(13) **Today**

Sections  2.11: Lewis Acids and Bases

Section 2-12: Non-Covalent Interactions Between Molecules

2.11 Problems: 2-17, 2-18, 2-24, 2-25, 2-40 (2-42 is a good question but theLewis acid-base concept is not strongly emphasized in our organic class), 2-43, 2-44, 2-46, 2-47, 2-48, 2-54, 2-55, 2-61, 2-64

Section 3.1: Functional Groups

Section 3.2: Alkanes and Isomers

**Next Class** (14)

Section 3.2: Alkanes and Isomers

Section 3.3: Alkyl Groups

Section 3.4: Nomenclature

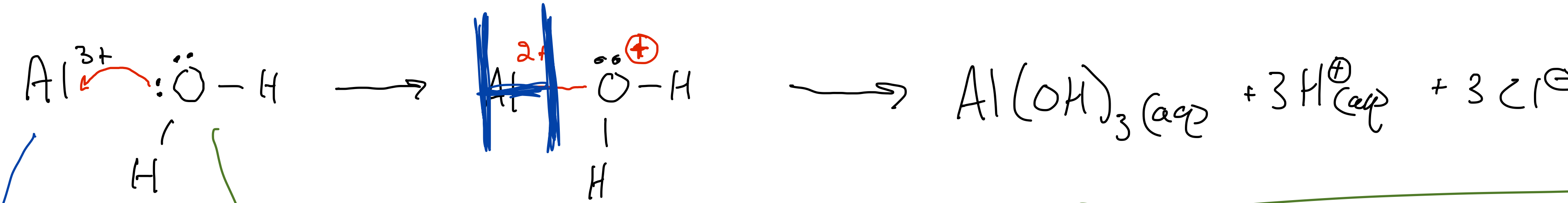
(15) **Second Class from Today**

Test 1 on Chap 1 and 2

**Third Class from Today** (16)

$NaCl_{(s)} \xrightarrow{H_2O} Na^{+}_{(aq)} + Cl^{-}_{(aq)}$ pH remains the same

$AlCl_{3(s)} \xrightarrow{H_2O} Al^{3+}_{(aq)} + 3\,Cl^{-}_{(aq)}$ pH becomes acidic




pretend covalent bond

Lewis acids are $e^-$ pair acceptors

Lewis base $e^-$ pair donor

+2 and higher metals are Lewis acids

+1 metals $Li^+$, $Na^+$, $K^+$ typically not considered to be Lewis acidic

$H^+$ is an acid under all definitions

To remember donor vs acceptor...

