Name ____________________________ Section ________ Date __________

Chapter 3: Basic Review Worksheet

1. What is an element? How many elements are presently known? How many of these occur naturally and how many are man-made? Which elements are most abundant on the earth?

2. What are the three fundamental particles that compose all atoms? Indicate the electrical charge and relative mass of each of these particles. Where is each type of particle found in the atom?

3. What is meant by the term *nuclear atom*?

4. What are *isotopes*?

5. Are most elements found in nature in the elemental or in the combined form? Why? Name several elements that are usually found in the elemental form.

6. Give the names of some of the families of elements in the periodic table.

7. Which general area of the periodic table contains the metallic elements? Which general area contains the nonmetallic elements?

8. What are *ions*? How are ions formed from atoms? To what do the terms *cation* and *anion* refer?

9. What are some general physical properties of ionic compounds such as sodium chloride? How do we know that substances such as sodium chloride consist of positively and negatively charged particles?

10. Write the *symbol* and *atomic number* for each of the following elements: magnesium, tin, lead, sodium, hydrogen, chlorine, and silver.

11. Write the *name* and *atomic number* for each of the following elements:
    a. He c. Se e. P
    b. B d. Ba f. Sr

12. Write the *name* and *chemical symbol* for each of the following elements:
    a. 19 c. 1 e. 82
    b. 12 d. 6 f. 2

13. Indicate the number of protons, neutrons, and electrons in isolated atoms having the following nuclear symbols:
    a. $^{4}_{2}He$ b. $^{37}_{17}Cl$ c. $^{40}_{20}Ca$

14. What simple ion does each of the following elements most commonly form?
    a. Mg c. Ba e. O
    b. F d. Na f. Cl

15. For each of the following simple ions, indicate the number of protons and electrons the ion contains.
    a. K^+ c. Br^- e. Na^+

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Chapter 3: Review Worksheet

1. Why do the symbols for some elements seem to bear no relationship to the name for the element? Give several examples and explain.

2. What is a compound? Give examples.

3. Describe the points of Rutherford's model for the nuclear atom and how he tested this model. Based on his experiments, how did Rutherford envision the structure of the atom? How did Rutherford's model for atomic structure differ from Thomson's "plum pudding" model?

4. Which of the subatomic particles is responsible for the chemical behavior of a given type of atom? Why?

5. To what do the *atomic number* and the *mass number* of an isotope refer? How are specific isotopes indicated symbolically? Give an example and explain.

6. Describe the periodic table of the elements. How are the elements arranged in the table? What significance is there in the way the elements are arranged into vertical groups? How can the periodic table be used to predict what ion an element's atoms will form?

7. In terms of subatomic particles, how is a cation related to the atom from which it is formed? An anion? Does the nucleus of an atom change when an atom is converted into an ion?

8. Since ionic compounds are made up of electrically charged particles, why doesn't such a compound have an overall electric charge?

9. Write the *symbol* and *atomic number* for each of the following elements: potassium, calcium, bromine, neon, aluminum, gold, mercury, and iodine.

10. Write the *name* and *atomic number* for each of the following elements:
    a. Si   c. F   e. O
    b. C   d. Be   f. Cr

11. Write the *name* and *chemical symbol* for each of the following elements:
    a. 36   c. 15   e. 29
    b. 92   d. 79   f. 8

12. Indicate the number of protons, neutrons, and electrons in isolated atoms having the following nuclear symbols:
    a. $^{79}_{35}Br$ b. $^{238}_{92}U$ c. $^{1}_{1}H$

13. What simple ion does each of the following elements most commonly form?
    a. Ag   c. Br   e. S
    b. Al   d. K   f. Ca

14. For each of the following simple ions, indicate the number of protons and electrons the ion contains.
    a. H^+ c. N^{3-} e. F^-

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Chapter 3: Challenge Review Worksheet

1. Without consulting any reference, write the name and symbol for as many elements as you can.

2. Without consulting your textbook or notes, state as many points as you can of Dalton's atomic theory. Explain in your own words each point of the theory.

3. What is meant by the *law of constant composition* for compounds and why is this law so important to our study of chemistry?

