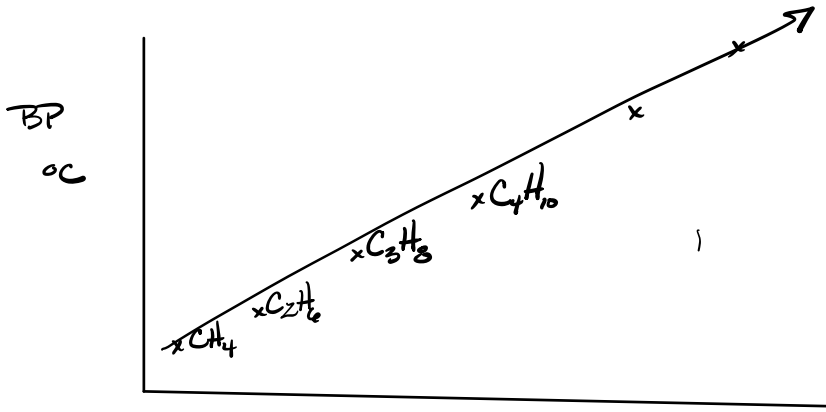
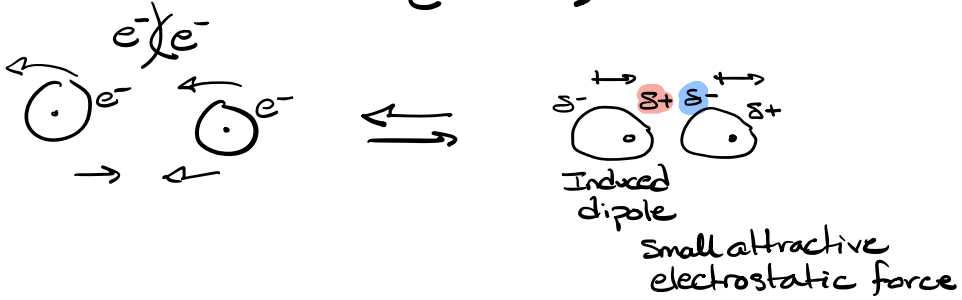
Intermolecular Forces

Van der Waals Forces

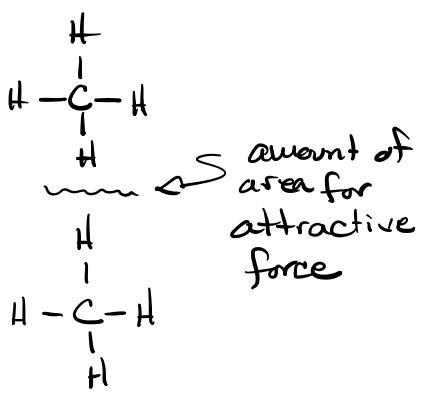
Homologus Series (addition of $-CH_2-$)



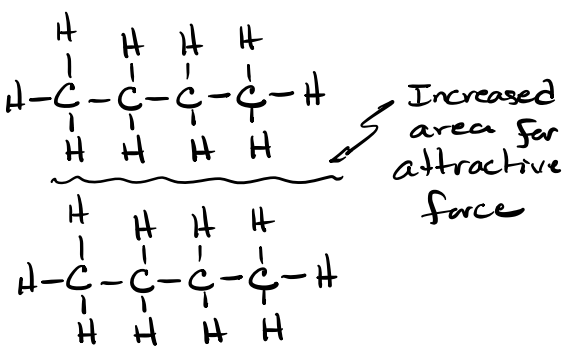
	°C
methane	−164°
Ethane	−89°
propane	−42°
butane	0°
pentane	36°
hexane	69°



