Chemistry 1010

Elements, Compounds, and Mixtures
How atoms are combined to make substances

Review

What information does each block of your Periodic Table contain?

atomic number, symbol, name, atomic mass

What does it mean for something to be periodic?

properties have repeating patterns

Who first organized the Periodic Table of Elements?

Dmitri Mendeleev

What happens across the rows?

atomic number and mass get larger

What are the rows called? periods

What do the columns have in common?

elements with similar properties

What are the columns called? families

What is the smallest and largest element in the 5th period? Rb, Xe

What is the smallest and largest alkali metal? Li, Fr

What is the smallest and largest halogen? F, At (Uus?)

What is the smallest and largest noble gas? He, Rn (Uuo?)

What is the smallest and largest alkaline earth metal? Be, Ra

What is the smallest and largest nonmetal? H, Rn (Uuo?)

What is the smallest and largest transition metal? Sc, Cn

What is the smallest and largest inner transition metal? Ce, Lr

What is the smallest main group metal? Li

Which would you expect to have properties similar to sulfur?

phosphorus selenium chlorine oxygen

Which would you expect to have properties similar to strontium?

calcium rubidium yttrium barium

Give the atomic numbers and masses of the following elements:

antimony – 51 121.76

tellurium – 52 127.60

iodine – 53 126.90

xenon – 54 131.29

Which is better to use to organize the Periodic Table, mass or atomic number?

atomic number

Introduction

Now that we have talked about atoms, elements, and the Periodic Table, we are ready to discuss how atoms are combined to make the actual substances that we see around us.

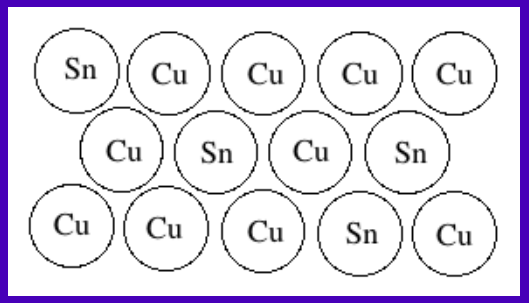
water
H_2O

oxygen
O_2

sand
SiO_2

sun tan
lotion
$C_7H_7NO_2$

Each of the following boxes represents the atoms found in one of the substances below. See if you can match them up.



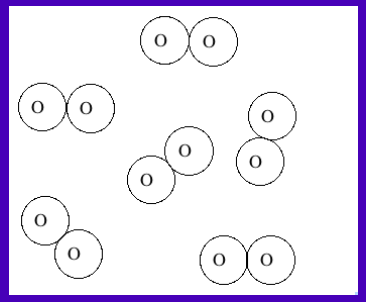
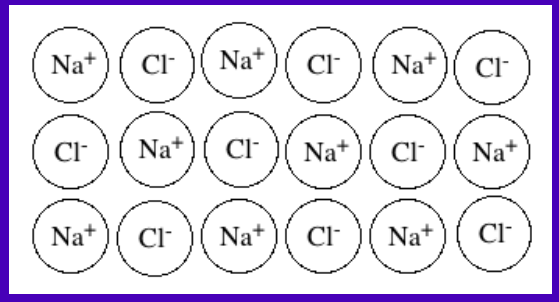
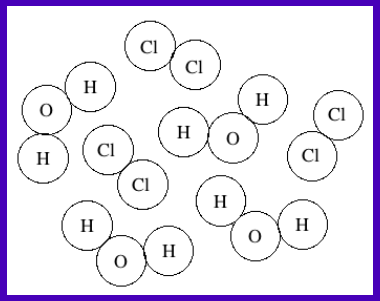


