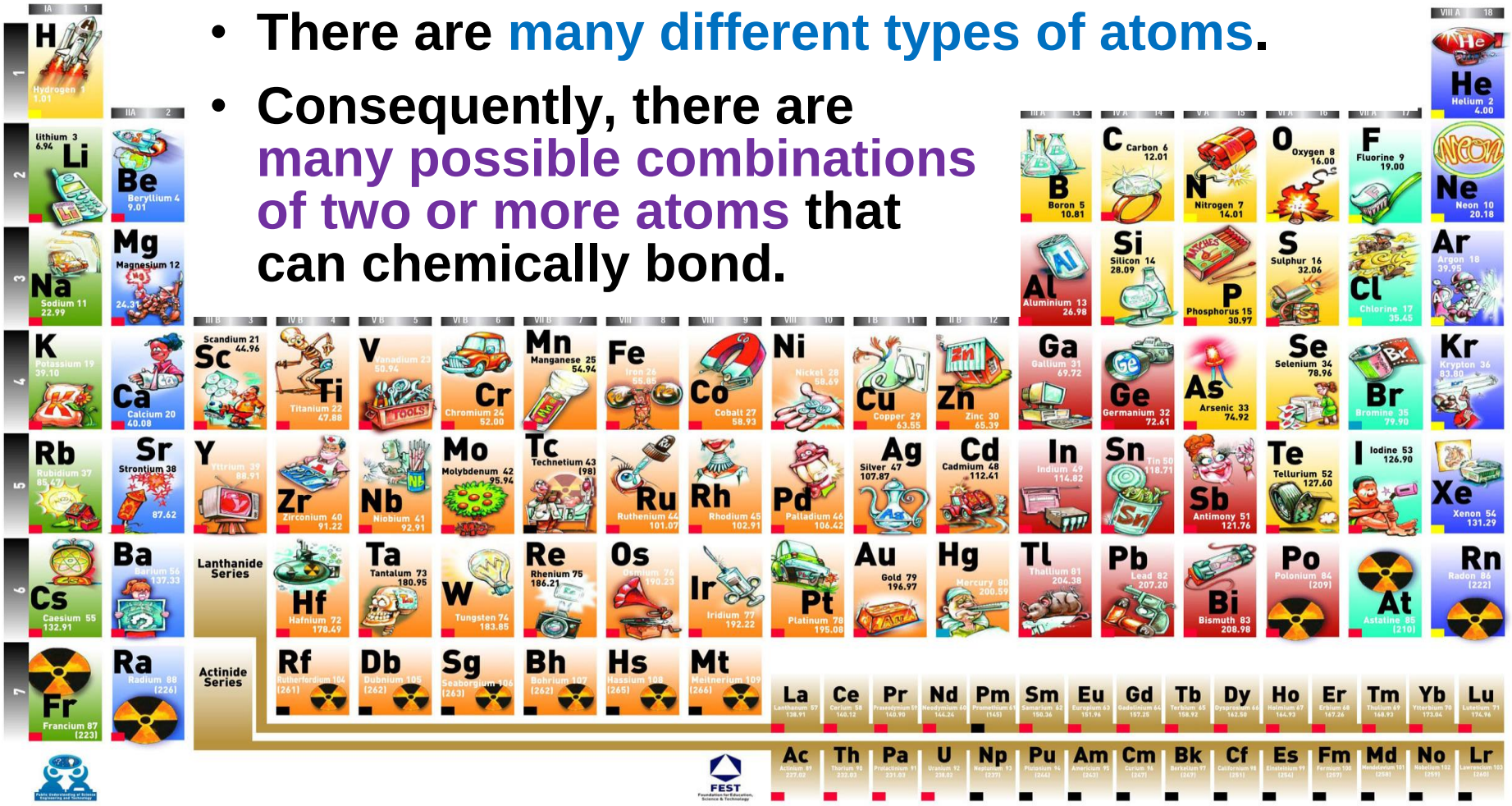
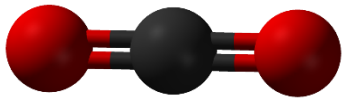
Matter in Chemistry

<u>Ordinary matter</u> is composed of <u>atoms</u> and groups of atoms *bonded* together, called <u>molecules</u>.