4. Do the isotopes of a given element have the same chemical and physical properties? Explain.

5. Do isolated atoms form ions spontaneously? Explain.

6. Can an ionic compound consist only of cations or anions but not both? Explain.

7. Indicate the number of protons, neutrons, and electrons in isolated ions having the following nuclear symbols:
   a. $^{19}_{9}F^-$ b. $^{24}_{12}Mg^{2+}$ c. $^{56}_{26}Fe^{3+}$

8. For each of the following simple ions, indicate the number of protons and electrons the ion contains.
   a. Rb^+ c. H^- e. Cl^-
   b. Fe^{2+} d. Al^{3+} f. O^{2-}

9. Using the ions indicated in question 8, write the formulas and give the names for all possible simple ionic compounds involving these ions.

2. Answers will vary.

3. No, physical properties are not necessarily accompanied by chemical changes. However, chemical changes are always accompanied by physical changes.

4. No. Some elements can be composed of molecules. For example, the oxygen that we breathe is made of diatomic oxygen molecules (O_2).

5. When we analyze sulfur dioxide, for example, we notice that each and every molecule consists of one sulfur atom and two oxygen atoms, and on a mass basis, consists of 50% each of sulfur and oxygen. Thus, sulfur dioxide has a constant composition. The reason the mass percent of all sulfur dioxide is constant is because of a constant number of atoms of each type present in the compound's molecules.

6. Yes. For example, if a scientist anywhere in the universe analyzed sulfur dioxide, he or she would find the same composition: if a scientist finds something that does not have the same composition, then the substance cannot be sulfur dioxide.

7. Answers will vary. Examples may include dirt, sand, paper, and chunky peanut butter.

8. All solutions are mixtures but not all mixtures are solutions. Only homogeneous mixtures are solutions.

9. Answers will vary. Examples include: a. a sugar water solution, homogeneous; b. air, homogeneous (although air consists of more than two gases, it is mainly oxygen and nitrogen); c. rubbing alcohol, homogeneous; d. brass, homogeneous.

10. Filtration and distillation are both physical methods. They do not involve a change in the chemical makeup of the substances that are separated.

Chapter 3: Basic Review Worksheet

1. An element is a pure substance that cannot be broken down into simpler substances by chemical means. There are presently more than 110 elements recognized, of which 88 occur in nature (the remaining have been synthesized by nuclear processes). The most abundant elements (by mass) on the earth are oxygen (49.2%), silicon (25.7%), and aluminum (7.50%), with less than 5% of each the other elements present.

2. The three fundamental particles from which atoms are composed are electrons, protons, and neutrons. The properties of these particles are summarized below:

Particle	*Relative Mass*	*Relative Charge*	*Location*
proton	1836	1+	nucleus
neutron	1839	none	nucleus
electron	1	1-	outside of nucleus

3. The expression *nuclear* atom indicates that we view the atom as having a dense center of positive charge (called the nucleus) around which the electrons move through primarily empty space.

4. Isotopes represent atoms of the same element that have different atomic masses. Isotopes are atoms of a given element that have different numbers of neutrons in their nuclei.

5. Most elements are too reactive to be found in nature in other than the combined form. Aside from the noble metals gold, silver, and platinum, the only other elements commonly found in nature in the uncombined state are some of the gaseous elements (such as O_2,. N_2, He, Ar, etc), and the solid nonmetals carbon and sulfur.

6.

Group	Family Name
1	Alkali Metals
2	Alkaline Earth Elements
6	Chalcogens (not used commonly)
7	Halogens
8	Noble Gases

7. Based on the arrangement by electronic structure, the metallic elements tend to be towards the left-hand side of the chart, while the non-metallic elements are found towards the right-hand, upper side. Since metallic nature increases going downward within any vertical column (as the outermost shell gets farther from the nucleus), there are also some metallic elements among the lower members of groups at the right-hand side of the table (many periodic tables indicate the dividing line between metallic and nonmetallic elements with a colored "stairstep").

8. Ions are electrically charged particles formed from atoms or molecules that have gained or lost one or more electrons. Positively charged ions are called *cations*, while negative ions are termed *anions*.

