The Components of Matter

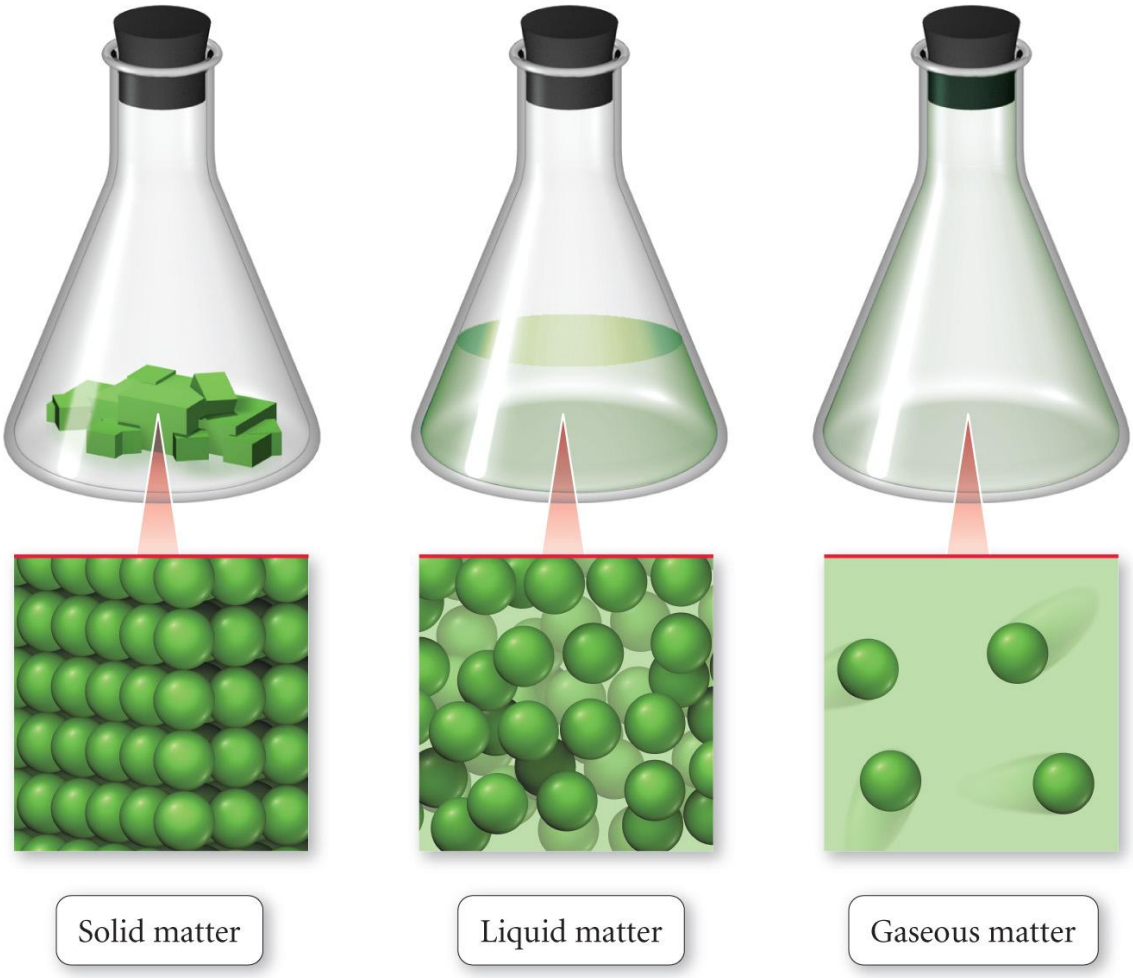
Reading: Ch 1 sections 1 - 5	Homework: Chapter 1: 37, 39, 41, 43, 45, 47*, 49

* = 'important' homework question

Review: What is 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).

