

Beryllium (Be) will most likely form an ion with what charge?

- a) -1
- b) -2
- c) +1
- d) +2

What would the chemical formula for magnesium fluoride (a salt of Mg and F) be?

- a) MgF
- b) Mg_2F
- c) MgF_2
- d) MgF_3

Ionic compounds are neutral (no net charge). What are the ionic charges in the following compounds?



Naming convention for salts

- The metal comes first with its name unchanged
- The nonmetal comes second, with the suffix “ide” appended

If aluminum and chlorine form a compound, what would the formula be?



Covalent Bonding

“To find the truth you have to try and you have to persist in trying. Sometimes it’s fun. Sometimes it’s hard or boring. But it’s always worth it...”

“The Creator of the Universe has implanted a message in every created thing. Geology, astronomy, physics – all science is really nothing more than an effort to read those messages.”

Henry Eyring

- What are non-metal bonds like?
 - covalent, polar, hydrogen bonds, dispersion
- How strong are they?
- Can this help explain trends in melting and boiling temperatures and in conductivity?

Today's class

- Forces between atoms in molecules.
- Forces between molecules in a liquid or solid.

Covalent Bonding

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- Many compounds used by our bodies are non-metals (water, oxygen, carbon dioxide, etc.)
- Liquids or gases at room temperature.
- Do not conduct electricity

What are Covalent Materials like?

- Generally have melting and boiling points in the intermediate to low range
- Poor conductors of heat and electricity
- May be solids, liquids, or gases
- Exist as molecules!



Electron sharing

- Chemistry worries about electrons in the largest unfilled orbitals
- non-metals form molecules by sharing electrons to fill orbitals
- produces “real” molecules

non-metal bonds

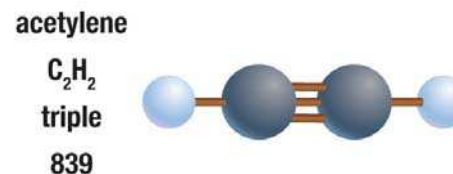
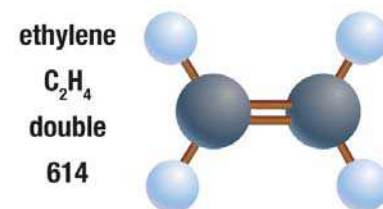
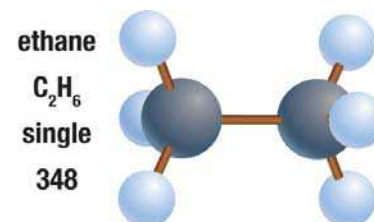
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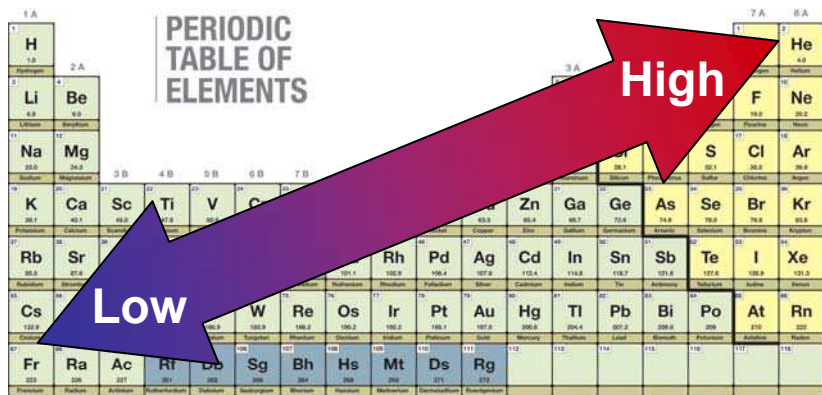
single, double, triple