9. Ionic compounds typically are hard, crystalline solids with high melting and boiling points. Ionic substances like sodium chloride, when dissolved in water or when melted, conduct electrical currents. Chemists have taken this evidence to mean that ionic substances consist of positively and negatively charged particles (ions).

10.

Name	Symbol	Atomic Number
magnesium	Mg	12
tin	Sn	50
lead	Pb	82
sodium	Na	11
hydrogen	H	1
chlorine	Cl	17
silver	Ag	47

11. a. helium, 2; b. boron, 5; c. selenium, 34; d. barium, 56; e. phosphorus 15; f. strontium 38.

12. a. potassium, K; b. magnesium, Mg; c. hydrogen, H; d. carbon, C; e. lead, Pb; f. helium, He.

13. a. 2p, 2n, 2e; b. 17p, 20n, 17e; c. 20p, 20n, 20e

14. a. Mg^{2+}; b. F^-; c. Ba^{2+}; d. Na^+; e. O^{2-}; f. Cl^-

15. a. 19p, 18e; b. 35p, 36e; c. 11p, 10e

Chapter 3: Review Worksheet

1. The symbols for some elements may refer to an archaic name for the element, or to the element's name in a modern language other than English. Here are some examples:

Element	English Name	Derivation of Name
Na	sodium	Latin: *natrium*
K	potassium	Latin: *kalium*
Fe	iron	Latin: *ferrum*
W	tungsten	German: *wolfram*

2. A compound is a distinct, pure substance that is composed of two or more elements held together by chemical bonds. Carbon dioxide and water are two examples, but answers will vary.

3. Rutherford's experiment involved shooting a beam of particles at a thin sheet of metal foil. According to the then current "plum pudding" model of the atom, most of these positively charged particles should have passed right through the foil. However, Rutherford detected that a significant number of particles effectively bounced off something and were deflected backwards to the source of particles, and that other particles were deflected from the foil at large angles. Rutherford realized that his observations could be explained if the atoms of the metal foil had a small, dense, positively charged nucleus, with a significant amount of empty space between nuclei. The empty space between nuclei would allow most of the particles to pass through the atom. However, if a particle hit a nucleus head-on, it would be deflected backwards at the source. If a positively charged particle passed near a positively charged nucleus (but did not hit the nucleus head-on), then the particle would be deflected by the repulsive forces between the positive charges. Rutherford's experiment conclusively disproved the "plum pudding" model for the atom, which envisioned the atom as a uniform sphere of positive charge, with enough negatively charged electrons scattered through the atom to balance the positive charge.

4. It is the number and arrangement of the *electrons* in an atom which are responsible for the chemical behavior of the atom. The electrons are found in nearly the entire region of space occupied by an atom, from just outside the nucleus all the way out to the outermost *edge* of the atom. When two atoms approach each other in space prior to a reaction taking place, the electrons from one atom interact with the electrons of the other atom. The nucleus is so small, compared to the overall size of the atom that the nuclei of atoms do not interact with each other.

5. Isotopes have the same atomic number (number of protons in the nucleus) but have different mass numbers (total number of protons and neutrons in the nucleus). The different isotopes of an atom are indicated by symbolism of the form $^{A}_{Z}X$ in which Z represent the atomic number and A the mass number of element X. For example, $^{13}_{6}C$ represents a nuclide of carbon with atomic number 6 (6 protons in the nucleus) and mass number 13 (reflecting 6 protons plus 7 neutrons in the nucleus).

6. The periodic table arranges the elements in order of increasing atomic number. The table is further arranged by placing elements with similar electronic structure (and hence similar chemical properties) into the same vertical column (group). Since the periodic table is arranged with the elements in the same vertical column having *similar* electronic structures, the mere *location* of an element in the periodic table can be an indication of what simple ions the element forms. For example, the Group 1 elements all form 1+ ions (Li^+, Na^+, K^+, Rb^+, Cs^+). while the Group 7 elements all form 1- ions (F^-, Cl^-, Br^-, I^-). You will learn more about how the charge of an ion is related to an atoms' electronic structure in a later chapter.

