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**WS 4.1 Dalton’s Theory of Atomic Structure**

1) Distinguish between the terms atom and molecule.

2) What distinguishes an atom of nitrogen from an atom of oxygen?

3) Cyclopropane, a very effective anesthetic, contains the elements carbon and hydrogen combined in a ratio of 1.00 grams of hydrogen to 6.00 g of carbon. If a given sample of cyclopropane was found to contain 24.0 g of hydrogen, how many grams of carbon would it contain? (144)

4) Three samples of a solid substance composed of elements X and Y were prepared. The first was found to contain 4.31 g X and 7.69 g Y; the second was composed of 35.9% X and 64.1% Y; it was observed that 0.718 g X reacted with Y to form 2.00 g of the third sample. Show how these demonstrate the law of definite proportions (also known as law of constant composition).

5) Two samples of Freon (a coolant used in refrigerators and air conditioners) were analyzed. In one sample, 1.00 g C was found to be combined with 6.22 g F and 11.67 g Cl. In the second sample, 2.00 g C was found to be combined with 12.66 g F and 23.34 g Cl.

a. What are the ratios of the masses of carbon to fluorine, carbon to chlorine and fluorine to chlorine in each of these samples.

b. Do the data support the law of definite proportions (aka definite proportions)?

Explain your answer.

6) Which law (if any) is illustrated by the following statements:

a. When copper (I) oxide decomposes, the total mass of the copper and oxygen formed equals the mass of copper oxide decomposed.

b. Analysis of water in the rain collected in the Amazon rain forest and of that

formed in a test tube by combining hydrogen and oxygen gives the same value for the percent oxygen.

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7) Which law does the following statement illustrate?

a. A sealed bag of popcorn has the same mass before and after it is put in a microwave oven (assume no breaks in the bag after it has been put into the microwave oven).

b. A teaching assistant writes “highly improbable” in a student’s report that states that his unknown is S2.1O2.7.

8) Mercury (II) oxide, a red powder, can be decomposed by heating to produce liquid mercury and oxygen gas. When a sample of this compound is decomposed, 3.87 g of oxygen and 48.43 g of mercury are produced. In a second experiment, 15.68 g of mercury is allowed to react with an excess of oxygen; 16.93 g of red mercury (II) oxide is produced. Show that these results are or are not consistent with the law of definite proportions (constant composition).

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**WS 4.2 Symbols and Isotopes**

1) Oxygen consists of three different , each having eight protons but different numbers of neutrons.

2) What is the name of the element represented by each of the following atomic symbols:

a. Ne b. Zn

c. Ag d. Mg

|  |  |  |
| --- | --- | --- |
| 3) | Give the atomic symbol for each of the following elements: |  |
|  | a. potassium | b. sulfur |
|  | c. iron | d. manganese |

4) The following table gives the number of protons and neutron in the nuclei of various atoms.

a. Which atom is the isotope of atom A?

b. Which atom has the same mass number as atom A?

|  |  |  |
| --- | --- | --- |
|  | Protons | Neutrons |
| Atom A | 17 | 18 |
| Atom B | 16 | 19 |
| Atom C | 17 | 19 |
| Atom D | 18 | 22 |

5) Naturally occurring chlorine is a mixture of the isotopes Cl-35 and Cl-37.

a. How many protons and how many neutrons are there in each isotope?

b. How many electrons are there in the neutral atoms?

6) What is the nuclide symbol for the nucleus that contains 17 protons and 16 neutrons?

7) A particular atom of potassium contains 19 protons, 19 electrons and 20 neutrons. a. What is the atomic number of this atom?

b. What is its mass number?

c. Write the symbol for this potassium nucleus.

8)

a. How many electrons, neutrons, and protons are in atoms of uranium with mass number 238?

b. How many electrons, neutrons, and protons are in the atoms of barium with mass number 138?

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**WS 4.3 Symbols, Isotopes & Average Atomic Mass**

1) Yttrium was discovered in 1794. It is one of the elements used in superconductors. How many electrons, protons, and neutron are in an atom of yttrium-88?

2) How many neutrons and protons are in each of the following nuclides?

a. Carbon-14

b. Phosphorus-32 c. Nickel-63

d. Iridium-192

3) What isotope is used as the reference standard in defining the atomic mass unit?

4) Magnesium has naturally occurring isotopes with the following masses and abundances.