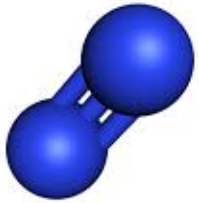
- **There are many different types of atoms.**
- **Consequently, there are many possible combinations of two or more atoms that can chemically bond.**

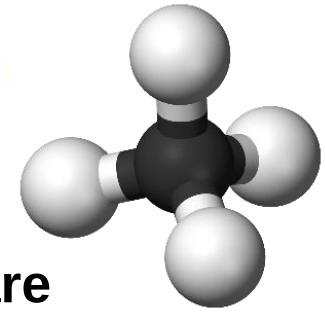


Molecule

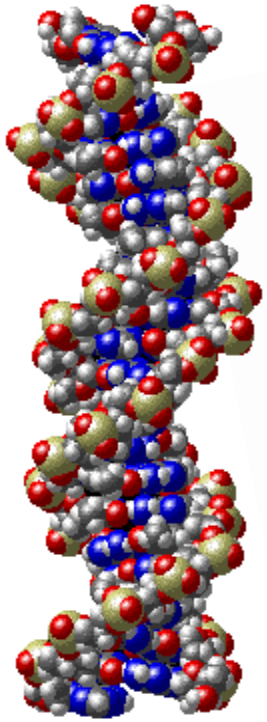


Molecules are neutral groups of two or more atoms held together by chemical bonds.

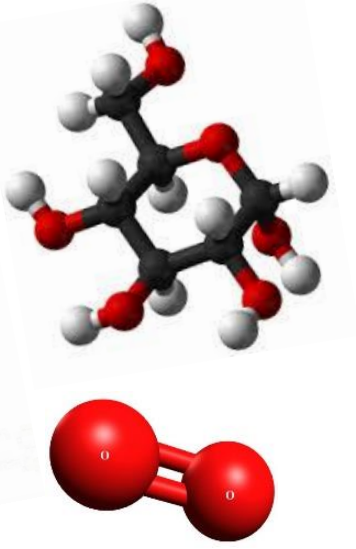




- **Molecules can be thought of as the smallest identifiable physical unit of a chemical substance.**

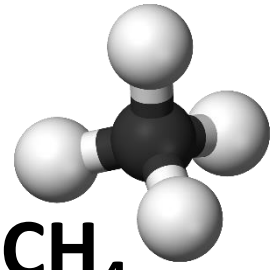


- **Molecules as components of matter are common in organic substances. They also make up most of the oceans and atmosphere.**

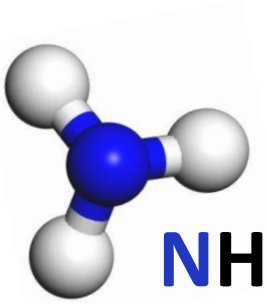


- **However, the majority of familiar solid substances on Earth, including most of the minerals that make up the crust, mantle, and core of the Earth, contain many chemical bonds, but are not made of identifiable molecules.**

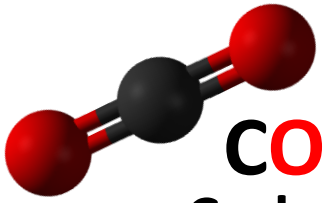
Simple inorganic molecules



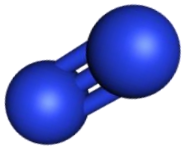
CH_4
Methane



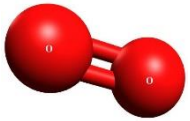
NH_3
Ammonia



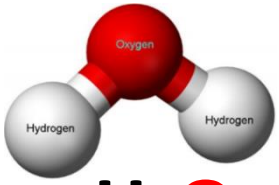
CO_2
Carbon Dioxide



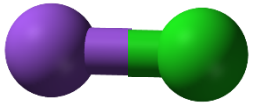
N_2, Nitrogen



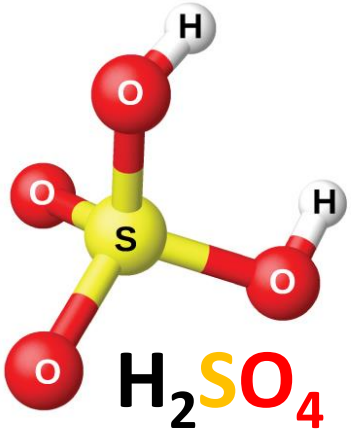
O_2, Oxygen



H_2O
Water



NaCl
Table Salt



H_2SO_4
Sulfuric Acid

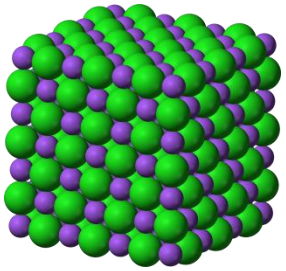
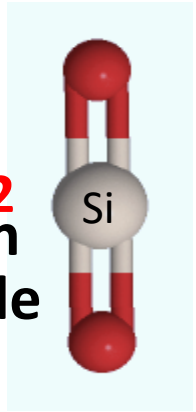