table salt

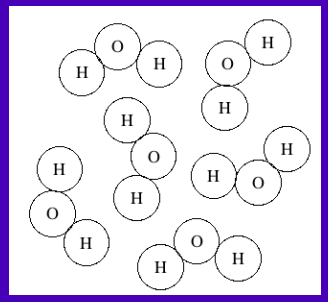
gold

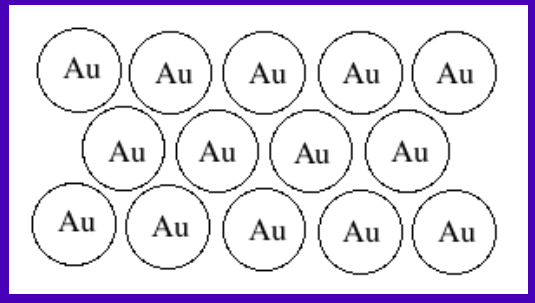




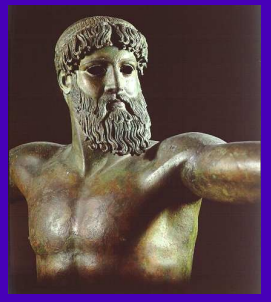
water

oxygen gas

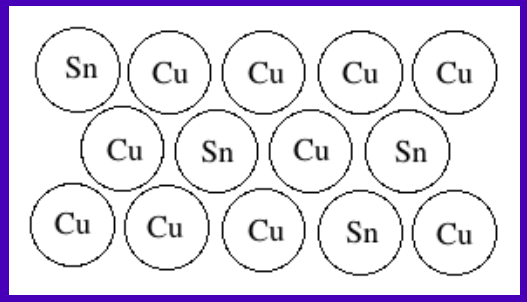


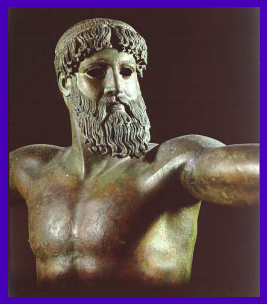


chlorinated water

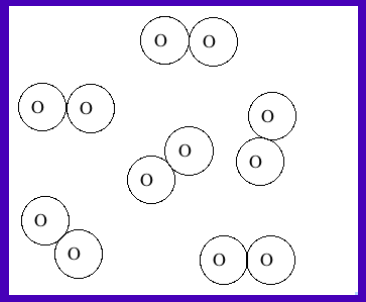


bronze





bronze



oxygen gas

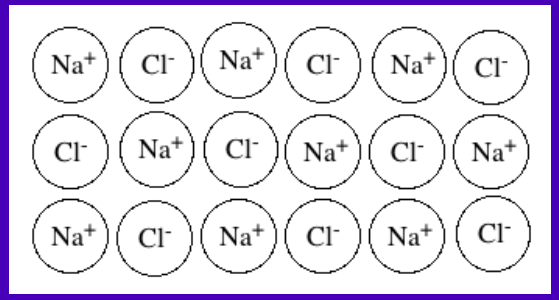
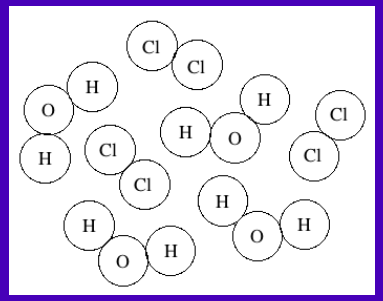
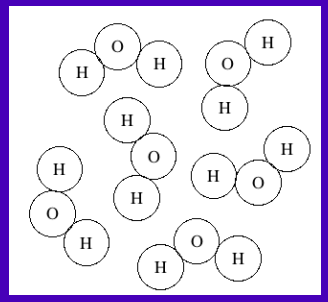


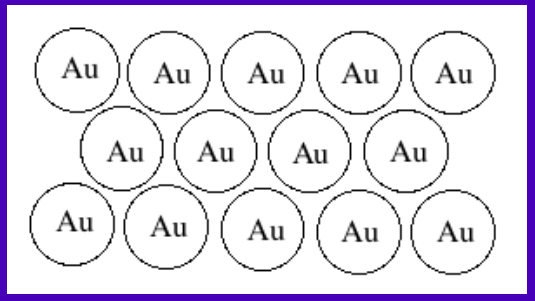
table salt



chlorinated water

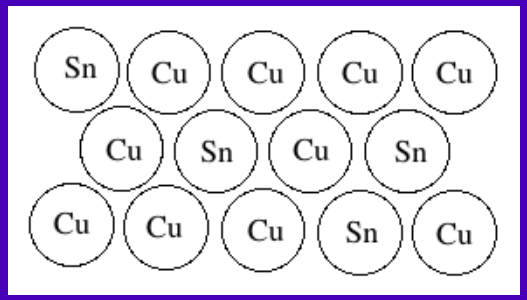


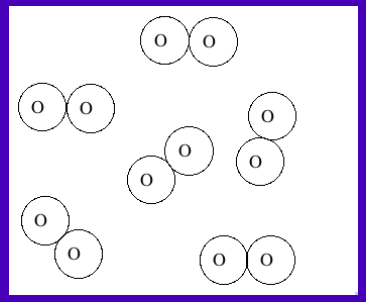
water

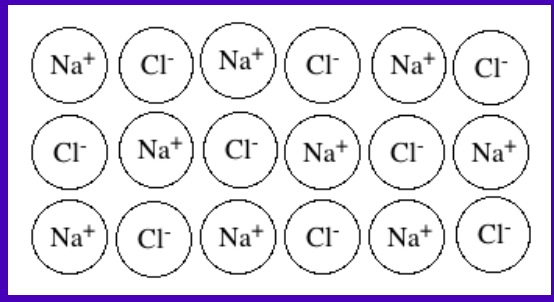


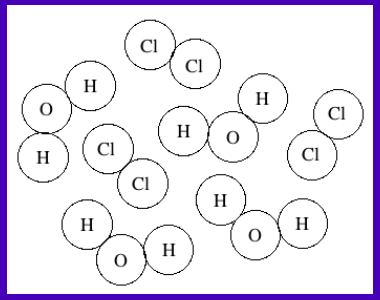
gold

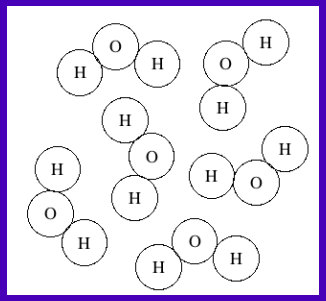
What differences and similarities can you find between the identity and arrangements of these atoms?

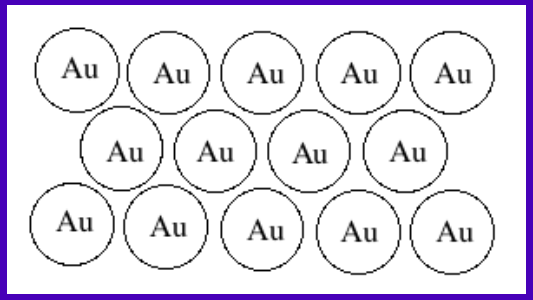












some contain only one element, others contain more than one

some atoms are connected to each other, some are not

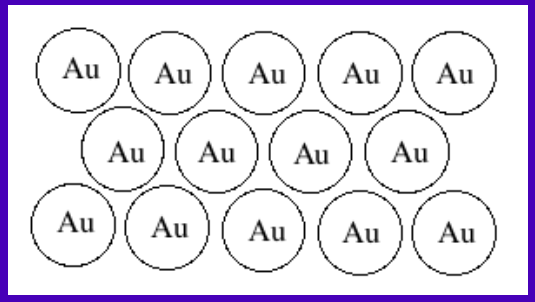
one contains ions

some have a set ratio of elements, some do not

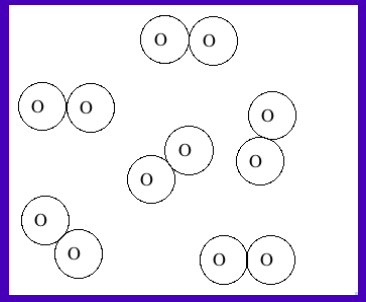
Pure elements

Which of the examples above are pure elements?

