Matter

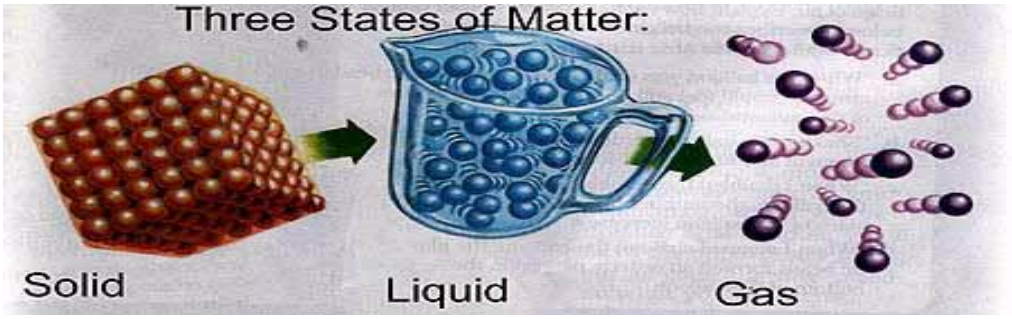
Reading: Ch 3 sections 1 - 5	Homework:	3.1, questions 2, 4, 6, 8 3.2, questions 12, 14*, 18* 3.3, questions 20, 22 3.4, questions 28*, 30*, 32 (optional) 3.5, questions 34, 36

* = 'important' homework question

Review: What is the ('MTV') definition of matter?

Recall: "Chemistry is the study of matter and its *properties*, the changes matter undergoes and the *energy* associated with those changes"

Recap: There are 3 stable states of matter – *solid* (s), *liquid* (l) and *gas* (g).



Specific physical properties define the 3 states of matter

State of Matter	Macroscopic Description (observation)	Microscopic Description (chemical model)
Solid		
Liquid		
Gas		

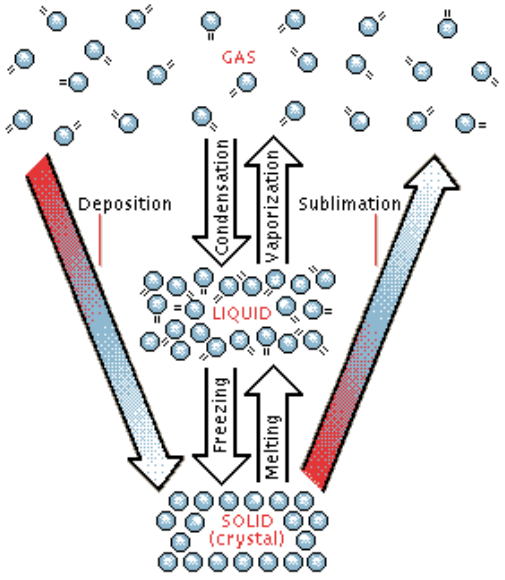
The state matter is in depends on the strength of the forces (chemical bonds) between the individual microscopic particles within the matter

Task: Rank the *intermolecular* forces present in steam, ice and water in order of increasing strength. Use the slide or above figure as a guide.

Changing between the 3 states of matter (a physical property)

Question: How do you convert H_2O (s) (ice) $\rightarrow$ H_2O (l) (water) and back again?

Question: What happens on the microscopic level during the above processes (recall previous slide)? ***How is this related to boiling and freezing points??***



Notes

Physical and Chemical Properties – what's the difference?

Analogy: We all posses 'as is' properties, or characteristics, that define us. For example, Dr. Mills is 5'11" and has green eyes.

Physical Properties As with people, each chemical also possesses a unique set of 'as is' (physical) properties that define it. For example, water is a clear, colorless, tasteless molecular material that has a fpt. of $0^{o}C$ and a bpt. of $100\ ^{o}C$.

