5th Grade Workshop: Chemistry Content

Chemical Formulas, Chemical vs. Physical Properties, Chemical vs. Physical Changes, Phases and Phase Changes (1 hr – 9 am to 10 am)
Standard g: "Students know properties of solid, liquid, and gaseous substances, such as sugar ($C_6H_{12}O_6$), water (H_2O), helium (He), oxygen (O_2), nitrogen (N_2), and carbon dioxide (CO_2)."
Standard a: "Students know that during chemical reactions the atoms in the reactants rearrange to form products with different properties."

- Handout of definitions and interactive lecture
- Demonstrations of chemical and physical changes. ID properties.
- Activity – teachers break into groups and come up with an activity they could do with their students to illustrate a concept in this section.
- Pop Rocks activity and share ideas from K-8 classes.
- Law of conservation of mass

Break for 10 min

Pure Substances vs. Mixtures, Mixture separations (1 hr – 10:10 am – 11:10 am)
Standard f: "Students know differences in chemical and physical properties of substances are used to separate mixtures and identify compounds."

- Handout of definitions
- Activity – figure out how to separate several mixtures.

Break for 10 min

Definitions of Atom, Element, Compound and Molecule (20 min)
Standard b: "Students know that all matter is composed of atoms, which may combine to form molecules."
Addresses several standards; need vocabulary to teach standards

- Provide handout of definitions, including Democritus' definition
- Balloon activity to differentiate terms

Subatomic Particles: Protons, Neutrons, and Electrons (1 hour)
How to determine the number of protons, neutrons, and electrons in a given atom

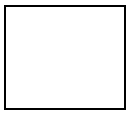
Break for Lunch at 12:30 pm (30 min)

Periodic table (1 hr – 1 – 2 pm)
Standard c: "Students know metals have properties in common, such as high electrical and thermal conductivity. Some metals, such as Al, Fe, Ni, Cu, Ag, and Au, are pure elements; others such as steel and brass are composed of a combination of elemental metals."
Standard d: "Students know that each element is made of one kind of atom and that the elements are organized in the periodic table by their chemical properties."

- Look at samples of several elements. How can you tell which are metals?
- Show BBC movie "The Periodic Table" (26 min)
- Provide handout of periodic table
- Walk through table together
- Metals: Elements vs. alloys
- Why do metals conduct electricity while non-metals do not? Activity with balloons.

Classifications of Matter

Phases of Matter

Phase	Arrangement of atoms/molecules	Movement of atoms/molecules	Relative space between atoms/molecules
Solid 			
Liquid 			
Gas 			

Phase Changes

Gas

Solid Liquid

Pure Substance

- A pure substance is a type of matter that cannot be broken down further by ordinary physical means.
  - Atoms, elements, molecules and compounds are all pure substances.
  - Examples: _____

Mixture

- A mixture is composed of two or more pure substances.
- Mixtures can be broken down into their constituent pure substances by ordinary physical means.
- Mixtures are often classified homogeneous (same throughout) or heterogeneous (not the same throughout).
  - Examples of homogeneous mixtures: _____
  - Examples of heterogeneous mixtures: _____

Chemical/Physical Properties/Changes

Every substance has a unique set of chemical and physical properties, which can be used to characterize and identify the substance as well as to determine its useful applications.

Physical property – observable property of a substance
Examples: density, color, mass, texture, temperature, phase

Chemical property – property that indicates a given chemical's potential to undergo some type of chemical change.
Examples:

Physical change – type of change that does *not* change the chemical identity of the substance.
Examples:

Chemical change – type of change that does change the chemical identity of the substance. (A chemical change is a chemical reaction.)
Examples:

Antoine Lavoiser (French chemist, 1700s)

- Law of Conservation of Mass: matter cannot be created or destroyed; it can just be rearranged
    - (we now know that matter can be created and destroyed in nuclear reactions. Matter and energy are interconverted by the equation $E=mc^2$)

Mixture Separations Activity

Work in groups to try to separate several mixtures that have been provided. If you need any special supplies that are not readily available, please ask and we'll try to accommodate your request. (Note: We will fill in the right-most column after we've completed the activity.)

Mixture	**Description of what you did to separate the mixture**	**Name(s) of mixture separation method(s) used to separate the mixture and description of why could be used**

Mixture Separations: Terms

In order to separate a mixture into its components, the components must possess at least one physical property that is unique to each component.