gold



oxygen gas



How could you recognize other examples of pure elements?

only one kind of atom is present

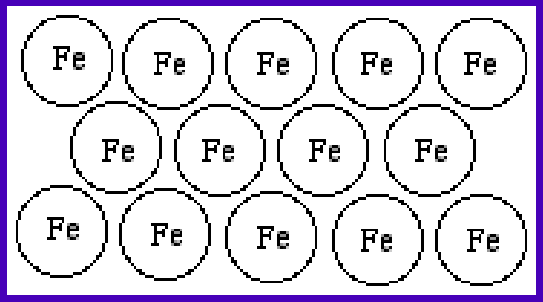
What difference do you see between these examples?

one has individual atoms, one atoms held together in molecules

What other elements would have individual atoms like gold?

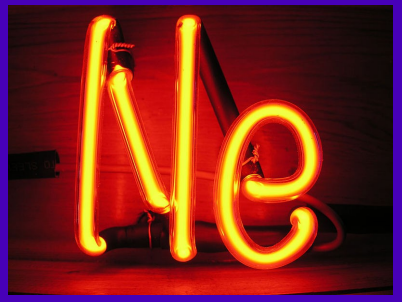
all metals have individual atoms like gold

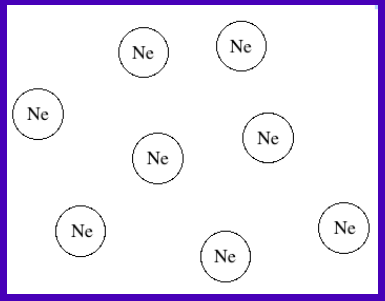
iron



all of the noble gases have individual atoms as well

neon



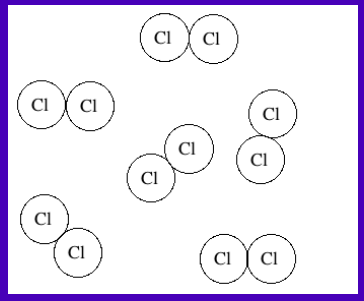


These atoms are not held together by chemical bonds.

Which elements would have molecules like oxygen?

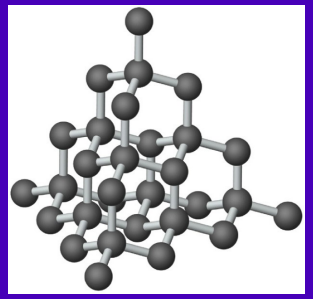
elements with diatomic molecules: hydrogen, nitrogen, oxygen, fluorine, chlorine, bromine, iodine

chlorine gas

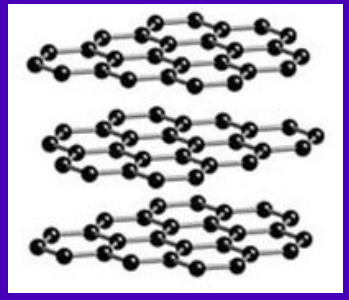


elements with more complex molecules: boron, carbon, silicon, phosphorus, sulfur, arsenic, selenium, tellurium

