

# Chapter 2

## Atomic Structure

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# Atomic Structure

## Atom

Nucleus { Protons (+)  
Neutrons (neutral)

Electrons (-): “surrounds” nucleus

**Atomic number ( $Z$ )** = # of protons in nucleus of atom  
= # of electrons for a **neutral** atom

**Isotope:** same  $Z$ , different # of neutrons, e.g.,  $^{10}\text{B}$  and  $^{11}\text{B}$

**Atomic mass unit (amu):** 1/12 of the mass for a single  $^{12}\text{C}$  atom

**Atomic mass (or weight)  $A$**  = average mass with respect to natural isotopes for an element

Unit of atomic mass: **g/mol (preferred)** or amu/atom

1 mole of atoms: Avogadro number  **$N_A = 6.022 \times 10^{23}$**  of atoms

For hydrogen or H, atomic mass  $A = 1.008$  g/mol  $\rightarrow$

mass for 1 mol or  $6.022 \times 10^{23}$  number of *naturally occurring* H atoms would be 1.008 g

# Class Exercise: Review of Basics for Atom

Element name  
& symbol

Atomic number ( $Z$ )

# of electron in each shell

(Averaged) Atomic mass ( $A$ )

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1	1 <b>H</b> Hydrogen 1.008	Atomic Sym Name Weight																2 <b>He</b> Helium 4.002602	
2	3 <b>Li</b> Lithium 6.94	4 <b>Be</b> Beryllium 9.0121...																	
3	11 <b>Na</b> Sodium 22.989...	12 <b>Mg</b> Magnesium 24.305																	
4	19 <b>K</b> Potassium 39.0983	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.955...	22 <b>Ti</b> Titanium 47.867	23 <b>V</b> Vanadium 50.9415	24 <b>Cr</b> Chromium 51.9961	25 <b>Mn</b> Manganese 54.938...	26 <b>Fe</b> Iron 55.845	27 <b>Co</b> Cobalt 58.933...	28 <b>Ni</b> Nickel 58.6934	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.38	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.63	33 <b>As</b> Arsenic 74.921...	34 <b>Se</b> Selenium 78.971	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 83.798	
5	37 <b>Rb</b> Rubidium 85.4678	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.90584	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.90637	42 <b>Mo</b> Molybdenum 95.95	43 <b>Tc</b> Technetium (98)	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.90...	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.8682	48 <b>Cd</b> Cadmium 112.414	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.710	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.60	53 <b>I</b> Iodine 126.90...	54 <b>Xe</b> Xenon 131.293	
6	55 <b>Cs</b> Caesium 132.90...	56 <b>Ba</b> Barium 137.327	57-71	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.94...	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.217	78 <b>Pt</b> Platinum 195.084	79 <b>Au</b> Gold 196.96...	80 <b>Hg</b> Mercury 200.59	81 <b>Tl</b> Thallium 204.38	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.98...	84 <b>Po</b> Polonium (209)	85 <b>At</b> Astatine (210)	86 <b>Rn</b> Radon (222)	
7	87 <b>Fr</b> Francium (223)	88 <b>Ra</b> Radium (226)	89-103	104 <b>Rf</b> Rutherfordium (267)	105 <b>Db</b> Dubnium (268)	106 <b>Sg</b> Seaborgium (271)	107 <b>Bh</b> Bohrium (272)	108 <b>Hs</b> Hassium (270)	109 <b>Mt</b> Meitnerium (276)	110 <b>Ds</b> Darmstadtium (281)	111 <b>Rg</b> Roentgenium (280)	112 <b>Cn</b> Copernicium (285)	113 <b>Uut</b> Ununtrium (284)	114 <b>Fl</b> Flerovium (289)	115 <b>Uup</b> Ununpentium (288)	116 <b>Lv</b> Livermorium (293)	117 <b>Uus</b> Ununseptium (294)	118 <b>Uuo</b> Ununoctium (294)	

- Element name? **Carbon**
- # of electrons in a neutral atom?  $Z = 6$
- # protons in such an atom?  $= Z = 6$
- Atomic number ( $Z$ )?  $Z = 6$
- (Averaged) Atomic mass ( $A$ ) and Unit?  $A = 12.011 \text{ g/mol}$

# Electronic Structure for Atoms

- Electrons are in a series of **orbitals** with different, discrete **energy states following certain rules**
- Electrons occupy lower energy states (orbitals) then higher:
  - Shell ( $n$ )  $K, L, M, N, O$  (or 1, 2, 3, 4, 5)...., from low to high energy
  - Subshell ( $l$ ):  $s, p, d, f$ , within a shell ... from low to high energy
  - Orientations or orbits ( $m_l$ ) 1, 3, 5, 7...
  - Spin state ( $m_s$ )  $\frac{1}{2}, -\frac{1}{2}$  (or spin up & spin down) for each substate

# Valence Electrons

➤ **Valence electrons** – those electrons occupy outmost **shell(s)** (for transition metals, a few of the inner shell electrons in the d-orbits as well)

➤ Most available for bonding

**Example:** Neutral Cl atom - atomic number  $Z = 17$ ,  
Electron configuration:  $[ 1s^2 2s^2 2p^6 ] 3s^2 3p^5$

➤ Valence electrons determine the following properties:

- Chemical
- Electrical
- Thermal
- Optical

➤ **Atoms/ions with filled outmost shell will be stable:**

- Most atoms                      Outmost shell with eight (8)  $e^-$  would be stable
- H, Li, Be, B, C                Gain/lose  $e^-$  so that two (2)  $e^-$  for 1s as the outmost shell would be stable

# Periodic Table & Electronegativity

## Periodic Table

Columns: Similar **valence** electron structure – Group

Row: Same number of electron shells (not subshells) – Period

## Electronegativity

- A number representing the tendency for an atom to acquire/lose electrons
- From 0.7 to 4.0:
  - Higher the number, greater tendency to obtain/gain electrons
  - Lower the number, greater tendency to lose electrons

# Periodic Table & Electronegativity

HIGHER electronegativity

(easier to gain e<sup>-</sup>, except inert elements)

