Directions: Use the textbook to complete the following notes. Terms in italics are vocabulary terms. Their definitions should be memorized and understood.

When doing Ch. 3 problems, omit problems from sections 3.3 and 3.5 as well as problems 25

- Alchemists were mostly concerned with turning cheap metals into gold but they did learn some valuable things. Namely, they discovered a few ______________________ and they learned how to prepare _______________________.
- Robert Boyle’s contributions to science included:
  - Pioneering work on the properties of ____________.
  - Promoting the importance of _________________ in science
  - A definition of _________________ as a substance that could not be broken down into simpler substances.

3.1 The Elements

| The Five Most Abundant Elements in the Earth’s Crust |
| --- | --- |
| Element | Mass Percent |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

| The Five Most Abundant Elements in the Human Body |
| --- | --- |
| Element | Mass Percent |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
Challenges with the term “Element”

● Sometimes when we say *element*, we mean ____________________________.

● Other times when we use the term *element*, we mean ____________________________ ____________________________. Sometimes we mean a single atom (like an O atom) and other times we use the term *element* to describe a molecule (like O₂ or O₃).

● Oxygen makes up about _____% of our atmosphere but is much more common in the ___________, ___________ and ___________ of the earth’s crust. There oxygen exists not as an element (O₂) but rather as a ____________________.

3.2 Symbols for the Elements

● The names for the elements come from ____________________________ ____________________________ ____________________________.

   For example, gold (Au) was originally called ____________________ and lead (Pb) was called ____________________

3.3 Dalton’s Atomic Theory

● Eighteenth century scientists understood the following:

   1. ____________________________

   2. ____________________________

   3. A given compound always contains the same proportions (by mass) of elements. For example, water always contains 8g of oxygen for every 1 g of hydrogen. This principle became
known as the ________________________________. It means that a given compound always has the same composition, regardless of where it comes from.

**Dalton’s Atomic Theory**

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________
4. Atoms of one element can combine with atoms of other elements to form ___________.
   A given compound always has the same relative numbers and types of atoms.
5. Atoms are __________________________ in chemical processes. That is, atoms are not created or destroyed in chemical reactions. A chemical reaction simply changes the way the atoms are grouped together.

**3.4 Formulas of Compounds**

**Rules for Writing Chemical Formulas**

1. ____________________________________________
2. ____________________________________________
3. ____________________________________________

- The formula for a compound made of one sulfur atom bonded to three oxygen atoms is written as _______________________.
- The formula for a compound made of two nitrogen atoms bonded to five oxygen atoms is written as _______________________.

**3.5 The Structure of the Atom**

Thomson’s ‘Cathode Ray Tube’ Experiment
Thomson’s Experiment showed that atoms can emit (shoot-out) tiny negative particles called ________________.

Thomson created the __________________________ model of the atom which contains tiny, negatively-charged electrons scattered throughout a positively charged substance.

A Picture of Plum Pudding Model of the Atom

Rutherford’s ‘Gold Foil’ Experiment

Rutherford’s Gold Foil Experiment showed that most of an atom is made of ________________ because most alpha particles passed straight through gold atoms without deflection.

Rutherford’s experiment proved the existence of a nucleus at the center of all atoms which always contain ____________________ and usually also contain ________________.

Protons and neutrons have masses which are much, much larger than an ________________.

A proton has a charge of __________, an electron has a charge of __________ and a neutron is __________ which means it has no charge.

3.6 Introduction to the Modern Concept of Atomic Structure

If the nucleus was the size of a grape the average electron would be ________________ away from the nucleus.
All atoms are made of protons, neutrons and electrons but atoms of different elements have different chemical properties because of the ____________________________

<table>
<thead>
<tr>
<th>The Mass and Charge of the Electron, Proton and Neutron</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Particle</strong></td>
</tr>
<tr>
<td>Electron</td>
</tr>
<tr>
<td>Proton</td>
</tr>
<tr>
<td>Neutron</td>
</tr>
</tbody>
</table>