diamond

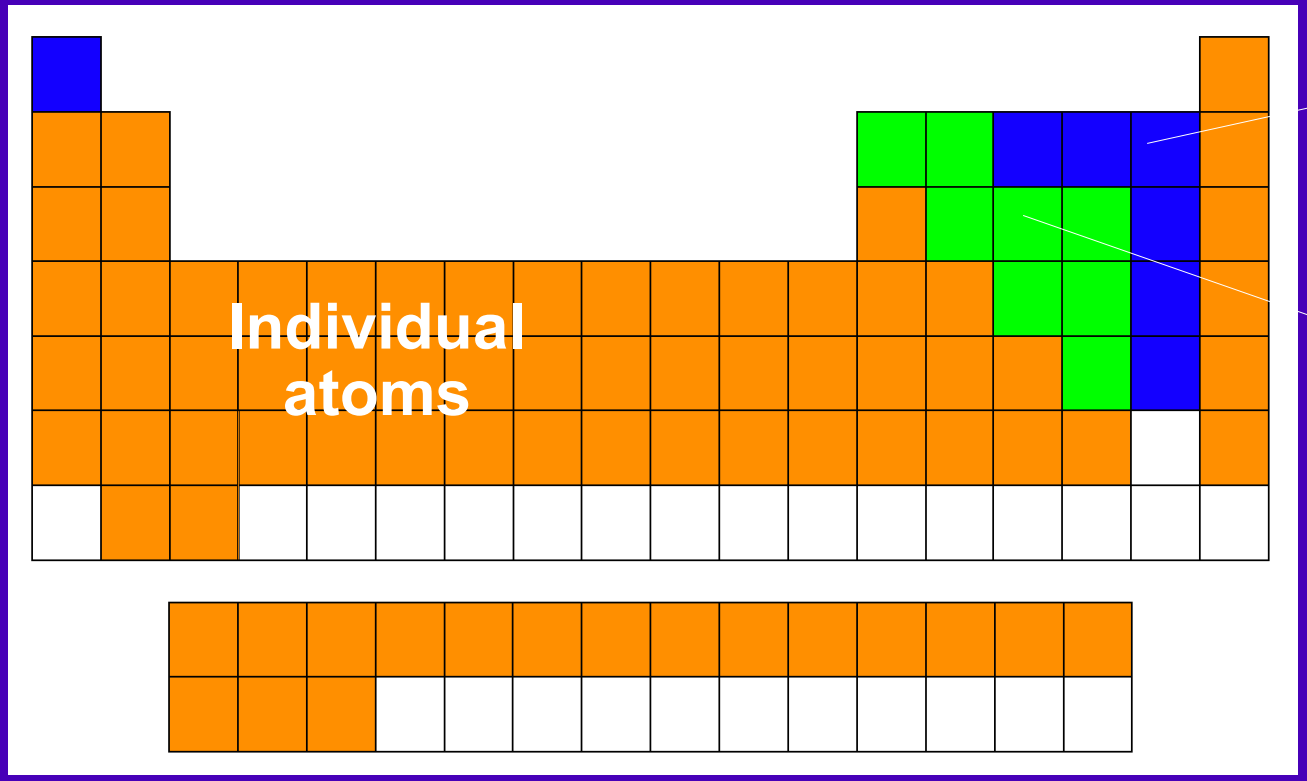


graphite



These atoms are held together by chemical bonds.

How can you find these on the Periodic Table of Elements?



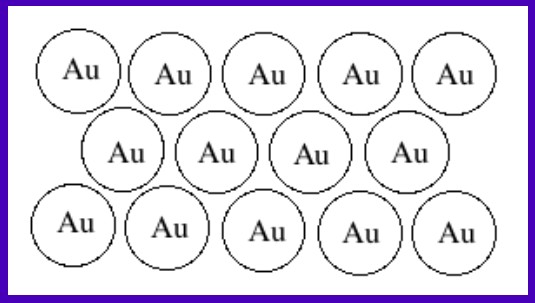
individual atoms: all metals, noble gases

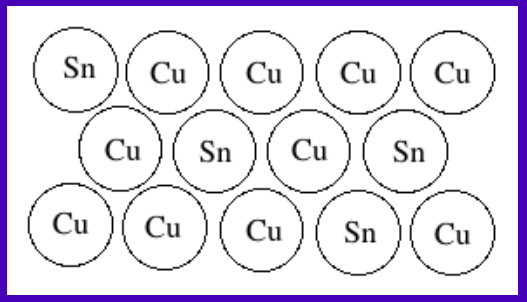
diatomic molecules: hydrogen, nitrogen, oxygen, and the halogens

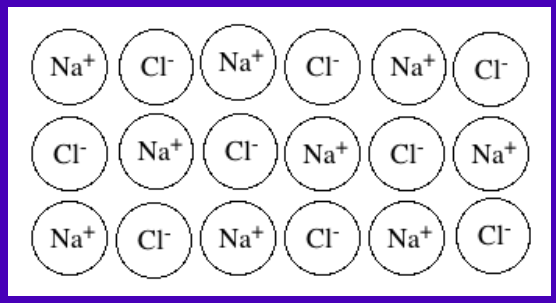
complex molecules: all other nonmetals

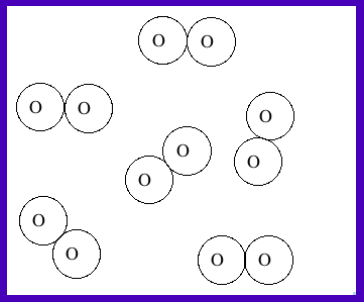
Compounds and mixtures

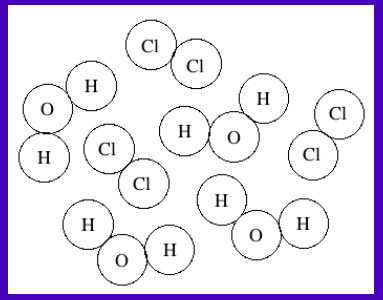
What is the difference between the examples on the left and on the right?

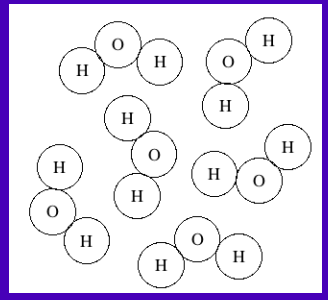








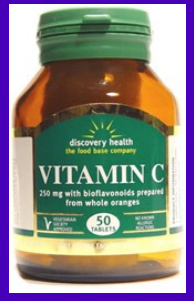




pure elements

contain more than one element

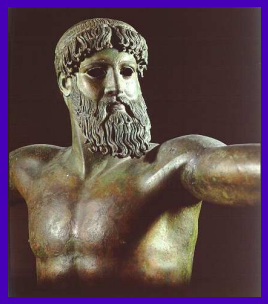
Which of these are pure elements, and which are not?



What is the difference between these examples on the left and on the right?

