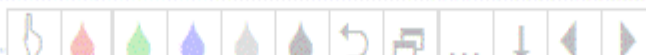


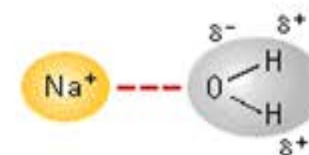
Announcements – Lecture III – Tuesday, Jan 30th

1. Class Web Site: <https://genchem.chem.umass.edu> – Under Spring, click on Chem 112 – the click on my picture!
2. iClicker for Credit: Starts, Thursday, Feb 1st
Registration re-opened until Jan 30th.
3. Quiz 1: Now on class web site. Will be collected in class on Tuesday, Feb 6th.



11.4 The Nature of Intermolecular Forces

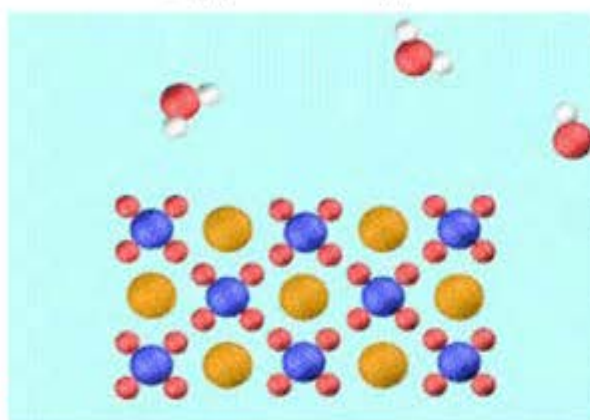
Ion - Dipole - The Dissolution Process



$H_2O(l)$ $KMnO_4(s)$

Cation	Ion Radius pm	Enthalpy of Hydration kJ
1 ✓ Li^+	90	-515
2 Na^+	118	-405
3 K^+	152	-312
4 Rb^+	166	-296
5 Cs^+	181	-263

A measure of the Ion/Dipole glue ... Enthalpy of Hydration ... amount of energy given off when an ion is surrounded - usually by 6 - water molecules.



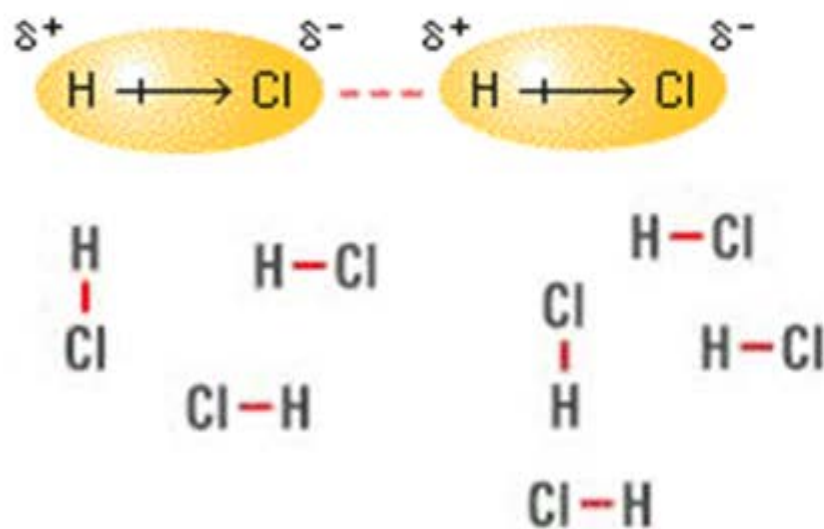
Which of the above cations has the greatest Ion/Dipole interaction - strongest binding glue!

