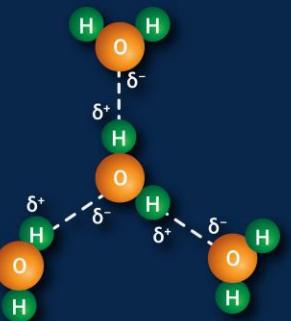


CHEMICAL BONDING - L10



CHEMISTRY





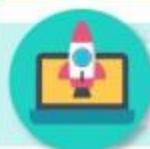


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Hydrogen Bonding

Strongest dipole-dipole interaction is **H - Bonding**

Attractive force which binds
the **H atom** of one molecule

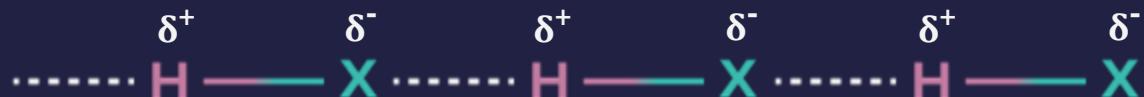
with the **E.N. atom (F, O, N &
sometimes Cl)** of another molecule

Hydrogen Bonding

H is bonded **covalently** to E.N. element 'X'

Shared pair of electrons moves far away from the **H** atom

H acquires δ^+ charge & **X** acquires δ^- charge



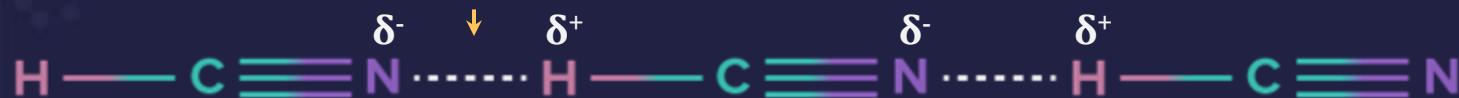
Main Conditions for Hydrogen Bond

Hydrogen should be **covalently bonded**
to **highly E.N. atoms** like F, O & N

Atleast **one lone pair** on E.N. element

H - bonding in HCN

H-Bonding



E.N. of C (sp) & N

Hydrogen Bond

Strength of the H bond is determined by the coulombic interaction b/w the **lone pair of the E.N. atom & H atom**

Factors Affecting Strength of H - bonding

Ease of donation of lone pair of E.N. atom ↑

Strength of H - bonding ↑

N

>

O

>

F

Decreasing tendency to donate lone pair

Higher electronegativity difference



Greater δ^+ charge on H - atom



Strength of H - bonding ↑



Remember!!

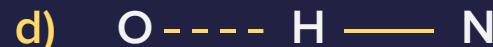
To compare strength of H - bond



First check $\Delta E.N.$ and then
tendency to donate lone pair

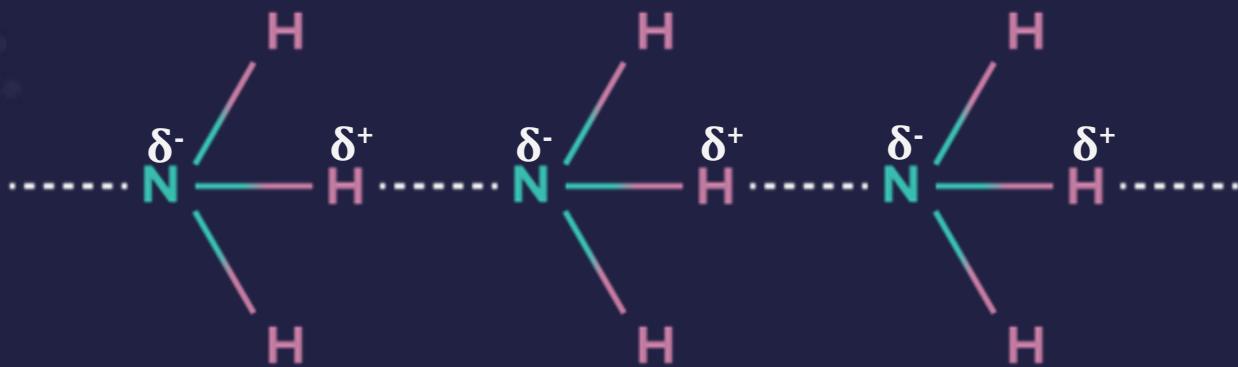


Arrange the following in the increasing order of strength of H - bond.