Table Salt crystal

SiO_2
Silicon Dioxide



Quartz (sand) crystal

Chemical Substance

A chemical *substance* is a form of matter that has a definite chemical composition throughout and distinct characteristic properties.

glass

gold ingots

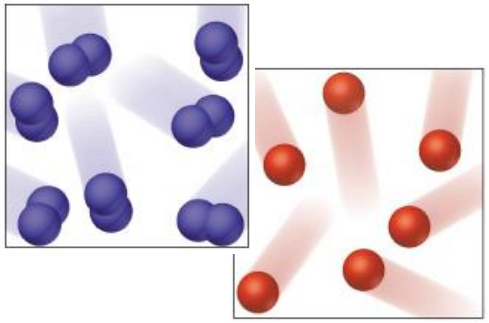
honey

liquid nitrogen

All ordinary matter can be classified *chemically* as either a *pure substance* or a *mixture*.

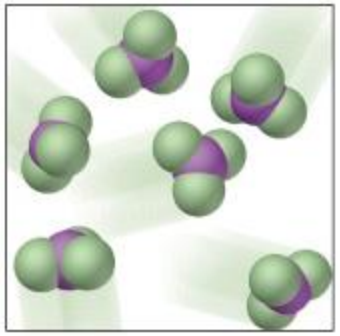
Classification of Substances

- **Elements: substances that are made from one type of atom only.**

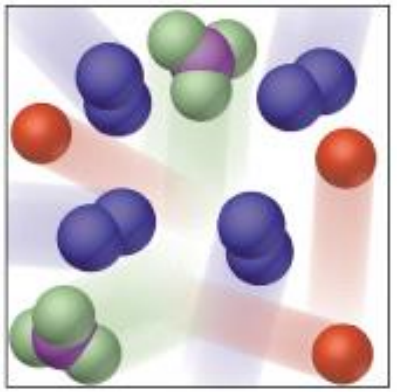


How many types are there?

- **Compounds: substances that are made from more than one type of atom chemically bonded together.**



- **Mixtures: substances that are made from more than one type of atom combined physically, but not chemically bonded.**



Periodic Table of Elements

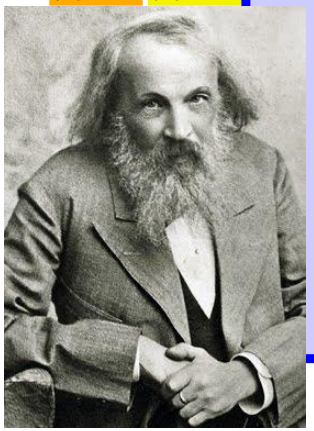
today, there are 118 known elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H Hydrogen 1.00794																	2 He Helium 4.002602
2 Li Lithium 6.941	4 Be Beryllium 9.012182											5 B Boron 10.811	6 C Carbon 12.0107	7 N Nitrogen 14.0067	8 O Oxygen 15.9994	9 F Fluorine 18.9984032	10 Ne Neon 20.1797
3 Na Sodium 22.98976928	12 Mg Magnesium 24.3050											13 Al Aluminium 26.9815386	14 Si Silicon 28.0855	15 P Phosphorus 30.973762	16 S Sulfur 32.065	17 Cl Chlorine 35.453	18 Ar Argon 39.948
4 K Potassium 39.0983	20 Ca Calcium 40.078	21 Sc Scandium 44.955912	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938045	26 Fe Iron 55.845	27 Co Cobalt 58.933195	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.64	33 As Arsenic 74.92160	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.798
5 Rb Rubidium 85.4678	38 Sr Strontium 87.62	39 Y Yttrium 88.90585	40 Zr Zirconium 91.224	41 Nb Niobium 92.90638	42 Mo Molybdenum 95.96	43 Tc Technetium (97.9072)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90550	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.411	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90447	54 Xe Xenon 131.293
6 Cs Caesium 132.9054519	56 Ba Barium 137.327	57–71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.94788	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.084	79 Au Gold 196.966569	80 Hg Mercury 200.59	81 Tl Thallium 204.3833	82 Pb Lead 207.2	83 Bi Bismuth 208.98040	84 Po Polonium (208.9824)	85 At Astatine (209.9871)	86 Rn Radon (222.0176)
7 Fr Francium (223)	88 Ra Radium (226)	89–103	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (277)	109 Mt Meitnerium (268)	110 Ds Darmstadtium (271)	111 Rg Roentgenium (272)	112 Uub Ununbium (285)	113 Uut Ununtrium (284)	114 Uuq Ununquadium (289)	115 Uup Ununpentium (288)	116 Uuh Ununhexium (292)	117 Uus Ununseptium	118 Uuo Ununoctium (294)