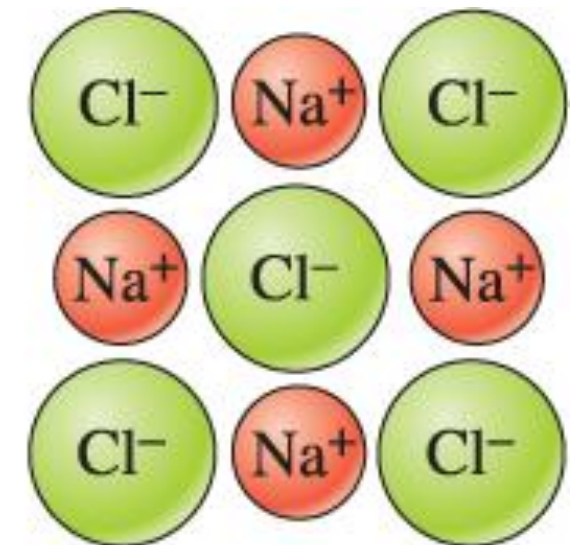
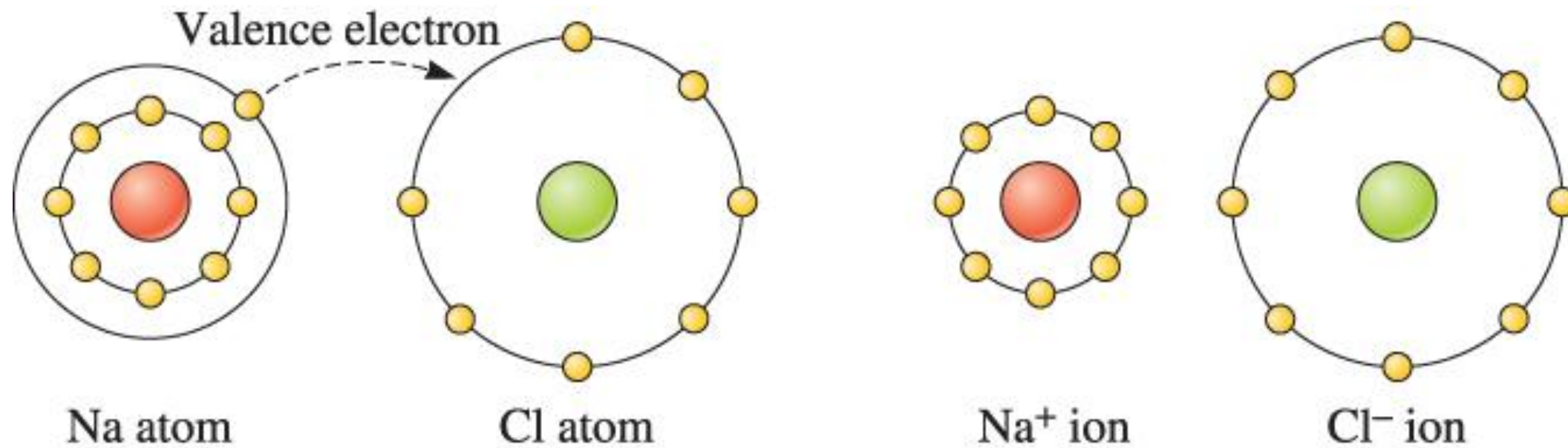
1	1A	2											13	14	15	16	17	18	
1	1.01 H Hydrogen -259 0.09 -253 2.1																	4.00 He Helium -269 -	
2	3 6.94 [He] 2s 1 Li Lithium 181 0.53 1330 1.0	4 9.01 [He] 2s 2 Be Beryllium 1277 1.85 2970 1.5											5 10.81 [He] 2s <sup>2</sup> 2p 3 B Boron (2030) 2.35 2550 2.0	6 12.01 [He] 2s <sup>2</sup> 2p 4, 2, -4 C Carbon (3550) 2.2 4830 2.5	7 14.01 [He] 2s <sup>2</sup> 2p 5, 4, 3, 2, -3 N Nitrogen -210 1.25 -196 3.0	8 16.00 [He] 2s <sup>2</sup> 2p -2, -1 O Oxygen -219 1.43 -183 3.5	9 19.00 [He] 2s <sup>2</sup> 2p -1 F Fluorine -220 1.7 -188 4.0	10 20.18 [He] 2s <sup>2</sup> 3p - Ne Neon -249 0.9 -246 -	
3	11 22.99 [Ne] 3s 1 Na Sodium 98 0.97 892 0.9	12 24.31 [Ne] 3s 2 Mg Magnesium 650 1.74 1107 1.2	3A	4A	5A	6A	7A	8	8	8	10	11	12	13 26.98 [Ne] 3s <sup>2</sup> 3p 3 Al Aluminum 660 2.70 2450 1.5	14 28.09 [Ne] 3s <sup>2</sup> 3p 4, -4 Si Silicon 1410 2.33 2680 1.8	15 30.97 [Ne] 3s <sup>2</sup> 3p 5, 3, -3 P Phosphorus 44 1.82 280 2.1	16 32.06 [Ne] 3s <sup>2</sup> 3p 6, 4, 2, -2 S Sulfur 119 2.07 445 2.5	17 35.45 [Ne] 3s <sup>2</sup> 3p 7, 5, 3, 1, -1 Cl Chlorine -101 3.2 -35 3.0	18 39.95 [Ne] 3s <sup>2</sup> 3p - Ar Argon -189 1.78 -183 -
4	19 39.10 [Ar] 4s 1 K Potassium 64 0.86 760 0.8	20 40.08 [Ar] 4s 2 Ca Calcium 838 1.55 1440 1.0	21 44.96 [Ar] 3d 4s 3 Sc Scandium 1539 3.0 2730 1.3	22 47.88 [Ar] 3d <sup>2</sup> 4s 4, 3 Ti Titanium 1668 4.54 3260 1.5	23 50.94 [Ar] 3d <sup>3</sup> 4s 5, 4, 3, 2, 0 V Vanadium 1900 6.1 3450 1.5	24 52.00 [Ar] 3d <sup>4</sup> 4s 6, 3, 2, 0 Cr Chromium 1875 7.19 2200 1.6	25 54.94 [Ar] 3d <sup>5</sup> 4s 7, 6, 4, 3, 2, 0, -1 Mn Manganese 1245 7.43 2097 1.5	26 55.85 [Ar] 3d <sup>6</sup> 4s 6, 3, 2, 0, -2 Fe Iron 1536 7.86 3000 1.8	27 58.93 [Ar] 3d <sup>7</sup> 4s 3, 2, 0, -1 Co Cobalt 1495 8.9 2900 1.9	28 58.70 [Ar] 3d <sup>8</sup> 4s 3, 2, 0 Ni Nickel 1453 8.9 2730 1.9	29 63.55 [Ar] 3d <sup>10</sup> 4s 2, 1 Cu Copper 1453 8.9 2730 1.9	30 65.38 [Ar] 3d <sup>10</sup> 4s 2 Zn Zinc 420 7.13 906 1.6	31 69.72 [Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p 3 Ga Gallium 30 5.91 2237 1.6	32 72.59 [Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p 4 Ge Germanium 937 5.32 2830 1.8	33 74.91 [Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p 5, 3, -3 As Arsenic Subl. 5.72 - 2.0	34 74.91 [Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p 6, 4, 2 Se Selenium 217 4.79 685 2.4	35 79.90 [Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p 7, 5, 3, 1, -1 Br Bromine -7 3.12 58 2.8	36 83.80 [Ar] 3d <sup>10</sup> 4s <sup>2</sup> 4p - Kr Krypton -157 3.7 -152 -	