Small attractive electrostatic force



amount of area for attractive force



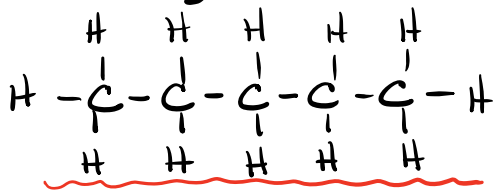
Increased area for attractive force

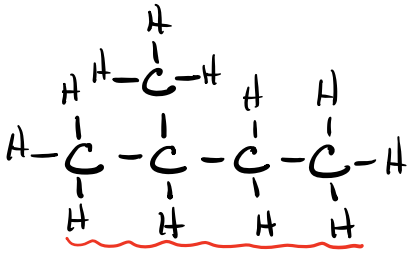
model => Velcrow

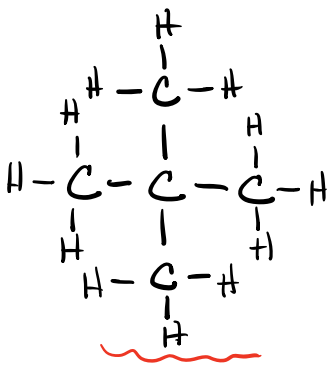
Increased area = increase force

BP

Branching for Non-polar C_5H_{12}

36.1°C  pentane

27.9°C  2-methyl butane

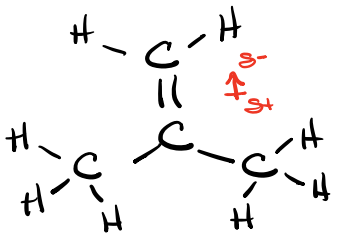
9.5°C  2,2-dimethylpropane

Less area for attractive forces

Stronger attractive force = Higher BP

Branching decreases surface area and decreases attractive forces.

Dipole-Dipole

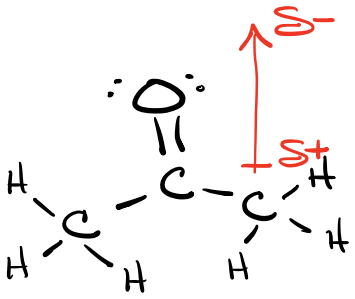


Isobutylene

mp −140.3°C

Bp −6.9°C

Non-polar
Van der Waals



more like a bar magnet

Acetone

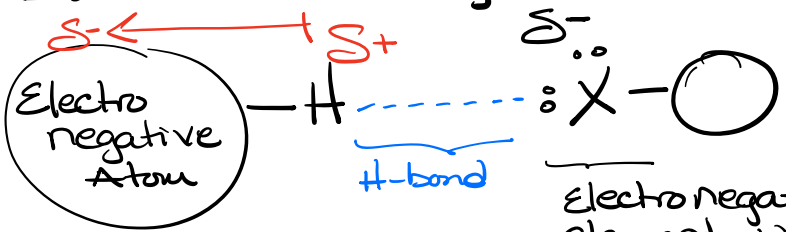
mp −94.9°C

Bp 56.3°C

Polar
dipole-dipole

Stronger intermolecular forces require more energy for phase transition.

Hydrogen Bonding



e⁻ poor

H — O, N, S

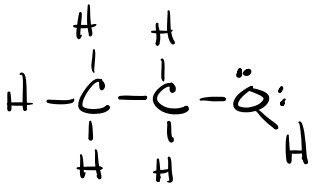
Hydrogen must be attached to oxygen, nitrogen or Sulfur