7. A positive ion forms when an atom or molecule loses one or more of its electrons (negative charges). For example, sodium atoms and magnesium atoms form ions as indicated below

   Na (atom) $\rightarrow$ Na^+ (ion) + e^- Mg (atom) $\rightarrow$ Mg^{2+} (ion) + $2e^-$

   The resulting ions contain the same number of protons and neutrons in their nuclei as do the atoms from which they are formed, since the only change that has taken place involves the electrons (which are not in the nucleus). These ions contain fewer electrons than the atoms from which they are formed. A negative ion forms when an atom or molecule *gains* one or more electrons from an outside source (another atom or molecule). For example, chlorine atoms and oxygen atoms form ions as indicated below:

   Cl (atom) + e^- $\rightarrow$ Cl^- (ion)   O (atom) + $2e^-$ $\rightarrow$ O^{2-} (ion)

8. Although an ionic substance is made up of positively and negatively charged particles, there is no net electrical charge on a sample of such a substance because the total number of positive charges is balanced by an equal number of negative charges.

9.

Name	Symbol	Atomic Number
potassium	K	19
calcium	Ca	20
bromine	Br	35
neon	Ne	10
aluminum	Al	13
gold	Au	79
mercury	Hg	80
iodine	I	53

10. a. silicon, 14; b. carbon, 12; c. fluorine, 9; d. beryllium, 4; e. oxygen, 8; f. chromium, 24.

11. a. krypton, Kr; b. uranium, U; c. phosphorus, P; d. gold, Au; e. copper, Cu; f. oxygen, O.

12. a. 35p, 44n, 35e; b. 92p, 146n, 92e; c. 1p, 0n, 1e

13. a. Ag^+; b. Al^{3+}; c. Br^-; d. K^+; e. S^{2-}; f. Ca^{2+}

14. a. 1p, 0e; b. 7p, 10e; c. 9p, 10e

Chapter 3: Challenge Review Worksheet

1. While students certainly don't have to memorize all the elements, they should at least be able to give the symbols and names for the most common elements.

2. Dalton's atomic theory as presented in this text consists of five main postulates. Although Dalton's theory was exceptional scientific thinking for its time, some of the postulates have been modified as our scientific instruments and calculational methods have become increasingly more sophisticated. The main postulates of Dalton's theory are as follows: (1) Elements are made up of tiny particles called atoms; (2) all atoms of a given element are identical; these atoms are different from the atoms of all other elements; (4) atoms of one element can combine with atoms of another element to form a compound, and such a compound will always contain the same relative numbers and types of atoms; (5) atoms are rearranged into new groupings during an ordinary chemical reaction, and no atom is ever destroyed and no new atom is ever created during such a reaction. Students should explain these in their own words.

3. A given compound always contains exactly the same relative masses of its constituent elements. This statement is termed the law of constant composition. The law of constant composition is a result of the fact that a given compound always contains the same types and numbers of each constituent atom. For example, water's composition by mass (88.8% oxygen, 11.2% hydrogen) is a result of the fact that each water molecule contains one oxygen atom (relative mass 16.0) and two hydrogen atoms (relative mass 1.008 each). The law of constant composition is important to our study of chemistry because it means that we can always assume that any sample of a given pure substance, from whatever source, will be identical to any other sample.

4. The various isotopes of an element have virtually identical chemical properties since the chemical properties of an atom are a function of the electrons in the atom (*not* the nucleus). The physical properties of the isotopes of an element (and compounds containing those isotopes) may differ because of the difference in mass of the isotopes.

5. Isolated atoms do not form ions on their own, but are induced to gain or lose electrons by some other species (which loses or gains the electrons).

6. An ionic compound could not possibly exist of just cations or just anions: there must be a balance of charge or the compound would be very unstable (like charges repel each other).

7. a. 9p, 10n, 10e; b. 12p, 12n, 10e; c. 26p, 30n, 23e

8. a. 37p, 36e; b. 26p, 24e; c. 1p, 2e; d. 13p, 10e; e. 17p, 18e; f. 8p, 10e

9. RbH, $RbCl$, Rb_2O; FeH_2, $FeCl_2$, FeO; AlH_3, $AlCl_3$, Al_2O_3.

Chapter 4: Basic Review Worksheet

1. When naming ionic compounds, we name the positive ion (cation) first. Sodium chloride is an example.