*The electron is arbitrarily assigned a mass of 1 for comparison

3.7 Isotopes

- “All atoms of the same element contain the same number of protons and electrons but atoms of a given element may contain different numbers of __________________.”
- Isotopes are ___________________________________________________________________________
  ____________________________________________________________________________.
- The atomic number is __________________________.
- The mass number is __________________________
  ____________________________________________________________________________.
- For the symbol $^{A}_{Z} X$
  - $X = $ __________________________________________________________________________
  - $A = $ __________________________________________________________________________
  - $Z = $ __________________________________________________________________________
- Sodium-23 ($^{23}_{11} Na$) has _____ electrons, _____ protons, and _____ neutrons
3.8 Introduction to the Periodic Table

- Elements are listed on the periodic table in order of increasing ____________________.
- Elements are arranged into “families” based on similar ____________________________.
- Families with similar chemical properties are found on the periodic table in vertical columns called ________________.
- On the periodic table given to you, label the groups using numbers along the top and the main groups using roman numerals (IA, IIA, IIIA, IVA, VA, VIA, VIIA & VIIIA).
- On the periodic table given to you, label the following families: Alkali metals, alkaline earth metals, halogens, noble gases and transition metals.
- Most elements are metals and are found ____________ and to the ____________ of the “stair-step” on the periodic table. Nonmetals are usually found ____________ and to the ____________ of the “stair-step.”

Physical Properties of Metals

1. ____________________________
2. ____________________________
3. ____________________________
4. ____________________________

- Most metals are solid at room temperature except ___________________ which is a liquid at room temperature.
- While most metals are solid at room temperature, many nonmetals are gaseous like __________________________ and one is a liquid called __________________________.
• Metalloids are also known as ________________ and lie close to the “stair-step.” They have properties that are mixture of nonmetals and metals. They tend to be brittle and lustrous.

3.9 Natural States of the Elements

• The matter around us consists mainly of ___________________________ so we do not usually find elements in ________________ form.

• Noble gases and noble metals are relatively ______________________. The term _______________________ implies that they are different and apart from the other elements. They are often found as as elements (not compounds) in nature.

• Three examples of diatomic molecules in their elemental form: ________________

3.10 Ions

• Neutral atoms have the same number of protons (+) and electrons (-) so the overall charge (net charge) for a neutral atom is ________________.

• Charged entities called ions are created when electrons are __________________________ __________________________.

• If a sodium (Na) atom loses one electron there will be __________________________ positively-charged protons and __________________________ negatively-charged electrons. This creates an ion with a net __________________________ charge. We can represent this process as follows:
Cations and Anions

- Cations have a ___________________ charge and are created when atoms __________________ electron(s).
- Anions have a ___________________ charge and are created when atoms __________________ electron(s).
- Ions are never formed by changing the number of __________________ in an atom because it would change the element.
- Nonmetal anions have special names which are obtained by starting with the root of the atoms name and adding a(n) ______________ suffix at the end. For example, a Cl\(^+\) is called _____________. O\(^-\) is called ________________.
- Metal ions are named by adding the word ion after the name of the metal. So Al\(^+\) is called an ____________________________.

Ion Charges and the Periodic Table

- Group 1 metals form ________ ions
- Group 2 metals for _________ ions
- Group 13 (3A) metals form _______ ions
- Group 16 (6A) nonmetals form ________ions
- Group 17 (7A) nonmetals form ________ions
- Transition metals form cations with ______________________ charges.
- Metals always form ________________________ ions because they tend to __________________________ electrons and nonmetals always form ________________________ ions because they tend to __________________________ electrons.
3.11 Compounds that Contain Ions

- Ionic compounds have ________________ melting points.
- Ionic compounds ________________ the electrical conductivity of water.
- A substance which contains ions can conduct an electric current only if ________________.
- Ionic compounds contain positively and negatively charged ________________.
- Chemical compounds must have a net charge of ________________.
  - Example:
    \[
    \text{Na}^{1+} + \text{Cl}^{-} \rightarrow \text{NaCl}
    \]
    Charge: _____ + charge: _____ = _____
  - Example:
    \[
    \text{Mg}^{2+} + \text{Cl}^{-} + \text{Cl}^{-} \rightarrow \text{MgCl}_2
    \]
    Charge: _____ + charge: _____ + _____ = _______