H - Bonding in Ammonia

$\text{NH}_3(\text{g})$



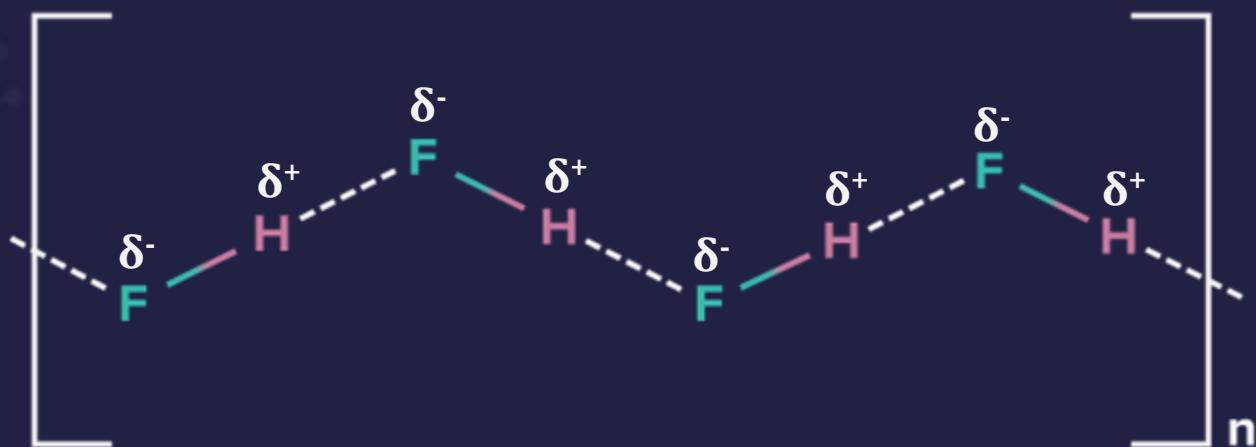
Degree of H bond

=

2

H - Bonding in HF

In **solid** and **liquid** state



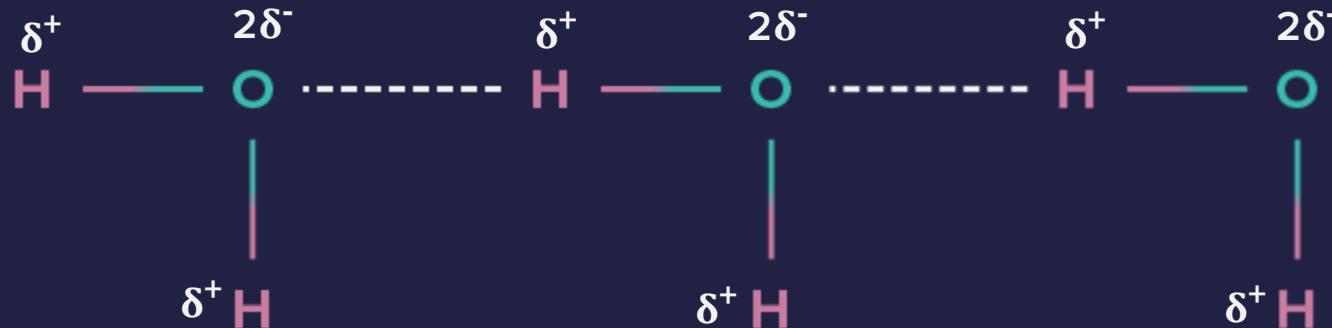
Degree of H bond

=

2



H - Bonding in Water



(Degree of H bond)liquid

=

2

(Degree of H bond)ice

=

4



Out of H_2O & HF , which will have higher melting point?





Extent of H - bonding

Degree of H - bonds

Strength of H - bonding

Dominant factor

Order of M.P. :

