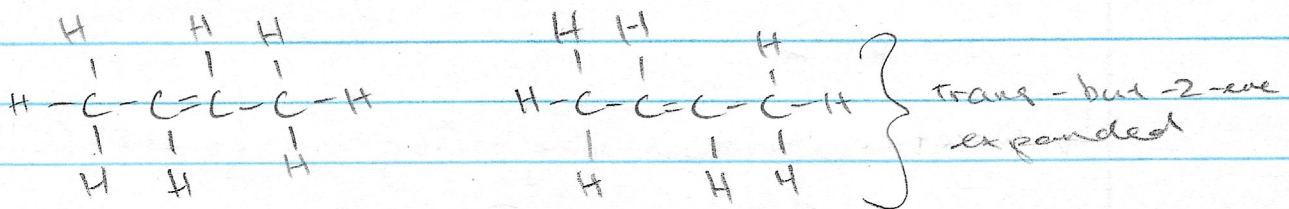
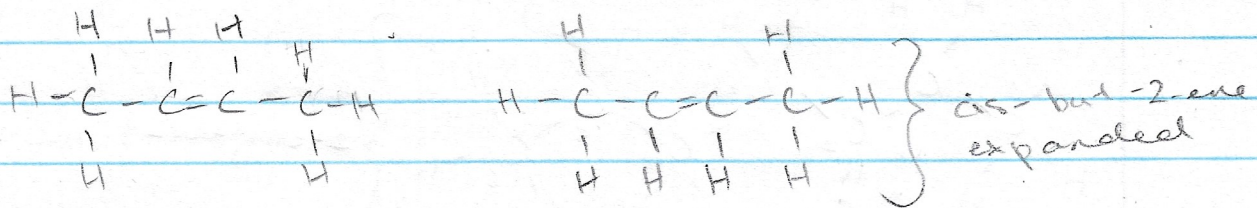


3. Name substituents same way as alkanes
- 3-methylbut-1-ene

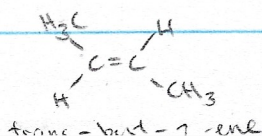
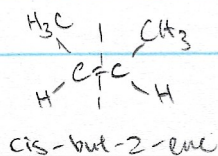
Molecular formula for alkenes

- C_nH_{2n}
- $n = \text{no. of C}$
- $\text{H} = 2n$
- C_4H_8

Geometrical structural isomers



- Two molecules can form where C=C is in same place but spatial arrangement is different
- cis isomer - CH_3 on same side of C=C
- rotation possible
- trans isomer - CH_3 on different sides (can't rotate)



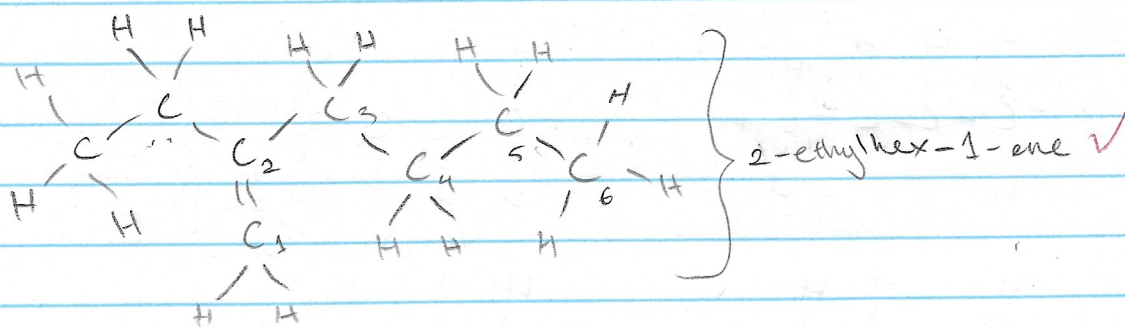
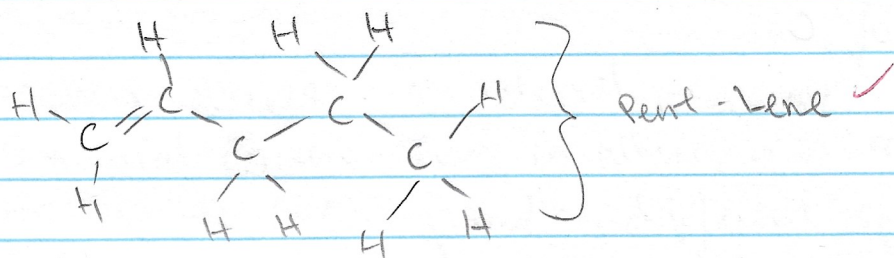
Properties