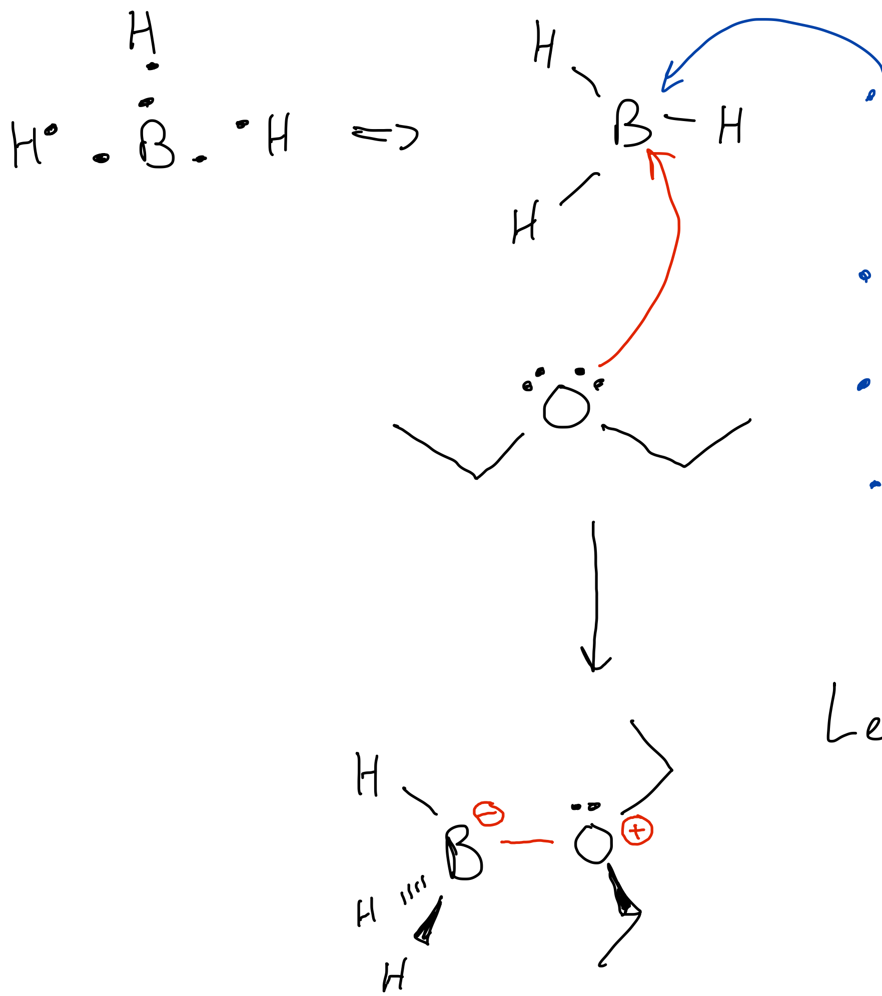
what can $H^+$ do with a pair of $e^-$'s?

Has no $e^-$'s to donate so must accept.

# Lewis Acids



$BH_3$



- only 6 $e^-$'s in B's valence shell
- room for 2 more $e^-$'s
- can accept a pair of $e^-$'s
- Lewis acid

Lewis acid-base adduct

Collectively referred to as...

IMF

intermolecular forces, van der Waals forces, or noncovalent interactions

London Dispersion Forces (LDF)

All molecules interact with other molecules using LDFs
Interaction between spontaneous, random dipoles and induced dipoles
Weak for molecules with few valence electrons and low surface area
Strength increases with increasing valence electrons, surface area, and volume

Dipole-dipole interactions

Occurs between opposite ends of dipoles on polar molecules
Presence of dipole dipole interactions can have a substantial affect on attraction between molecules

H Bond interactions

Occurs between H-bond donors and H-bond acceptors
The strongest of these intermolecular forces (on an interaction by interaction basis)
Important for water solubility and in biochemistry

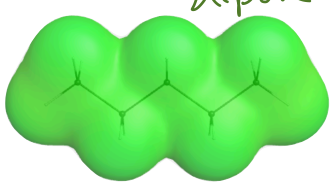
# Noncovalent Interactions

Section 2.12

## Collectively referred to as...

intermolecular forces, van der Waals forces, or noncovalent interactions

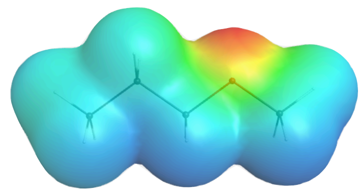
no permanent dipole



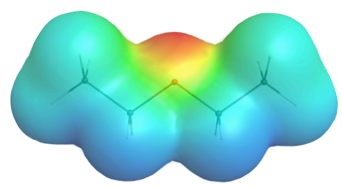
35.9 °C

weaker IMF

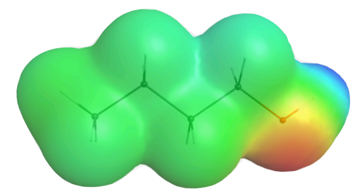
permanent dipole



40.2 °C



36.4 °C



117 °C

stronger IMF

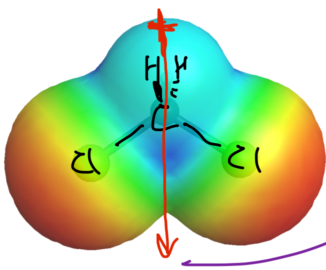
What do these boiling points tell you about the strength of the attraction between the molecules? What does it tell you