H_2O

$>$

HF

Hydrogen Bonding

Magnitude of Hydrogen bonding depends on the **physical state** of the compound

Maximum

Solid state

Minimum

Gaseous state



Hydrogen Bond

H - Bond

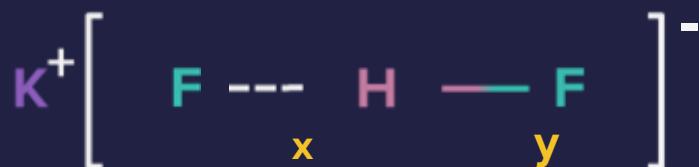
Energy varies
between
8 to 42 kJ mol⁻¹

Determines the
structure &
properties of
many compounds



Symmetrical H-bonding

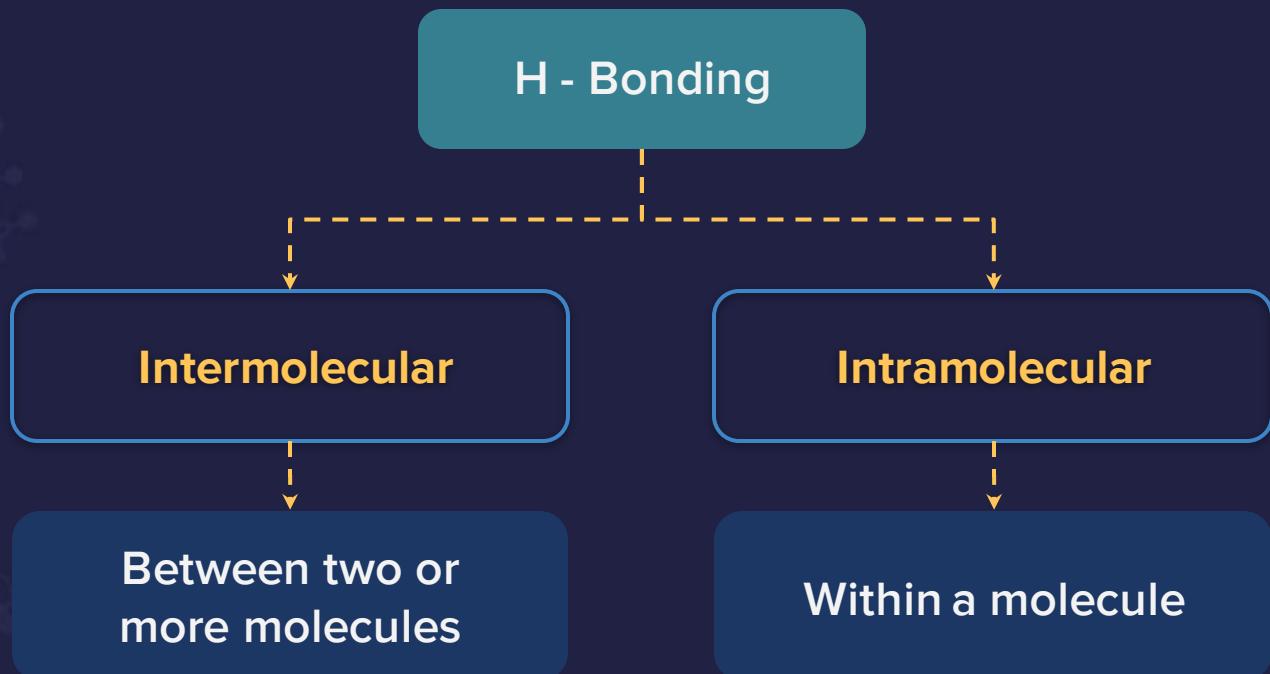
Very **strong H-bonding** occurs in the alkali metal hydrogen fluorides of formula **M [HF₂]**



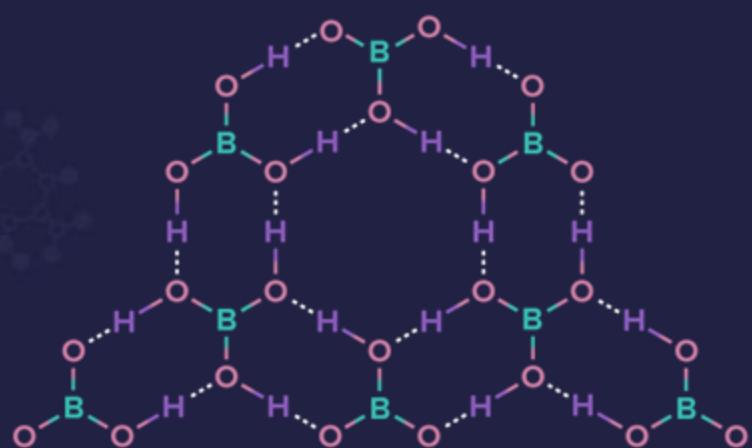
Bond lengths : $x = y = 113 \text{ pm}$

Bond energy
of **both H-F** = 163 kJ/mol

Types of H - Bonding



Examples of Intermolecular H - Bonding



Boric Acid (solid state)