5	37 85.47 [Kr] 5s 1 Rb Rubidium 39 1.53 688 0.8	38 87.62 [Kr] 5s 2 Sr Strontium 768 2.6 1380 1.0	39 88.91 [Kr] 4d 5s 3 Y Yttrium 1509 4.47 2927 1.2	40 91.22 [Kr] 4d <sup>2</sup> 5s 4 Zr Zirconium 1852 6.49 3580 1.4	41 91.22 [Kr] 4d <sup>4</sup> 5s 5, 3 Nb Niobium 2468 8.57 4927 1.6	42 95.94 [Kr] 4d <sup>5</sup> 5s 6, 5, 4, 3, 2, 0 Mo Molybdenum 2610 10.2 5560 1.8	43 (98.91) [Kr] 4d <sup>5</sup> 5s 7 Tc Technetium 2140 11.5 5030 * 1.9	44 101.07 [Kr] 4d <sup>7</sup> 5s 8, 6, 4, 3, 2, 0, -2 Ru Ruthenium 2500 12.4 3900 2.2	45 102.91 [Kr] 4d <sup>8</sup> 5s 5, 4, 3, 1, 2, 0 Rh Rhodium 1966 12.4 3730 2.2	46 106.42 [Kr] 4d <sup>10</sup> 4, 2, 0 Pd Palladium 1552 12.0 3140 2.2	47 107.87 [Kr] 4d <sup>10</sup> 5s 2, 1 Ag Silver 961 10.5 2210 1.9	48 112.41 [Kr] 4d <sup>10</sup> 5s 2 Cd Cadmium 321 8.65 765 1.7	49 114.82 [Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p 3 In Indium 156 7.31 2080 1.7	50 118.69 [Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p 4, 2 Sn Tin 232 7.30 2270 1.8	51 121.75 [Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p 5, 3, -3 Sb Antimony 631 6.69 1380 1.9	52 127.60 [Kr] 3d <sup>10</sup> 5s <sup>2</sup> 5p 6, 4, -2 Te Tellurium 450 6.24 990 2.1	53 126.90 [Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p 7, 5, 1, -1 I Iodine 114 4.94 183 2.5	54 131.29 [Kr] 4d <sup>10</sup> 5s <sup>2</sup> 5p - Xe Xenon -112 5.89 -108 -	
6	55 132.91 [Xe] 6s 1 Cs Cesium 29 1.90 690 0.7	56 137.33 [Xe] 6s 2 Ba Barium 714 3.76 1640 0.9	71 174.97 [Xe] 4f <sup>14</sup> 5d 6s 3 Lu Lutetium 1652 9.84 3327 1.2	72 178.49 [Xe] 4f <sup>14</sup> 5d <sup>2</sup> 6s 4 Hf Hafnium 2222 13.31 5400 1.3	73 180.95 [Xe] 4f <sup>14</sup> 5d <sup>3</sup> 6s 5 Ta Tantalum 2996 16.5 5425 1.5	74 183.85 [Xe] 4f <sup>14</sup> 5d <sup>4</sup> 6s 6, 5, 4, 3, 2, 0 W Tungsten 3410 19.3 5930 1.7	75 186.21 [Xe] 4f <sup>14</sup> 5d <sup>5</sup> 6s 7, 6, 4, 2, -1 Re Rhenium 3180 21.0 5900 1.9	76 190.20 [Xe] 4f <sup>14</sup> 5d <sup>6</sup> 6s 8, 6, 4, 3, 2, 0, -2 Os Osmium 3050 22.6 5500 2.2	77 192.22 [Xe] 4f <sup>14</sup> 5d <sup>7</sup> 6s 6, 4, 3, 2, 1, 0, -1 Ir Iridium 2454 22.7 4500 2.2	78 195.08 [Xe] 4f <sup>14</sup> 5d <sup>8</sup> 6s 4, 2, 0 Pt Platinum 1769 21.4 3830 2.2	79 196.97 [Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s 3, 1 Au Gold 1063 19.3 2970 2.4	80 200.59 [Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s 2, 1 Hg Mercury -38 13.6 357 1.9	81 204.38 [Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6p 3, 1 Tl Thallium 303 11.85 1457 1.8	82 207.20 [Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p 4, 2 Pb Lead 327 11.4 1725 1.9	83 208.98 [Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p 5, 3 Bi Bismuth 271 9.8 1560 1.9	84 (209) [Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p 6, 4, 2 Po Polonium 254 9.3 962 2.0	85 (210) [Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p 7, 5, 3, 1, -1 At Astatine (302) - 337 2.2	86 (222) [Xe] 4f <sup>14</sup> 5d <sup>10</sup> 6s <sup>2</sup> 6p - Rn Radon (-71) 9.73 -62 -	

