

Mass # (protons + neutrons)

symbol

Atomic # (protons or electrons)

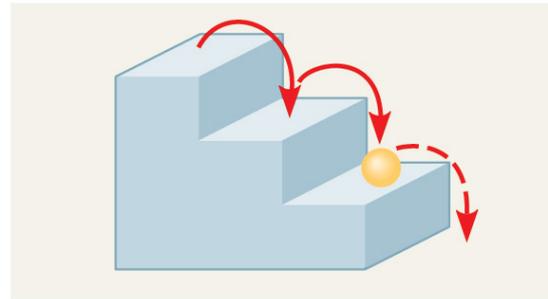
identifies element is **Isotopes** → different number
of protons of neutrons

- # neutrons varies, but same # of protons
- Radioactive isotopes used as tracers (follow molecules, medical diagnosis)
- Uncontrolled exposure causes harm

	Carbon-12	Carbon-13	Carbon-14
Protons	6	6	6
Neutrons	6	7	8
Electrons	6	6	6

Electrons exist only at fixed levels of potential energy called **electron shells**

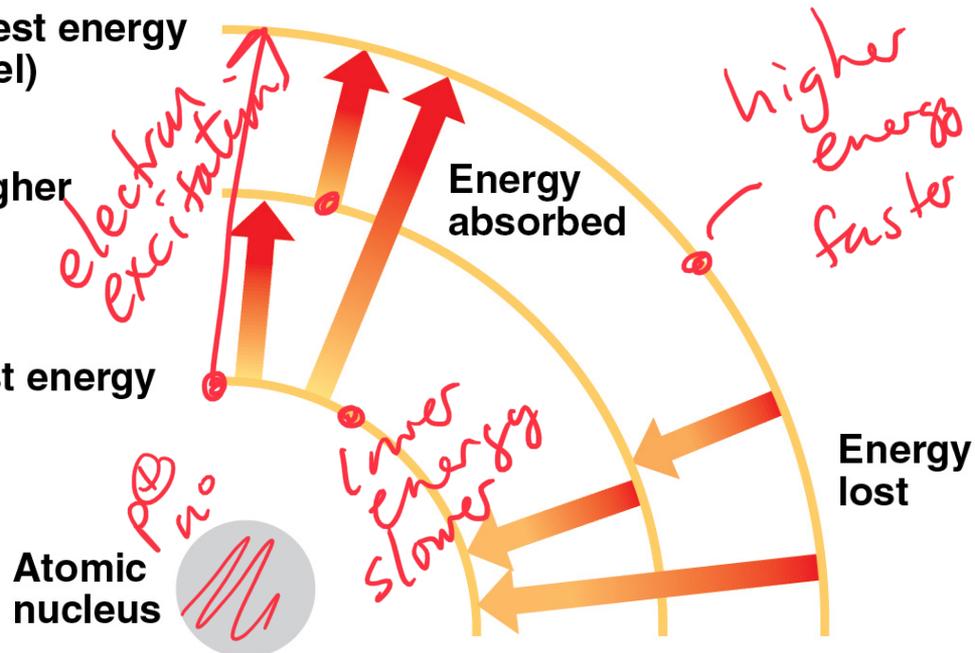
(a) A ball bouncing down a flight of stairs can come to rest only on each step, not between steps.



Third shell (highest energy level in this model)

Second shell (higher energy level)

First shell (lowest energy level)



(b)