Higher BP's means there are stronger IMF's

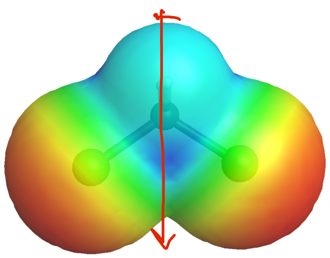
Collectively referred to as...

intermolecular forces, van der Waals forces, or noncovalent interactions

dipole-dipole interactions



So that is a dipole interaction is the attraction of the negative end of one dipole on one molecule for the positive end of another another molecule



Noncovalent Interactions

$CH_4$

g



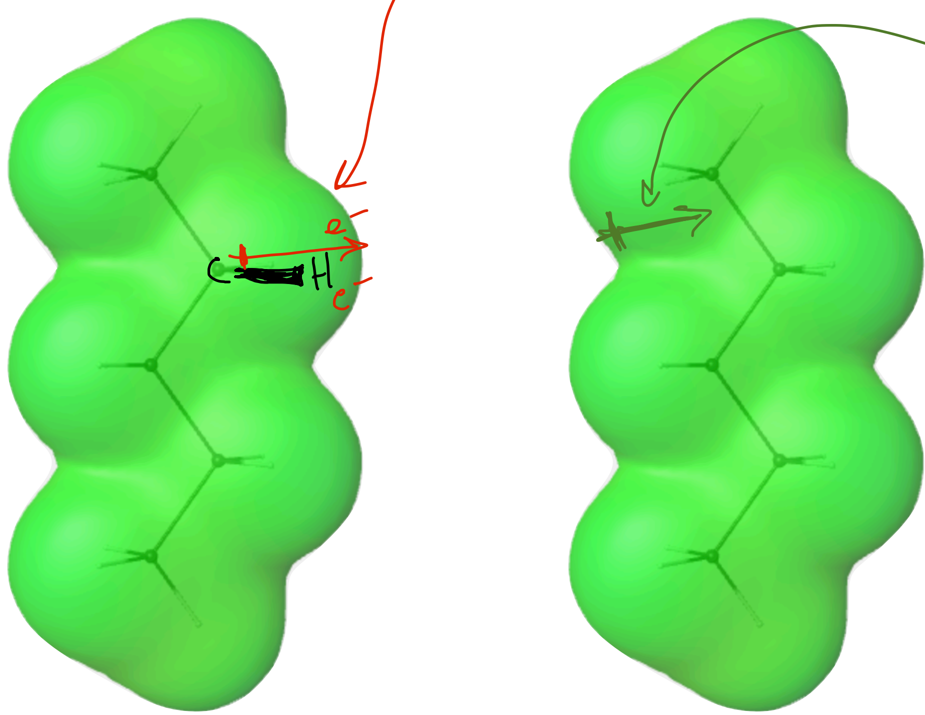
Collectively referred to as...

intermolecular forces, van der Waals forces, or noncovalent interactions

London dispersion forces (sometimes called dispersion forces)

$CH_4$ g @RT

$C_2H_6$ g @RT



The electrons in the molecule can spontaneously move to one side of the molecule, inform a random dipole.

That random spontaneous dipole can induce a dipole to form on a neighboring molecule

A brief momentary dipole-dipole interaction can occur in the molecules will be attracted to each other

42 $e^-$ any $e^-$ can be "misplaced"