Atomic number: 43 (98.91)  
 Atomic mass (mean relative): (98.91)  
 Electron configuration: [Kr] 4d<sup>5</sup> 5s<sup>2</sup>  
 Oxidation states: 7  
 Symbol: Tc  
 Name: Technetium  
 Melting point [°C]: 2140  
 Boiling point [°C]: 5030 \* 1.9  
 Density [g/cm<sup>3</sup>], for gases [g/l] (0° C, 1013 mbar): 11.5 / 1.9  
 Electronegativity: 1.9  
 Radioactive

LOWER electronegativity (easier to lose e<sup>-</sup>)

# Primary Bond (1) - Ionic Bond

- Between positive (+) and negative (-) ions
- Requires electron transfer between atoms
- Mostly between atoms with large difference in electronegativity (often at left & right ends of the periodic table)
- Example: NaCl

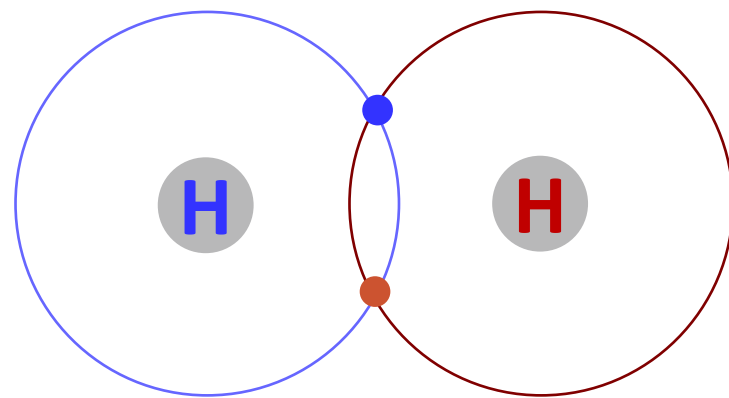


# Primary Bond (2) - Covalent Bond

➤ Between non-metals with **same or similar electronegativity** → share electrons

## H<sub>2</sub> Example

Each H has 1 valence e<sup>-</sup>, needs 1 more  
Same electronegativity  
Have to share e<sup>-</sup>