- More reactive than alkanes
- Relatively unstable C=C
- Breaking C=C uses less energy than C-C
- Boiling and melting points slightly lower than alkanes
- straight chain alkanes higher than branched for boiling

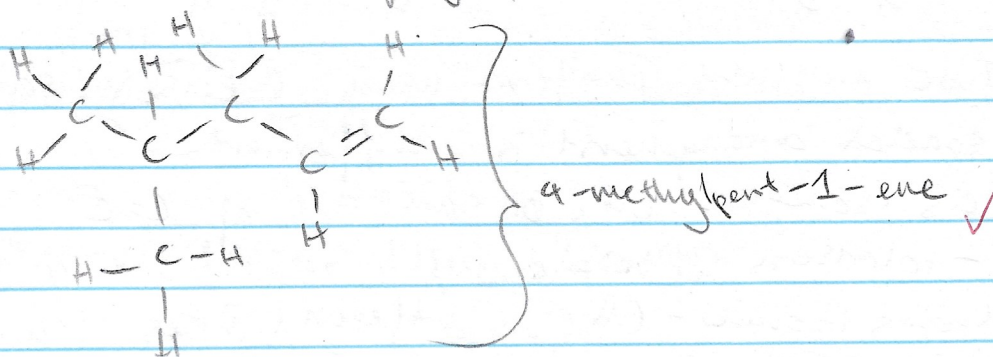
(like alkanes)

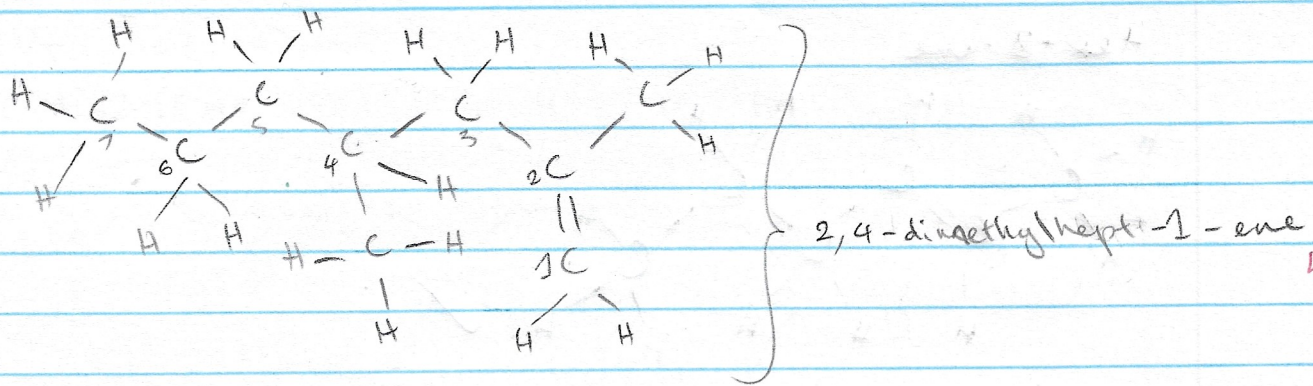
- Alkenes 2-4 carbon = gas
- Alkenes 5-17 = liquid
- Viscosity increases with chain length
- Volatility decreases with chain length