Separation Method	**Based on difference in this physical property:**	**Example of a mixture that might be separated by this method:**
Distillation	Boiling point. This is specifically used if the components in the mixture are dissolved in each other.	Gasoline, kerosene, etc. from crude oil
Extraction	Solubility* If you add a liquid to the mixture, then one component in the mixture will dissolve and the other(s) will not.	Coffee flavor, aroma and color chemicals from coffee beans
Filtration	Physical state This works for a solid floating in a liquid. Use a piece of filter paper for this.	Prepared coffee (liquid) from used coffee grounds (solid)
Decantation	Density This only works if the components exist as defined layers in mixture and one can be gently poured out, leaving the other behind.	Pebbles and water
Chromatography	Relative attraction of substances in the mixture to the two components of the chromatography apparatus The relative attraction may be based upon one of several properties but is often based on a property called "polarity".	Separation of pen inks into their constituent colors.
Magnet	Magnetism	Iron filings from dirt

*Solubility – the ability of one substance to dissolve in another

Atoms, Molecules, Elements and Compounds

Terms:

- Atom - tiny particle of which all matter is composed
- Element – an individual or combination of one type of substance on the periodic table
- Molecule - two or more atoms connected together
- Compound - Two or more atoms of *different* elements connected together

FYI: Democritus (Greek philosopher, 400 BC) came up with the concept of the Atom: An atom is the smallest unit into which matter can be divided ("atomos" in Greek means "indivisible" or "uncuttable")

Do balloon demonstration to illustrate definitions. Need balloons in different colors.

Classify each by putting a check mark in the appropriate boxes.

Chemical Formula	Atom	Element	Molecule	Compound
H_2				
H_2O				
Ag				
CO_2				
Kr				
$C_6H_{12}O_6$				
S_8				
NaCl				
O_3				
$CaCO_3$				
Au				

Note: later in this workshop we will briefly discuss ionic compounds. These types of compounds do not exist as individual small molecules (mark them on this sheet).

Quick Reference: The Atom

Characteristics of the three types of subatomic particles:

Sub-Atomic Particle	Symbol	Relative Charge	Relative Mass	Where it resides
Proton	p	+1	1	Nucleus
Neutron	n	0	1	Nucleus
Electron	e	-1	0	Around the nucleus

Terms to Know:

- **Atomic number** – number of protons in an atom; this defines the identity of the element. For example, an atom that contains 7 protons is always going to be an atom of N (nitrogen).
- **Mass number (also called "atomic mass")** – number of protons PLUS number of neutrons in a given atom.
- **Isotopes** – atoms of elements that contain the same number of protons but different numbers of neutrons. ("Isotope" comes from the Greek "iso-topos," which mean "same place" – isotopes are found in the same place on the periodic table.) For example, some atoms of nitrogen contain 7 neutrons and some atoms of nitrogen contain 8 neutrons.
- **Ion -** an atom that has either gained or lost electrons so that its total electron count no longer equals the total number of protons

Good to know:

- Each square on the periodic table contains a symbol, an atomic number, and a mass number. The atomic number is the smaller, whole number. The larger number (not a whole number) is the atomic mass.
- The reported atomic mass is an average of all the naturally-occurring isotopes.

Writing Symbols for Atoms:

- There is a specific symbol format for writing information about an atom. For a given element symbol, X, information is always recorded in this manner:

$$\begin{matrix}\text{mass number} \\ \text{atomic number}\end{matrix} \mathrm{X} \begin{matrix}\text{charge, if any} \\ \text{number of atoms}\end{matrix}$$

  - The atomic number is usually not written because it can easily be found from the element's symbol.
  - The mass number is only written to specify a particular isotope.
  - A charge results when the numbers of protons and electrons are not equal.
  - The number of atoms is only written if it is greater than one.

Naming Isotopes

If you know the particular isotope, then name it in this manner: "Name of Atom – atomic mass". For example, an oxygen atom containing 10 neutrons is named "oxygen-18".

Periodic Table Movie Sheet

Questions for movie "The Periodic Table" Movie (BBC Production)

1. How did Mendeleev contribute to the development of the periodic table? What key assumption did he make?

2. At first, the scientific community was skeptical about Mendeleev's assumptions. What key event convinced people that Mendeleev's periodic table was, in fact, creditable?

3. Consider lithium (Li) and sodium (Na).
   a) List one physical property that they share: _____
   b) List one chemical property that they share: _____
   c) How many valence electrons does each have? Li _____ Na _____

4. List three properties of metals.

5. Why is the periodic table so useful to chemists?