Acetic Acid

Intermolecular H - bonding

Intermolecular
H - bonding

Homo
intermolecular

Hetero
intermolecular

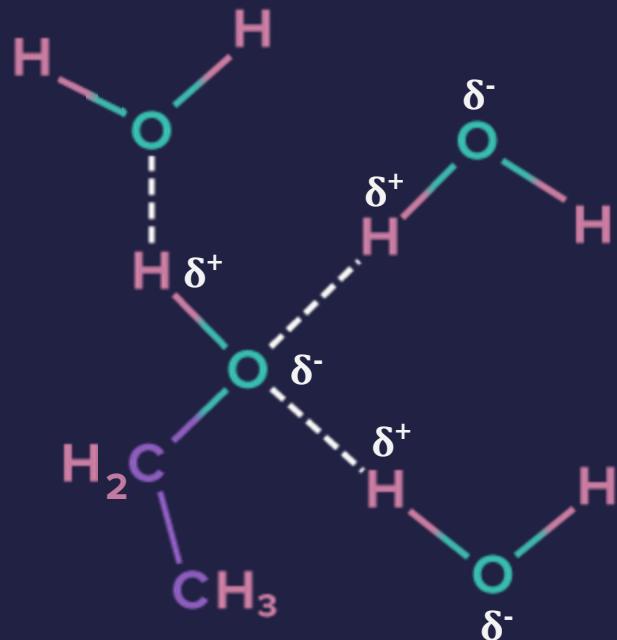
Homo Intermolecular H - Bonding



Water



Hetero Intermolecular H - Bonding



Alcohol in water

Conditions for the Formation of Intramolecular H - Bond

01

Ring formed as a result of
H bonding should be
planar

02

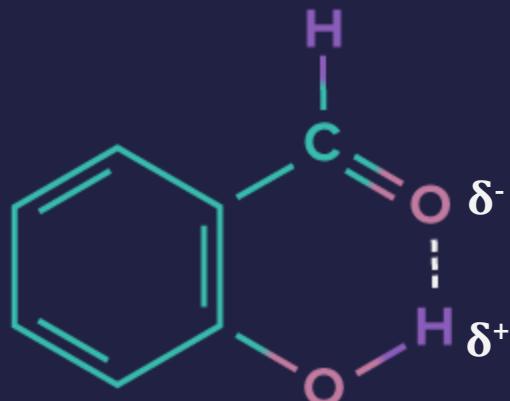
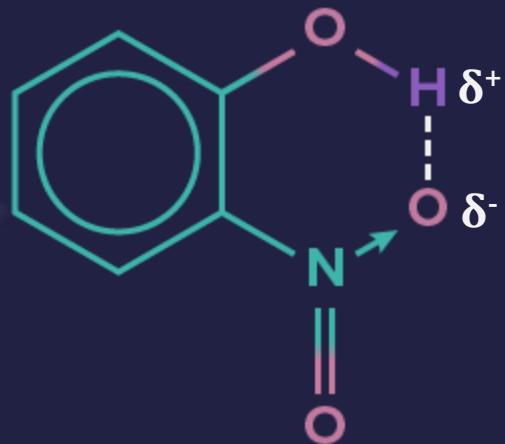
5 or 6 membered ring
should be formed

03

Minimum strain should be
there during the ring closure



Intramolecular H - Bonding

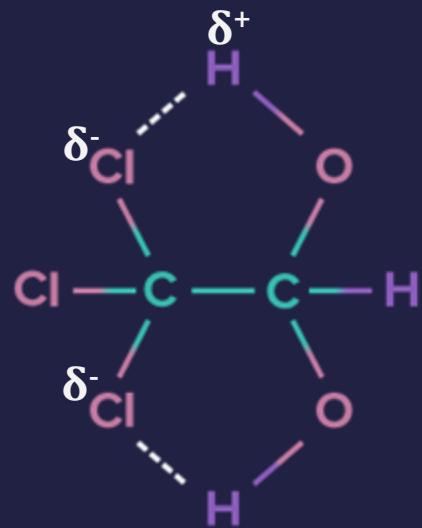


***o*-nitrophenol**

Salicylaldehyde

Remember!!

Cl usually doesn't form H - bond due to their **low charge density**



Chloral hydrate ($\text{CCl}_3\text{CH}(\text{OH})_2$)