What is the atomic mass of magnesium, calculated from these data?

|  |  |  |
| --- | --- | --- |
| Isotope | Isotopic Mass (amu) | Fractional Abundance |
| Mg-24 | 23.985 | 0.787 |
| Mg-25 | 24.986 | 0.1013 |
| Mg-26 | 25.983 | 0.1117 |

5) An element has two naturally occurring isotopes with the following masses and abundances.

a. What is the atomic mass of this element?

b. What is the identity of the element?

|  |  |
| --- | --- |
| Isotopic Mass (amu) | Fractional Abundance |
| 84.9118 | 0.7215 |
| 86.9092 | 0.2785 |

6) Find the average atomic mass of silver if 51.83% of the silver atoms occurring in nature have mass of 106.905 amu and 48.17% of the atoms have mass of 108.905 amu.

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7) Find the average atomic mass of krypton if the relative amounts are as follows: Isotopic Mass Percentage

77.920 amu 0.350

|  |  |
| --- | --- |
| 79.916 amu | 2.27 |
| 81.913 amu | 11.56 |
| 82.914 amu | 11.55 |
| 83.912 amu | 56.90 |
| 85.911 amu | 17.37 |

8) Selenium is widely sold as a dietary supplement. It is advertised to “protect” women from

breast cancer. Write the nuclide symbol for naturally occurring selenium. It has 34 protons and 46 neutrons.

9) Radon is a radioactive gas that can cause lung cancer. How many protons are there in a

Rn-222 atom? How many neutrons?

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**WS 4.4 Nuclear Emissions**

|  |  |  |  |
| --- | --- | --- | --- |
| Type | Symbol | Charge | Mass |
| Alpha particle | α | +2 | 4 |
| Beta particle | β | -1 | 0 |
| Gamma Ray | γ | 0 | 0 |

Radioactive decay occurs through a series of nuclear reactions. These are usually a combination of alpha and beta emissions, meaning that an atom releases either an alpha or a beta particles from its nucleus. A change in the nucleus generally changes the identity of the atom. It becomes another element.

Alpha emission:

238

U 

92

4

He +

2

234

Th

90

Beta emission:

234

90

0

Th  *e* +

 1

234

Pa

91

Notice that the product of one decay reaction becomes the element that decays (starting point) in the next step.

In a series of 14 steps (the first two are above), Uranium-238, a fuel used in nuclear reactors, decays until it reacts a stable element. This final element is not radioactive. It will no longer undergo decay. It is stable.

Write radioactive decay reactions for the steps below. What stable element is the U-238 finally converted to?

3. Beta emission

NOTE: Work your way  **across**

234

91

Pa   +



|  |  |  |
| --- | --- | --- |
| 4) alpha emission | 5) alpha emission | 6) Beta emission |
| 7) alpha emission | 8) alpha emission | 9) Beta emission |
| 10) alpha emission | 11) beta emission | 12) Alpha emission |
| 13) beta emission | 14) alpha emission |  |

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**WS 4.5 The Periodic Table Introduction**

1) Which of the following are transition elements? As, W, Ag, Al, Sr, Ru

2) Which of the following is a halogen: Na, Ca, Fe, F, As?

3) Write the formulas of the molecules formed by the halogens in their elemental states.

4) Which of the following are metals? Ta, Nd, Se, F, Cs

5) Which of the following elements is an alkali metal? Br, K, O, S, N

6) Which of the following elements is an alkaline earth metal? Cu, B, Ba, Ne, Se?

7)

a. Identify the metals, nonmetals, and metalloids in period 4.   
b. Identify the metals in the alkali metals group.

8) Classify the following elements as metals or nonmetals

Manganese Fluorine Silver

Mercury Cobalt Praseodymium Nitrogen Niobium Hydrogen Lithium Radium Carbon

9) Iodine is used in many commercials chemicals and dyes.

a. To what family does iodine belong?

b. What are the other members of this family?

10) What are the major differences in properties among metals, nonmetals, and metalloids?