The Periodic Table of the Elements, in Pictures

Periods
1
2
3
4
5
6
7
8

Alkali Metals
Group 1

H 1 1
Hydrogen

Sun and Stars

Li 3 3
Lithium

Batteries

Na 11 11
Sodium

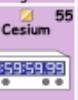
Salt

K 19 19
Potassium

Fruits and Vegetables

Rb 37 37
Rubidium

Global Navigation

Cs 55 55
Cesium

Atomic Clocks

Fr 87 87
Francium

Laser Atom Traps

Alkali Earth Metals
2

Be 4 4
Beryllium

Emeralds

Mg 12 12
Magnesium

Chlorophyll

Ca 20 20
Calcium

Shells and Bones

Sr 38 38
Strontium

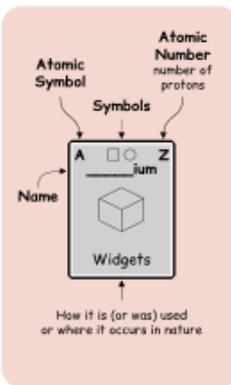
Fireworks

Ba 56 56
Barium

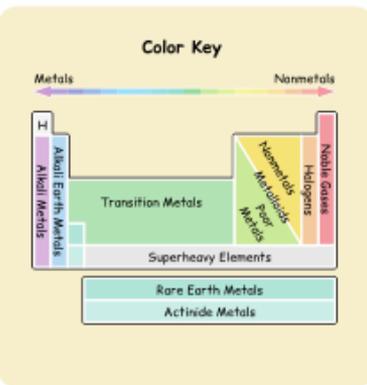
X-Ray Diagnosis

Ra 88 88
Radium

Luminous Watches



- Solid
- Liquid
- Gas at room temperature
- Human Body: top ten elements by weight
- Earth's Crust: top eight elements by weight
- Magnetic: ferromagnetic at room temperature
- Noble Metals: corrosion-resistant
- Radioactive: all isotopes are radioactive
- Only Traces Found in Nature: less than a millionth percent of earth's crust
- Never Found in Nature: only made by people



Noble Gases
18

He 2 2
Helium

Balloons

Ne 10 10
Neon

Advertising Signs

Ar 18 18
Argon

Light Bulbs

Kr 36 36
Krypton

Flashlights

Xe 54 54
Xenon

High-Intensity Lamps

Rn 86 86
Radon

Surgical Implants

Og 118 118
Oganesson


Boron Group 13 Carbon Group 14 Nitrogen Group 15 Oxygen Group 16 Halogens 17

B 5 5
Boron

Sports Equipment

C 6 6
Carbon

Basis of Life's Molecules

N 7 7
Nitrogen

Protein

O 8 8
Oxygen

Air

F 9 9
Fluorine

Toothpaste

Al 13 13
Aluminum

Airplanes

Si 14 14
Silicon

Stone, Sand, and Soil

P 15 15
Phosphorus

Bones

S 16 16
Sulfur

Eggs

Cl 17 17
Chlorine

Swimming Pools

Ga 31 31
Gallium

Light-Emitting Diodes (LEDs)

Ge 32 32
Germanium

Semiconductor Electronics

As 33 33
Arsenic

Poison

Se 34 34
Selenium

Copiers

Br 35 35
Bromine

Photography Film

In 49 49
Indium

Liquid Crystal Displays (LCDs)

Sn 50 50
Tin

Plated Food Cans

Sb 51 51
Antimony

Car Batteries

Te 52 52
Tellurium

Thermoelectric Coolers

I 53 53
Iodine

Disinfectant

Tl 81 81
Thallium

Low-Temperature Thermometers

Pb 82 82
Lead

Weights

Bi 83 83
Bismuth

Fire Sprinklers

Po 84 84
Polonium

Anti-Static Brushes

At 85 85
Astatine

Radioactive Medicine

Superheavy Elements
radioactive, never found in nature, no uses except atomic research

