Chemistry Midterm Review Sheet

*Use this review sheet to guide your studying. It summarizes the **topics** that you need to study, but not all of the actual information. Study all your notes, read the text, review the homework, and know the lab material.*

What is **Science**?

It is reducing the complexity of how we perceive nature, or summarizing many observations into simple concepts, supported by experiment.

What is **Chemistry**?

The science of stuff, which is the science of matter, which is summarizing many observations about matter into simple concepts, supported by experiment.

The **Scientific Method**

1) Observation
2) Hypothesis
3) Experiment
4) Analysis
5) Conclusion/ Theory → *If needed, repeat.

Why can't we "prove" a **theory**?

There is always some uncertainty about our conclusions. We can only "demonstrate" what seems to be occurring. For instance, the accuracy of our instruments might limit the detail with which we perceive a phenomenon and, as a result, our theory may be over-simplified.

Experiments

Why do we do experiments?
What is a **Variable**?
What is a **Control**?
How many variables should we have in a proper experiment?

1, so that we know that it is responsible for any effects we observe. For instance, when we change water from solid to liquid to gas, we want to keep all factors the same (these are the controls) except the temperature (which is the variable) so that we can attribute the change to temperature alone.

What was Aristotle's approach to learning?
How does the scientific method improve its accuracy?
What types of problems is science best for solving?
What are examples of non-scientific hypotheses? How can they be adjusted to become testable and thus scientific hypotheses?
Even if the exact scientific method isn't used (experimentation is always used, but not necessarily everything else), why do we use it to formally present scientific findings?

Matter – anything that takes up space and has mass

The three **phases** of matter:

1) Solid
2) Liquid
3) Gas

*Know the **Kinetic-Molecular Theory** and how it explains the volume and shape of these phases. How does heat make the atoms vibrate and move in each?

Mixtures verses **Pure Substances**

What is the difference?
What types of mixtures are there?
What types of pure substances are there?
Know how to arrange them in our hierarchical tree.

How does building a hierarchical tree like theorizing in science?

Chemical and **Physical Properties**

Know the difference.
Be able to identify properties as one or the other.
Know the rhizomatic connections that connect our hierarchical tree horizontally (ie, physical separations and chemical separations)
What gives an element its properties?

Plato

What is a perfect form?
How is a theory like a perfect form?
What type of thinking did Deleuze and Guattari propose in place of Platonic hierarchical thought?

Dalton's Atomic Theory

Know the 5 parts of it.

Elements

Who created the modern definition of an element? Robert Boyle
What is his definition of an element?
What is an element symbol?
How many elements are there?
What were the 4 Greek elements?
How don't they adhere to Robert Boyle's definition?
What Greek philosopher established the 4 Greek elements? Empedocles
Even though his 4 elements are outdated, what two important concepts did he establish? That everything should be able to be made from several simple elements and that when they are put together they are held by bonds ("philia").
How is Robert Boyle's definition more powerful than Empedocle's definition?
How do the atoms of various elements differ?

Atomic Structure

Know the overall structure.
Know Atomic number, Atomic Mass (amu), Electron Clouds.
What are the parts of the atoms?
What are their charges?
How do electron clouds determine chemical and physical properties?
How do atoms bond into compounds?
What is a chemical formula?
How does it tell us how many atoms of each element there are in a molecule?
What is an Isotope?
Know how to calculate the number of neutrons.
How was Dalton's Atomic Theory revised when isotopes were discovered?

Measurement

-Know how many places to read a measurement (always estimate one digit beyond the smallest readable increment)
-Know what a meniscus is and how to read volume on a graduated cylinder

Accuracy & Precision

-Know their definitions
-Be able to compare
-Which is more important for a comparative experiment?

Units & Prefixes

-Know all unit names, their abbreviations, and what type of quantity they measure (distance, mass, etc.)

-Know all the prefixes and what they mean

Significant Figures

-Be able to count sig figs
-Be able to identify "ambiguous" measurements
-Be able to identify the estimated digit in a measurement

Scientific Notation

-Be able to put numbers into scientific notation
-Be able to compare different numbers in scientific notation (which is greater?)