Effect of H - bonding on Physical Properties

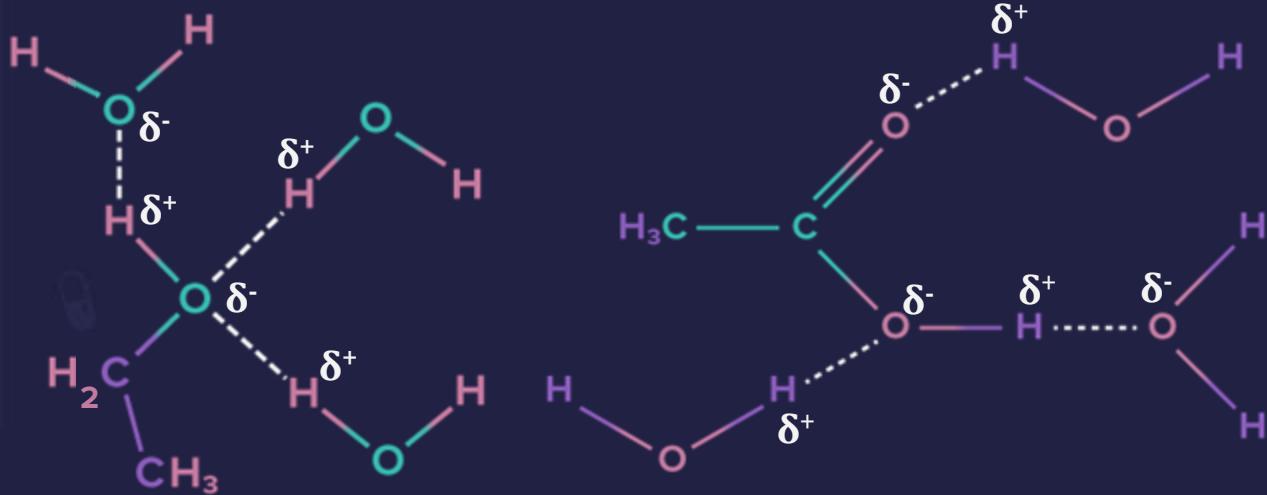
Solubility

Due to **intermolecular**
H-bonding

Solubility ↑

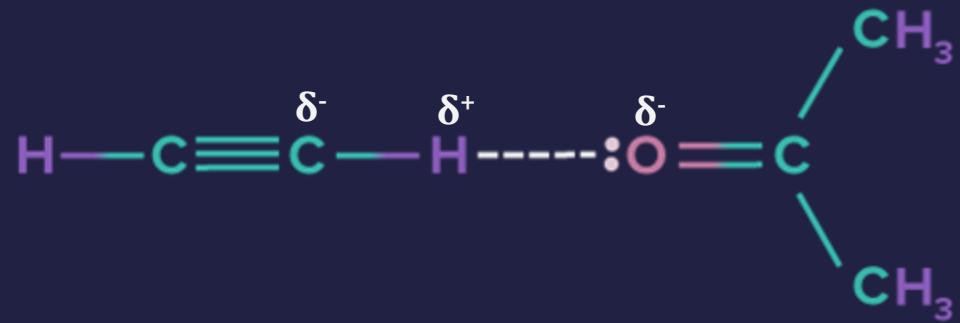
Few **organic compounds** are **soluble**
in water due to H-bonding

Alcohol,
Acetic acid etc.



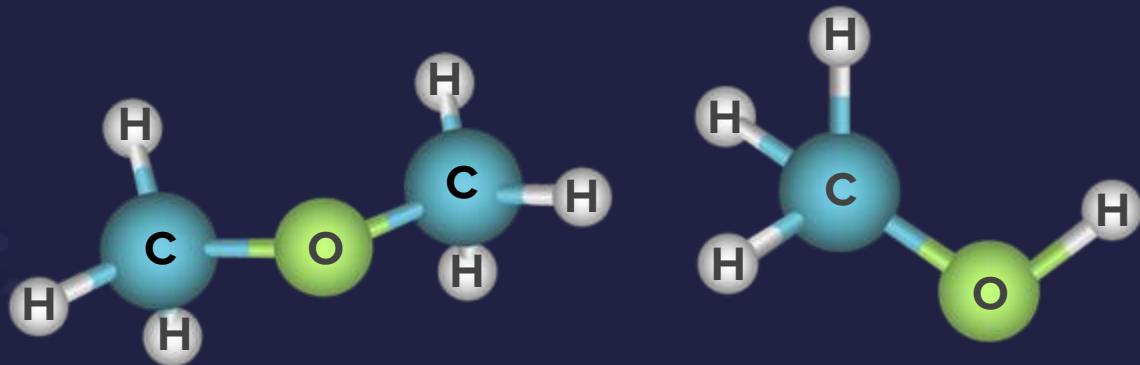
Solubility of Ethyne

C_2H_2 is highly **soluble** in acetone due to **H-bonding** but is not soluble in water