- bond strength = energy required to separate atoms



Electronegativity

- Some atoms are not as good at sharing as others.
- Electronegativity: how strongly atoms attract electrons



metals non-metals artificially prepared

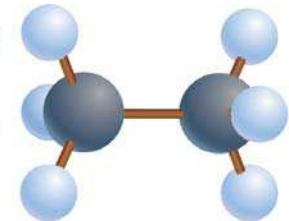
Atomic Number 90 Symbol Th
Atomic Weight 232.0 Name Thorium

90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu						
140.1	140.9	144.2	147	150.4	151.9	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0						
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu						
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr						
232.0	231.0	238.0	237	244	243	247	247	251	252	257	258	259	262						
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr						
Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lanthanum						

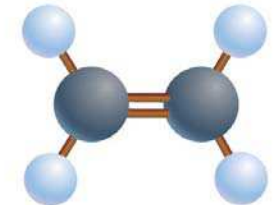
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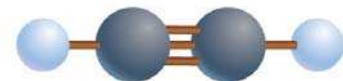
ethane
C₂H₆
single
348



ethylene
C₂H₄
double
614

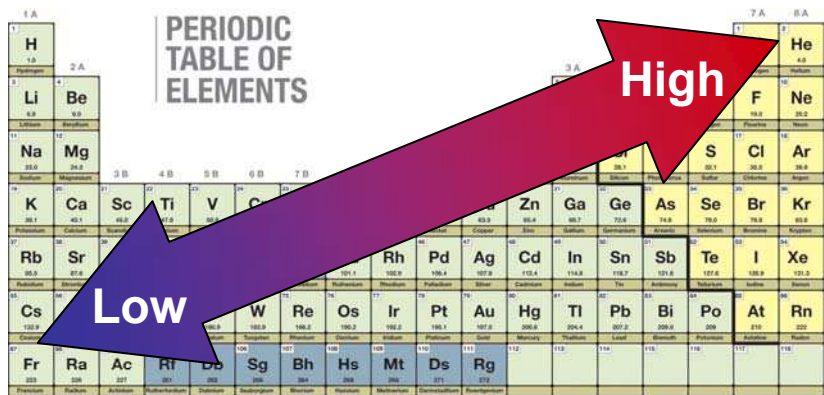


acetylene
C₂H₂
triple
839



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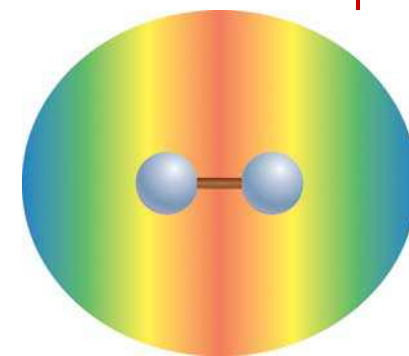
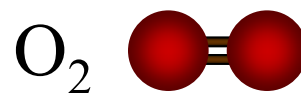


metals	non-metals	artificially prepared
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Atomic Number	90	Symbol
Atomic Weight	232.0	Name
	Th	
	Thorium	

Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
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
140.1	140.9	144.2	144.9	150.4	151.9	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0
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Polarity

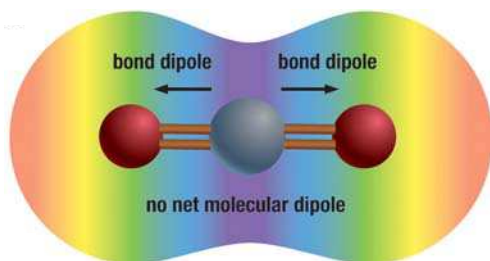
- Polarity: from unequal electronegativity AND geometry
- NON-POLAR:



Electron density is largest between the molecules.