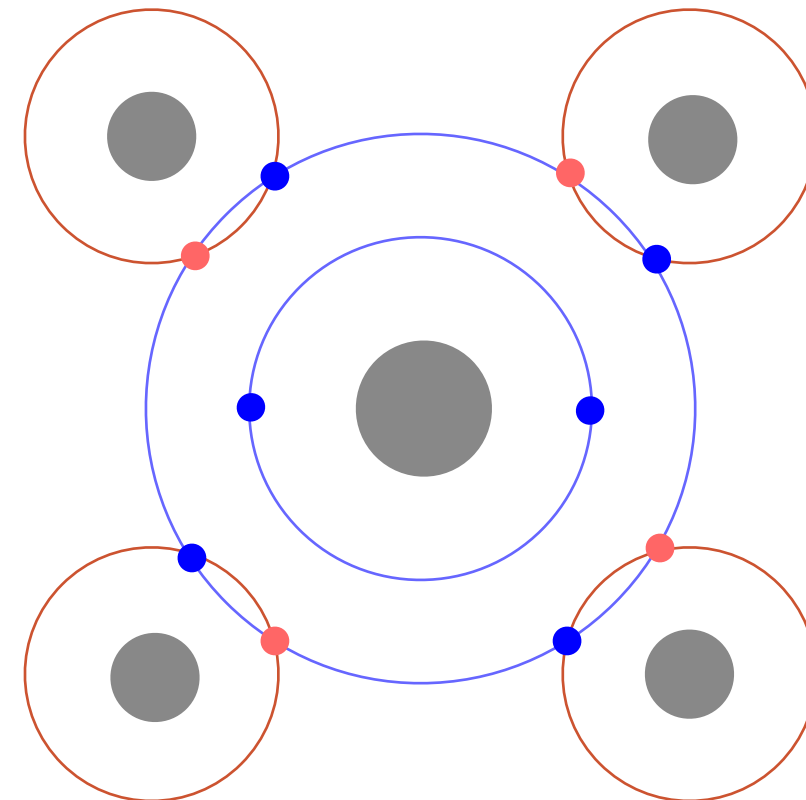
## CH<sub>4</sub> Example

C has 4 valence e<sup>-</sup>, needs 4 more

H has 1 valence e<sup>-</sup>, needs 1 more

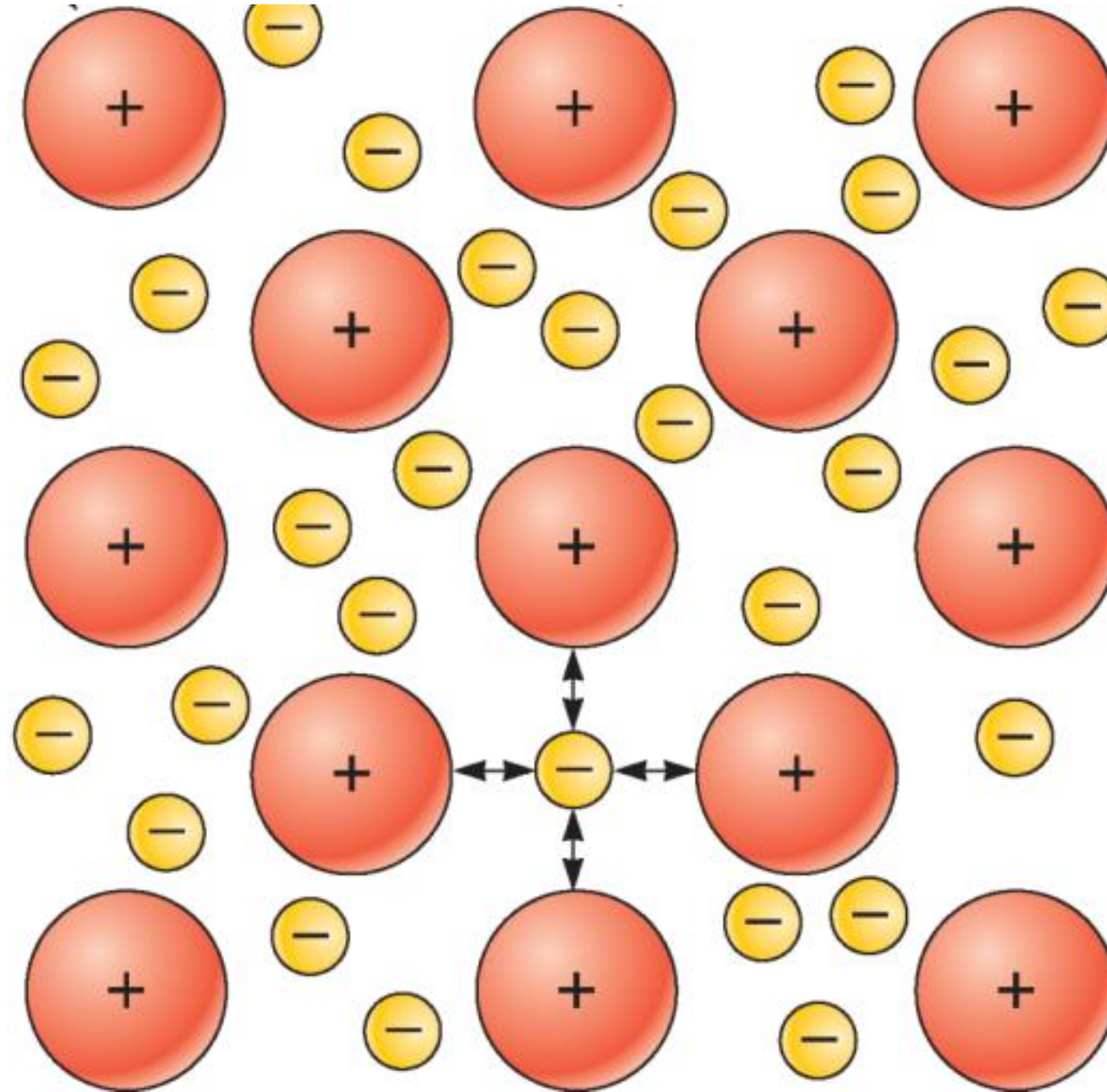
Small electronegativity difference:  $2.5 - 2.1 = 0.4$

Have to share e<sup>-</sup>



# Primary Bond (3) - Metallic Bond

➤ Bonds between metal cations and **delocalized** electron cloud

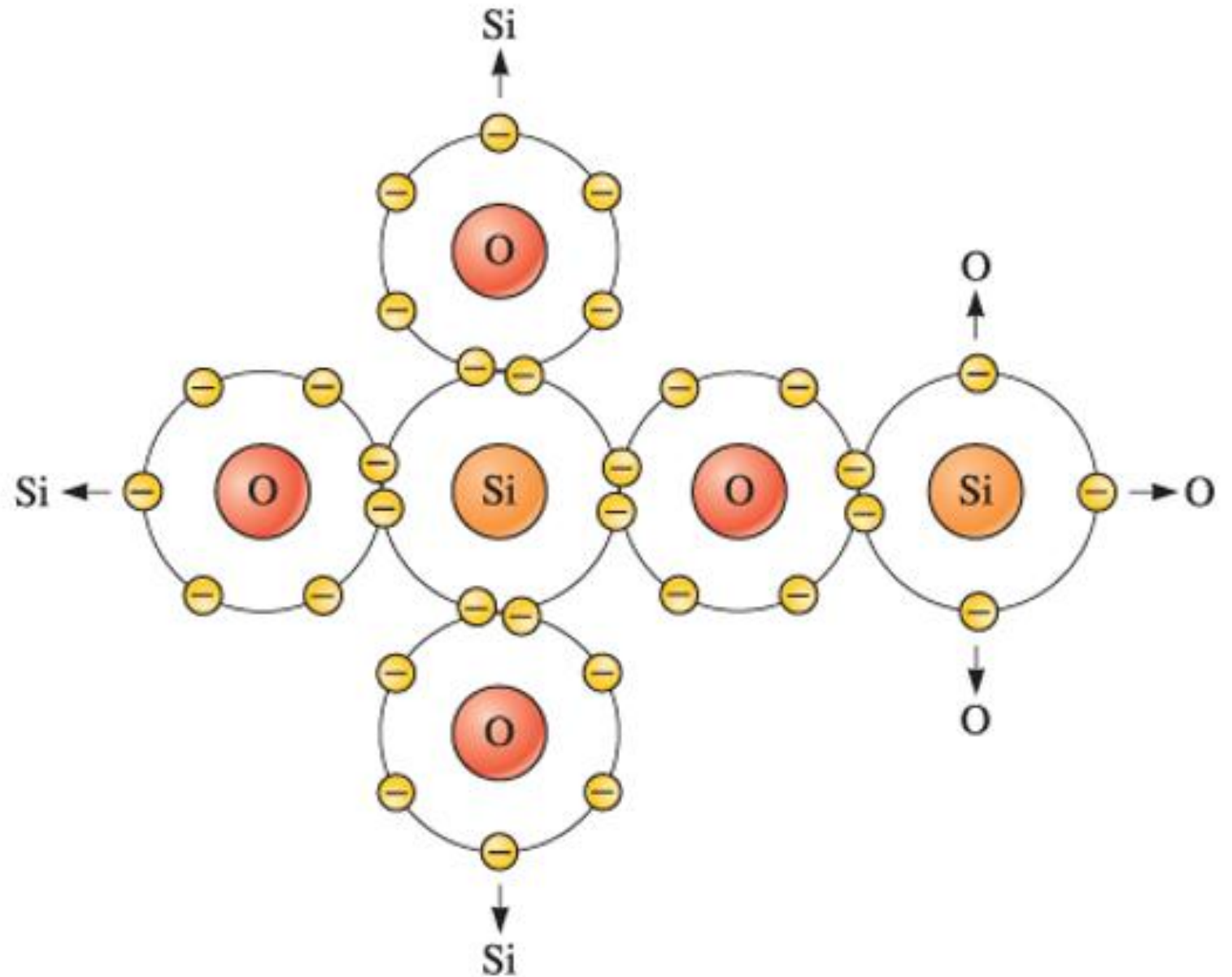


# Mixed Bond

- Ceramics with electronegativity difference not large (as in ionic bonding) but also not small (as in covalent bonding) can be viewed as to have mixed ionic-covalent bonding
- Example:  $\text{SiO}_2$