C Solid
Hg Liquid
H Gas
Rf Unknown

Metals: Alkali metals; Alkaline earth metals; Lanthanoids; Actinoids; Transition metals; Poor metals
Nonmetals: Other nonmetals; Noble gases

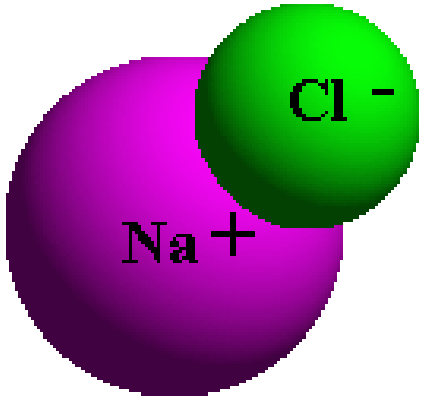
57–71	57 La Lanthanum 138.90547	58 Ce Cerium 140.116	59 Pr Praseodymium 140.90765	60 Nd Neodymium 144.242	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92535	66 Dy Dysprosium 162.500	67 Ho Holmium 164.93032	68 Er Erbium 167.259	69 Tm Thulium 168.93421	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.9668
89–103	89 Ac Actinium (227)	90 Th Thorium 232.03806	91 Pa Protactinium 231.03588	92 U Uranium 238.02891	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)



94 naturally occurring elements and 24 synthetic (man-made)

Elements and Compounds

- **Sodium** is an **element**.
- **Chlorine** is an **element**.
- When sodium and chlorine **bond** they make up the **compound sodium chloride**, commonly known as **table salt**.



Compounds have *different properties than the elements that make them up*:

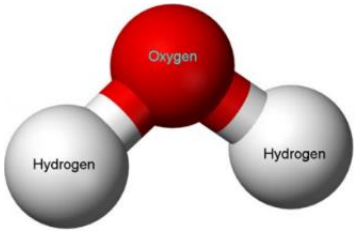
for example, table salt has different properties than **sodium**, an explosive metal, and **chlorine**, a poisonous gas.

Elements, Compounds, Mixtures

- **Hydrogen** is an **element**.
- **Oxygen** is an **element**.
- When hydrogen and oxygen **bond** they make the **compound water**.
- When **salt** and **water** are **combined**, a **mixture** is created.