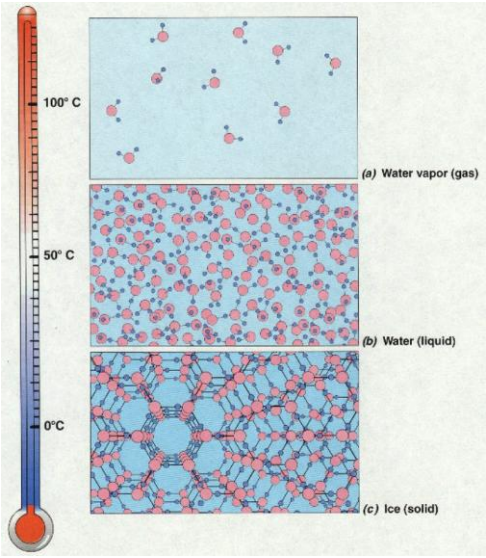


Specific *macro*- and *micro*scopic ***physical*** properties define the three* states of matter

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 included figures as a guide.

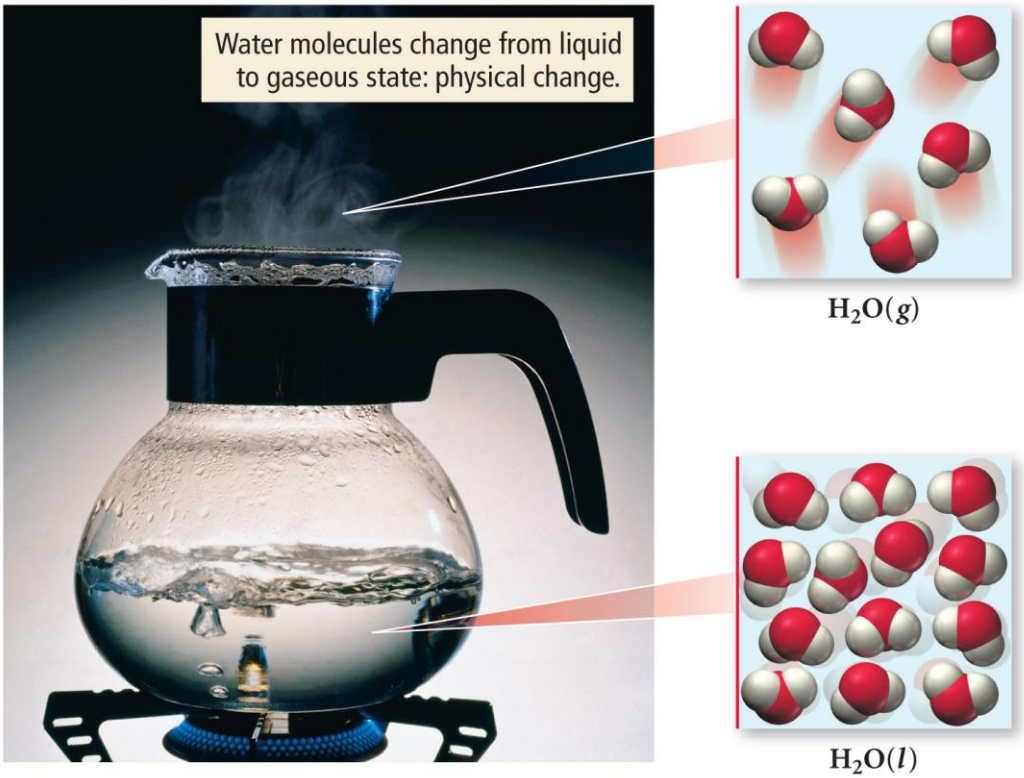


Ranking

Changing between the 3 states of matter

Describe the relationship between the mpt. and bpt. of matter, with regard to *microscopic* processes, occurring at these specific temperatures

Example: The boiling of water to make steam ($H_2O_{(l)} \rightarrow (H_2O_{(g)}$)



Physical and Chemical Properties – what's the difference?

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

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

Property	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*	
Melting of ice*	

Think up two more chemical properties of your own

Elements and Compounds – the further classification of ***pure*** matter

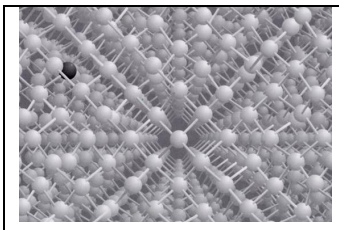
Task: State which of the following are *elements*, and which are *compounds.* When done, try to come up with a definition of what elements and compounds are.