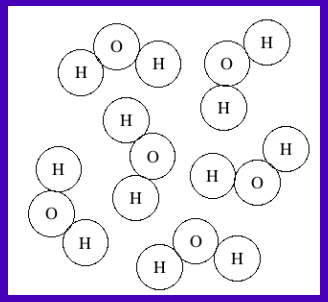
water

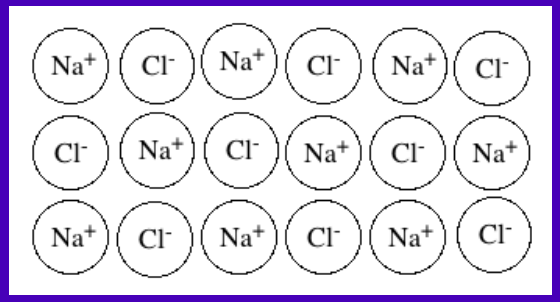
table salt



bronze

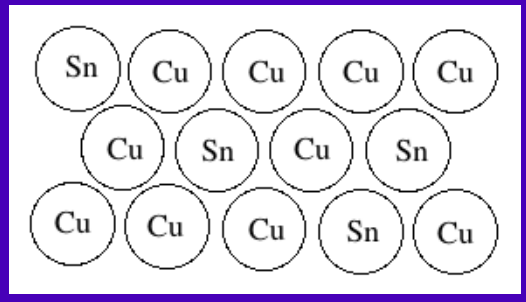
chlorinated water

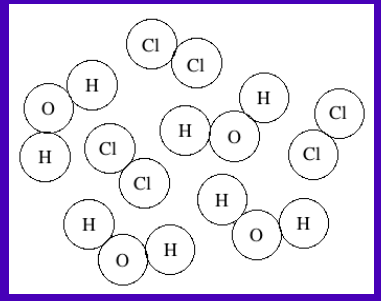




same ratio of elements

compounds



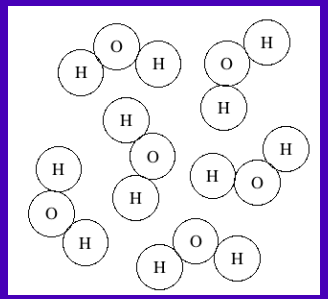


different amounts of each element

mixtures

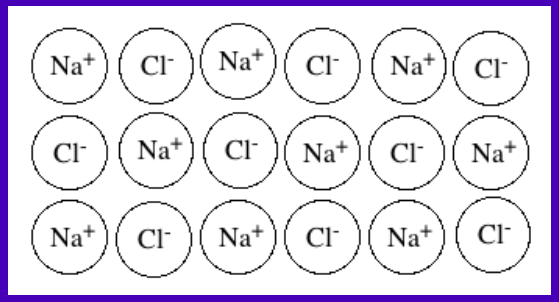
Compounds always have the same ratio of elements. We can show this using a formula.

water



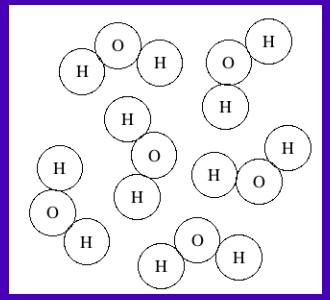
H_2O two hydrogen atoms, one oxygen atom

table salt

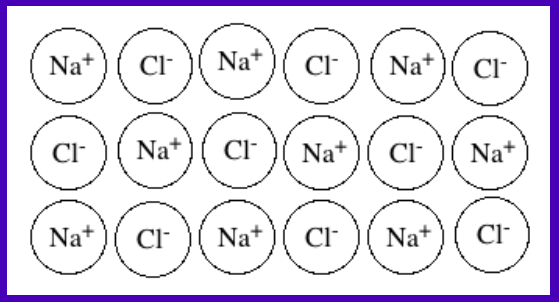


NaCl one sodium atom one chlorine atom

Are these atoms held together by chemical bonds? yes!

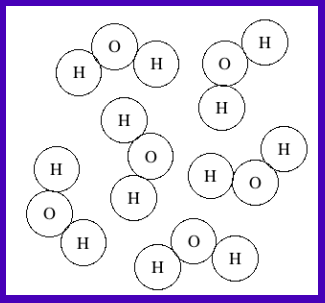


covalent bonds



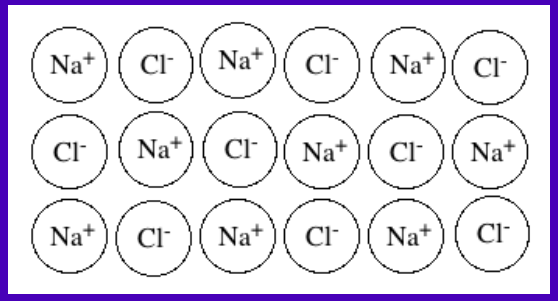
ionic bonds

How can you tell which compounds will have covalent bonds, and which will have ionic bonds?



H_2O

covalent compounds contain only atoms which are nonmetals



NaCl

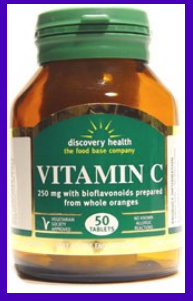
ionic compounds contain metal and nonmetal atoms

Which of the following are ionic, and which are covalent?

rust

Fe_2O_3

ionic compound



vitamin C

$C_6H_8O_6$

covalent compound

baking soda

$NaHCO_3$

ionic compound

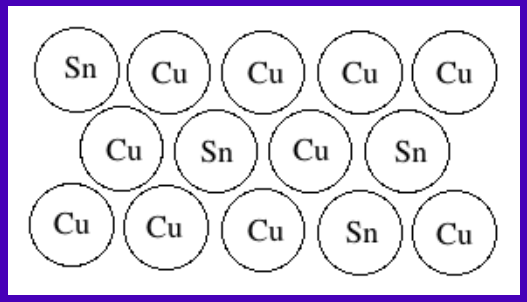
sugar

$C_{11}H_{22}O_{11}$

covalent compound

Mixtures, on the other hand, do not have a set ratio of elements.