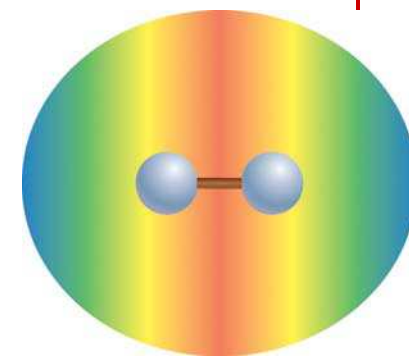
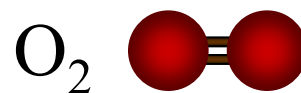
Also non-polar

- CO₂ combines atoms with unequal electronegativity.
- Non-polar by geometry



Polarity

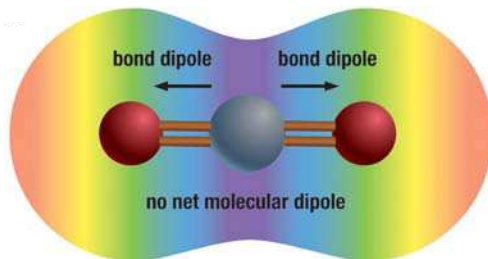
- Polarity: from unequal electronegativity AND geometry
- NON-POLAR:



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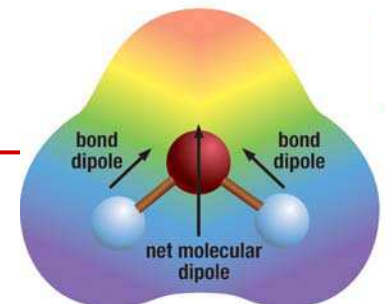
Also non-polar

- CO_2 combines atoms with unequal electronegativity.
- Non-polar by geometry



Polar Molecules

- Water is polar.