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:

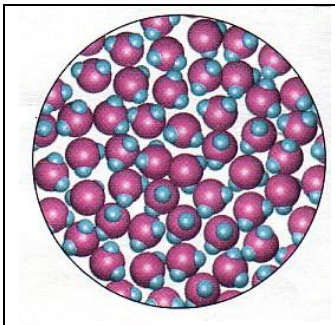
Compounds:

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



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

<u>Examples</u>: sand (SiO_2), diamond (C), table salt (NaCl)



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

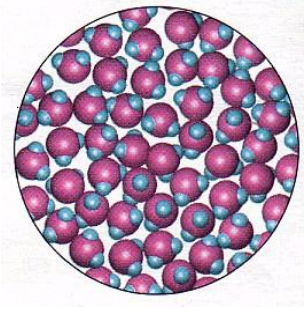
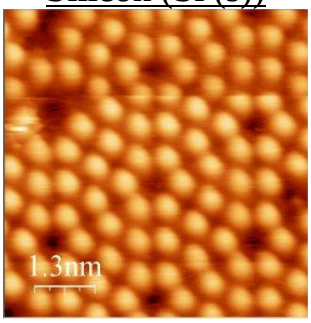
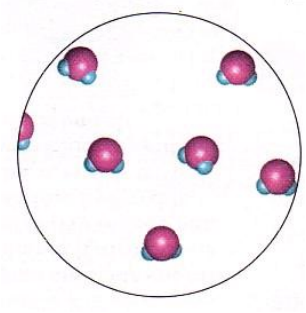
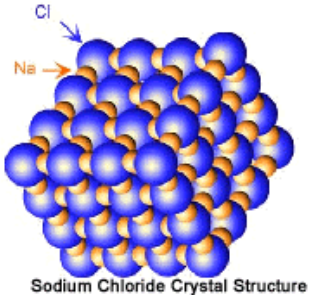
<u>Definition</u>: ***Molecule* – a small, independent particle of matter made up from 2 or more atoms**

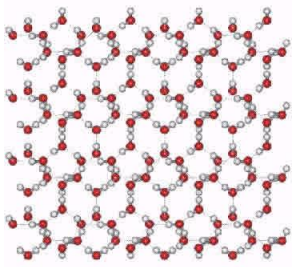
<u>Examples</u>: water (H_2O), carbon dioxide (CO_2), Nitrogen gas (N_2)

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……

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

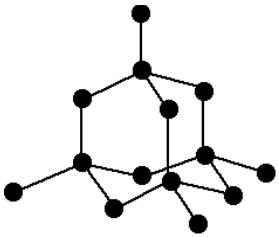
Water (H_2O (l)) _ 	Silicon (Si (s)) 
Steam (H_2O (g)) _ 	Sodium Chloride (NaCl)  Sodium Chloride Crystal Structure



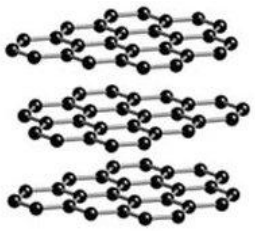
Details: Ice is a solid (crystalline) form of water (a molecular compound). How would you describe the structure of ice? Can you think of other similar examples?

More Details: Allotropes of an Element

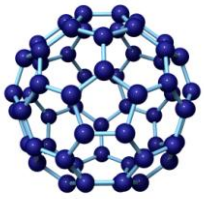
Example: Carbon



$C_{(diamond)}$



$C_{(graphite)}$



C_{60}

Pure Matter 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)

Recall: **A molecule is an independent unit containing two or more atoms**. Remember the car / passenger analogy. Molecules can exist as *either* elements *or* compounds

Mixtures

ANY combination of different types of pure 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), or water (H_2O) vs pepsi (H_2O + sugar….)

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.?

Task: Assign generic labels that describe to microscopic scale matter shown on the slide (e.g. ‘gaseous atomic element’ etc.)