Chemical Properties, in contrast, are a function of *change* (usually associated with a chemical reaction). For example, Iron (Fe) reacts with oxygen gas to form rust:

$$4\ Fe\ (s)\ +\ 3\ O_2(g)\ \rightarrow\ 2\ Fe_2O_3\ (s)$$

Task: Identify the flowing as either chemical or physical properties

Properties	Chemical or Physical
Diamond is the hardest known substance.	
Charcoal burns to make CO_2 (g)	
The statue of liberty turned 'green'	
Copper is a good conductor of electricity	
Sugar dissolves in water	

*Think up two more chemical properties of your own - ***6 more physical properties to beat the record(!)***

Elements and Compounds

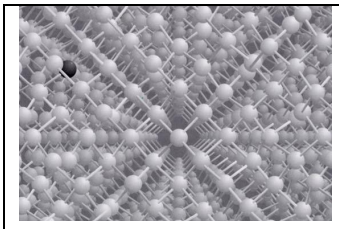
Task: State which of the following are *elements*, and which are *compounds.* When done, try to come up with a definition of what elements and compounds are.

Material	Chemical Formula	Element or Compound?
Water	H_2O (l)	
Oxygen gas	O_2 (g)	
Pure silver coin	Ag (s)	
Sugar crystals	$C_6H_{12}O_6$ (s)	
Carbon dioxide gas	CO_2 (g)	

Elements:

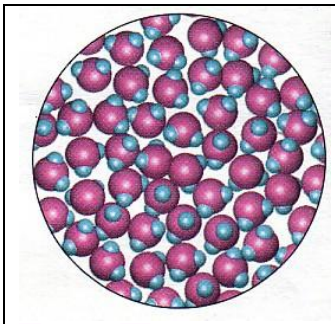
Compounds:

Note: Compounds and elements can have either *'giant'* or *molecular* structures:



'Giant': Repeating *lattice* of particles – usually strongly bound (high mpt.) solids.

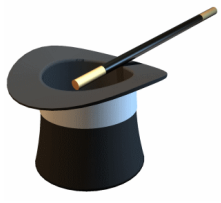
Examples: sand (SiO_2), diamond (C), table salt (NaCl)



Molecular: a collection of *independent* molecular units (molecules will be discussed in more detail later). Usually (low mpt) liquids or gasses at room temp.

Definition: ***Molecule* – a small, independent particle of matter made up from 2 or more atoms**

Examples: water (H_2O), carbon dioxide (CO_2), Nitrogen gas (N_2)

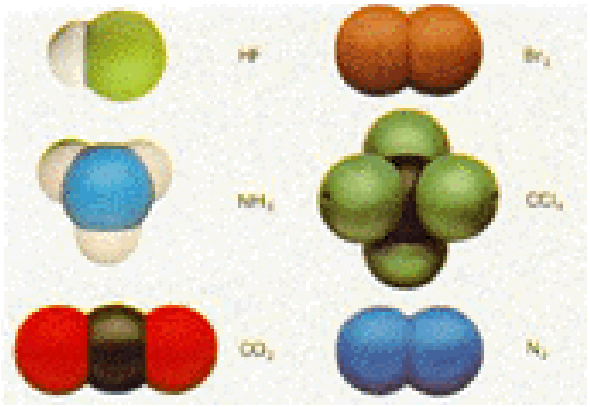


Think of molecules like cars on the expressway – each car (molecule) is a separate, independent unit that contains a number of passengers (atoms). The cars (molecules) are free to move while the people (atoms) stay fixed inside.

'Giant' materials are like people (atoms) 'locked' in place at a *very* crowded concert, the DMV waiting room etc……

A molecule is an independent unit containing two or more atoms. *Remember the car / passenger analogy from above*