Scientific Calculation

-Be able to report your answers with the correct number of places or sig figs when you add, subtract, multiply, or divide measurements and non-measured numbers (3 rules)

Scientific Calculation

Unit conversions using dimensional analysis
Moles
Converting grams to particles (atoms/molecules) and particles to grams
Calculating relative weights for chemical reactions
Adding/Subtracting/Dividing/Multiplying Measurements

We use equalities to make **conversion factors**.

Using an equality like 1 centimeter = 2.54 inches, then we can create two conversion factors

$$\frac{1 \text{ centimeter}}{2.54 \text{ inches}} \quad \text{OR} \quad \frac{2.54 \text{ inches}}{1 \text{ centimeter}}$$

All such conversion factors equal one because the numerator equals the denominator.

We can multiply values by conversion factors to convert the units in which they are expressed.

$$4.00 \text{ inches} \times \frac{1 \text{ centimeter}}{2.54 \text{ inches}} = 1.57 \text{ centimeter} \quad \text{OR} \quad 1.57 \text{ centimeter} \times \frac{2.54 \text{ inches}}{1 \text{ centimeter}} = 3.99 \text{ inches}$$

Why is the value of the result still equal to the original measurement?

We only multiplied the measurement by one.

What is a **mole**?

It is a unit that refers to having 6.022×10^{23} of something.
For instance, 1 mole of atoms = 6.022×10^{23} atoms
"Mole" is abbreviated "mol". It is not short for "molecule".
The mole is also called "**Avogadro's Number**"

What is **molar mass**?

It is the weight (in grams) of one mole of a substance.
We find it by looking at the periodic table.
If we want to know the molar mass of H_2O, we look at the periodic table to see that 1 mole of H would weigh 1 gram and 1 mole of O would weigh 16 grams. Thus, the molar mass of H_1O equals 18 grams (1 + 1 + 16 grams).

What is a **particle**?

The constituent part (or piece) of a given substance.
In an element, the particle is an atom.
In a compound, the particle is a molecule.

There are two main types of dimensional analysis used in chemistry:

1) Converting mass to particles:

$$\text{Mass (in } \cancel{\text{grams}}) \times \frac{1\ \cancel{\text{mole}}}{\text{Molar Mass (in } \cancel{\text{grams}})} \times \frac{6.022 \times 10^{23} \text{ particles (atoms or molecules)}}{1\ \cancel{\text{mole}}}$$

2) Converting particles to mass:

$$\#\text{ of } \cancel{\text{particles (atoms or molecules)}} \times \frac{1\ \cancel{\text{mole}}}{6.022 \times 10^{23}\ \cancel{\text{particles}}} \times \frac{\text{Molar Mass (in grams)}}{1\ \cancel{\text{mole}}}$$

We simply substitute the molar mass (which we calculate from the periodic table) and either the original mass (in case #1) or the original number of particles (in case #2) to arrive at an answer.

If given a number of moles, we can arrive at either the number of particles or the mass in one step:

Converting moles to particles:

$$\#\text{ of } \cancel{\text{moles}} \times \frac{6.022 \times 10^{23} \text{ particles (atoms or molecules)}}{1\ \cancel{\text{mole}}}$$

Converting moles to mass:

$$\#\text{ of } \cancel{\text{moles}} \times \frac{\text{Molar Mass* (in grams)}}{1\ \cancel{\text{mole}}}$$

Chemical reactions provide us with **mole ratios**.

For example, the chemical reaction:

$$2H_2 + O_2 \longrightarrow 2H_2O$$

Tells us that we must react 2 moles of H_2 for each (1) mole of O_2. This can also be read to tell us that for each mole of O_2 used, we will have 2 moles of H_2O produced. Lastly, we can also read this to say that for every 2 moles of H_2 used, 2 moles of H_2O are produced.