Rare Earth Metals

Actinide Metals

La 57 57
Lanthanum

Telescope Lenses

Ce 58 58
Cerium

Lighter Flints

Pr 59 59
Praseodymium

Torchworkers' Eyeglasses

Nd 60 60
Neodymium

Electric Motor Magnets

Pm 61 61
Promethium

Luminous Dials

Sm 62 62
Samarium

Electric Motor Magnets

Eu 63 63
Europium

Color Televisions

Gd 64 64
Gadolinium

MRI Diagnosis

Tb 65 65
Terbium

Fluorescent Lamps

Dy 66 66
Dysprosium

Smart Material Actuators

Ho 67 67
Holmium

Laser Surgery

Er 68 68
Erbium

Optical Fiber Communications

Tm 69 69
Thulium

Laser Surgery

Yb 70 70
Ytterbium

Scientific Fiber Lasers

Lu 71 71
Lutetium

Photodynamic Medicine

Ac 89 89
Actinium

Radioactive Medicine

Th 90 90
Thorium

Gas Lamp Mantles

Pa 91 91
Protactinium

Radioactive Waste

U 92 92
Uranium

Nuclear Power

Np 93 93
Neptunium

Radioactive Waste

Pu 94 94
Plutonium

Nuclear Weapons

Am 95 95
Americium

Smoke Detectors

Cm 96 96
Curium

Mineral Analyzers

Bk 97 97
Berkelium

Radioactive Waste

Cf 98 98
Californium

Mineral Analyzers

Es 99 99
Einsteinium


Fm 100 100
Fermium


Md 101 101
Mendelevium


No 102 102
Nobelium


Lr 103 103
Lawrencium


Determine the characteristics of the element

Valence Electrons

electrons involved in reactions
Noble Gases

outermost electrons

stability = complete set of valence electrons
octet rule → want 8 e⁻s in outer orbital

First shell	Hydrogen ₁ H							Helium ₂ He	
		<p>Atomic number: 2 Element symbol: He Atomic mass: 4.003 Electron distribution diagram</p>							
Second shell	Lithium ₃ Li	Beryllium ₄ Be	Boron ₅ B	Carbon ₆ C	Nitrogen ₇ N	Oxygen ₈ O	Fluorine ₉ F	Neon ₁₀ Ne	
	Third shell	Sodium ₁₁ Na	Magnesium ₁₂ Mg	Aluminum ₁₃ Al	Silicon ₁₄ Si	Phosphorus ₁₅ P	Sulfur ₁₆ S	Chlorine ₁₇ Cl	Argon ₁₈ Ar

III. Chemical Bonds

Strongest Bonds:

1. Covalent: sharing of e^- between atoms that differ in **electronegativity**

- Polar: covalent bond

- Nonpolar: e^- shared equally;

- Eg. O_2 or H_2



unequal sharing

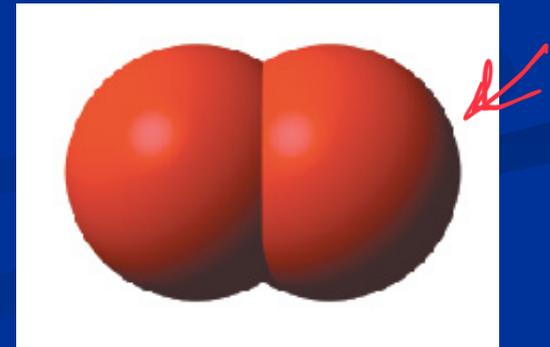
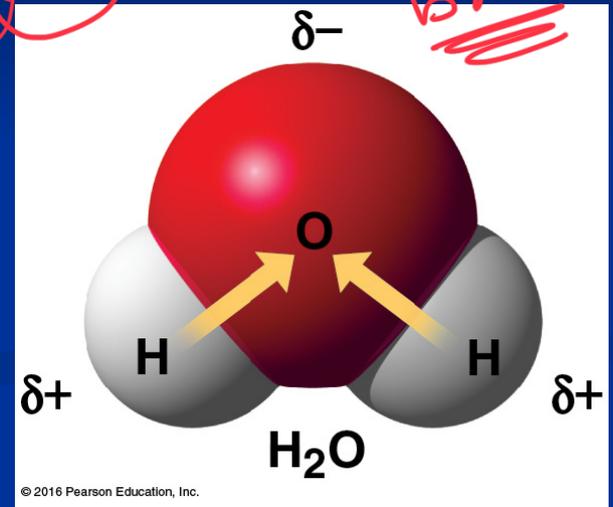
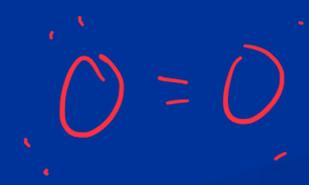
between atoms that differ in **electronegativity**

- Eg. H_2O

- Nonpolar: e^- shared equally;

