## 4:2a The Role of Electrons in Bonding

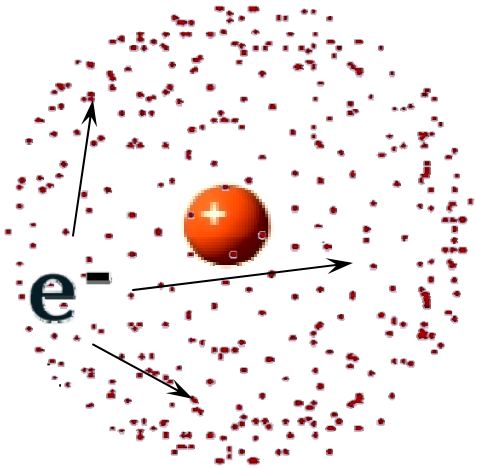
**Last time we saw that atoms with unfilled orbitals have a tendency to gain or lose electrons in order to achieve a stable $e^-$ configuration**

# 2. COVALENT BONDS

**A covalent bond occurs when two atoms SHARE a pair of electrons**

# 4:2b The Role of Electrons in Bonding

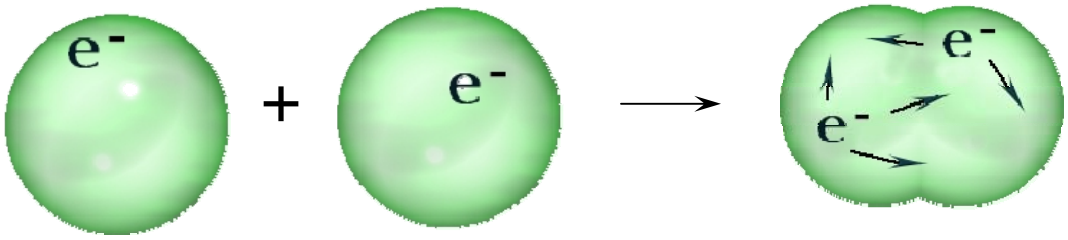
## Draw a hydrogen atom at this time

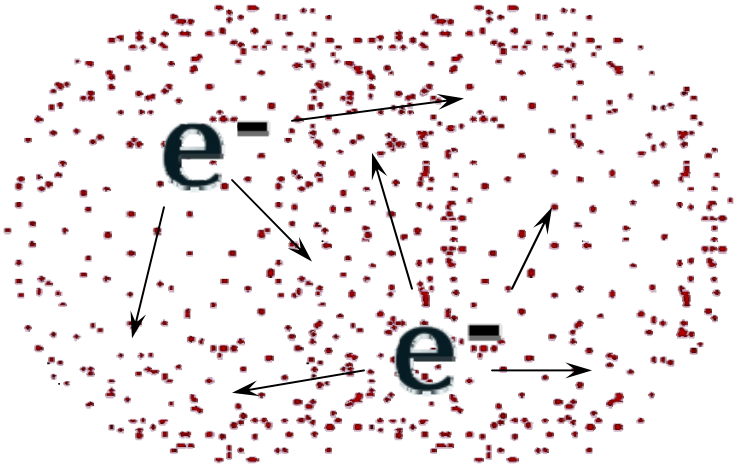



- **Does hydrogen have a stable electron configuration?**
  No: $1s^1$ means its s-orbital is not filled
- **What could hydrogen do to achieve a stable configuration like one of the inert gases?**
- **Which inert gas could hydrogen most easily emulate?**
  Helium: $1s^2$