Electronegative element w/ Lone pairs

e⁻ Rich

X = O, N, S

Increasing strength

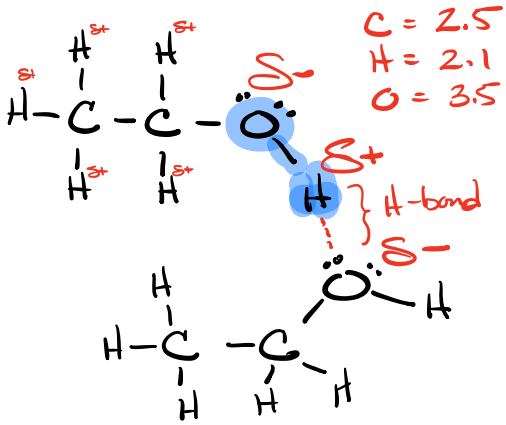


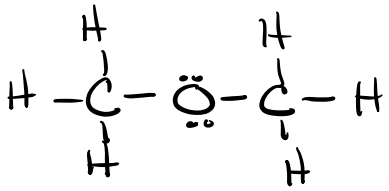
Ethanol

Ethyl alcohol

C_2H_6O

Bp 78.4°C



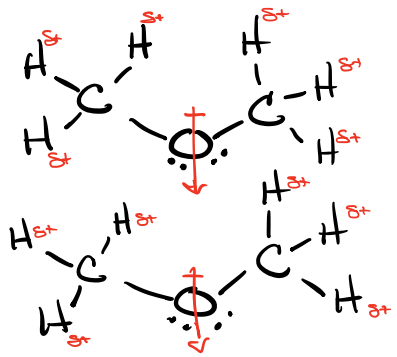


dimethyl ether

C_2H_6O

Bp −23°C

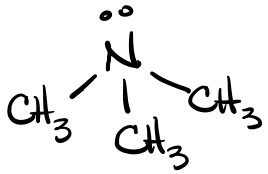
gas at room temp



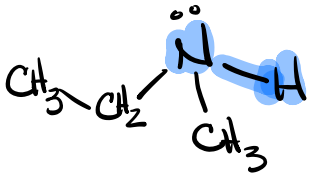
dipole-dipole

Can't H-bond

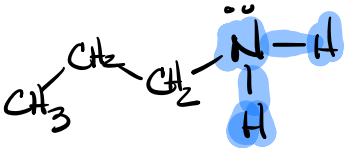
BP 3.5°C 37°C 49°C



trimethyl amine



methyl ethyl amine



propyl amine

A

Cannot H-bond
dipole-dipole only

B C

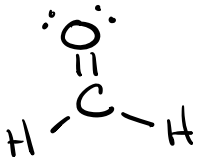
can H-bond

which has the lowest boiling point? A

Structural Formulas

CH_2O

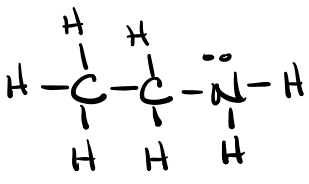
molecular formula

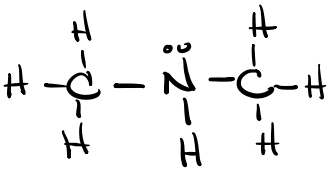


Lewis Structure
Structural Formula

C_2H_7N

molecular formula





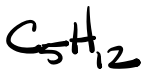
"Constitutional" or Structural Isomers

$CH_3CH_2NH_2$

CH_3NHCH_3

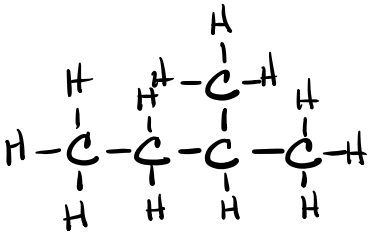
$(CH_3)_2NH$

Condensed structural formulas



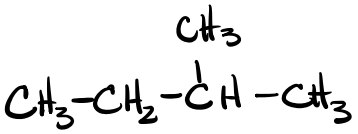
Molecular Formula

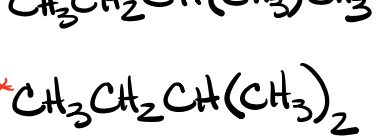
not specific to an isomer



Lewis Structure

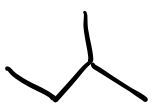
Takes a lot of time & space





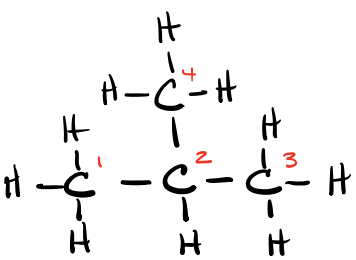
Condensed formulas

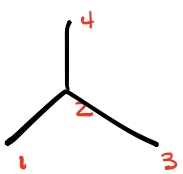
Require time to write & *Can be confusing