None of the above two has H-bonding individually

Solubility of Alcohols and Ethers



Solubility order

ROR

<

ROH

Example

CH₃OCH₃

<

CH₃OH

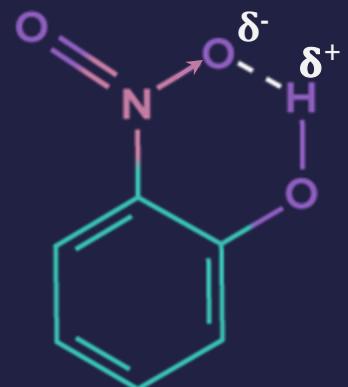


Solubility

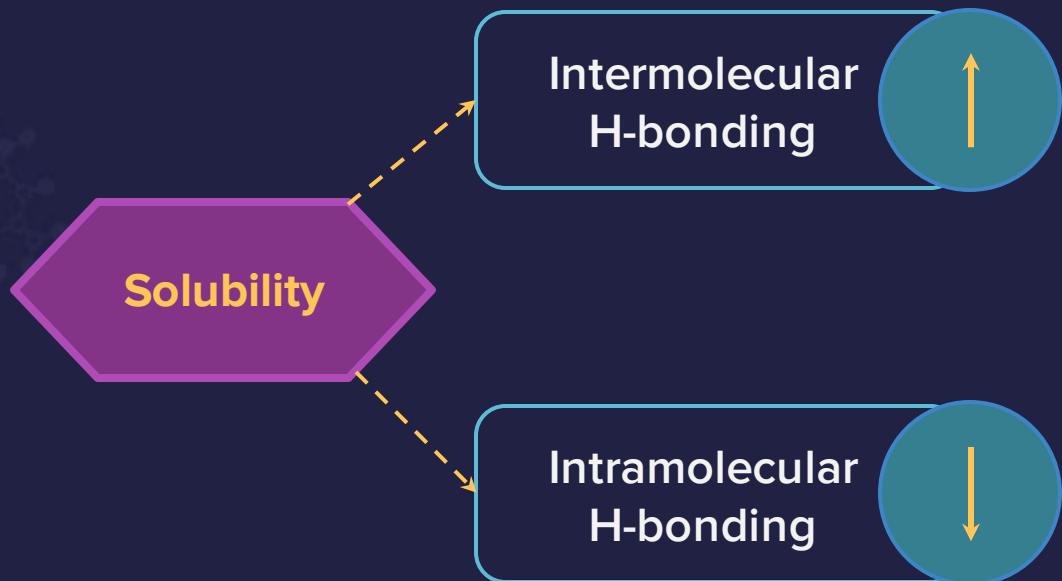
Due to **intramolecular H-bonding**

H is not available
for other molecule

Solubility



Solubility

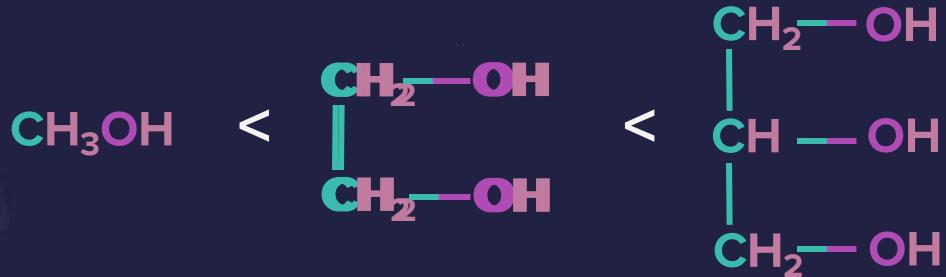


Viscosity

Hydrogen bond associates molecules together

Viscosity ↑

Order of viscosity:



Boiling point

Intermolecular
H-bonding

Boiling point ↑

Intramolecular
H-bonding

Boiling point ↓

Order of Boiling point

SbH_3 > NH_3 > AsH_3 > PH_3

H_2O > H_2Te > H_2Se > H_2S

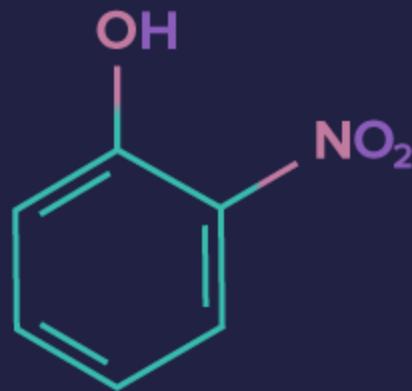
HF > HI > HBr > HCl

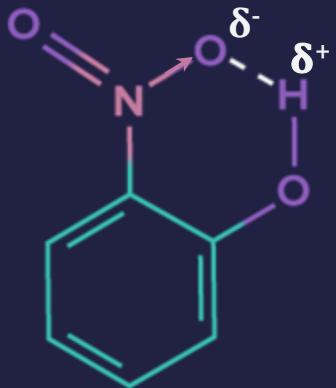




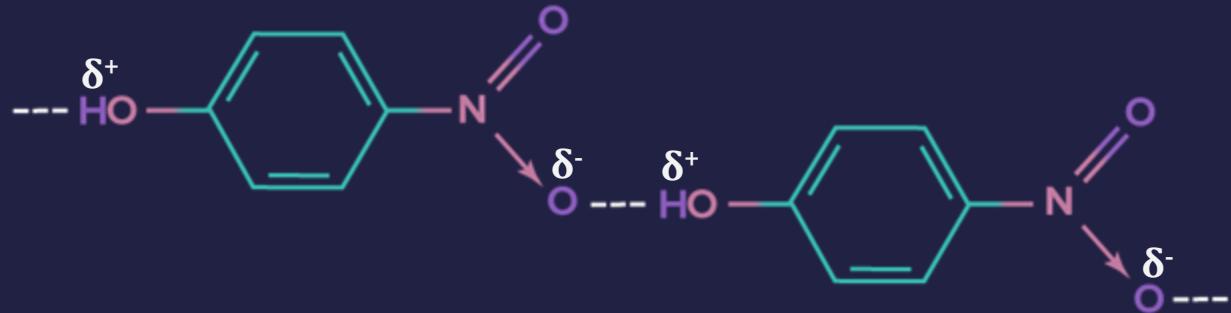
Which of the following molecules has higher boiling point?

