

# EFN103 – 13.kafli

Ljósrit

# Samloðun efna

- Efni hafa mjög mismunandi **samloðun**.  
Samloðun og samtenging milli atóma sést m.a. á hve auðveldlega efni gufar upp, hve hratt það brotnar niður, bráðnar og leysist upp í öðrum efnum.

# Efnatengjum er skipt í tvennt

- **Sterk efnatengi** (intramolecular). Bein tengi innan sameindar eða á milli atóma eða jóna. Heil rafeind tekur þátt í tenginu.
- **Veik efnatengi** (intermolecular). Rafeindir innan sameindar dreifast ójafnt. Ein sameind togar því í aðra.

- Sterk efnatengi eru 100-1000 sinnum sterkari en veik.
  - Að brjóta O-H tengi í vatni: 930kJ/mol
  - Að breyta 1 moli af vatni í gufu: 41 kJ

# Sterk efnatengi

- Skiptast í 3. flokka
- A) Jónatengi
- B) Samgild tengi
- C) Málmteni

# Sterk efnatengi - jónatengi

- Jónatengi myndast oft á milli málmms og málmleysingja.
- Málmurinn myndar alltaf +plús jón
- Málmleysinginn – mínusjón
- Sameindir mynda stundum mínusjónir.

# Nokkrar atómjónir

1	2										3	4	5	6	7	8
Li <sup>+</sup>	Be <sup>2+</sup>													O <sup>2-</sup>	F <sup>-</sup>	
Na <sup>+</sup>	Mg <sup>2+</sup>										Al <sup>3+</sup>			S <sup>2-</sup>	Cl <sup>-</sup>	
K <sup>+</sup>	Ca <sup>2+</sup>										Ga <sup>3+</sup>			Se <sup>2-</sup>	Br <sup>-</sup>	
Rb <sup>+</sup>	Sr <sup>2+</sup>										In <sup>3+</sup>			Te <sup>2-</sup>	I <sup>-</sup>	
Cs <sup>+</sup>	Ba <sup>2+</sup>															

Transition metals form cations with various charges

# Sterk efnatengi - jónatengi

- Í jónaeiningu eru alltaf **jafnmargir + og –**
- Málmur gefur rafeind(ir) til málmleysingja.
- Út frá **jónatöflu** má alltaf finna hleðslu jóna.
- **Samsettar mínusjónir enda ævinlega -ít eða -at.**



# Efnaformúlor Jónefna

- **Natriumsúlfat:**
- 2 stk  $\text{Na}^+$  og 1stk  $\text{SO}_4^{2-}$   $\rightarrow \text{Na}_2\text{SO}_4$
- **Kalsíumsúlfat:**
- $\text{Ca}^{2+}$  og  $\text{SO}_4^{2-}$  jafnmargir + og -  $\rightarrow \text{Ca SO}_4$
- **Járn(III)súlfat:**
- $\text{Fe}^{3+}$  og  $\text{SO}_4^{2-}$  Tvær járn og þrjár af súlfati, þá eru 6 plúsar og 6 mínusar.  $\rightarrow \text{Fe}_2(\text{SO}_4)_3$ . (sé fleiri en ein samsett jón í formúlu þarf sviga).

# Sterk efnatengi – Samgild tengi

- Samgild tengi á milli 2 eða fleiri málmleys.
- Byggja á að samnýta rafeindir svo atóm fái 8 rafeindir á ysta hvolf. (2 fyrir vetni(H))
- **C-flokkur hefur 4 tengirafeindir**
- **N-flokkur hefur 3 - - - - -**
- **O-flokkur hefur 2 - - - -**
- **Halogenar og vetni hafa 1 tengirafeind**

# Málmleysingar

1																	2
H																	He
3	4											5	6	7	8	9	10
Li	Be											B	C	N	O	F	Ne
11	12											13	14	15	16	17	18
Na	Mg											Al	Si	P	S	Cl	Ar
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
87	88	89	104	105	106	107	108	109	110								
Fr	Ra	Ac	Unq	Unp	Unh	Uns	Uno	Une	Uun								

