

CHEMISTRY

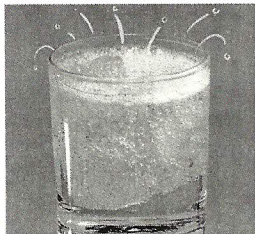
UNIT 2

"ATOMS"

Review Cards

Matter

- Anything that has mass and takes up space.
- All matter is made up of tiny particles called atoms.



States of Matter

- **Solid** - molecules are locked into rigid positions and are close together. Fixed volume and shape
- **Liquid** - molecules are still close together but can move around to some extent. Fixed volume only.
- **Gas** - molecules are far apart and move randomly. Neither fixed volume nor fixed shape

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Physical Properties

- In a physical property there is no change in chemical composition
- For example the melting point or boiling point of water involves no chemical change
 - The H₂O molecule is still H₂O - what is different is the position of the molecules to one another

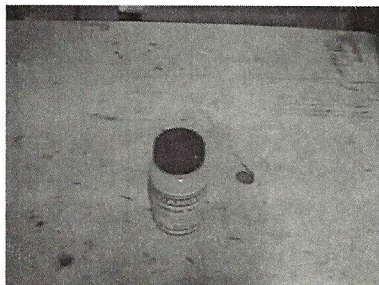


Some Physical Properties

Color	Malleability
Density	Ductility
Magnetism	Boiling Point
Luster	Melting Point

Chemical Properties

- Observed when matter undergoes a chemical change
- Sodium metal in water causes an explosion
($2\text{Na} + 2\text{H}_2\text{O} \rightarrow \text{H}_2 + 2\text{NaOH} + \text{energy}$)



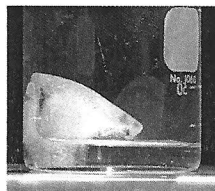
Chemical or Physical Property?

- Water boils at 100°C.
 - Physical Property
- Diamonds are capable of cutting glass.
 - Physical Property
- Water can be separated by electrolysis into hydrogen and oxygen.
 - Chemical Property
- Sugar is capable of dissolving in water.
 - Physical Property
- Vinegar will react with baking soda.
 - Chemical Property
- Yeast acts on sugar to form carbon dioxide and ethanol.
 - Chemical Property
- Aluminum has a low density.
 - Physical Property

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Chemical vs. Physical Changes.

- In a **chemical change**, the substances are altered chemically and display different physical and chemical properties after the change.



In a **physical change**, the substances are not altered chemically, but merely changed to another phase (i.e. gas, liquid, solid) or separated or combined.

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Chemical or Physical Change?

- Dry ice, solid carbon dioxide, is sublimated at 25°C
 - Physical Change
- Salt is dissolved in water.
 - Physical Change
- Iron rusts in a damp environment.
 - Chemical Change
- Gasoline burns in the presence of oxygen.
 - Chemical Change
- Hydrogen peroxide decomposes to water and oxygen
 - Chemical Change

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What are Elements?

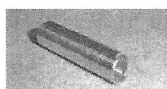
Elements - Substances that contain only one type of atom.

For example

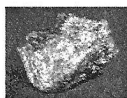
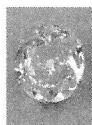
- pure aluminum contains only aluminum atoms
- elemental copper contains only copper atoms



Pure aluminum



elemental copper



Graphite and diamond are both elemental carbon

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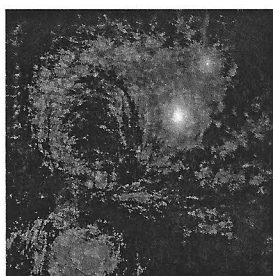
Elements

- They are 117 known elements.
- 92 occur naturally on earth.
- The 25 elements not found on earth are derived artificially
- All artificially derived elements are radioactive with short half-lives.
- Many element names and symbols have Greek and Latin roots.
- Many of the more recently discovered elements are named after countries or famous scientists or haven't been named yet!