- The oxygen side of the molecule is more negative (greater electronegativity)
- The hydrogen side is more positive (smaller electronegativity).

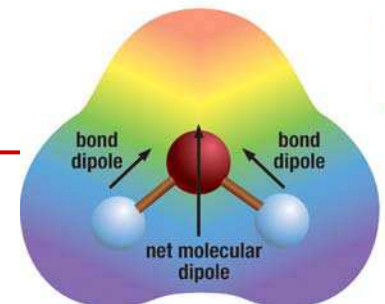


The extreme: an ionic bond

- In covalent bonds, electronegativity is nearly the same
- For metal/non-metal bonds, electronegativity is strongly unequal:
IONIC BONDS

Polar Molecules

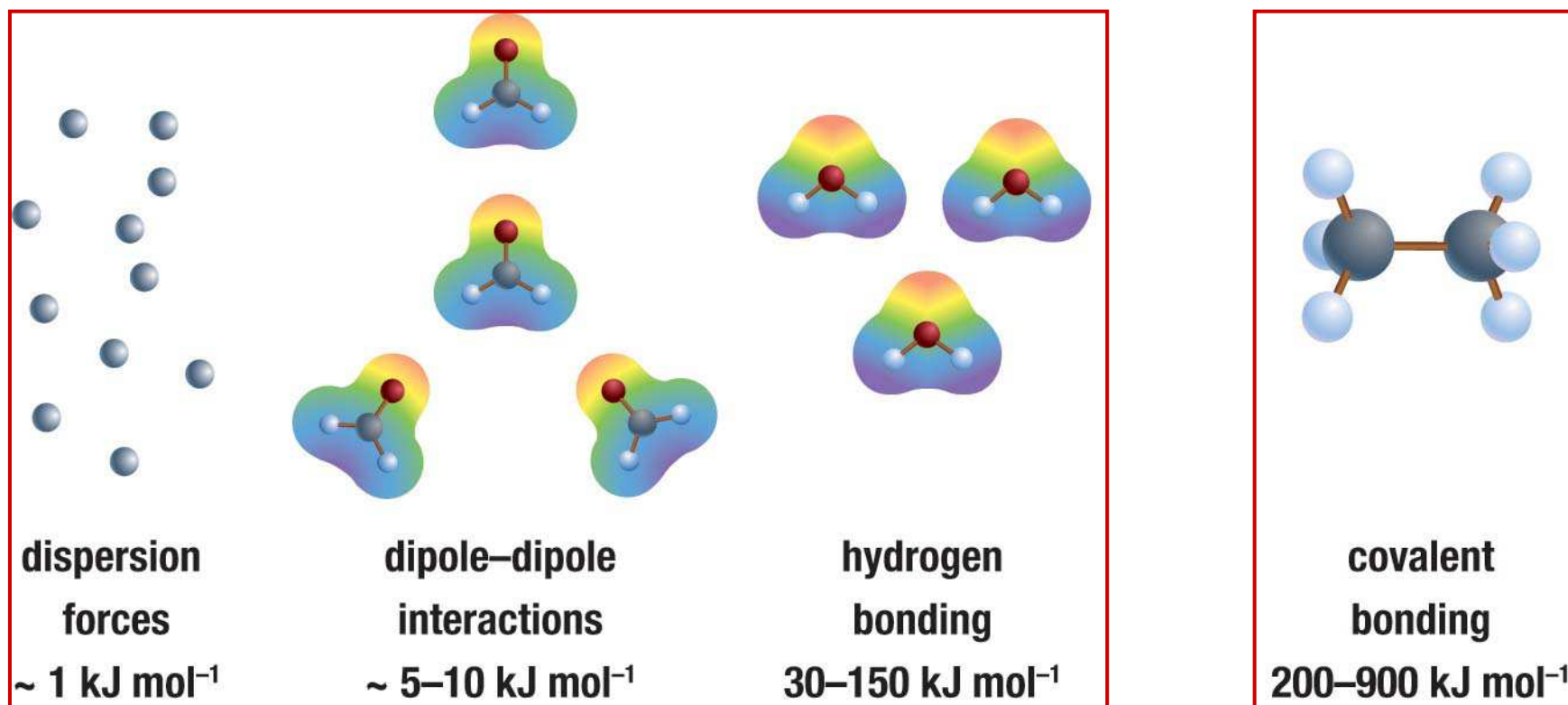
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Forces between molecules: how do they compare?