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

# Samgild tengi

- **Eintengi:** eitt samgilt tengi milli atóma (tvær tengirafeindir)



- **Tvítengi:** tvö samgild tengi milli atóma (fjórar tengirafeindir)

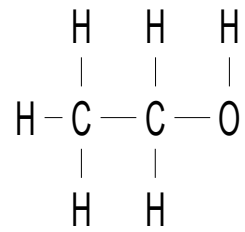
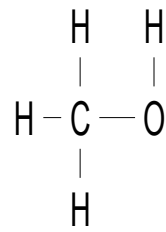
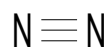
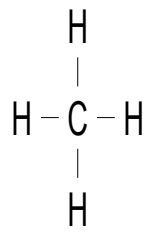


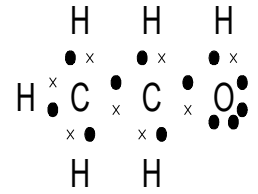
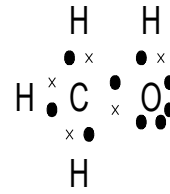
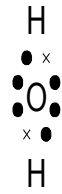
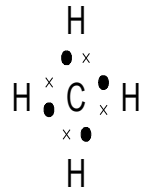
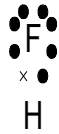
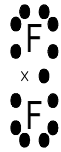
- **Þrítengi:** þrjú samgild tengi milli atóma (sex tengirafeindir)



# Samgild tengi

- Teiknið punktaformúlur og strikaformúlur af þessum efnum.
- $\text{H}_2$                        $\text{F}_2$                        $\text{HF}$
- $\text{CH}_4$                        $\text{H}_2\text{O}$
- $\text{O}_2$                        $\text{N}_2$
- $\text{CH}_4\text{O}$                        $\text{C}_2\text{H}_6\text{O}$





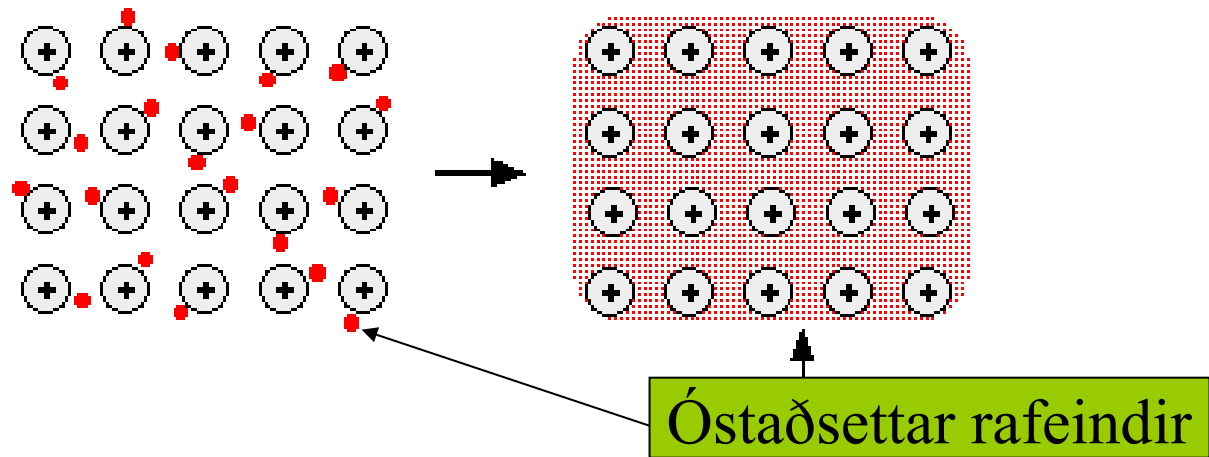
# Munið

- Súrefni, nitur, vetni, klór, flúor, bróm og Joð mynda allar tvíatóma sameindir við “venjulegar” aðstæður:
- $O_2$ ,  $N_2$ ,  $H_2$ ,  $Cl_2$ ,  $F_2$ ,  $Br_2$ ,  $I_2$



# Málmtenngi

- Málmatóm mynda málmkristal.
- Málmatóm hafa fáar gildisrafeindir sem flakka um hálfatóm gildishvolf (ystu hvolf).