bronze



What is bronze made of? mixture of copper and tin

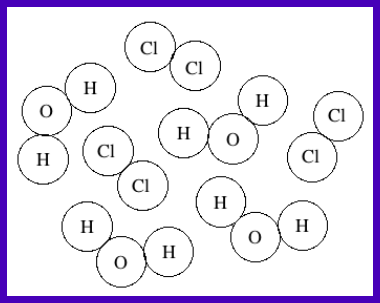
Can it have more or less tin and still be bronze? yes

Are the atoms arranged in any order? no

Are the atoms connected by chemical bonds? no

What are mixtures of metals called? alloys

chlorinated water



What does chlorinated water contain? chlorine and water

Can you have more or less chlorine? yes

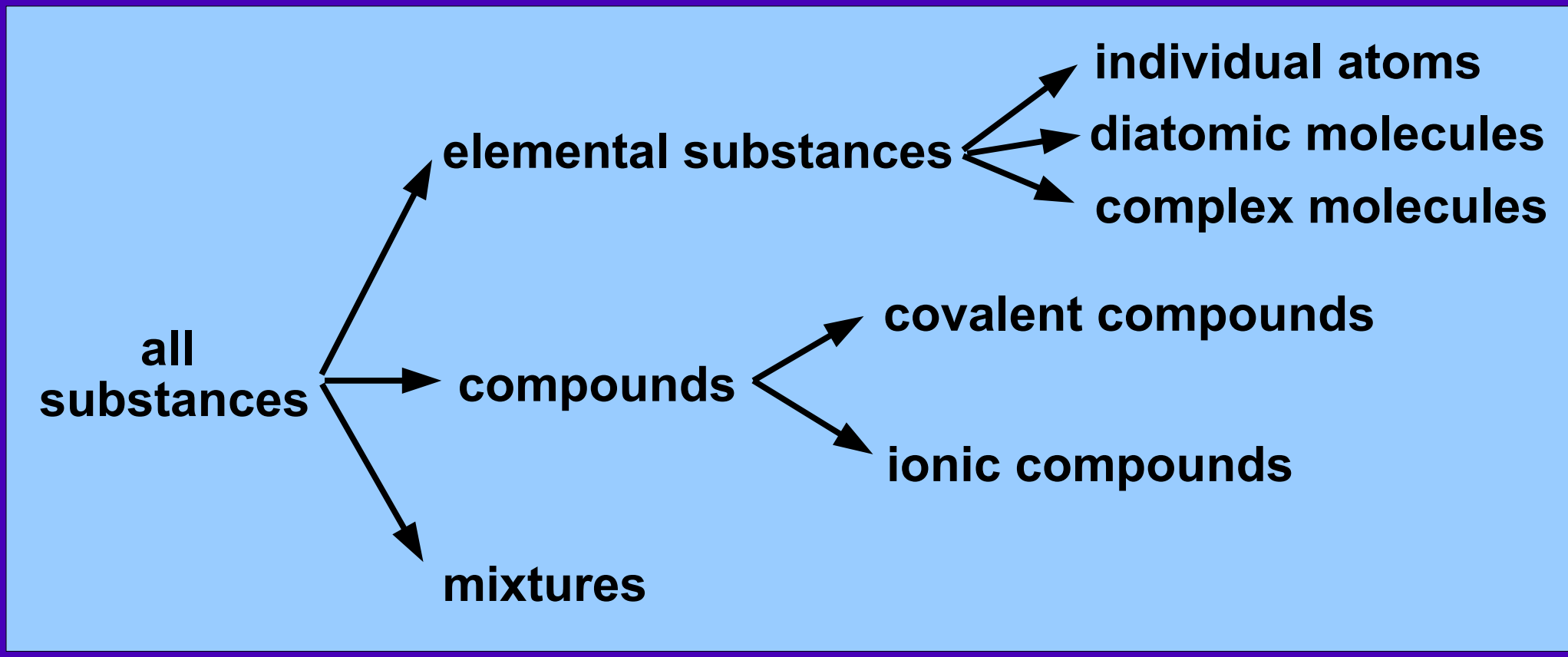
Are the atoms connected by chemical bonds?

yes – in both H_2O and Cl_2

Are the molecules in any particular arrangement? no

Summing up

Here is one way to represent how all of these categories are related:



Pure Elements:

- only one kind of atom
- may be individual atoms, or held together by chemical bonds

Compounds

- two or more elements
- atoms are bound together by chemical bonds
- have a formula (fixed ratio of elements)

Covalent compounds:

- contain only nonmetals
- atoms are joined together by covalent bonds
- form molecules

Ionic compounds:

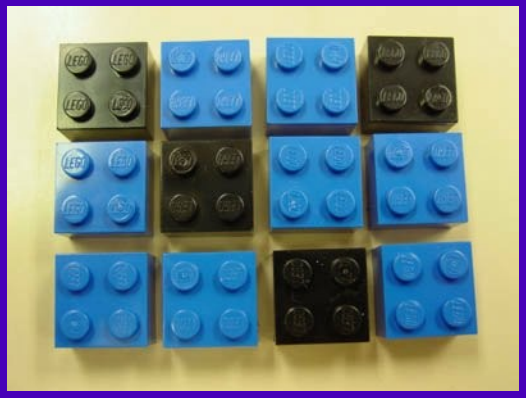
- contain a metal and one or more nonmetals
- atoms are held together by ionic bonds
- form ions (not molecules)

Mixtures

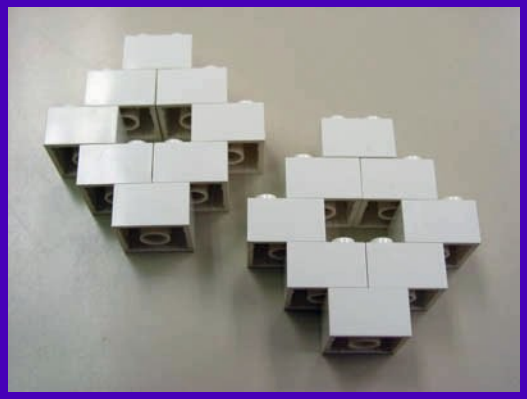
- two or more elements
- not all atoms held together by chemical bonds
- don't have a formula (any ratio of elements possible)

Remember our analogy with the Legos?