Forces between molecules in a liquid

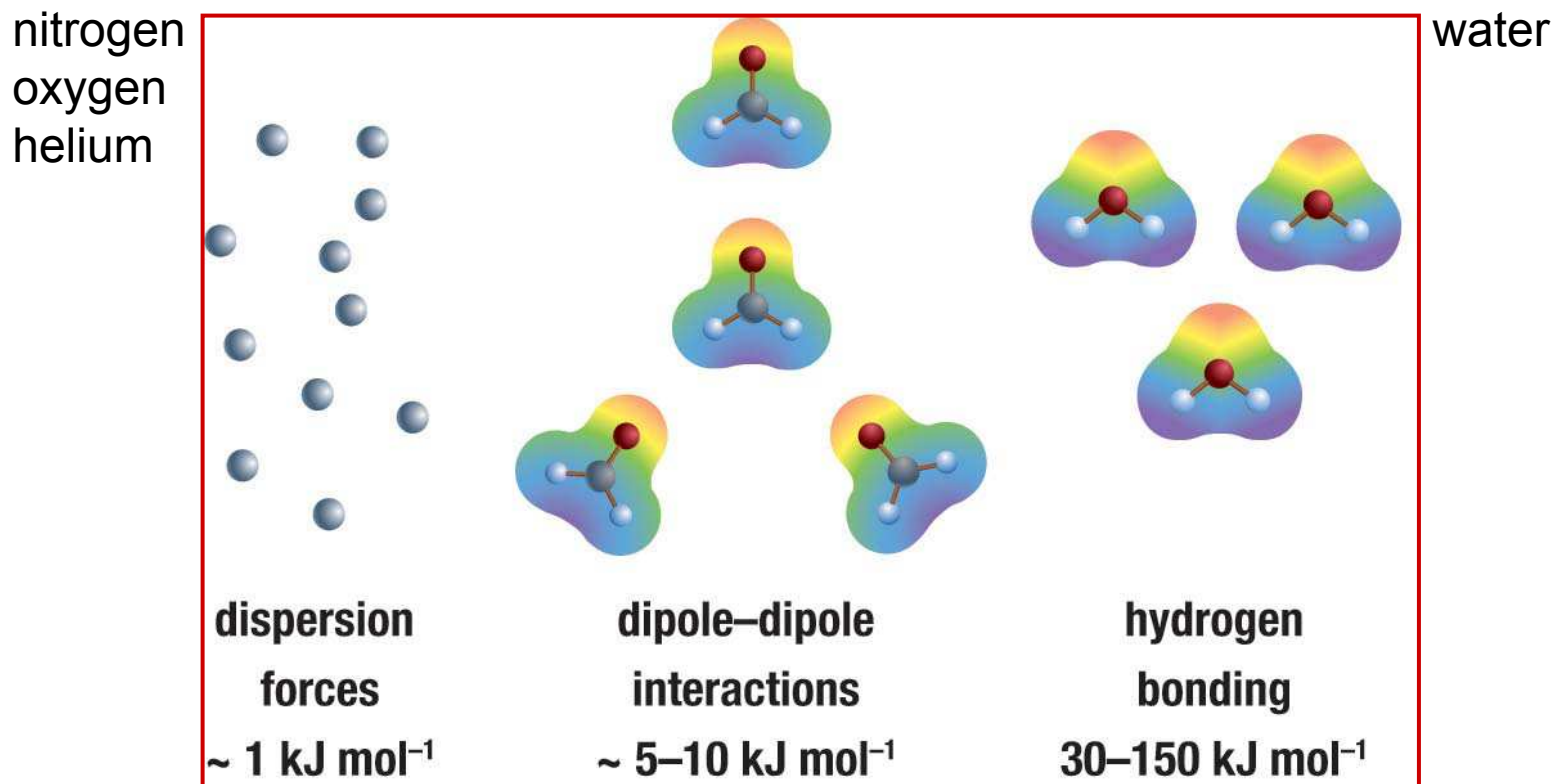
Force between
atoms in a molecule



weaker

stronger

Melting and boiling temperatures: how do they compare?



What best explains the high freezing temperature of water?

A. Covalent bonds between the molecules

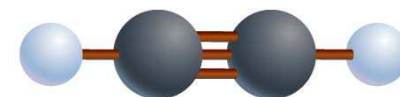


B. Hydrogen bonds between the molecules

C. Dispersion forces between the molecules

D. Attraction of the permanent dipole in one molecule to the dipole in another

How many electrons are shared between these two carbon atoms?