Practice Qs

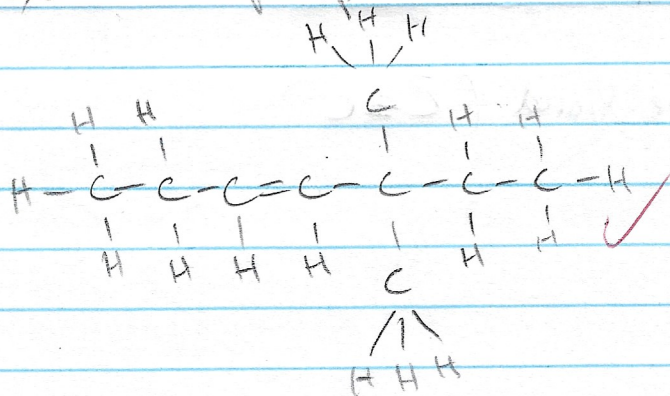


↳ Note that the chain going across isn't parent as no C=C

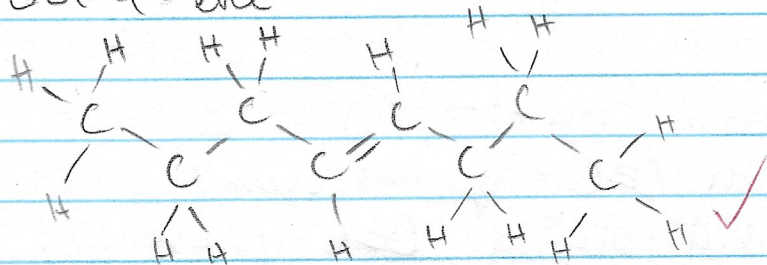




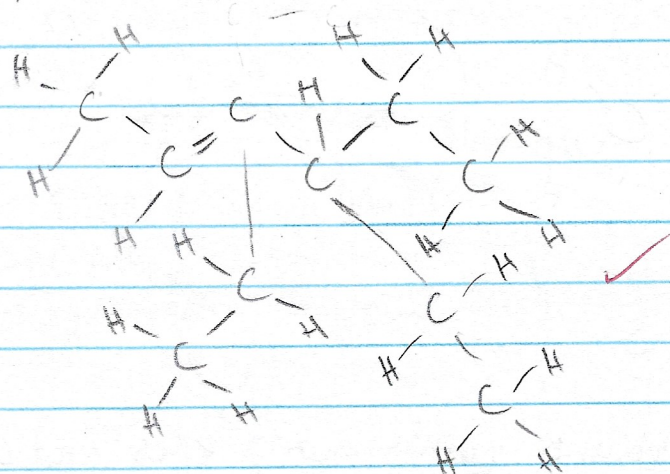
5,5-dimethylhept-3-ene



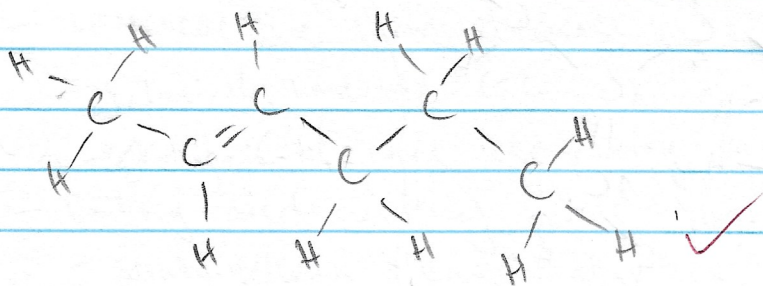
Oct-4-ene



3,4-diethylhex-2-ene



Hex-2-ene

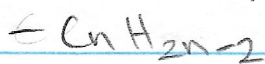


Alkynes

Alkynes

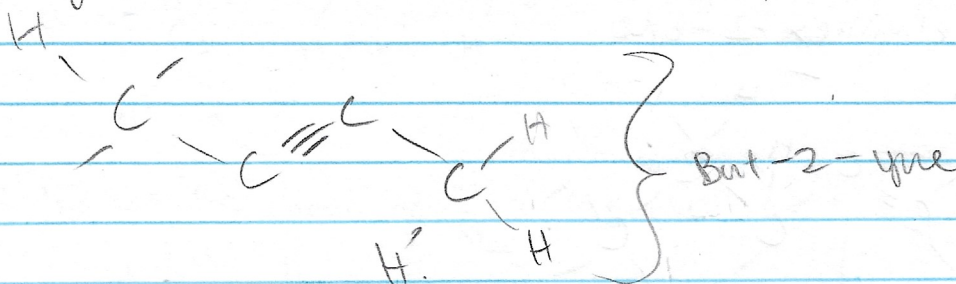
- Family with a triple bond ($C \equiv C$)
- Unsaturated