10 $e^-$ in $CH_4$

$C_7H_{16}$ 58 $e^-$ ... bp 101 °C

$C_5H_{12}$

# Noncovalent Interactions



$CH_4$ 16e⁻ g @ RT

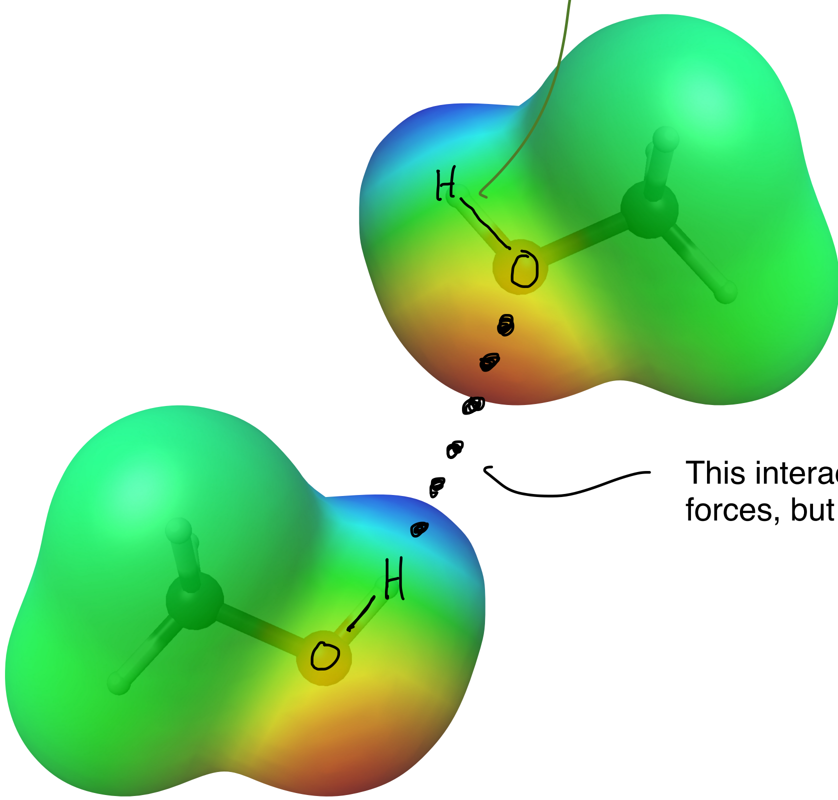
$H_2O$ 10e⁻ l up to 100 °C

Collectively referred to as...

intermolecular forces, van der Waals forces, or noncovalent interactions

Hydrogen bonds or H-bonds

not the H-bond - This is a covalent bond between oxygen and hydrogen



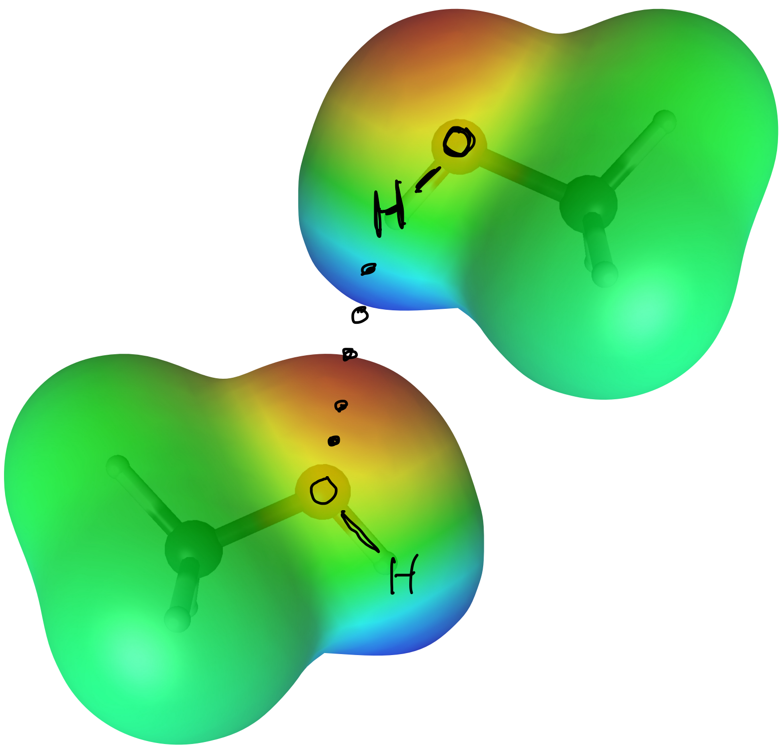

This interaction is the hydrogen bond. Hydrogen bonds are strong intermolecular forces, but they're very weak as compared to covalent bonds.