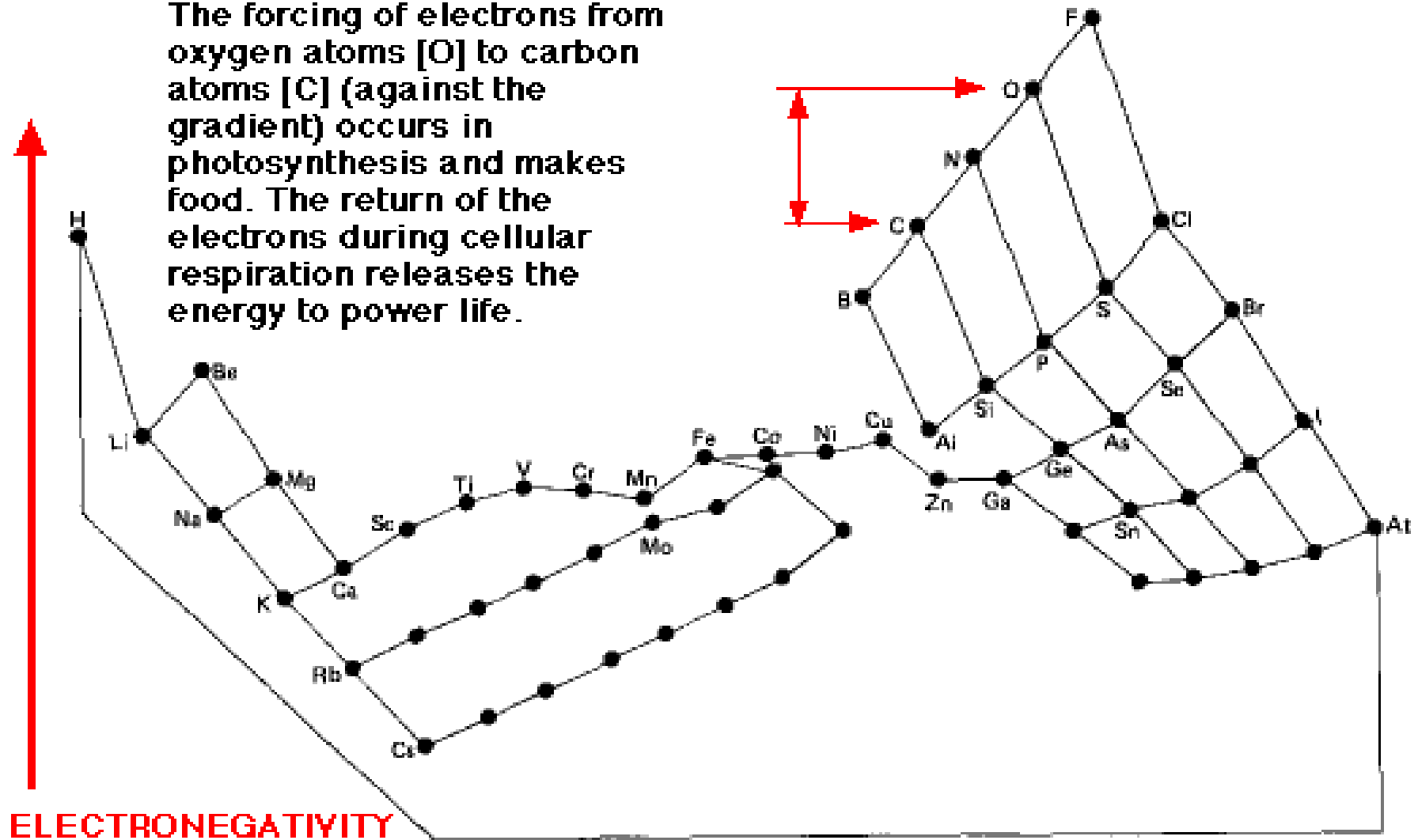
A. 2

B. 3

 **C. 6**

D. 12

The forcing of electrons from oxygen atoms [O] to carbon atoms [C] (against the gradient) occurs in photosynthesis and makes food. The return of the electrons during cellular respiration releases the energy to power life.



Arrange S, Cl, F in order of increasing electronegativity.

 **A. S, Cl, F**

B. Cl, F, S

C. F, Cl, S

D. F, S, Cl

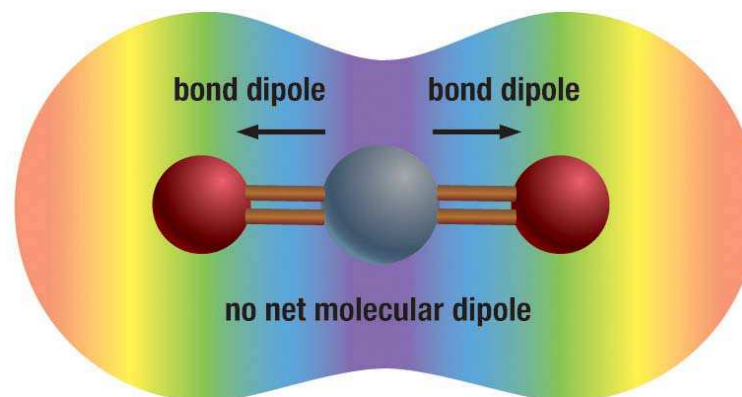
Some examples: Nitrogen

- Strong covalent bonds.
- No dipole.
- Only weak dispersion forces for attraction between molecules.
- Good electrical insulator.
- Low melting and boiling temperatures.