Electronegativity difference:  
 $3.5 \text{ (for O)} - 2.1 \text{ (for Si)} = 1.7$

Some would say:  
(partial) covalent + (partial) ionic



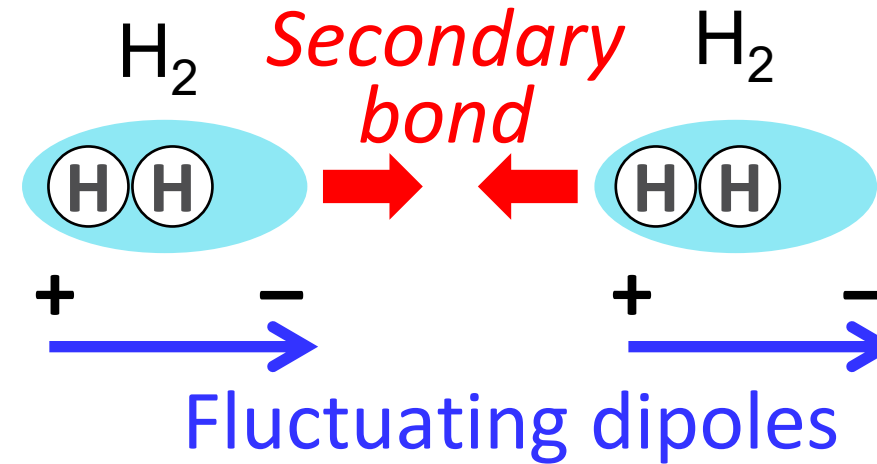
# Secondary Bond

➤ “Bond” arising from interactions between dipoles in molecules

Case 1: Between fluctuating (induced) dipoles (e.g., for H<sub>2</sub>, Cl<sub>2</sub>)

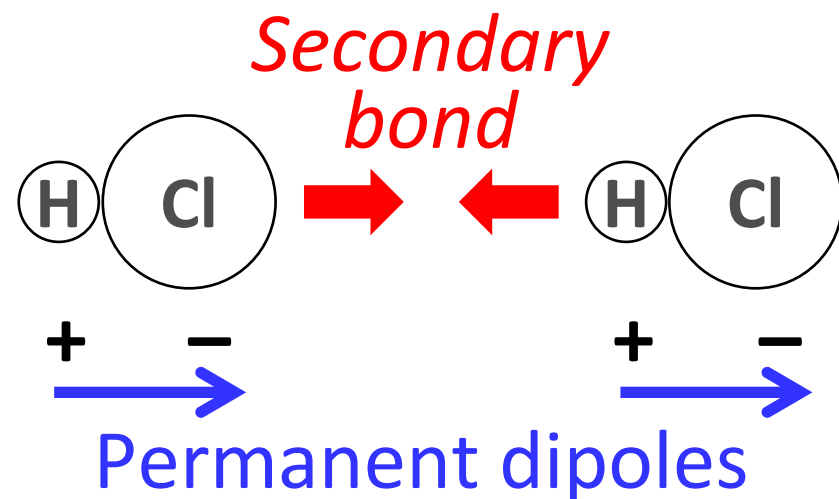
**Liquid H<sub>2</sub> example**

$$T_m = -253^\circ\text{C}$$

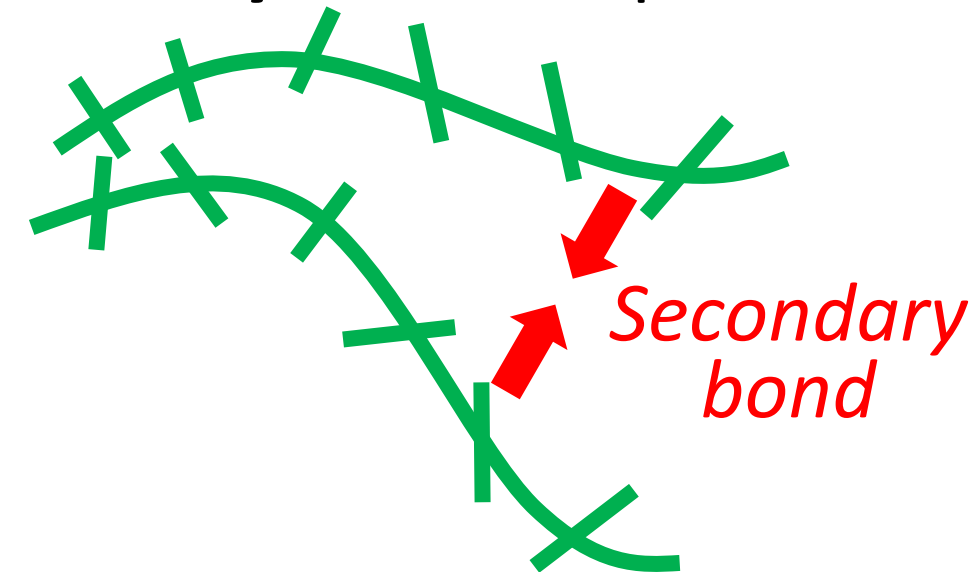


Case 2: Between permanent dipoles (e.g., for HCl or H<sub>2</sub>O)

**Liquid HCl example**  $T_m = -85^\circ\text{C}$



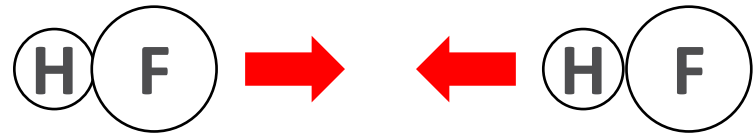
**Polymer example**



# Hydrogen Bond - A Special Secondary Bond

➤ A special permanent dipole induced bond:

**Between individual molecules** in which H is covalently bonded to atoms of F (e.g., HF), O (e.g., H<sub>2</sub>O), or N (e.g., NH<sub>3</sub>)



$$T_b (\text{HF}) \approx 20^\circ\text{C} \gg T_m \text{ for HCl } (-85^\circ\text{C}) \text{ or HBr } (-67^\circ\text{C})$$