H-F

Collectively referred to as...

intermolecular forces, van der Waals forces, or noncovalent interactions

A hydrogen bond requires an H-Bond donor and an H-bond acceptor

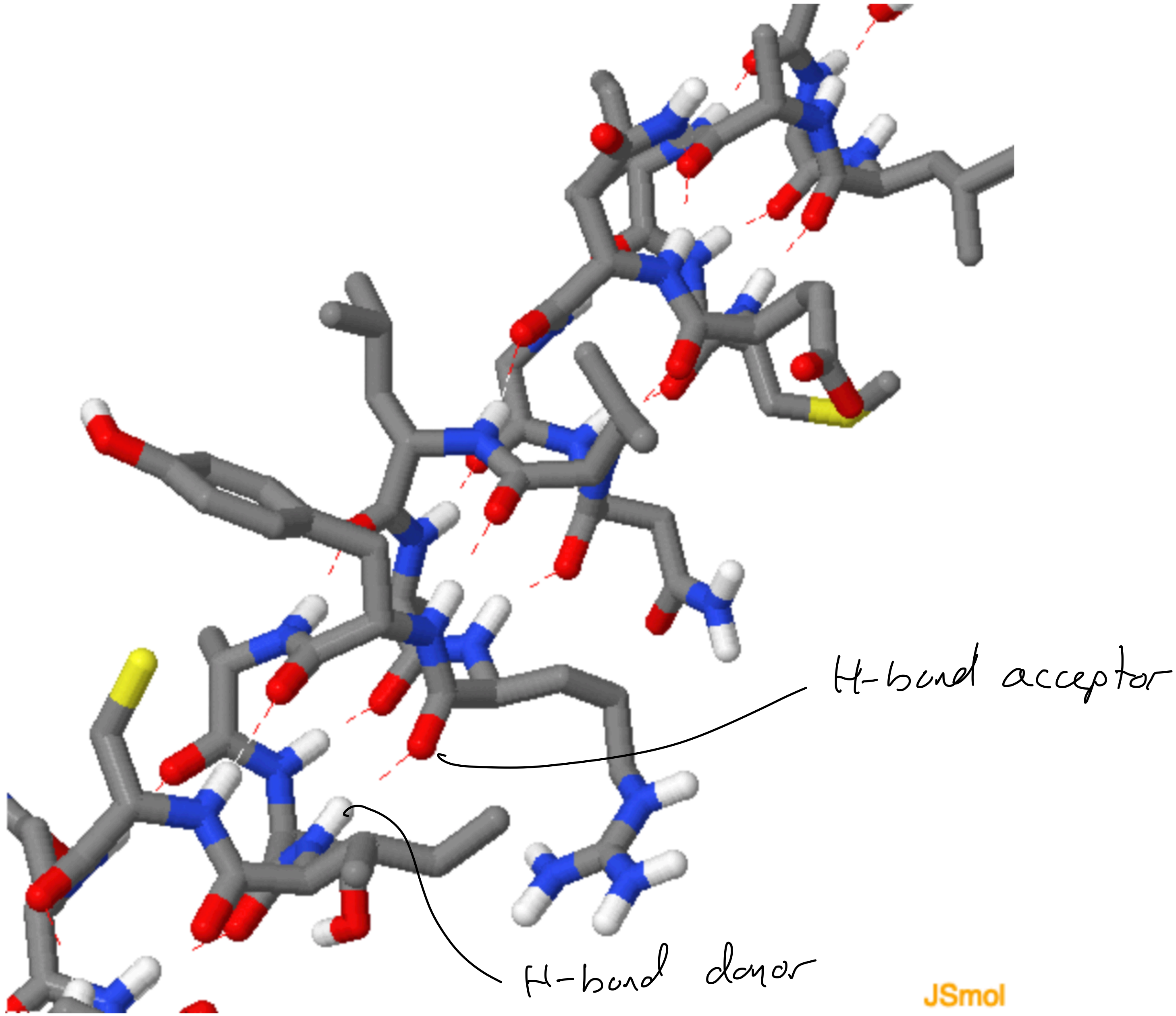



H-bond donor

any H atom that is covalently bonded to an N, O, or F atom

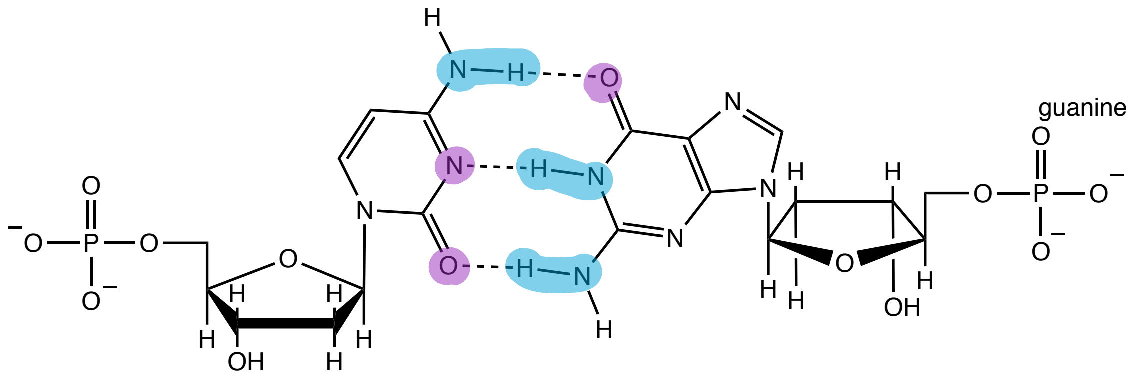
H-bond acceptor