- Lausu rafeindirnar mynda mínushlaðið rafeindaský sem dregst að öllum kjörnum atómanna og heldur þeim saman (+hlaðnir).
- Þetta er **málmtenngi**!

# Veik efnatengi

- Veik efnatengi segja til um hvernig óhlaðnar sameindir (og atóm) verka hver á aðra.
- + og – dragast hvort að öðru.
- Hefur áhrif á marga eðliseiginleika eins og suðumark, bræðslumark, leysni....

# Veik efnatengi framhald

- Hægt er að spá fyrir um styrk veikra tengja út frá [rafdrægnitöflu](#).



H 2.1																
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0
Na 0.9	Mg 1.2											Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0
K 0.8	Ca 1.0	Sc 1.3	Ti 1.5	V 1.6	Cr 1.6	Mn 1.5	Fe 1.8	Co 1.9	Ni 1.9	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8
Rb 0.8	Sr 1.0	Y 1.2	Zr 1.4	Nb 1.6	Mo 1.8	Tc 1.9	Ru 2.2	Rh 2.2	Pd 2.2	Ag 1.9	Cd 1.7	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5
Cs 0.7	Ba 0.9	La-Lu 1.0-1.2	Hf 1.3	Ta 1.5	W 1.7	Re 1.9	Os 2.2	Ir 2.2	Pt 2.2	Au 2.4	Hg 1.9	Tl 1.8	Pb 1.9	Bi 1.9	Po 2.0	At 2.2
Fr 0.7	Ra 0.9	Ac 1.1	Th 1.3	Pa 1.4	U 1.4	Np-No 1.4-1.3										

# Veik tengi

- Sé mismunur á rafdrægni:
  - 0 - 0,4 er sameindin óskautuð (tengin eru óskautuð samgild tengi)
  - 0,5-1,6 er sameindin skautuð (Skautað samgilt tengi)
  - >1,7 þá er um að ræða jónatengi.

# Skoða hvert tengi út frá töflu

- $\text{CH}_4$  ER óskautað þar sem mismunur C og H er 0,4 (öll olía er líka óskautuð)
- $\text{H}_2\text{O}$  er skautað þar sem mismunurinn er 1,4 (vatn leysist ekki upp í olíu)
- $\text{NaCl}$  er jónefni því mismunurinn er 2,1 (salt leysist í vatni en ekki í olíu...)

# Skipting veikra tengja

- GRÓFLEGA má skipta veikum tengjum í tvennt:
  1. Van der Waals tengi. Á milli lítt eða óskautaðra sameinda. “Frekar slappt lím”.
  2. Vetrstengi (hydrogen bond). Á milli H og N, O, F eða Cl. “Gott lím”

- Vetrastengi eru því t.d. í vatni, sykri, vínanda og ammoniaki ( $\text{NH}_3$ ) á föstu og fljóttandi formi