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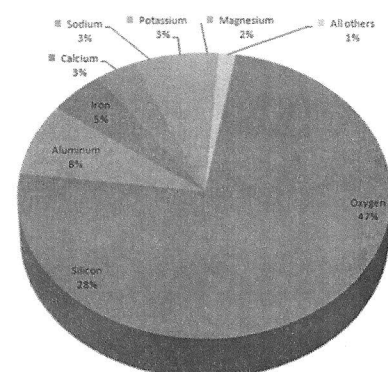
Top 10 Elements in the Universe

Element	Percent (by atoms)
1. Hydrogen	73.9
2. Helium	24.0
3. Oxygen	1.1
4. Carbon	0.46
5. Neon	0.13
6. Iron	0.11
7. Nitrogen	0.097
8. Silicon	0.065
9. Magnesium	0.058
10. Sulfur	0.044



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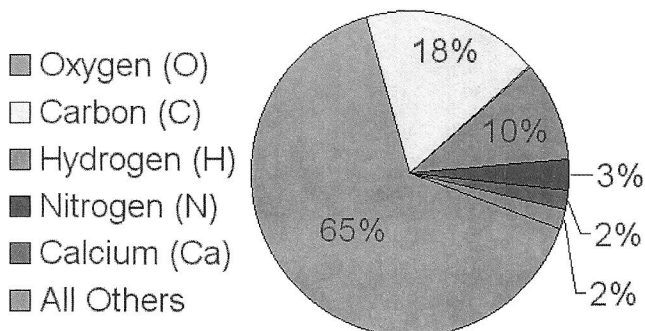
The most common elements in Earth's crust (by mass):



Abundance of Elements in the Earth's Crust

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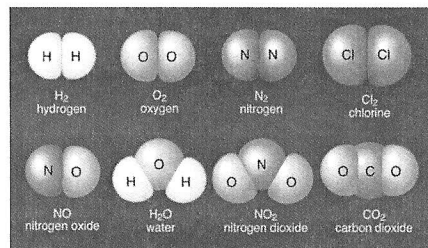
Elements in the Human Body (by mass)



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What are Compounds?

Compound - substances made by bonding atoms together in specific ways. These substances contain two or more different types of atoms



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Common Compounds

Atom Combinations	Name	Characteristics
	carbon monoxide	Carbon monoxide is a poisonous gas.
	carbon dioxide	You breathe out carbon dioxide as a waste material and plants use carbon dioxide to make oxygen.
	water	Water is the most important liquid on Earth.
	hydrogen peroxide	Hydrogen peroxide is used to disinfect cuts and bleach hair.

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Homogeneous

- The same throughout
- Salt dissolved in water and stirred well.
- All regions of the mixture have the same properties and same concentration of salt and water.

Heterogeneous

- Contains regions that have different properties from those of other regions.
- Sand poured into water results in mixture that has one region containing water and another, very different region containing mostly sand.

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Heterogeneous or Homogeneous?

- Farm fresh milk
- *Heterogeneous*
- Homogenized milk
- *Homogeneous*
- Gasoline
- *Homogeneous*
- The ocean
- *Heterogeneous*
- Oil and vinegar salad dressing
- *Heterogeneous*
- Maple syrup.
- *Homogeneous*



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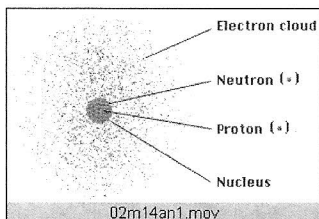
What is an Atom?

- The smallest particle of an element that has characteristics of that element.
- Atoms are very tiny particles that form the building blocks for all matter.
- Each element is made up of only one kind of atom.

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Atom Composition

The atom is mostly empty space



Protons and neutrons are located in the nucleus.

Electrons exist in the space around the nucleus.

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Subatomic Particles

Subatomic particle	Location	Symbol	Charge
Proton	nucleus	P ⁺	+
Neutron	nucleus	n ⁰	No charge
Electron	electron cloud	e ⁻	-

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Periodic Table Information

Atomic Mass — 14

Atomic Number — 6



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Alkaline earth metals																	Noble gases
1 1A	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg	Transition metals										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La*	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac†	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub						

*Lanthanides

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
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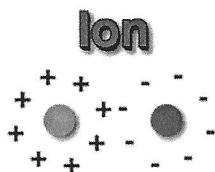
†Actinides

90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr
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Ions

- Ions are atoms or molecules or that carry an electrical charge -- either negative or positive -- because they have lost or gained electrons.



- A charged entity.

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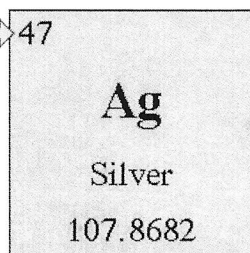
Atomic Number

- Tells us the number of protons in the nucleus of an atom.
- All atoms of an element have the same number of protons and therefore the same atomic number.

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Atomic Number \Rightarrow 47

- The atomic number is equal to the number of protons in an atom's nucleus.



Any atom that contains exactly 47 protons in its nucleus is an atom of silver.