## 4:2c The Role of Electrons in Bonding

**What if two hydrogens share a pair of electrons?**




**The two electrons thus orbit BOTH atomic nuclei, holding them together**

**When two atoms SHARE a pair of electrons, the bond that joins them is a COVALENT bond**

## 4:2d The Role of Electrons in Bonding

**The bonds that we study include many important properties**

Bond Distance

**The distance between two centers**

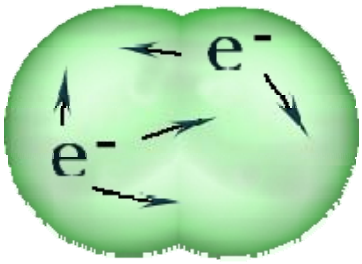
Bond Strength

**How much energy is required to break the bond?**

Bond Polarity

**Are the electrons shared equally between the two atoms (symmetrical), or is the electron density unsymmetrical?**

## 4:2e The Role of Electrons in Bonding



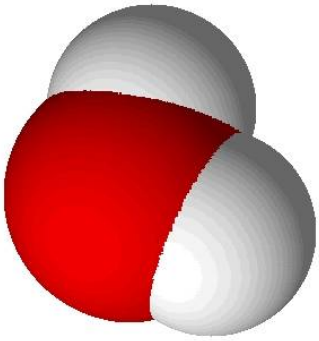

**The covalent bond between two hydrogen atoms is perfectly symmetrical**

**This is an example of a** NON-POLAR **covalent bond**

**Recall our demonstration the Immiscibility bottle**

**We saw that water is a polar molecule**

**It exhibits** POLAR COVALENT **bonds**

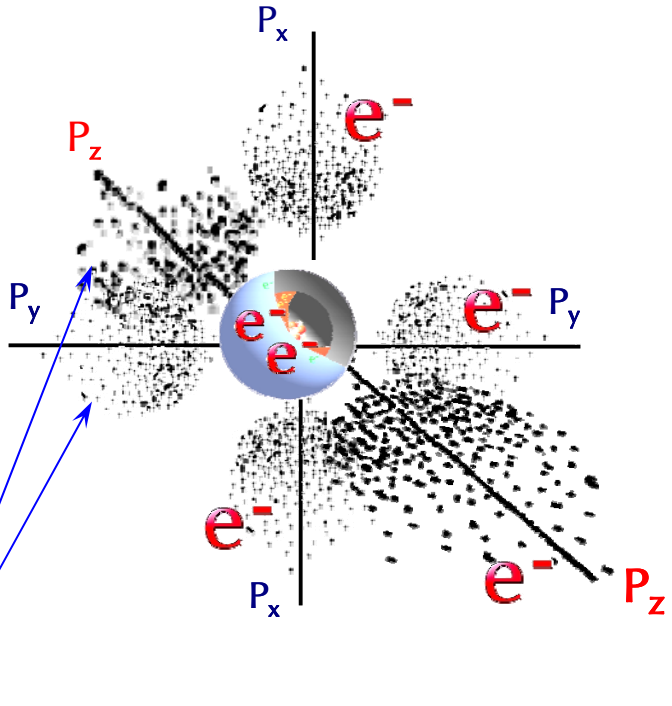


**The distribution of electrons (and charge) is** unsymmetrical **because the oxygen atom attracts the electrons more strongly**

## 4:2f The Role of Electrons in Bonding

**Draw an atom of oxygen at this time, showing all of its 2s and 2p orbitals and their electrons**

| 8 |
|---|
| O |
| 15.9994 |
| Oxygen |

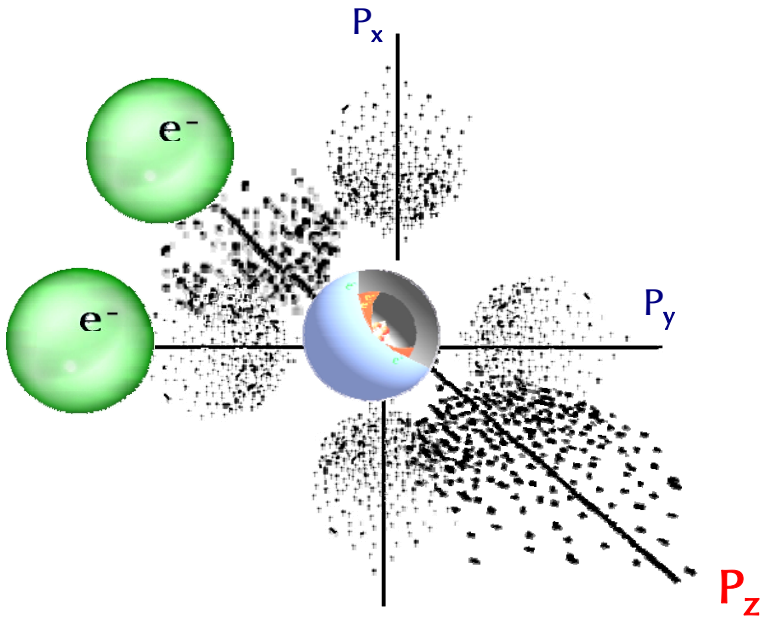



Notice that Py and Pz are missing one electron each

**Can you predict which oxygen orbitals will share electrons with the two hydrogens?**

Answer: The Py and Pz corbitals both need a second electron and will readily form covalent bonds with two H atoms