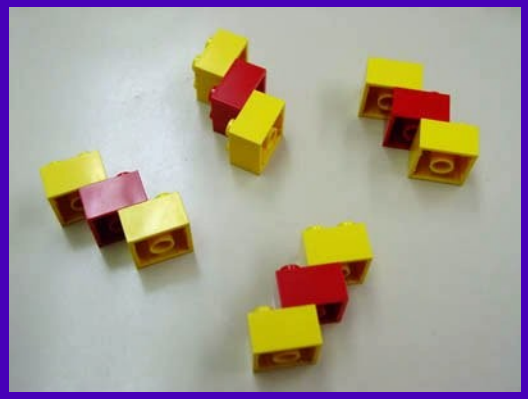
Identify the kind of substance represented by the following Legos.



mixture (alloy)



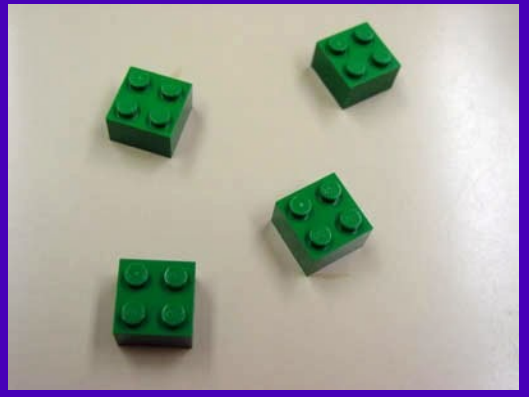
pure element
(complex molecule)



covalent
compound

pure element
diatomic molecule

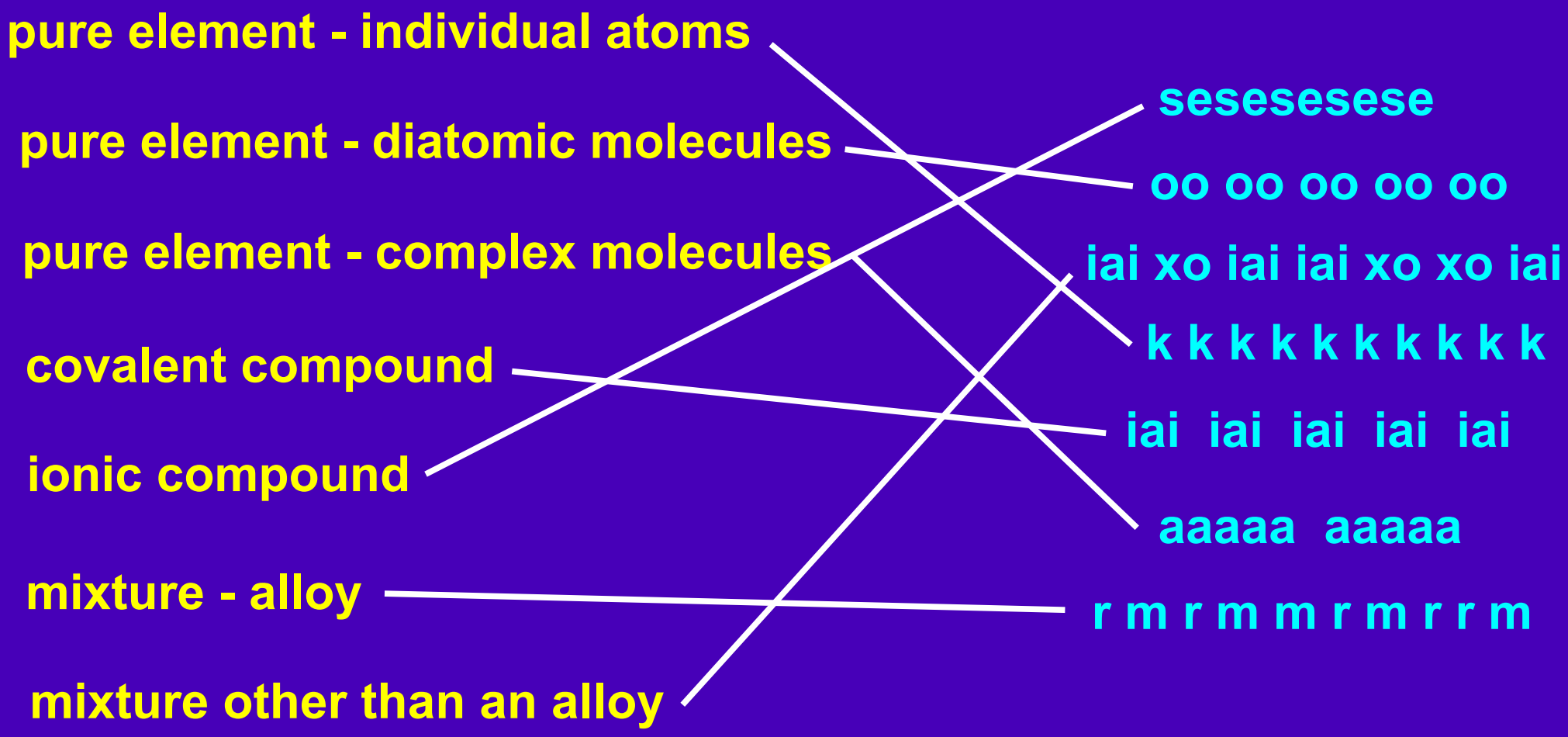
ionic
compound



pure element
individual atoms

Remember the analogy with letters?