Mixture Types

As viewed from a *macroscopic perspective*, mixtures are classified as *either* **HOMOGENEOUS** or **HETEROGENEOUS**

HOMOGENEOUS MIXTURES:

Examples:

HETEROGENEOUS MIXTURES:

Examples:

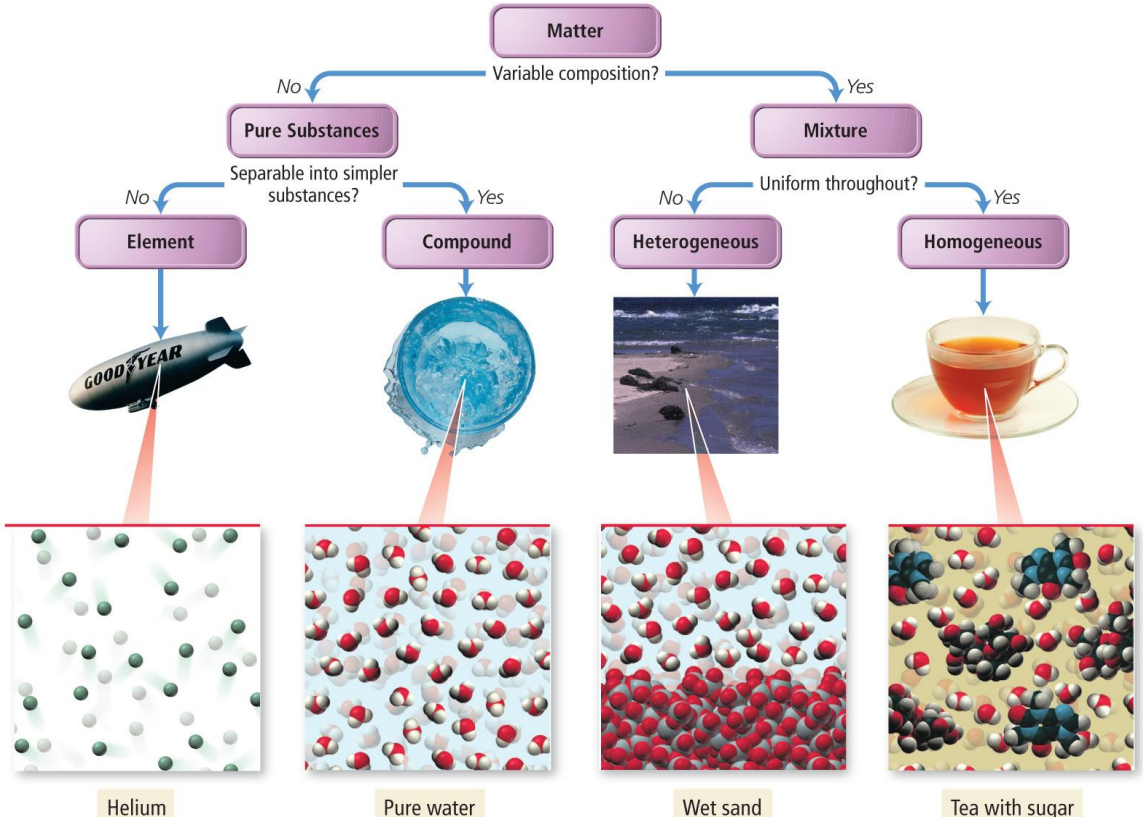
A *Bronze* statue of Caesar Augustus

Discussion: Can you think of something that is both a homogeneous mixture *and* a solid?

Examples of Alloys:

Classification of Matter Flowchart

(Dr. Mills really likes this slide – why? Hint: Recall the fundamental job of a chemist)



Task: Use the 'Classification of Matter' flowchart (above) to classify the following:

1. The compressed gasses in a deep sea diver's gas bottle (He(g) and $O_2(g)$)

2. A ham and cheese omelet

3. An ice cube (made from pure water)

4. A ruby ($Al_2O_3(s)$ with Cr^{3+} impurities)

Extra Credit: Ask me about the separation of mixtures assignment (based on background reading)

"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:

Carbon dioxide gas:

Air:

A cup of coffee:

Water:

Sand (SiO_2):

Oxygen gas:

**include additional details for extra credit!