# 4:2g The Role of Electrons in Bonding




*Knowing that the Px, Py, and Pz orbitals are all perpendicular to each other*

**can you predict the bond angle between the two hydrogens?**

( Which are shown here in green )

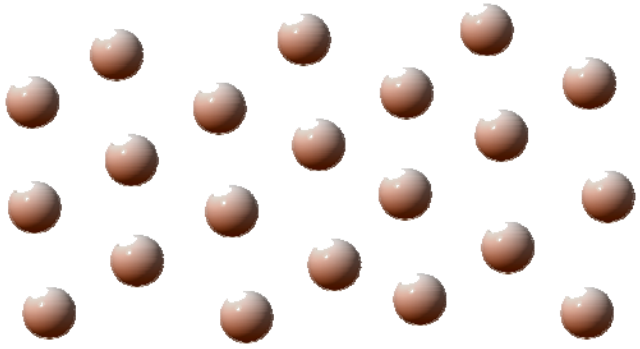
The expected bond angle is 90°, but the two hydrogens (both mildly positive) repel each other slightly resulting in an actual bond angle of about 104.5°

**What inert gas configuration does oxygen tend to emulate?**

Like that of NEON: $1s^2\ 2s^2\ 2p^6$

# 3. METALLIC BONDING

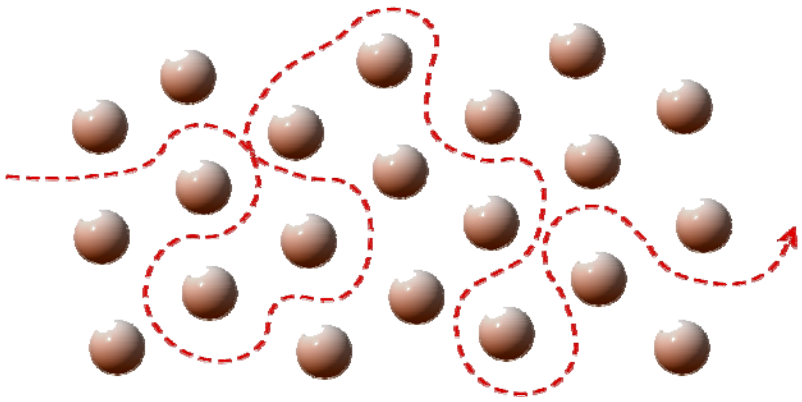
**In metals, we can imagine the atomic nuclei as islands in a sea of electrons**