Molecular formula



Straight chain

- Retain prefix from eth-
- Longest chain with $C \equiv C$ = parent chain
 - Start from end giving $C \equiv C$ lowest no.
- -yne suffix

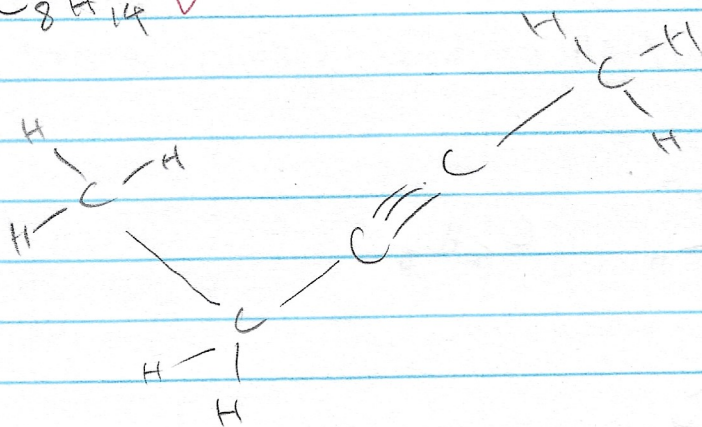
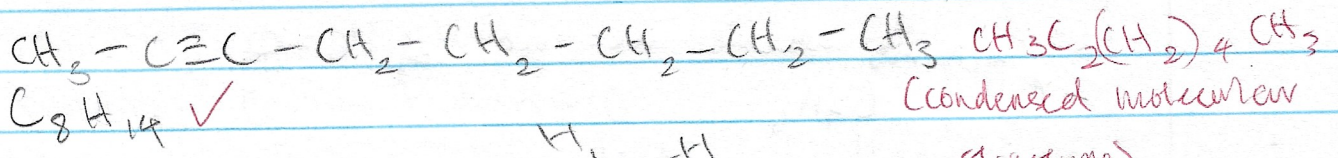
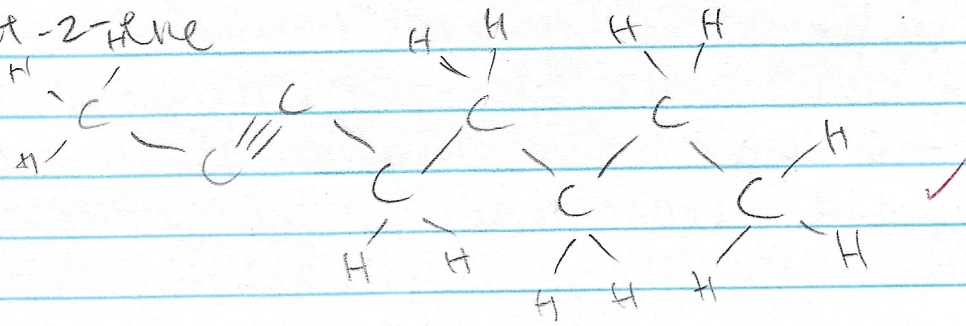


Properties

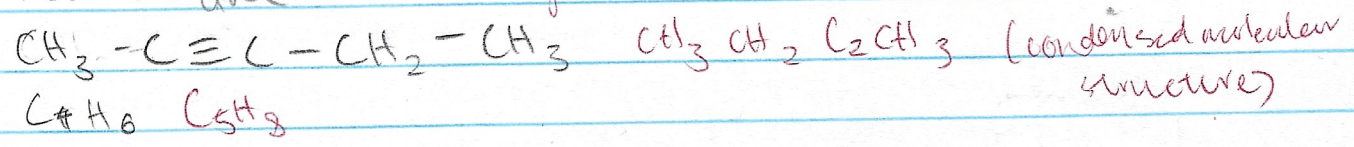
- Liquid from pentyne
- Alkynes have higher boiling points than alenes and alenes
- Viscosity increases with chain length
- Volatility decreases with chain length increased