Some examples: Carbon Dioxide

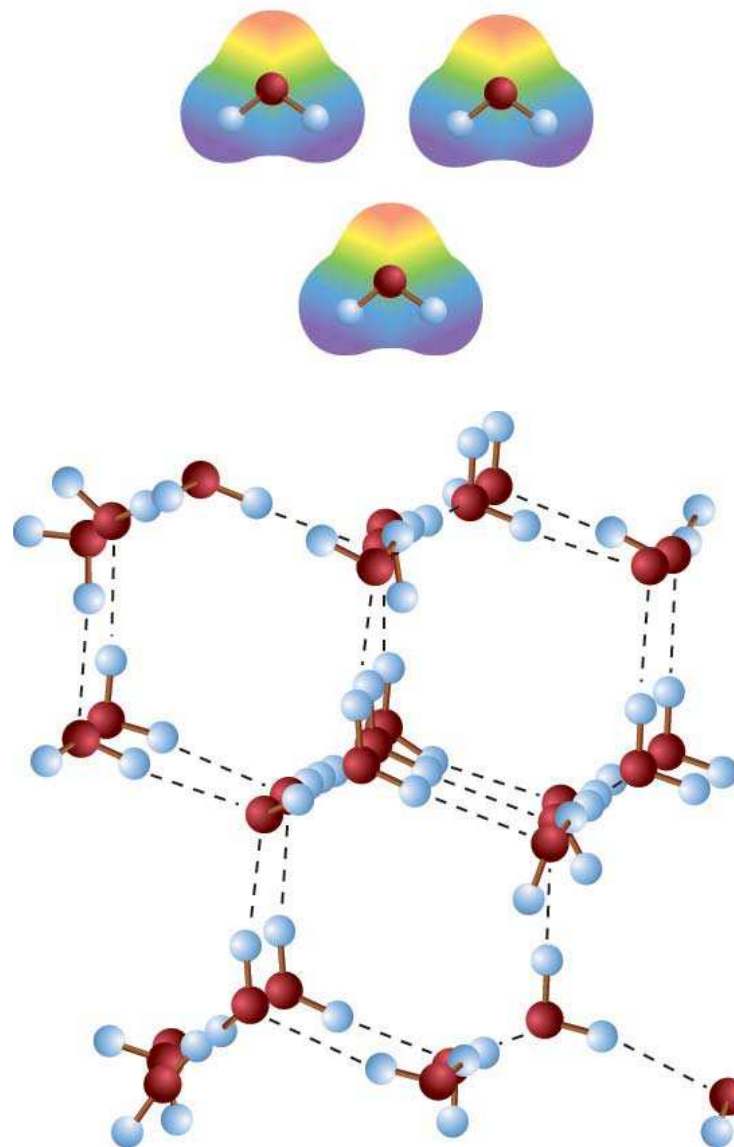
- Strong covalent bonds.
- No dipole.
- Only weak dispersion forces for attraction between molecules.
- Good electrical insulator.
- Low melting and boiling temperatures.



Some examples: Water

- Large dipole.
- Hydrogen bonding between molecules
- Higher melting and boiling temperatures.
- Can lose H^+ to form an acid
- Excellent solvent