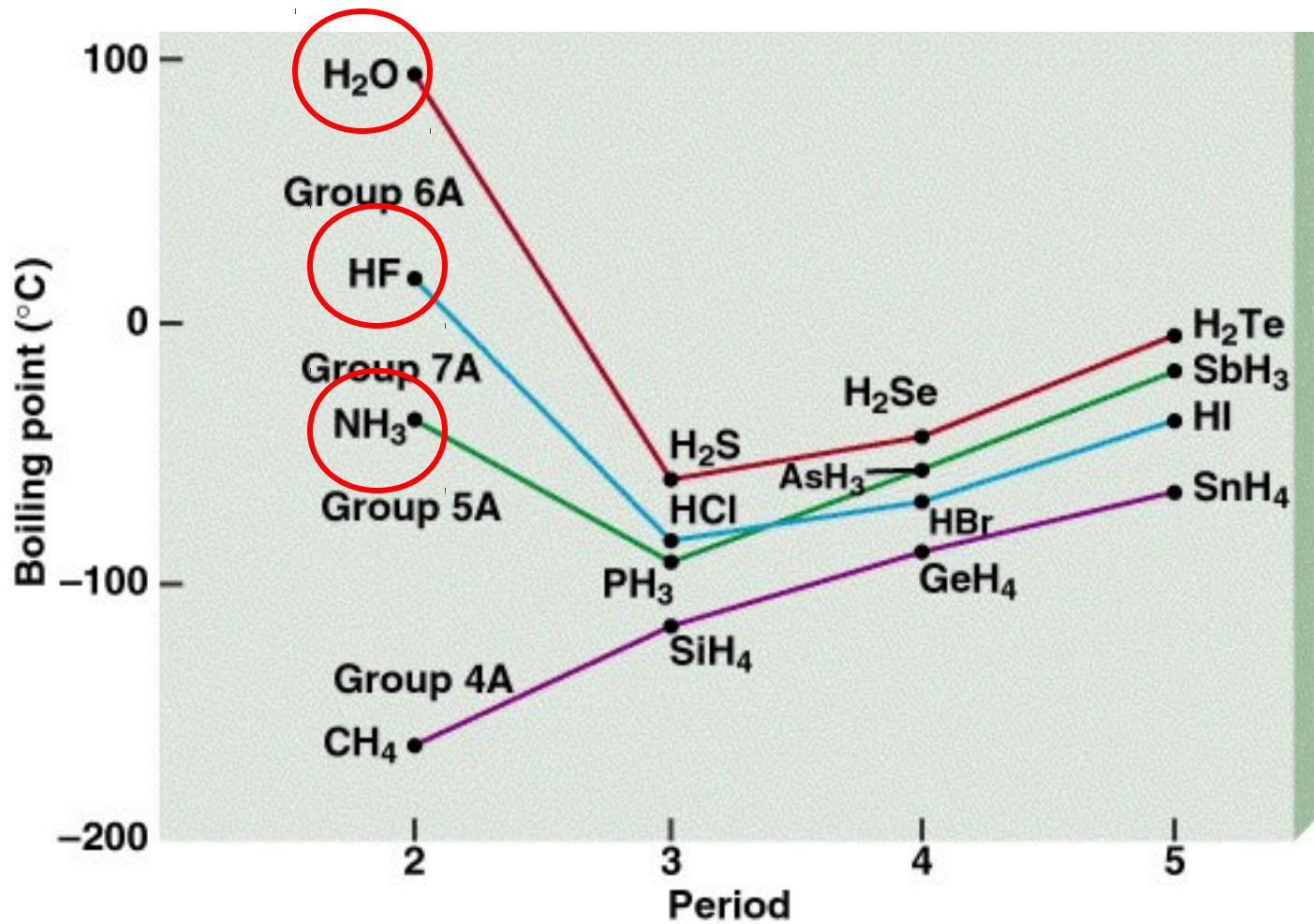
Í gasformi er of langt á milli sameinda til að vetrastengin virki.

- Van der Waals kraftar eru í olíu, metani, nitri og súrefni andrúmsloftsins.

# Þetta ræður suðumarki

1. Sameindamassi sameindar
2. Skautun sameindar
3. Lögum sameindar séu þættir 1 og 2 sambærilegir (efn 303 og 313)
  - Efni með vetnistengi hafa óvenjulega há suðumörk.
  - Skoðið  $\text{H}_2\text{O}$  vs.  $\text{CH}_4$  (b.p.  $-162^\circ\text{C}$ )