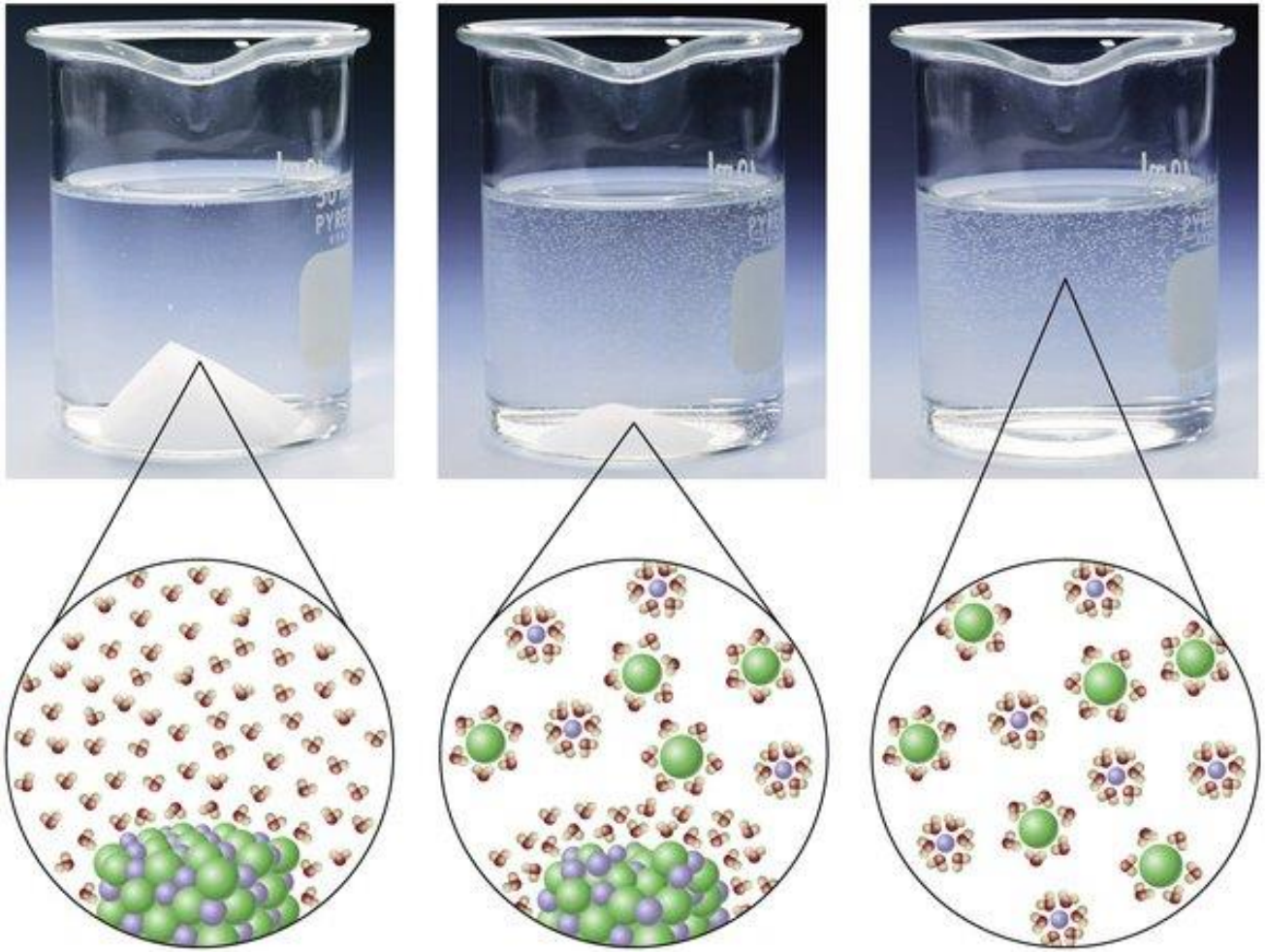
Components in mixtures *retain their individual properties*.

Water is a compound



Ocean water is a mixture

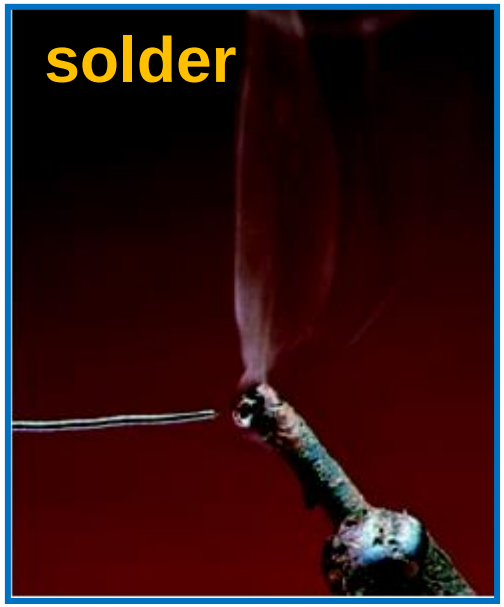
Example: Salt Dissolving in Water



a homogeneous (uniform) MIXTURE is created

Types of Mixtures

- ***Homogeneous*** **– composition of the mixture is the same throughout; only one state of matter is present.**



- ***Heterogeneous*** **– composition is not uniform throughout.**

Element, Compound, or Mixture?

Pure Water

Copper

Diamond

Jelly Beans