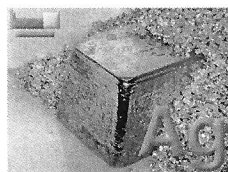
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Mass Number

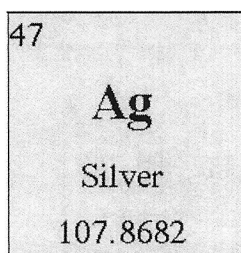


- The total number of protons and neutrons in the nucleus of an atom.
- **Mass Number = number of protons + number of neutrons**

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Atomic Mass \Rightarrow



- The atomic mass of silver is 107.8682 amu
- This is the weighted average of all naturally occurring isotopes of silver.

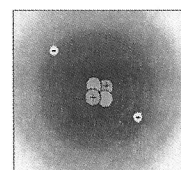
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Finding the Number of Subatomic Particles in an Atom

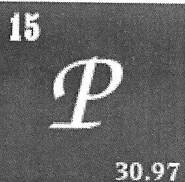
Protons = Atomic Number

Electrons = Atomic Number for a neutral atom

Neutrons = Mass number - Atomic Number



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Sample 1

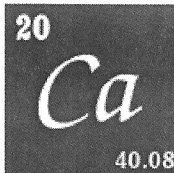


How many protons are there in the nucleus of a phosphorus atom? 15

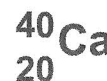
How many electrons does a neutral atom of phosphorus have? 15

How many neutrons are there in the nucleus of a phosphorus atom? 16

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Sample 2



How many protons are there in the nucleus of a calcium atom? 20

How many electrons does a neutral atom of calcium have? 20

How many neutrons are there in the nucleus of a calcium atom? 20

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Isotopes

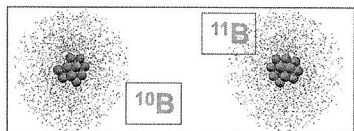
Two or more forms of atoms of the same element with different masses.

Isotopes contain the same number of protons but different numbers of neutrons.

Example

Boron-10 has 5 protons and 5 neutrons

Boron-11 has 5 protons and 6 neutrons

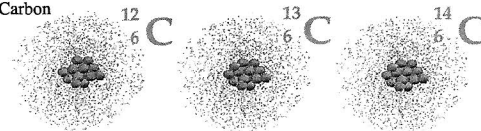


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Finding the number of Neutrons

$$\# \text{ Neutrons} = \text{Mass Number} - \# \text{ Protons}$$

Isotopes of Carbon



6 protons

$$12 - 6 = 6$$

6 neutrons

6 protons

$$13 - 6 = 7$$

7 neutron

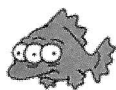
6 protons

$$14 - 6 = 8$$

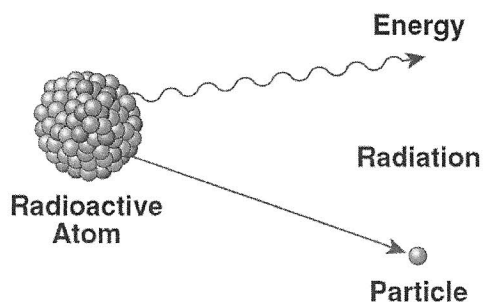
8 neutrons

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Radioactivity



When the nuclei of unstable isotopes breaks down and gives off radiation



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Mass of Subatomic Particles

Subatomic Particle	Mass (g)	Mass (amu)
Proton	1.673×10^{-24}	1
Neutron	1.675×10^{-24}	1
Electron	9.109×10^{-28}	0

An electron is 0.0001 times the mass of a proton. It is generally considered to have no mass.

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Atomic Mass

- The mass of an element depends on both the mass and the relative abundance of each element's isotopes.
- The average atomic mass of an element is found by multiplying the atomic mass of each isotope by its relative abundance (expressed in decimal form) and adding the results.
- This is why the atomic mass found on the periodic table is often not a whole number.

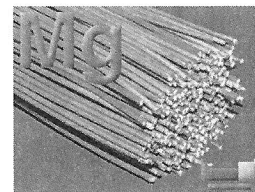
Average Atomic Mass = (relative abundance)(isotope mass) + (relative abundance)(isotope mass) + (relative abundance)(isotope mass) +

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Sample 1

What is the average atomic Mass of Mg?

Mg-24	78.99%
Mg-25	10.00%
Mg-26	11.01%



Average Atomic Mass =

$$(0.7899 \times 24) + (0.1000 \times 25) + (0.1101 \times 26)$$

$$= 24.32 \text{ amu}$$

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