➤ Much stronger than all other secondary bonds

➤ Still much weaker than primary bonds

# Coefficient of Thermal Expansion (CTE) & Bond Type

Material

Room T CTE ( $10^{-6}/^{\circ}\text{C}$ )

## Polymers

PP

~110

PS

~65

PTFE

~130

Polymers have much higher CTE than metals and ceramics due to weak secondary bonds

## Metals

Al

23

Au

14

W

4.5

## Ceramics

MgO

13.5

Al<sub>2</sub>O<sub>3</sub>

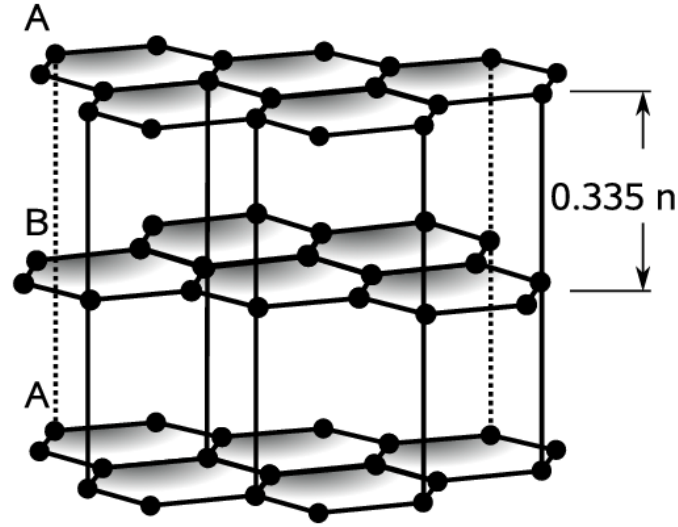
7.6

SiC

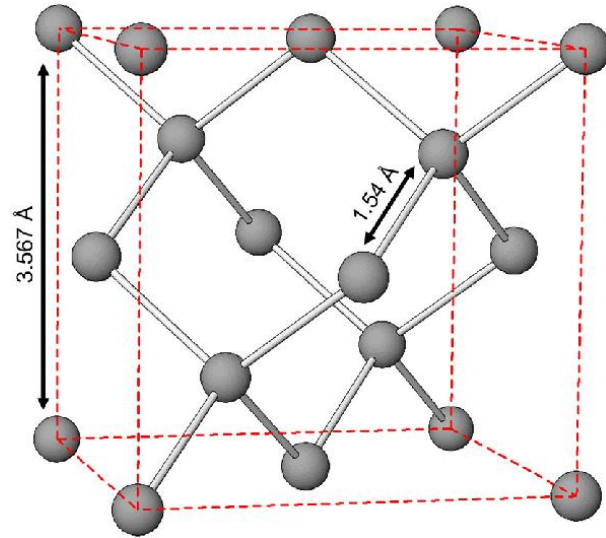
2.8

# Allotropes - Different Structures of Same Element: C Example

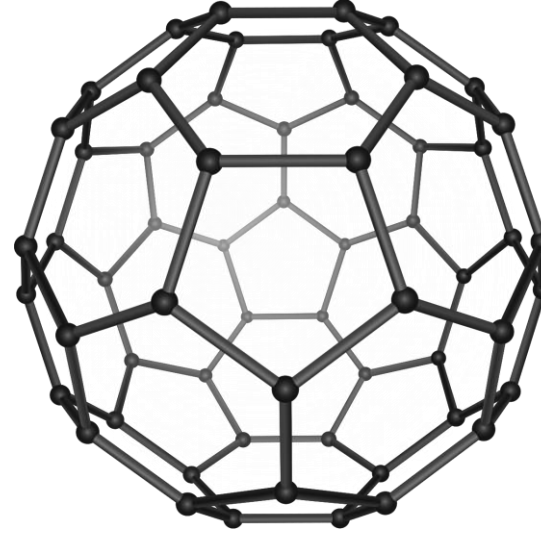
**Graphite**



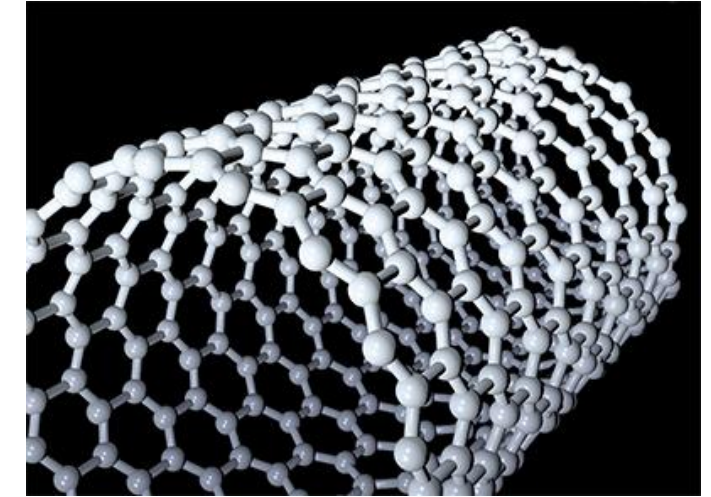
**Diamond**



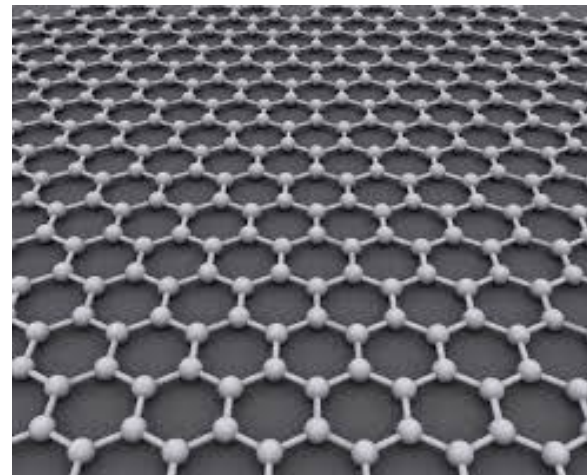
**Fullerene**



**Carbon nanotube (CNT)**



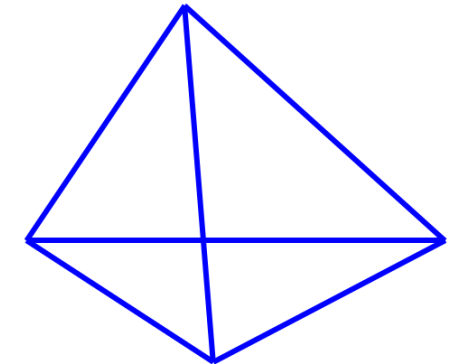
**Graphene**



**Many more!**

Properties & Performance

Synthesis & Processing



Structure

Composition

(Very) soft  
Electrically conductive  
Black

Hardest  
Electrically insulating  
Transparent

[https://www.anton-paar.com/uk-en/about-us/news/news/detail/graphite-from-pencil-to-energy-storage/?srsltid=AfmBOophQf3jtiEI3YoQJXKSUy-yHj3mpdbMPmcXez4D9sTvFMfuh\\_b0](https://www.anton-paar.com/uk-en/about-us/news/news/detail/graphite-from-pencil-to-energy-storage/?srsltid=AfmBOophQf3jtiEI3YoQJXKSUy-yHj3mpdbMPmcXez4D9sTvFMfuh_b0)

<https://www.growndiamondcorp.com/blog/types-of-diamonds/>

# Attendance Check

# Class Exercise – Periodic Table

Given information on right from periodic table for aluminum,

➤ What is the atomic number  $Z$

**13**

➤ What is the number of proton in Al nucleus

**13**

➤ What is the atomic weight  $A$  and the unit for atomic weight  $A$

**26.98 g/mol**

➤ On average, one gram of Al will contain how many Al atoms? ( $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ )

$$\frac{1g}{26.98g/mol} \times 6.02 \times 10^{23} /mol = 2.23 \times 10^{22}$$

➤ What is the averaged (over naturally occurring isotope) mass for one Al atom?

$$\frac{26.98g/mol}{6.02 \times 10^{23} /mol} = 4.48 \times 10^{-23} g$$

13	2
Al	8
Aluminium	3
26.9815385	

# Class Exercise

Given the following electronegativity  $\chi$  for different elements:

$$\chi(\text{Na})=0.9$$

$$\chi(\text{F})=4.0$$

$$\chi(\text{Si})=1.8$$

$$\chi(\text{C})=2.5$$

$$\chi(\text{Mg})=1.2$$

Determine the predominant primary bond type in the follow materials