Macroscopic Scale ▶

Nano Scale ▶

11.4 The Nature of Intermolecular Forces

Dipole – Dipole



Molar Masses Vs Boiling Points

	M	B.P.
	g/mol	$^{\circ}\text{C}$
CO	28	-192
PH ₃	34	-88
AsH ₃	78	-62
ICI	162	97

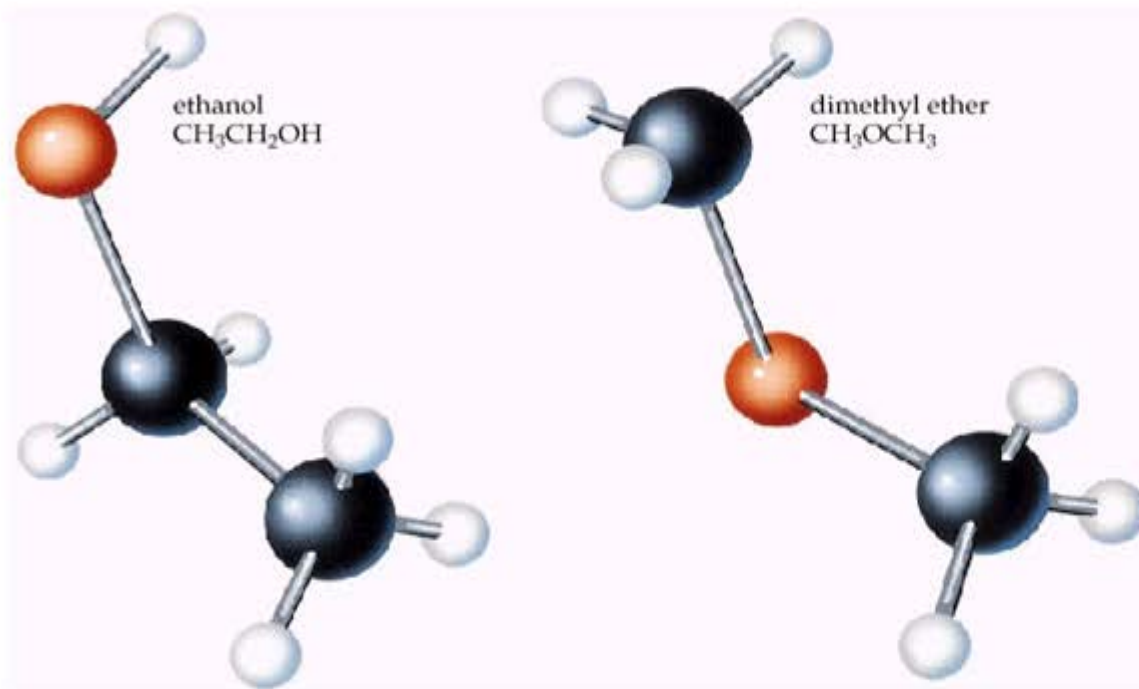
The higher the Boiling Point the stronger the Intermolecular Force.

Note: the Molar Mass and the Boiling Point Trend!

11.4 The Nature of Intermolecular Forces

Dipole-Dipole - A Special Case - Hydrogen Bonding

A very interesting thing occurs when a dipole is the result of an H-NOF bond, because of the small size of H and the large electronegativity of Nitrogen, Oxygen, and Fluorine, the resultant dipole-dipole interaction is much stronger than expected. N-H, O-H, F-H, form what we call **Hydrogen Bonds**.



CH₃OCH₃, Dimethyl Ether, Dipole-Dipole interaction but no **Hydrogen Bond**.