**The nuclei are fixed in relative positions within the crystal, but the**

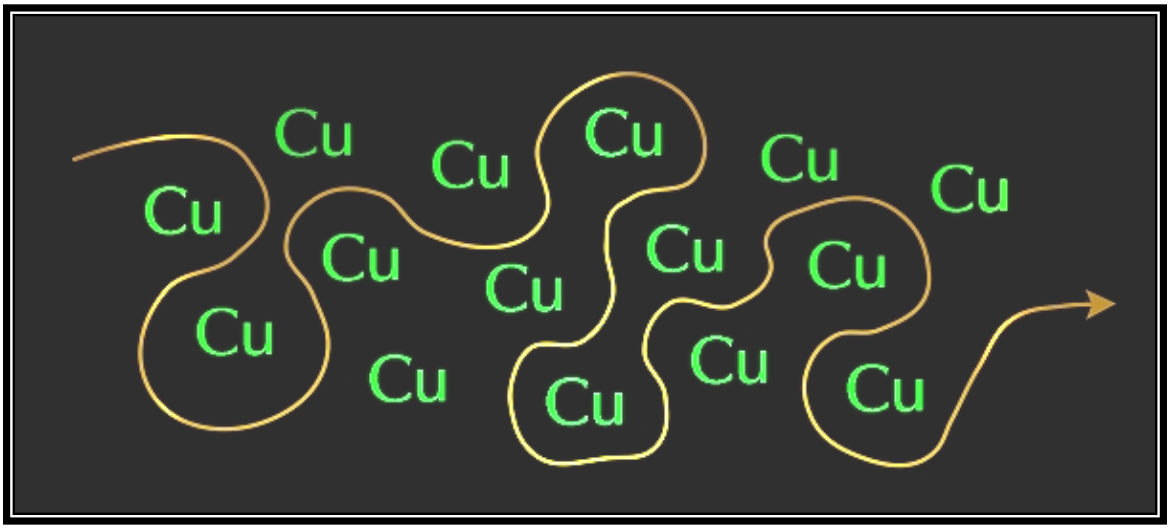
OUTERMOST ELECTRONS

**wander freely throughout the crystal**



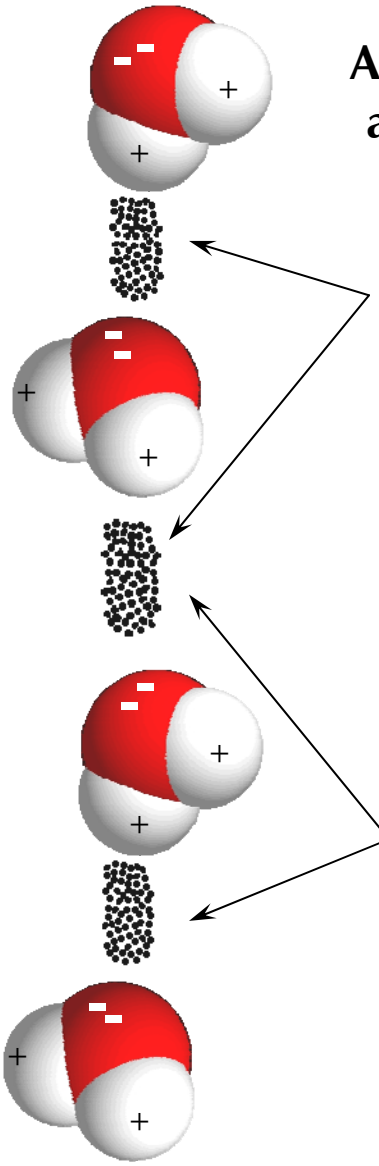
**first circling one nucleus and then another**

## 4:2i The Role of Electrons in Bonding




- **Metallic bonding is unique because of the mobility of the outermost electrons**
- *Metals have a weak hold on their outermost electrons and tend to lose them easily*
- *Since electricity involves the flow of electrons, this model of an electron sea helps us understand why metals are good* ***conductors***
- *Metals can be drawn into wire* (**ductility**) *and flattened into thin sheets* (**malleability**) *because these enveloping electrons act somewhat like a glue, holding all the nuclei together*

# 4:2J The Role of Electrons in Bonding



**Any molecule that is mildly polar and has weak electrical charges is likely to form**

## Hydrogen Bonds

**Water provides a good example of hydrogen bonding**

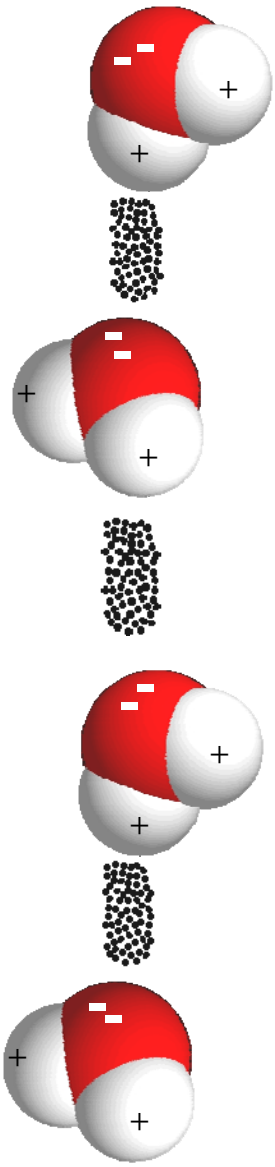
The mild opposite charges result in weak

## Hydrogen Bonds

**between neighboring molecules**

## 4:2K The Role of Electrons in Bonding

# About Hydrogen Bonds



1. *They do not join atoms together*
   *They join **molecules** together*

2. *They are **very weak** bonds*
   *and are broken very easily*

3. *When broken, however, new ones*
   ***form again** almost immediately*

*Hydrogen bonds in earth's oceans*
***help moderate earth's climate***

*Water's hydrogen bonds **absorb the***
***sun's heat** and then break –*
*-- only to instantly form again*

*It is easy for cells to temporarily*
***separate two strands of DNA***
*because the strands are held*
*together by weak hydrogen bonds*

*This allows cells to **access , use and***
***copy the genetic information***
*encoded in their DNA*