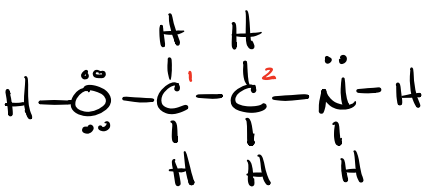


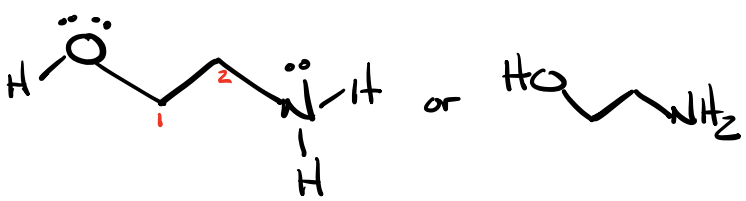
Bond line formula

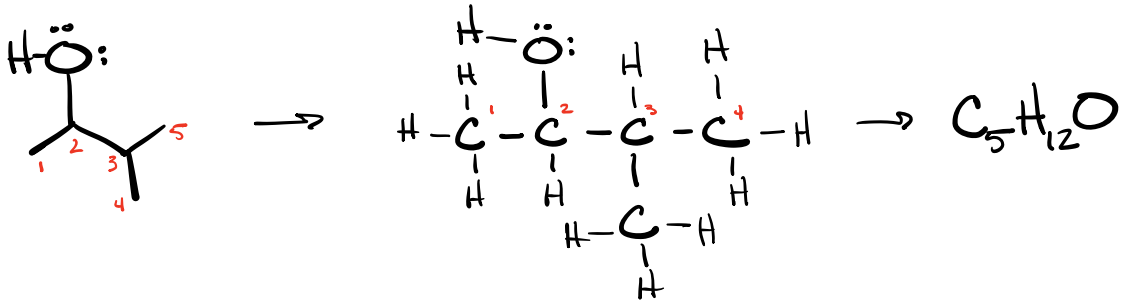
Prefered Style

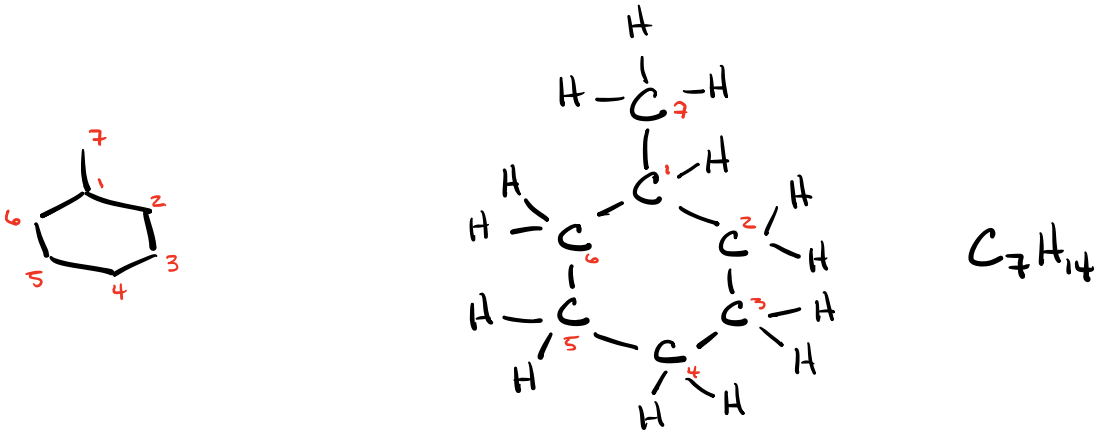






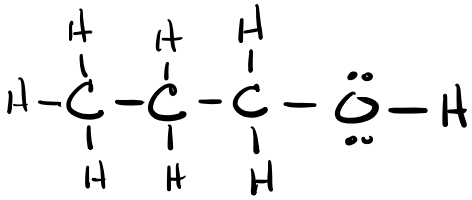






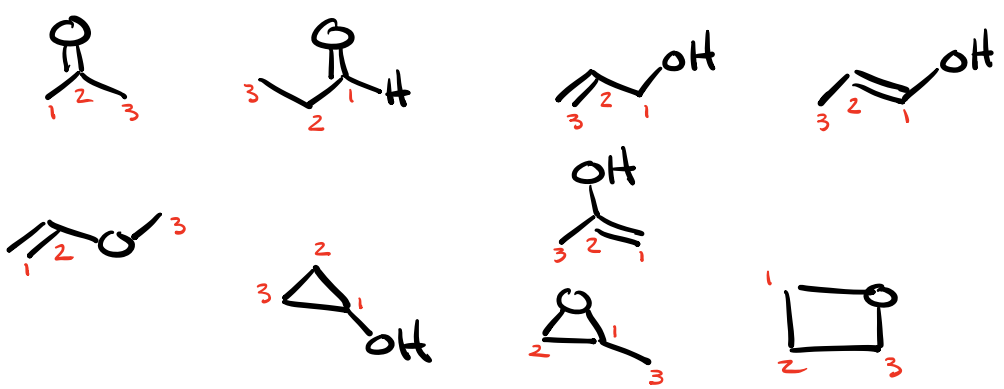
C_7H_{14}

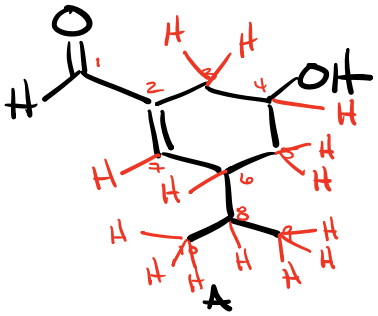
C_3H_6O How many isomers are there?



C_3H_8O X

⇒ Structure must have a double bond or ring





A

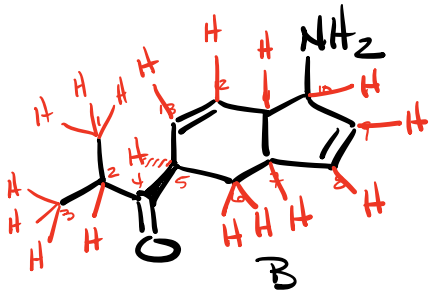
molecular formula?

$C_{10}H_{16}O_2$

$C_nH_{2n+2} = H_{2(10)+2} = H_{22}$

-6

H_{16} ✓



B

$C_{13}H_{19}ON$

$C_{13}H_{2(13)+2+1} = C_{13}H_{29}$

-10 2(2 rings + 3 double bonds)

$C_{13}H_{19}$ ✓

Saturated molecule $C_nH_{2n+2+*N-*X}$

no rings & no double bonds

* Each ring & each double bond represent the loss of 2 H's from that Saturated number.