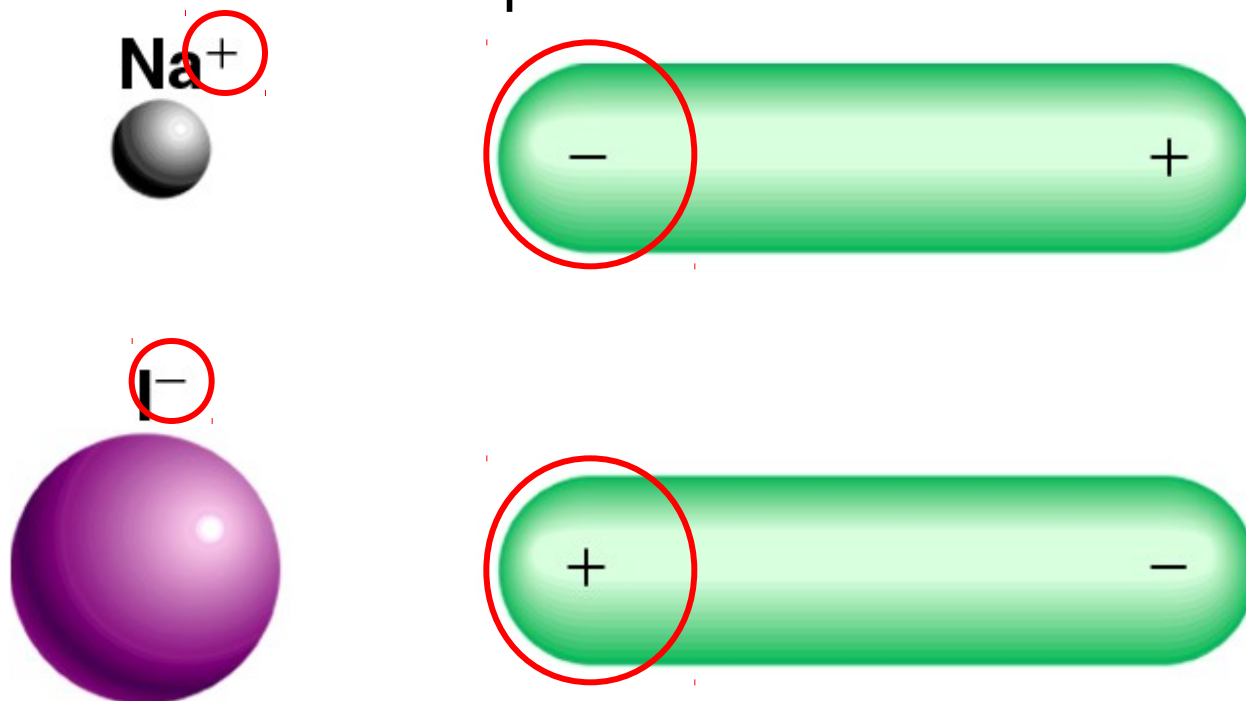


# Intermolecular Forces

## Ion-Dipole Forces

Attractive forces between an **ion** and a **polar molecule**

Ion-Dipole Interaction



# Intermolecular Forces

## Dispersion Forces

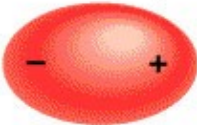
Attractive forces that arise as a result of **temporary dipoles induced** in atoms or molecules



Cation



Induced dipole

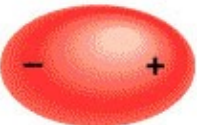


ion-induced dipole interaction

Dipole



Induced dipole



dipole-induced dipole interaction

# Intermolecular Forces

## Dispersion Forces Continued

**Polarizability** is the ease with which the electron distribution in the atom or molecule can be distorted.

Polarizability increases with:

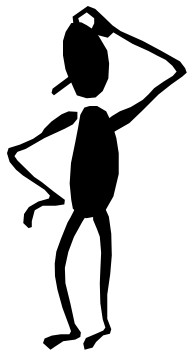
- greater number of electrons
- more diffuse electron cloud



Dispersion forces usually increase with molar mass.

**Table 11.2** Melting Points of Similar Nonpolar Compounds

Compound	Melting Point (°C)
CH <sub>4</sub>	-182.5
CF <sub>4</sub>	-150.0
CCl <sub>4</sub>	-23.0
CBr <sub>4</sub>	90.0
Cl <sub>4</sub>	171.0



What type(s) of intermolecular forces exist between each of the following molecules?

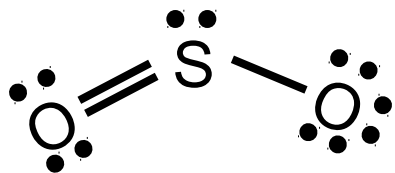
HBr

HBr is a polar molecule: dipole-dipole forces. There are also dispersion forces between HBr molecules.

CH<sub>4</sub>

CH<sub>4</sub> is nonpolar: dispersion forces.