Practice Q's

Oct-2-yne



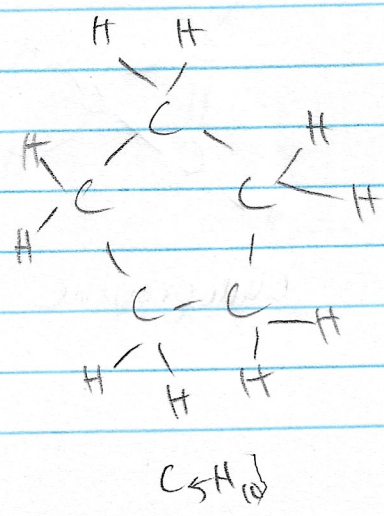
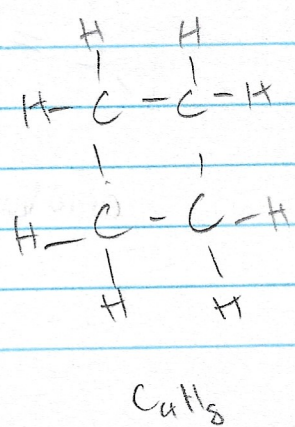
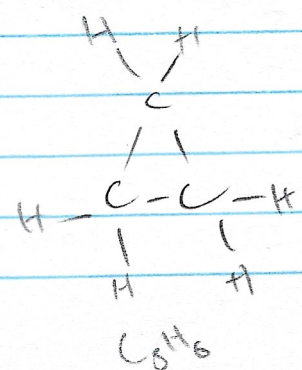
But-2-yne Pent-3-yne



Cycloalkanes and kene

Rings of carbon atoms = cycloalkane

- Distinguishing chem properties
- Only C-H and C-C
- C-C in a ring though
- Smallest is cyclopropane
- C_nH_{2n}

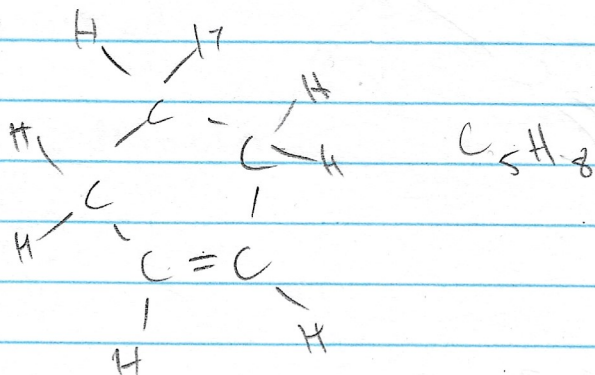


Naming

- Use prefix
- -ane
- Cydo - in front
- Cyclopentane, Cyclooctane

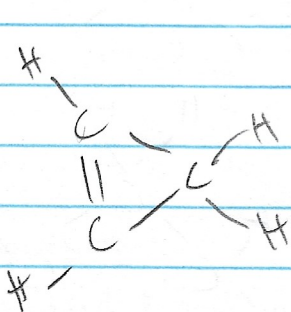
Cycloalkene

- $C_nH_{2(n-m)}$ where $m = \text{no. of } C=C$
- C_3H_4 , C_4H_6

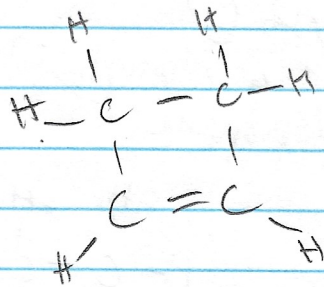


Naming

- Prefix
- -ene
- cydo -
- cyclopentene



cyclopropene



cyclobutene

Predicting products of combustion reactions

- Complete combustion = lots of O_2 present
 - Hydrocarbon + $O_2 \rightarrow CO_2 + H_2O + \text{energy}$
- Incomplete combustion = limited O_2
 - Still yields $CO_2 + H_2O$
 - Also creates toxic by-products CO and C

Balancing equations

- Balance C then H then O
- Alkanes always need to double hydrocarbon