Thus, if we have 4 moles of H_2, we need 2 moles of O_2:

$$4\ \cancel{\text{moles of } H_2} \times \frac{1 \text{ mole of } O_2}{2\ \cancel{\text{mole of } H_2}} = 2 \text{ moles of } O_2$$

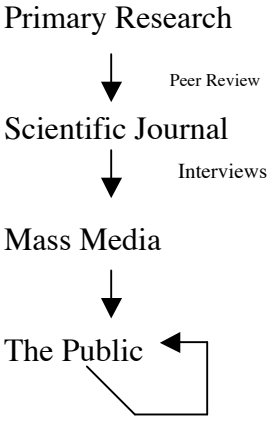
mole ratio

Also, if given the number of grams of H_2 we wish to use in the reaction, we can calculate moles of H_2. Then we can use the mole ratio to calculate moles of O_2. Lastly, moles of O_2 can be converted to tell us how many grams of O_2 we should use.

$$10.0 \text{ grams of } H_2 \times \frac{1 \text{ mol of } H_2}{2 \text{ grams}} \times \frac{1 \text{ mol of } O_2}{2 \text{ moles of } H_2} \times \frac{16 \text{ grams of } O_2}{1 \text{ mol of } O_2} =$$

This answer tells us how many grams of O_2 we should use to react with 10.0 grams of H_2.

What is scientific literacy?
What is the current process by which scientific information is disseminated?



How is this process prone to fallacy?

What are **appropriate sources** for a scientific paper?
-Primary Research, Scientific Journals, Peer Reviewed Textbooks/Books
What are **inappropriate sources** for a scientific paper?
-Encyclopedias, Magazines, Most Websites, The News, etc.

Science and the Public

Know what the 18th century **Enlightenment** was.
What were their main values/ what did they believe?

How did WWI and WWII change the public's perception of science?

Know what early 20th century **Modernism** is.
What had the main values become?
What happened to the public's connectedness with science?
How does this effect the current level of scientific literacy in the general public?

The Periodic Table

-developed primarily by **Dmitri Mendeleev**
-ordered by atomic number
-columns are called **groups** and rows are called **periods**
Know which ones are the **transition metals**
Know how to number the groups of the periodic table
Periods are called periods because each one is a set of behaviors that is repeated in the next row

Group 1A (The Alkali Metals)

H is technically not a metal
These are highly reactive – they even react in water
Because of this they are never found in pure form in nature
H or Li will simmer in water
Na or K will boil
Rb, Cs, or Fr will explode!!!

Group 2A are The Alkaline Earth Metals
Group 7A are The Halogens

Group 8A (The Noble Gases)

These are **inert**
Know what inert means

Ionic Reactions occur when 2 (or more) atoms exchange electrons to be more stable

The atoms that exchanged electrons become charged and are called **ions**

Positively charged ions formed from atoms that donated electrons are called **cations**

Negatively charged ions formed from atoms that accepted electrons are called **anions**

The electrons in the outermost layer of the electron cloud determine an atom's **chemical properties** (what it reacts with)

-these electrons are called **valence electrons**

This is how all the elements of a group can have similar chemical properties

-even though they have different numbers of total electrons, they have the same number of valence electrons

For the A groups, the number of valence electrons = the number of the group

*There is one notable exception, He, which actually only has 2 electrons total and only 2 valence electrons, **but still it is inert like all the other noble gases**

Usually, ionic reactions occur between metals and nonmetals

Metals form cations

-Transition metals also form cations

Nonmetals form anions

Rule for ionic reactions: For a reaction to take place, all atoms should end up with valences like those of the noble gases.

Be able to predict ionic reactions and *Memorize:*

Group	Typical Ionic Behavior
1A	donates 1 electron
2A	donates 2 electrons
3A	donates 3 electrons
4A	*depends*
5A	*depends*
6A	accepts 2 electrons
7A	accepts 1 electron
8A	doesn't form ions (already stable)

Know how to draw **Lewis Dot Structures**

Examples: *(All elements in the same group have the same Lewis Dot Structure)*

Group 1A 2A 6A 7A 8A

*Note, you can move the electrons (dots) around to make a reaction work. In class, we drew O with the two missing electrons on the same side to show that Be would easily fit with it, but the drawing above shows how two Li atoms would easily fit with it. Either is okay. The key is having the correct number of valence electrons, only 4 sides, and only 2 electrons per side.

Metals

Except for B and Al, elements touching the "staircase" of the periodic table are **metalloids**

-Know the definition of **metalloid**

To the right of the staircase are the **nonmetals**

To the left of the staircase are the **metals**

Know the properties of metals