SO<sub>2</sub>



SO<sub>2</sub> is a polar molecule: dipole-dipole forces. There are also dispersion forces between SO<sub>2</sub> molecules.

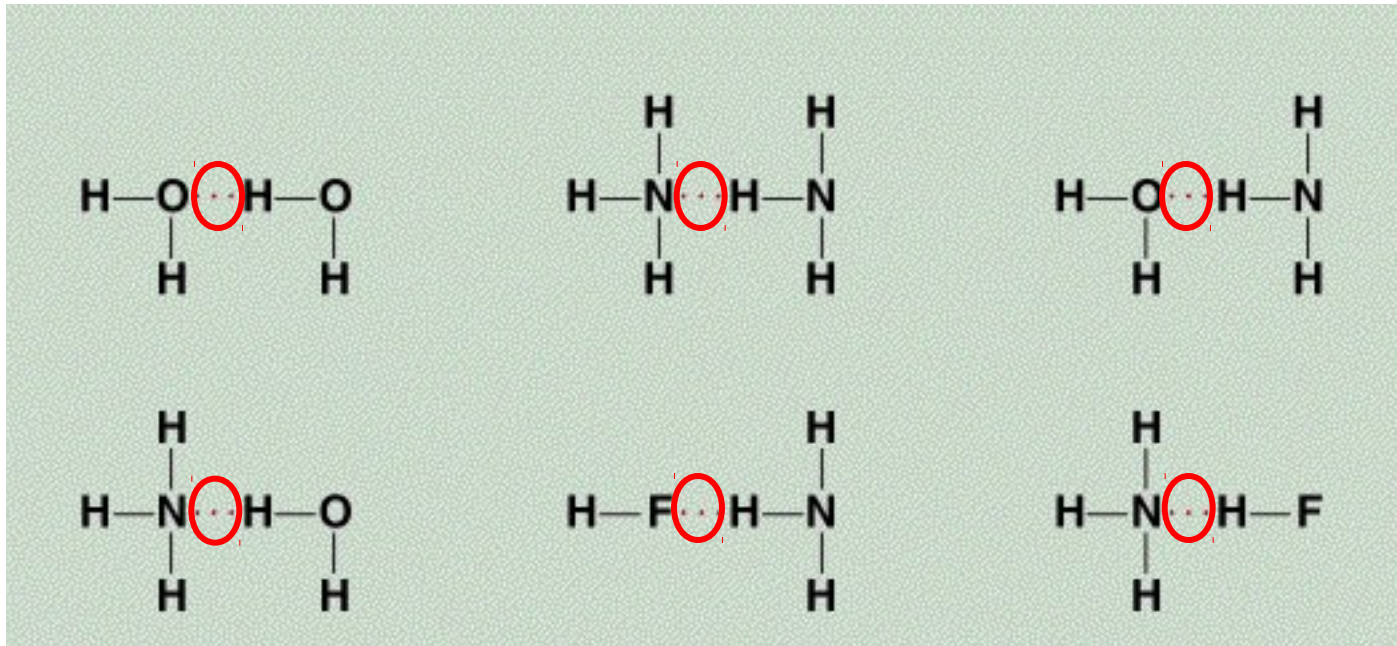
# Intermolecular Forces

## Hydrogen Bond

The **hydrogen bond** is a special dipole-dipole interaction between the hydrogen atom in a polar N-H, O-H, or F-H bond and an electronegative O, N, or F atom.