Match up the descriptions below with one of the letter combinations. Vowels represent nonmetals, and consonants represent metals.



Draw pictures to represent the atoms of each of the following substances.

brass (copper and zinc)

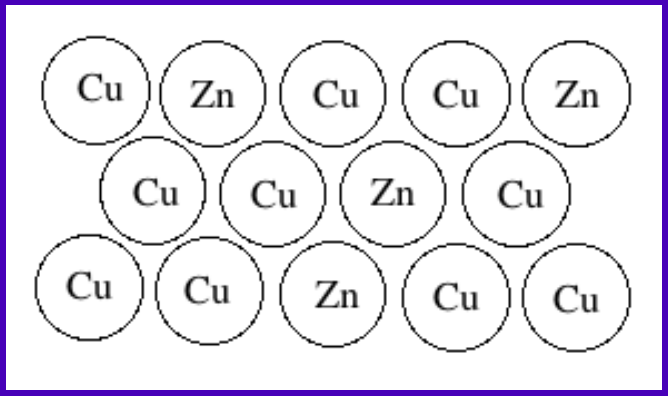
bromine

carbon monoxide (CO)

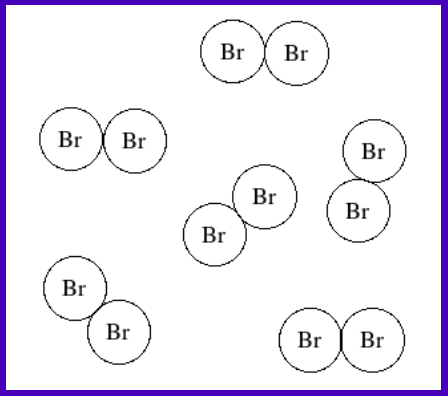
potassium chloride (salt substitute)

silver

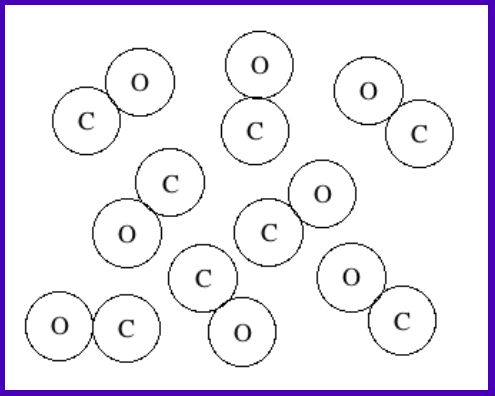
helium and oxygen



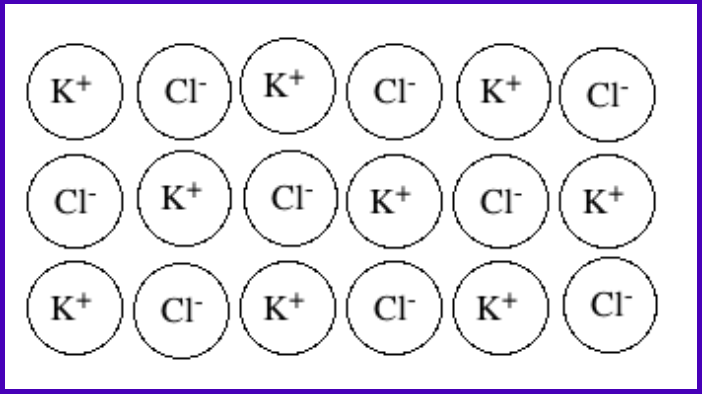
brass
(copper and zinc)



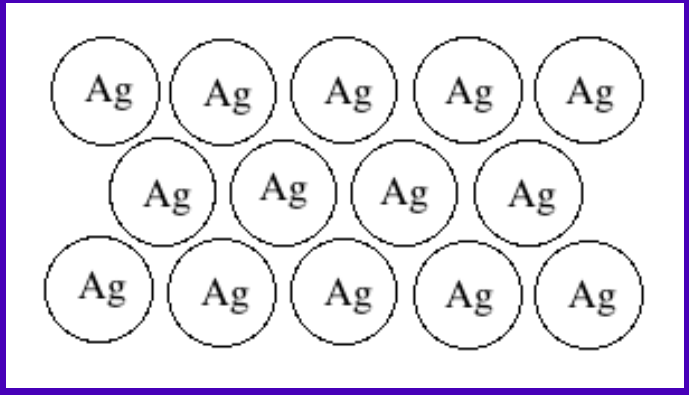
bromine



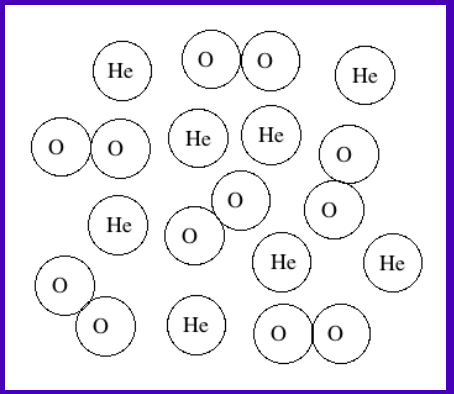
carbon monoxide
(CO)



potassium chloride
(salt substitute)



silver



helium and oxygen