- Eg. O_2 or H_2

equal sharing



Name and Molecular Formula	Electron Distribution Diagram	Structural Formula	Space-Filling Model
(a) Hydrogen (H ₂)	<p><i>bond</i></p>	H—H	
(b) Oxygen (O ₂)	<p><i>2 bonds</i></p>	O=O	
(c) Water (H ₂ O)		$\begin{array}{c} \text{O—H} \\ \\ \text{H} \end{array}$	
(d) Methane (CH ₄)		$\begin{array}{c} \text{H} \\ \\ \text{H—C—H} \\ \\ \text{H} \end{array}$	

Noncovalent bonds

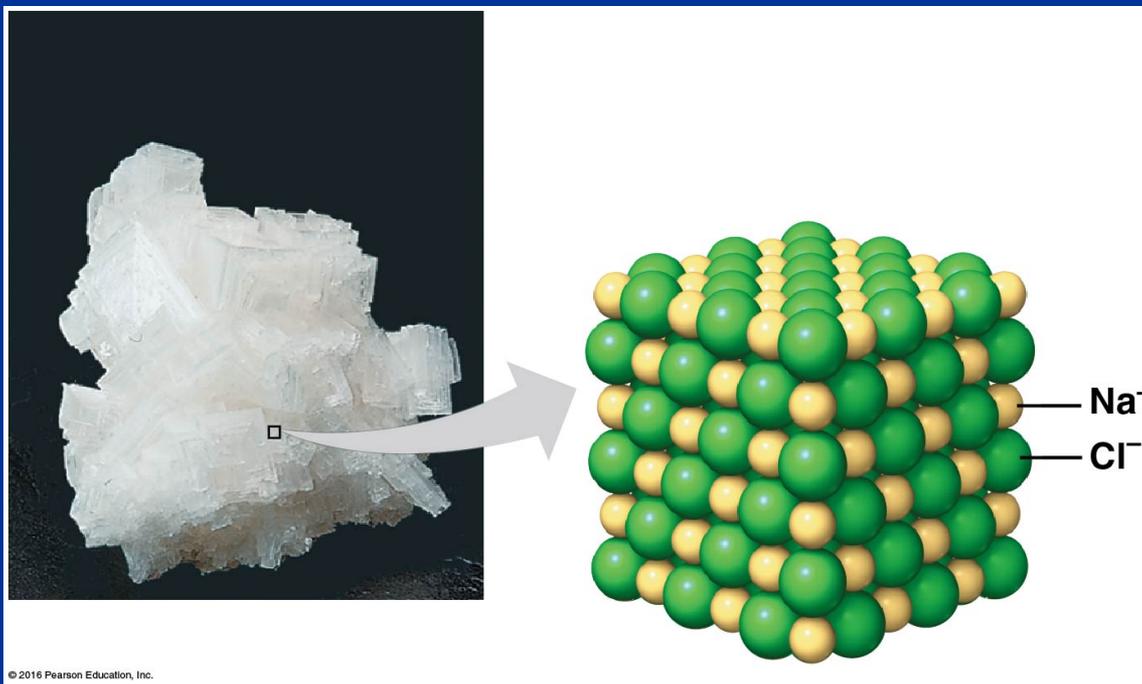
III. Chemical Bonds

Strongest Bonds:

2. Ionic: 2 ions (+/-) bond (givers/takers)

- Na^+Cl^-
- Affected by environment (eg. water)