Task: Classify the following molecules as either elements or compounds

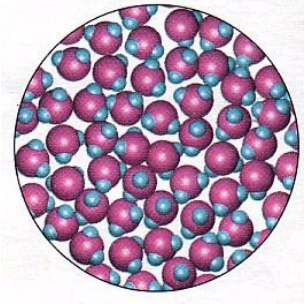
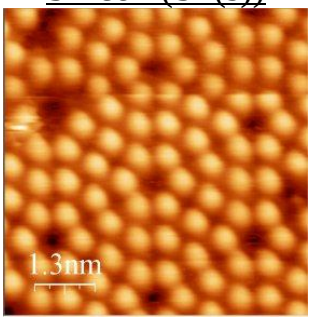
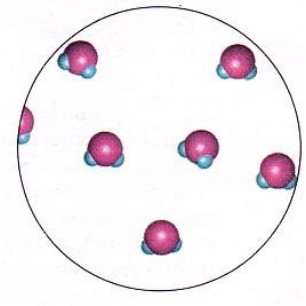
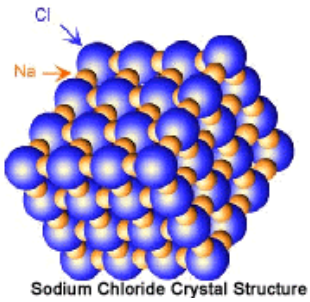


HF: Br_2:

NH_3: CCl_4:

CO_2: N_2:

Wrap Up: A microscopic scale view of several materials is presented below. Label each using *elemental* or *compound* **and** *molecular* or *'giant'* tags

Water (H_2O (l)) _ 	Silicon (Si (s)) 
Steam (H_2O (g)) _ 	Sodium Chloride (NaCl) 

Pure Materials v Mixtures

Recap: **Pure matter** is classed as ***either*** an ELEMENT ***or*** a COMPOUND.

Elements can have *either* Molecular *or* 'giant' structures. Examples: N_2 (g) (Nitrogen gas, molecular), Pb(s) (metallic lead, a 'giant' structure)

Compounds can also have *either* Molecular *or* 'giant' structures. Examples: H_2O(l) (water, molecular), Fe_2O_3(s) ('rust' (iron oxide), a 'giant' structure)

Discussion: Air contains a number of *different* components – what are they? How would you describe what air is made up from using words like element, compound, gas, molecular etc.?

ANY combination of different types of matter 'placed together' is defined as a mixture (eg. air, milk, pepsi).

Mixtures are NOT pure materials (eg. Pure gold (Au) vs 'white' gold* (Au+ Ag).

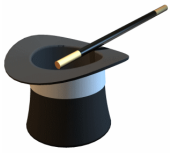
Mixtures can be either **HOMOGENEOUS** or **HETEROGENEOUS**.

*White gold is an example of a solid mixture, or ***alloy***. Others include…

Further Definitions of a mixture

HOMOGENEOUS MIXTURE:

HETEROGENEOUS MIXTURE:

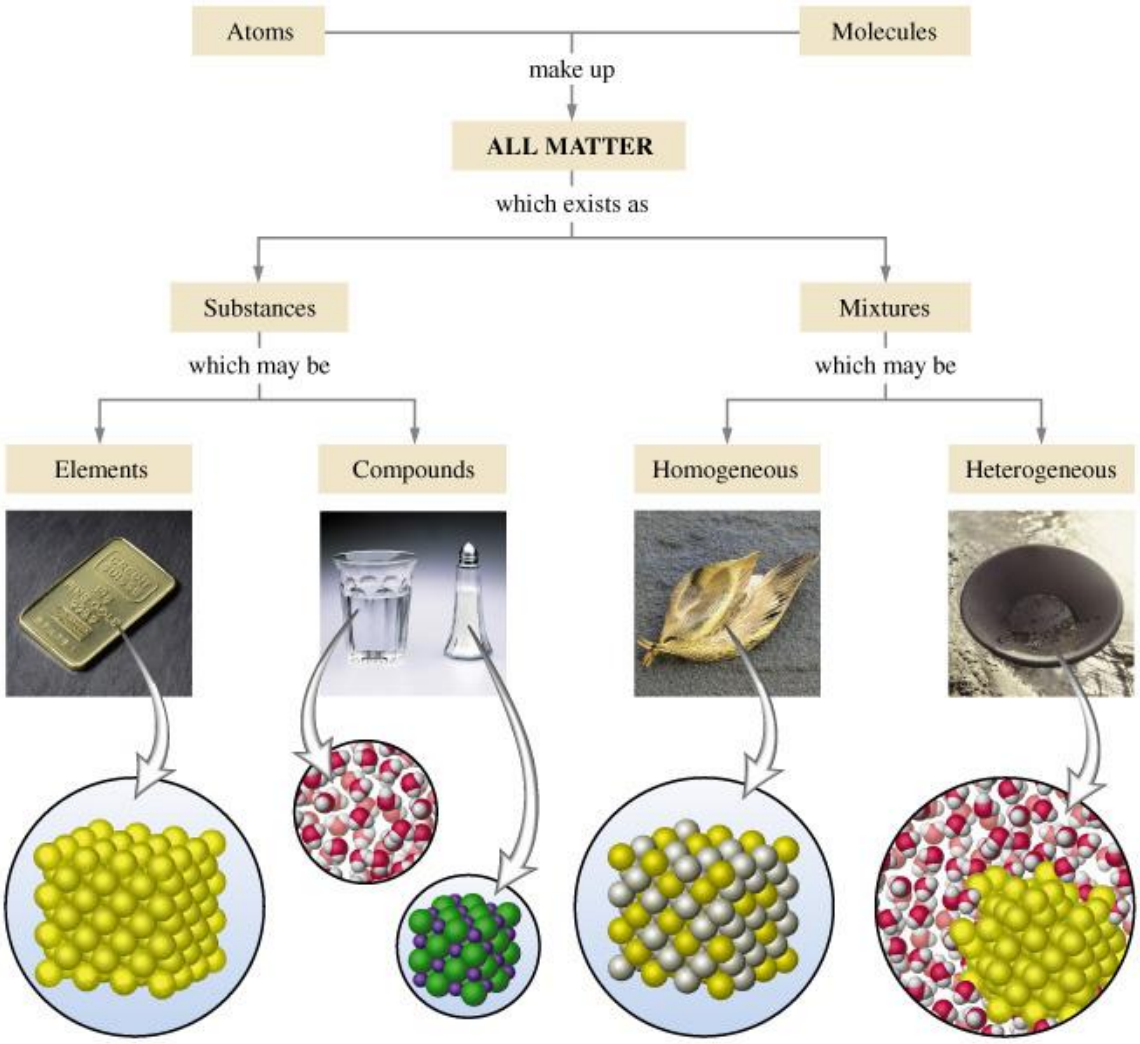


Fact: *Most* matter we interact with on a daily basis is in the form of a mixture.

Task: List four mixtures, and their components, *you* have interacted with today. Also state if your mixtures are *either* heterogeneous *or* homogeneous:

Mixture Name	Components	Homogeneous?

Classification of Matter Flowchart



Discussion: Dr. Mills really likes the above slide – why? Hint: What does a chemist do?

Separating Mixtures

Context: The separation of mixtures into their components is a widely used and important scientific method. For example, desalination plants on Navy vessels create drinking water by separating salt from seawater, while distillers separate alcohol from fermented 'mash' to make hard liquor.

Questions: How would you, using 'everyday' or simple lab equipment:

1. Separate the dissolved salt from seawater?

2. Separate and collect the alcohol from a water / alcohol mixture?

3. Separate a sand water mixture?

Discussion: Which chemical or physical properties of the components of a mixture do the separation methods rely on to 'get the job done'?

Evaporation:

Distillation:

Filtration:

In the lab, industry, (or even in the 'back woods'), *three* main methods are typically used to separate the components of mixtures:

EVAPORATION - DISTILLATION - FILTRATION

These methods can be employed either *singularly* or *in sequence* to separate most any mixture.

Task: Describe how the three components of a saltwater (dissolved salt + water) and sand mixture could be separated and collected.

"Mixtures, Elements and Compounds"

The following questions were taken from your 1st practice midterm:

State whether the following are classified as elements, compounds or mixtures:

Diamond: (giant) element

Carbon dioxide gas: (molecular) compound

Air: see class notes

A cup of coffee: (homogeneous or heterogeneous) mixture

Water: (molecular) compound

Sand (SiO_2): (giant) compound

Oxygen gas: (molecular) element

Gasoline (homogeneous) mixture

Fresh Milk: (homogeneous) mixture

Gold: (giant) element

Ice Cube (molecular) compound

A jar containing H_2 and O_2 gasses: (homogenous mixture)