any N, O, or F atom


H-bond acceptor
H-bond donor
JSmol

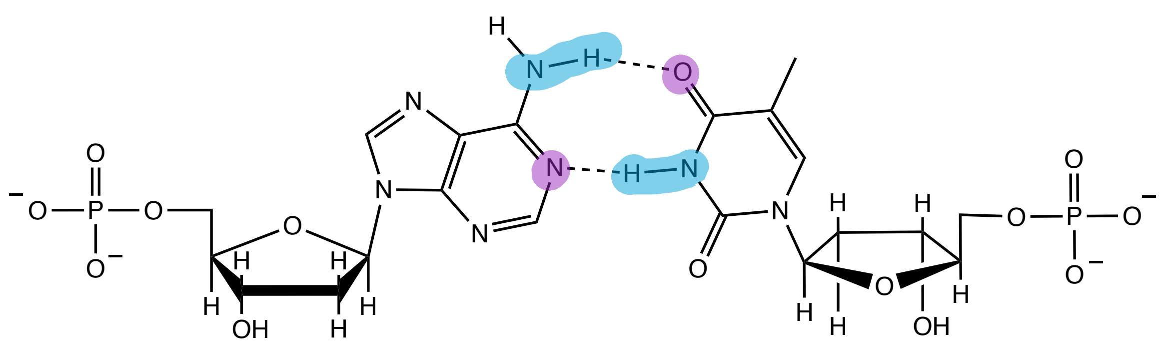
H-bond donors H-bond acceptors






deoxycytidine monophosphate

deoxygaunosine monophosphate



deoxyadenosine monophosphate

deoxythymidine monophophate

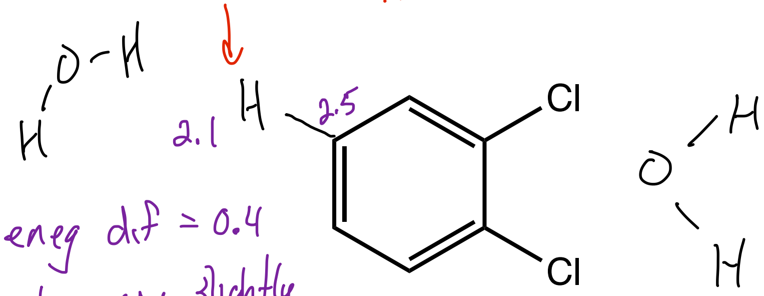
# H-Bonding Interactions and Water Solubility