B



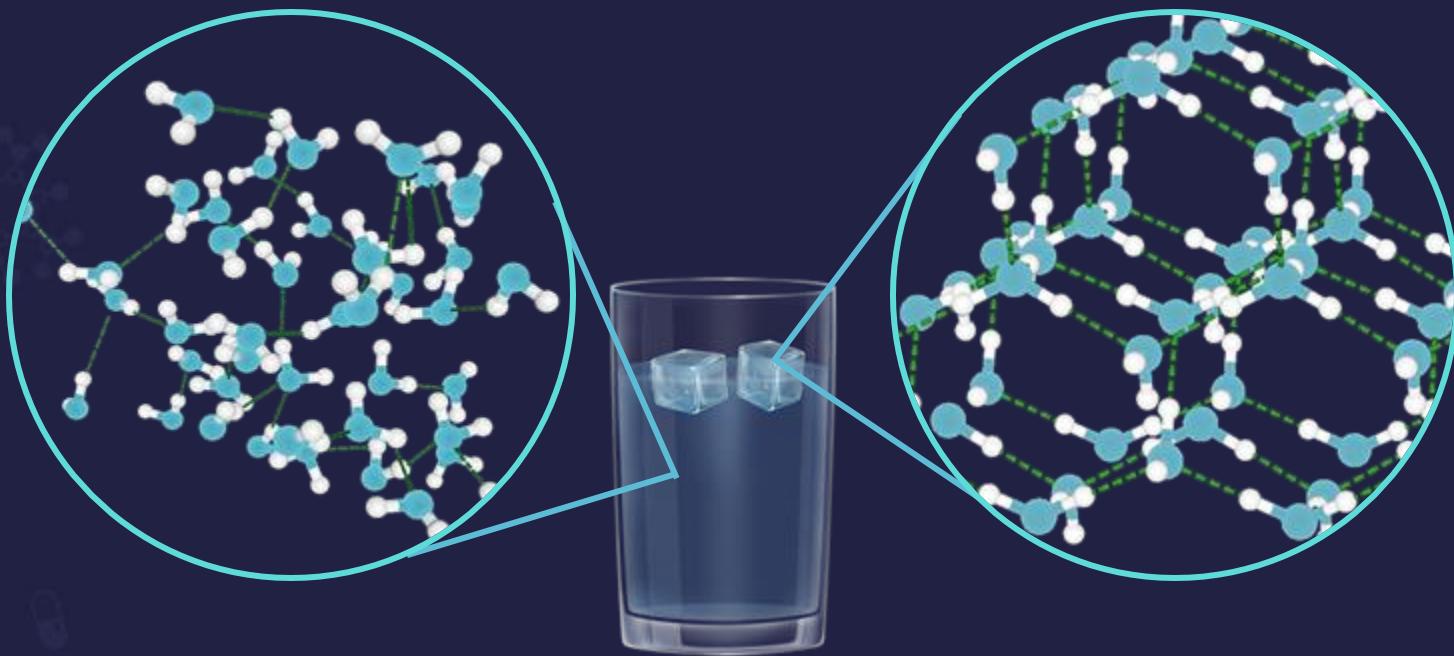


***o*-Nitrophenol**
(Intramolecular H - bonding)



***p*-Nitrophenol**
(Intermolecular H - bonding)

Why Does Ice Float Over Water?



Why Does Ice Float Over Water?

Extensive network of **H bonds**



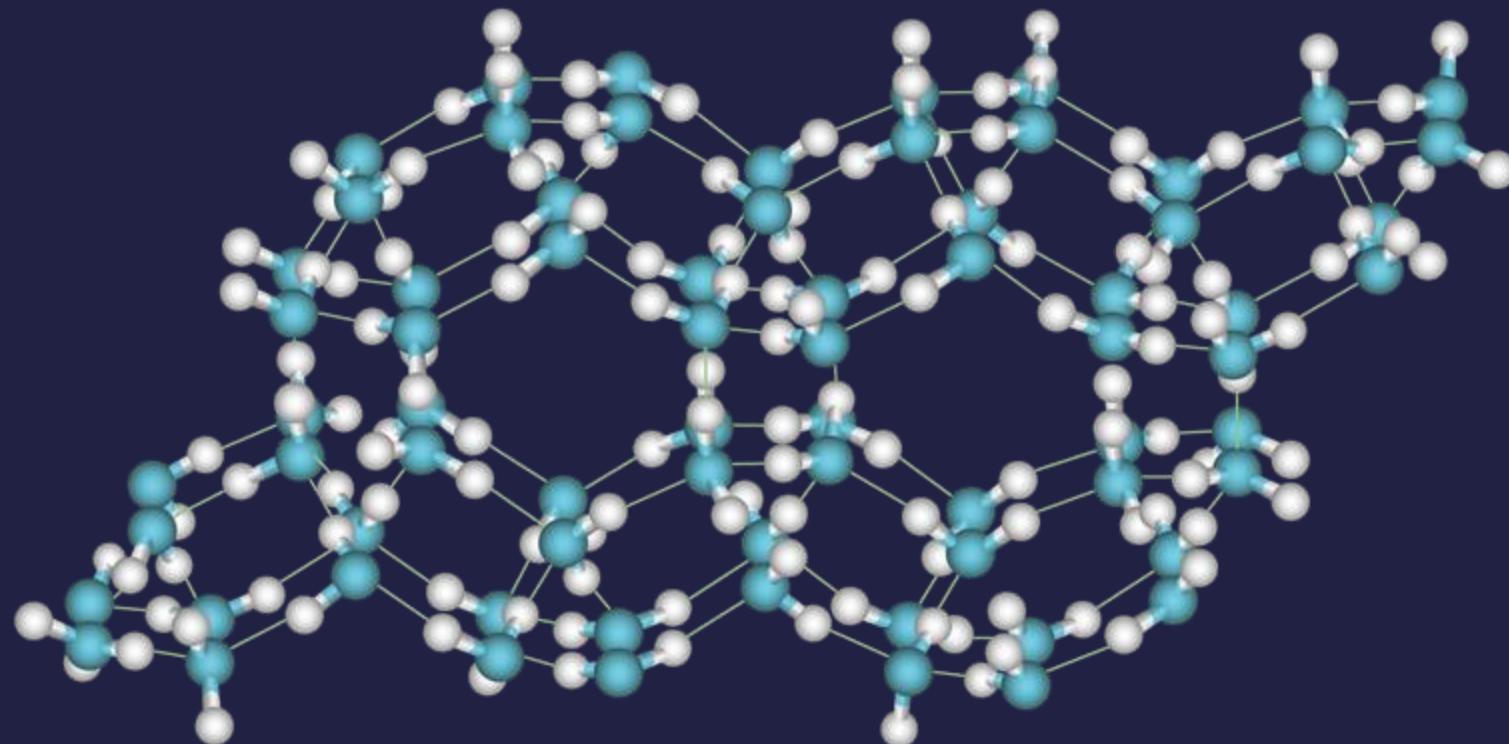
Ice has **cage like** structure
with vacant space