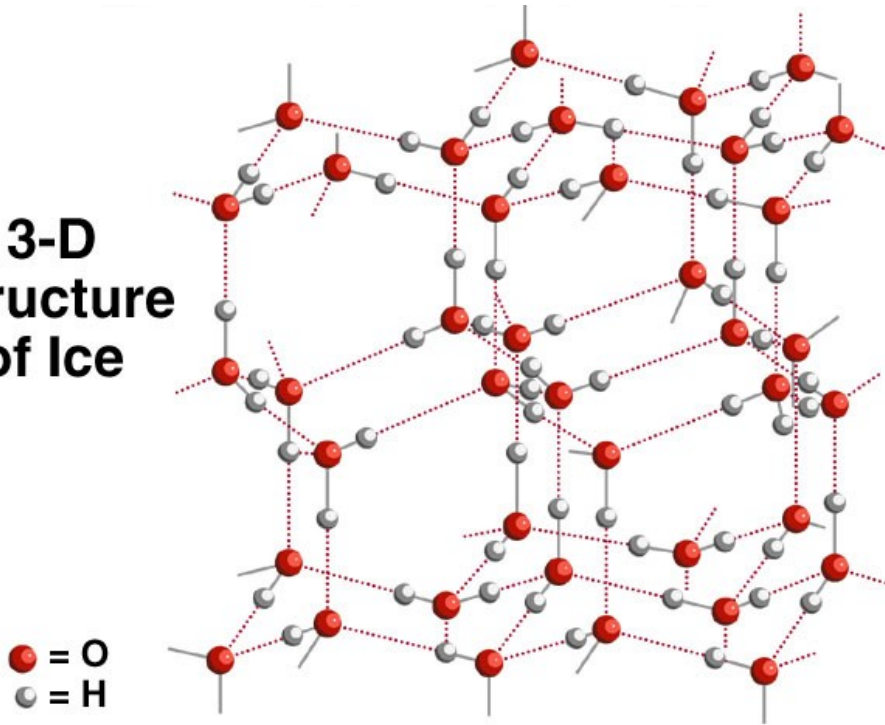


A & B are N, O, or F



# Water is a Unique Substance

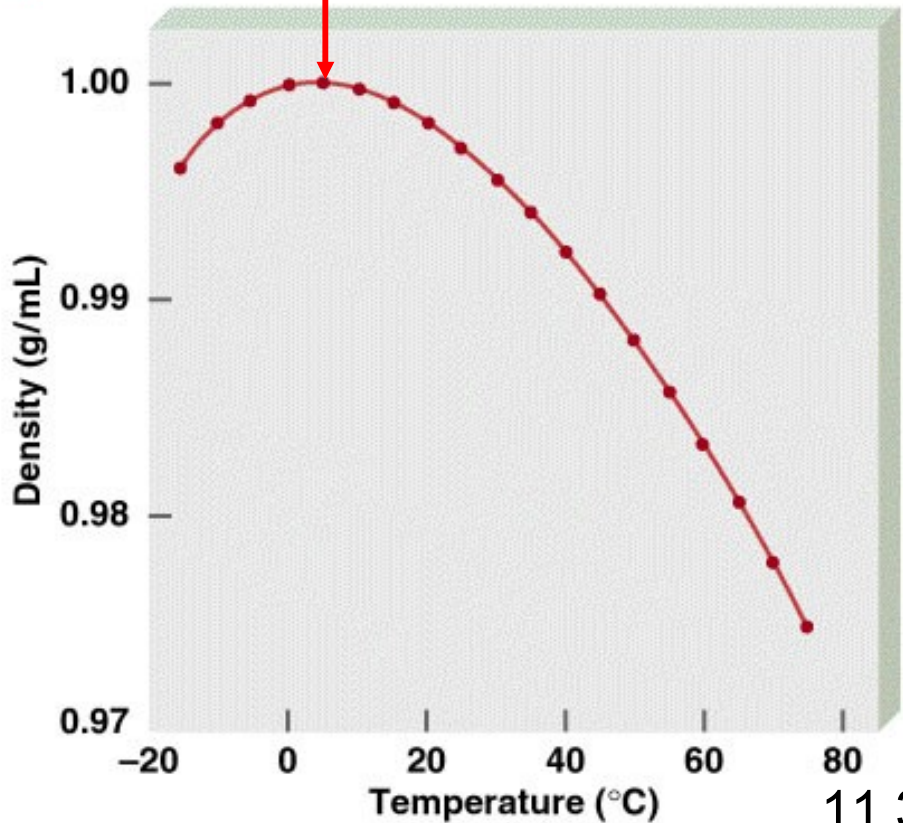
3-D  
Structure  
of Ice



Maximum Density

4°C

Density of Water



Ice is less dense than water