Water molecules, conform up to four hydrogen bonds with other water molecules.

immiscible

not an H-bond donor H




eneg dif = 0.4
only very slightly polar

1,2-dichlorobenzene

dipole moment = 2.14 D*

miscible in all proportions

H-bond donor H

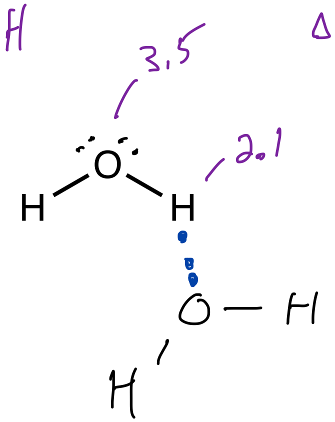

H-bond acceptor atoms

2-methoxyethanol

dipole moment = 2.04 D*

3.5

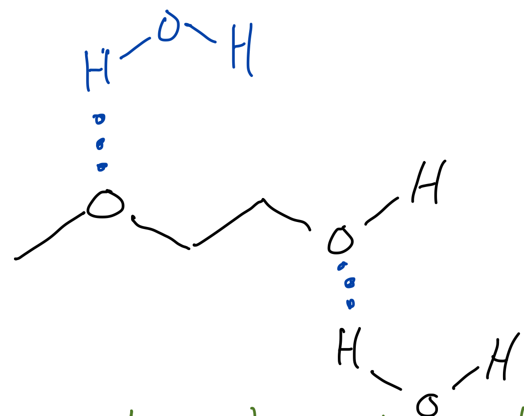
Δ = 1.4




very positive H atoms

dipole moment = 1.87 D*

To dissolve in $H_2O$, the $H_2O$ molecules must be separated. H-bonding between $H_2O$ molecules must be disrupted.



N–H, O–H, F–H

H-bond donors

N, O, F

H-bond acceptors

Do any H-bonds form with 1,2-dichlorobenzen? No, the H-bond interactions would be lost. This is energetically unfavorable

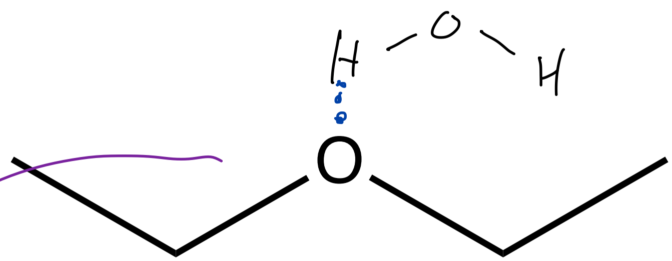
H-bonds not lost, just moved. Not energetically unfavorable. Entropically favorable so the methoxy ethanol dissolves

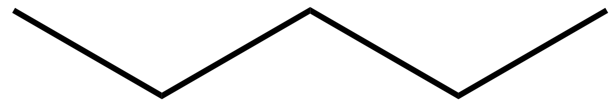
*https://macro.lsu.edu/Howto/solvents/dipole%20moment.htm accessed Oct. 16, 2023 ether

pentane

same # of e⁻'s same LDF

nonpolar solvents



60 g in 1 L $H_2O$

0.038 g in 1 L $H_2O$

because ether has an H-bond acceptor, some ether molecules will be able to dissolve in $H_2O$

60 g/L and 0.038 g/L