$\text{H}_2\text{O (s)}$ is less dense than $\text{H}_2\text{O (l)}$



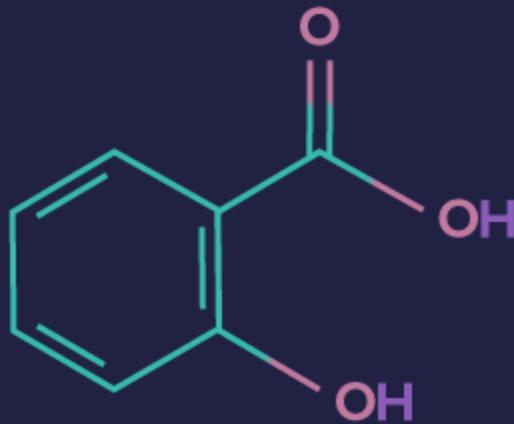
Why Does Ice Float Over Water?



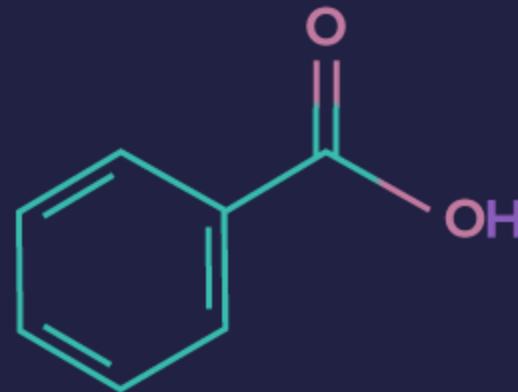


Which of the following molecules has the higher acidic strength?

B



A



B



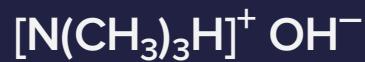


Out of the following molecules, which is a stronger base?

?

B

A



B



Which of the following are more viscous than water?

- a) H_2SO_4 (l)

- b) H_3PO_4 (l)

- c) H_2O_2 (l)

- d) HNO_3 (l)



Which of the following is/are correct?

- a) Boiling point of alcohol is higher than that of diethyl ether
- b) Density of water is higher than ice
- c) Glycerol is more viscous than ethanol
- d) Ammonia is more easily liquified than HCl due to bonding in NH_3

How many of the following has hydrogen bonding





Which of the following compounds can form H-bonding with each other? [NEET 2002]

a) CH_3COOH and H_2O

b) Phenol and CH_4

c) Acetone and CHF_3

d) HF and PH_3





Which of the following is not true about H_2O molecule?

B

[NEET 2001]

- a) The molecule has $\mu = 0$
- b) The molecule can act as base
- c) Shows abnormally high boiling point in comparison to the hydrides of other elements of oxygen group
- d) The molecule has bent shape



Which of the following represents the correct order of strength of H-bond? [NEET 2003]

- a) $H_2O > H_2O_2 > HF > H_2S$
- b) $HF > H_2O_2 > H_2O > H_2S$
- c) $HF > H_2O > H_2S > H_2O_2$
- d) $HF > H_2O > H_2O_2 > H_2S$

Which of the following molecules is expected to exhibit intermolecular H-bonding? [NEET 2000]

I) Acetic acid

II) o-nitrophenol

III) m-nitrophenol

IV) o-boric acid



Select correct alternate:

a) I, II, III

b) I, II, IV

c) I, III, IV

d) II, III, IV





Stay Positive. Work Hard. Make It Happen!

THANK YOU