*(polarity demo
pH demo)*

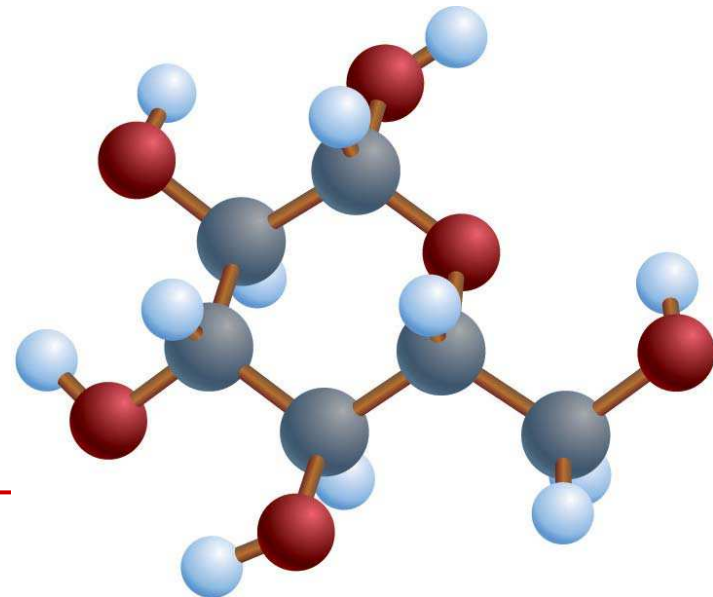


Some examples: Glucose

- Large dipole.
- Hydrogen bonding between molecules
- “Sticky” likes to form crystals:
2C sugar, 1C water,
string, patience



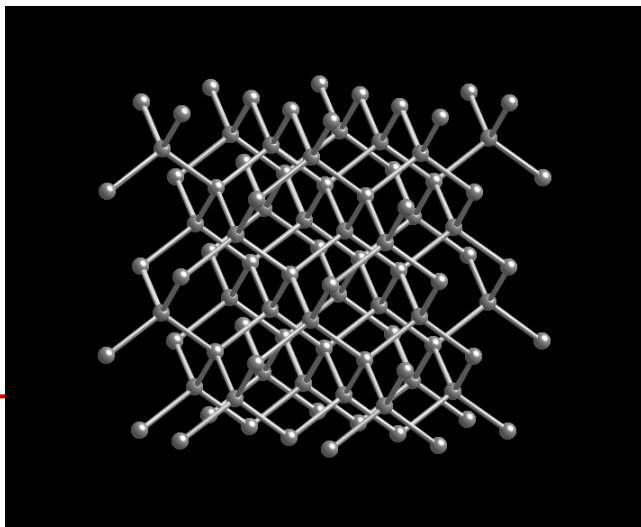
- Higher melting and boiling temperatures.
- A carbohydrate (“carbon water”)



Some examples: Carbon

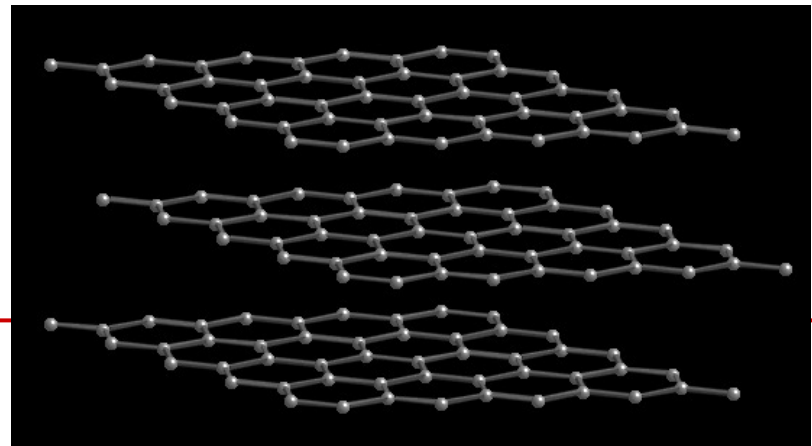
- DIAMOND

- Each carbon is attached to 4 other carbons
- Strong bonds between atoms: network
- Poor electrical conductor



- GRAPHITE

- Strong bonds to 3 other carbons in a plane
- Weak bonds between planes
- Excellent lubricant (for your pinewood derby)



Molecular ions

- Think of a happy family of atoms that is missing a few electrons.
- They can't share any more, so they go steal them.

Name	nitrate	sulfate	silicate	ammonium
Formula	NO_3^-	SO_4^{2-}	SiO_4^{4-}	NH_4^+
Chemical Drawing				
Molecular Model				

Summary

- Covalent bonds occur in non-metals, when atoms share electrons and form molecules.
- Usually strong forces between atoms in molecules.
- Usually weak forces between molecules in a liquid or solid.
- Bond characteristics help determine properties of more complex systems (stay tuned...).