- Sodium fluoride (NaF) **Ionic bond**
- Silicon carbide (SiC) **Covalent bond**
- Pure magnesium (Mg) **Metallic bond**

## Class Exercise – Bonds (2)

- What is the bond type between oxygen and oxygen atoms WITHIN a single O<sub>2</sub> molecule?  
**Covalent bond**
- Is the bond between different O<sub>2</sub> molecules in liquid oxygen primary bond or secondary bond?  
**Secondary bond**
- What is the bond type between Hydrogen (H) and oxygen WITHIN a single water H<sub>2</sub>O molecule?  
**Covalent bond**
- What is the bond type BETWEEN different H<sub>2</sub>O molecules in ice?  
**Secondary bond (Hydrogen bond, in particular)**

# Homework 2.0

Carefully review chapter 2 lecture slides and, if time allows, read textbook sections (Askeland chapter 2) and give an honor statement confirming the reading

# Homework 2.1

What type(s) of bonding would be expected for each of the following materials:

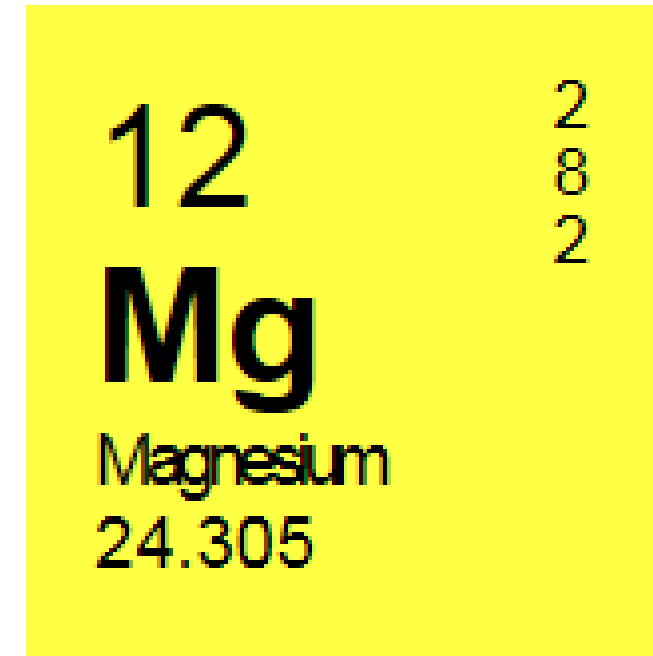
- 1) Bronze (a copper-tin or Cu-Sn alloy);
- 2) Rubber;
- 3) Barium oxide (BaO);
- 4) Nylon;
- 5) Gallium arsenide (GaAs). You may refer to the electronegativity table below.

IA																	0	
H 2.1																		He -
	IIA											IIIA	IVA	VA	VIA	VIIA		
Li 1.0	Be 1.5											B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne -	
Na 0.9	Mg 1.2																	Ar -
		IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB							
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 1.8	Ni 1.8	Cu 1.9	Zn 1.6	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr -	
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	Xe -	
Cs 0.7	Ba 0.9	La-Lu 1.1-1.2	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 1.8	Bi 1.9	Po 2.0	At 2.2	Rn -	
Fr 0.7	Ra 0.9	Ac-No 1.1-1.7																

## Homework 2.2

Given information on right from the periodic table for magnesium (Mg),

- What is the atomic number  $Z$  ?
- What is the number of proton in Mg nucleus ?
- What is the atomic weight  $A$  and the unit for atomic weight  $A$  ?
- On average, one gram of Mg will contain how many Mg atoms?
- What is the average (over naturally occurring isotope) mass for one magnesium atom?
- Knowing F has electron configuration of  $1s^2 2s^2 2p^5$  and atomic weight of 19.0, give the chemical formula for the stable compounds between Mg and F and calculate the mass for one mole of that compound.



12	2 8 2
<b>Mg</b>	
Magnesium	
24.305	