Boiling Point = 34.6°C

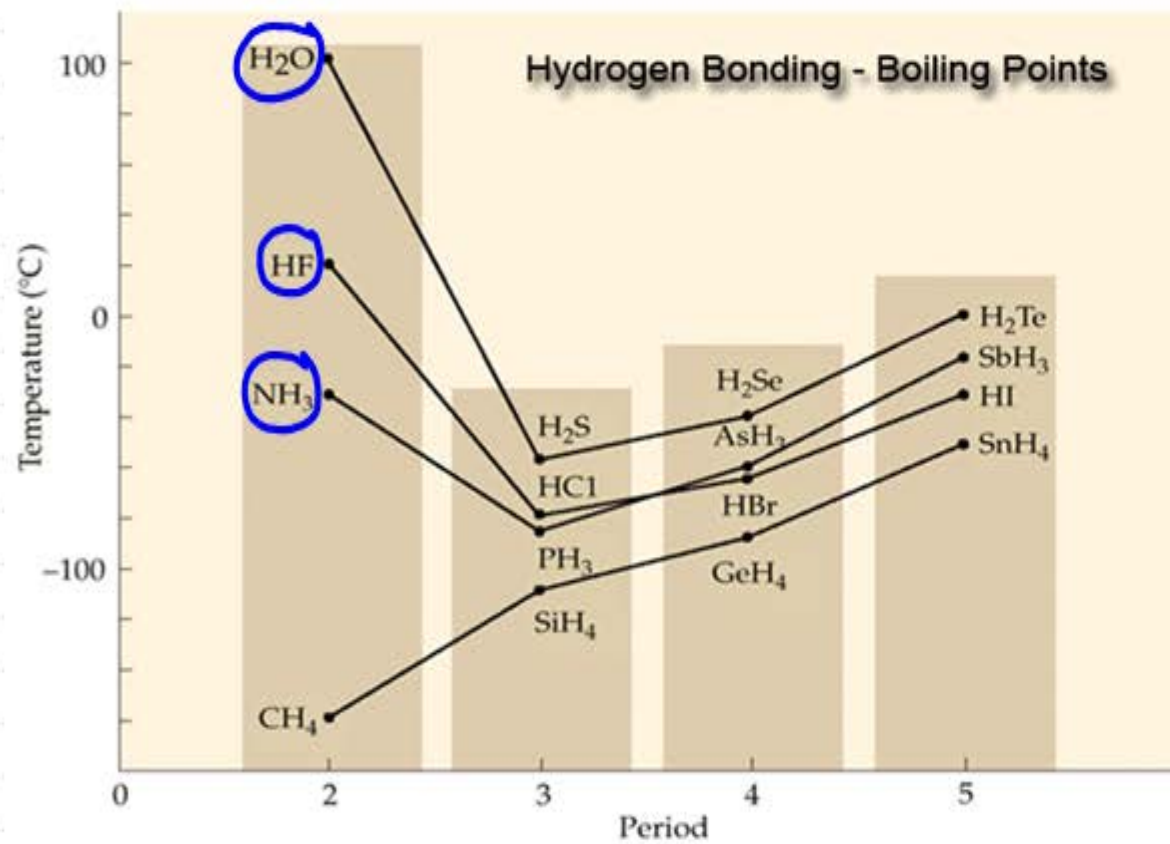
CH₃CH₂OH, Ethanol, Dipole-Dipole interaction with a **Hydrogen Bond**.

Boiling Point = 78.5°C



11.4 The Nature of Intermolecular Forces

Dipole – Dipole – A Special Case – Hydrogen Bonding



H₂Te, H₂Se, H₂S, and H₂O* - Bent, all polar ... Dipole - Dipole.

HI, HBr, HCl, and HF* - Linear, all polar ... Dipole - Dipole.

SbH₃, AsH₃, PH₃, and NH₃* - Trigonal Pyramid, all polar .. Dipole - Dipole.

SnH₄, GeH₄, SiH₄, and CH₄ - Tetrahedron, all non-polar.

*: These molecules contain a Hydrogen Bond.

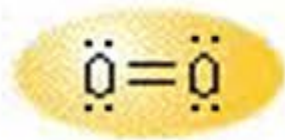


11.4 The Nature of Intermolecular Forces

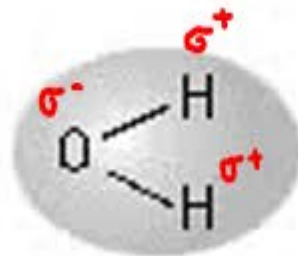
Dipole – Induced Dipole

Oxygen (non-polar) dissolved in water (polar)

Fish live in water – where do they get their oxygen from?



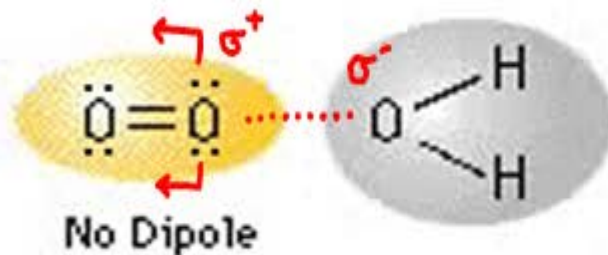
No Dipole
non-polar



polar

The Solubility of Some Gases in Water

Gas	Molar Mass g/mol	Solubility @ 20°C g/100g Water
H ₂	2.01	0.000160
N ₂	28.0	0.000190
O ₂	32.0	0.000434
Cl ₂	70.9	0.729



NOTE: While the solubility is relatively small it does increase with increasing Molar Mass. The larger the molecule the easier it becomes to induce a dipole.

11.4 The Nature of Intermolecular Forces

Induced Dipole– Induced Dipole – aka London Dispersion Forces

I₂ is non-polar yet it exists as a solid?

Chemistry Interactive: Induced Dipoles in Neighboring I₂ Molecules



See Class Web Site.