*not sharing electrons
taking \ominus e⁻ surplus
 \oplus e⁻ deficit*

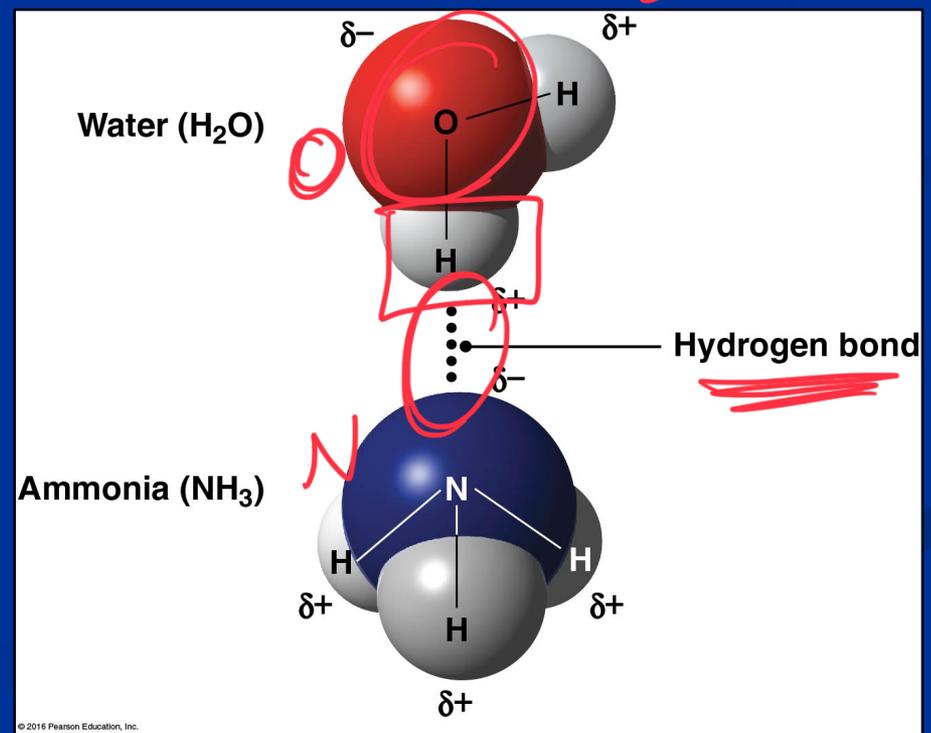
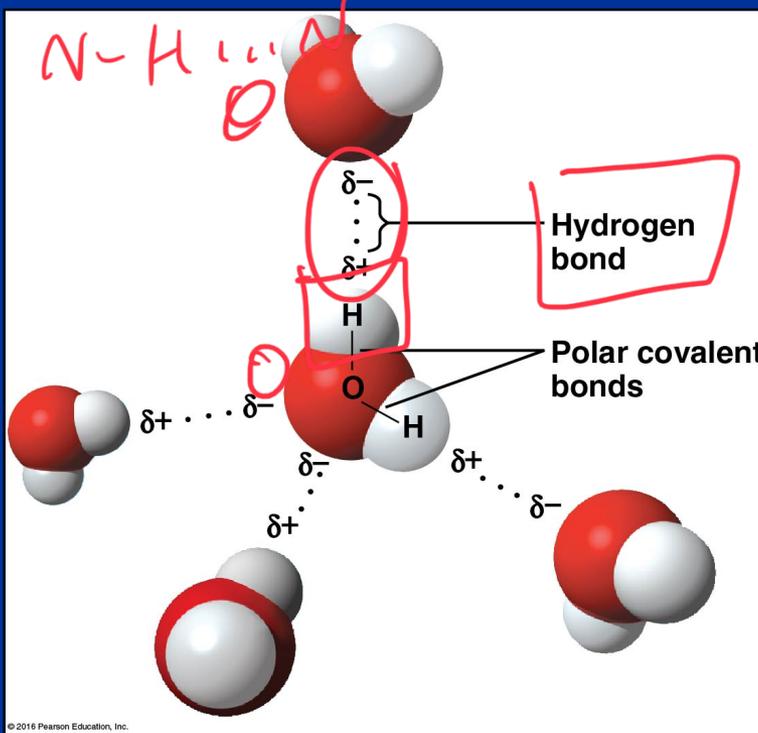


Noncovalent
Weaker Bonds:

hydrogen bonds are formed by water molecules - necessary for life.

3. Hydrogen: H of polar covalent molecule bonds to electronegative atom of other polar covalent molecules

when Hydrogen is shared between oxygen/nitrogen



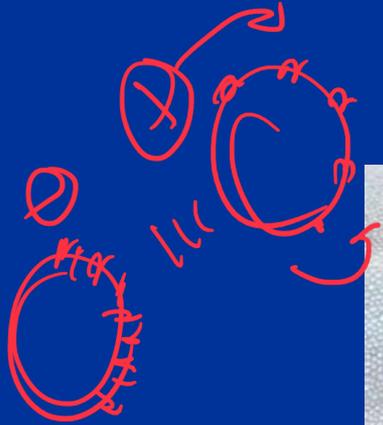
Weaker Bonds:

Noncovalent bond

4. Van der Waals Interactions: slight, fleeting attractions between atoms and molecules close together

- Weakest bond
- Eg. gecko toe hairs + wall surface

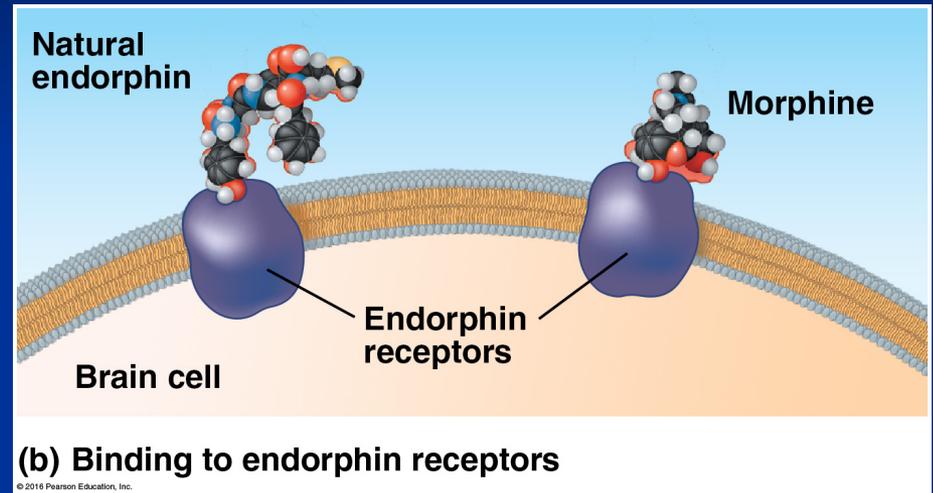
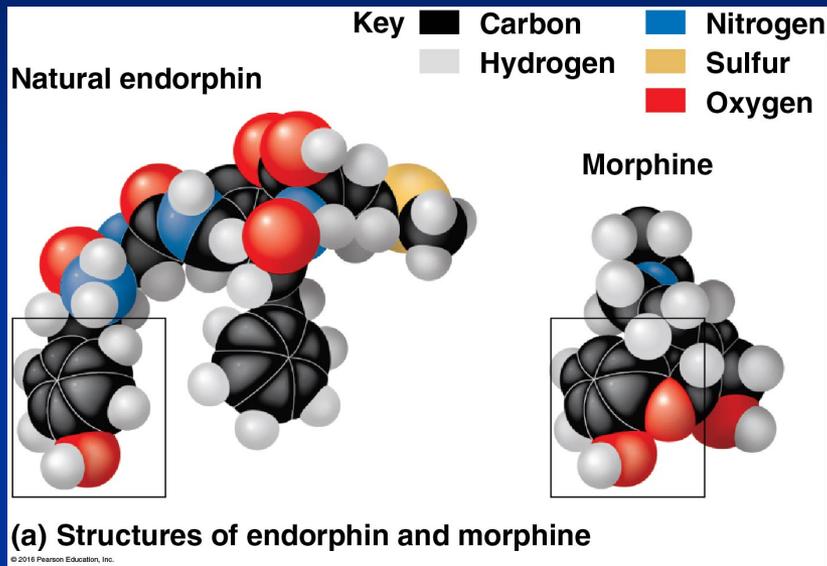
contact and surface



Bonds

Covalent	Ionic	Hydrogen
All important to life		
Form cell's molecules	Quick reactions/ responses	H bonds to other electronegative atoms
Strong bond	Weaker bond (esp. in H ₂ O)	Even weaker
Made and broken by chemical reactions		

A molecule's **STRUCTURE (SHAPE)** affects a molecule's **FUNCTION**



- **Similar shapes = mimic**
 - morphine, heroin, opiates mimic endorphin (euphoria, relieve pain)

Chemical Reactions

- **Reactants** → **Products**



- Some reactions are reversible:



- **Chemical equilibrium**: point at which forward and reverse reactions offset one another exactly

- Reactions still occurring, but **no net change** in concentrations of reactants/products