11) Give the symbol for:

Cesium Tungsten Antimony

Phosphorus Potassium

12) Name the elements whose symbols are:

|  |  |  |
| --- | --- | --- |
| C | Co | Cd |
| Cl | Cu |  |

13) How many elements are there in the following groups: Group 11 Group 2

Group 17 Group 5

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**WS 4.6 Atomic Structure Review**

Topics: Atomic Theory (Dalton & his theory, Thomson, Rutherford & Gold Foil Experiment), Atomic Structure (subatomic particles, atomic number, atomic mass, isotopes, mass spectrometry, calculating atomic mass from abundances), Periodic Table (symbols, families, groups, periods, metals, non-metals, metalloids), Chemical change vs. Nuclear change (radioactive particles & waves, nuclear emission equations).

1. Identify the name of the element represented by each of the following symbols. Then give atomic number, average atomic mass, period number, group number and family name (if possible.)

a. Ne b. Cl   
c. Ag d. Se e. P

f. Ba g. Na

2. Give the atomic symbol for each of the following elements:

a. Potassium b. Sulfur

c. Iron

d. Argon

e. Calcium

f. Arsenic



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3. An atom contains five protons and six neutrons. Give the nuclide symbol for the element.

What is the element’s name and what is its mass?

4. A magnesium atom has how many protons, neutrons and electrons?

5. Lithium has two isotopes: Li-6 and Li-7. Write a nuclide symbol for each isotope. In terms of subatomic particles, etc, how are the two similar and how are they different?

6. Boron has two isotopes: B-10 has a mass of 10.013 amu and an abundance of 0.1978, while B-11 has a mass of 11.009 amu and an abundance of 0.8022. Calculate the average atomic mass of boron.

7. An unknown element has three naturally occurring isotopes. The first has a mass of 27.977 amu and an abundance of 0.9221; the second has a mass of 28.976 amu and an abundance of 0.0470; and the third has a mass of 29.974 amu and an abundance of 0.0309. What is the average atomic mass of this element? What element is it?

8. Give the name and symbol for each of the following:

a. A transition metal in the fifth period b. A halogen in the 3rd period

c. An alkaline earth element in the 2nd period

d. A metalloid in group 16

e. A transition element in group 12

f. The element in group 4 and period 5

9. Thorium-232 is radioactive and decays into Radium-228. What type of particle does it emit?

10. Phosphorus-32 is radioactive and decays into Sulfur-32. What type of particle does it emit?

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11. Uranium-228 undergoes alpha emission, beta emission, beta emission and alpha emission.

Write a series of equations showing these changes and identify the isotope that is finally produced.

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**WS 4.7 Atomic Structure and Isotopes**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Isotope**  **Name** | **Nuclide Symbol** | **Atomic Number** | **Mass Number** | **# of Protons** | **# of Electrons** | **# of Neutrons** |
| 1. calcium-40 |  |  |  |  |  |  |
|  |  | 12 | 24 |  |  |  |
|  |  |  |  | 1 |  | 2 |
|  |  |  |  |  |  |  |
|  |  |  |  |  | 26 | 30 |
|  |  |  | 201 | 80 |  |  |
|  |  | 17 |  |  |  | 18 |

**Part B – Average Atomic Mass**

1. Calculate the average atomic mass for neon if its abundance in nature is 90.5% neon-20, 0.3% neon-21, and 9.2% neon-22.
2. Calculate the average atomic mass of silver if 13 out of 25 atoms are silver-107 and 12 out of 25 atoms are silver-109.
3. Distinguish between mass number, relative atomic mass, and average atomic mass.

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# WS 4.8 Atomic Theory Word List

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
7. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
8. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
9. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
10. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
11. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
12. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
13. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
14. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
15. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
16. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
17. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
18. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
19. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
20. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

atom mass number  
atomic number multiple proportions  
Bohr neutron  
Chadwick nucleus  
conservation of matter Dalton   
proton definite proportions  
Proust electron  
energy level Rutherford  
isotopes subatomic particle  
Lavoisier Thomson

More than 2000 years ago, Greek philosophers proposed the existence of very small, indivisible particles, each of which was called a(n) \_\_(1)\_\_. The theory that such particles existed was supported, much later, by \_\_(2)\_\_, who proposed, in his law of \_\_(3)\_\_, that matter cannot be created or destroyed. Then \_\_(4)\_\_ proposed, in his law of \_\_(5)\_\_, that the ratio of the masses of elements in any given compound is always the same. The law of \_\_(6)\_\_, proposed soon after, states that the masses of one element that combine with a fixed mass of another element in different compounds are in simple, whole-number ratios. An atomic theory based on these laws was developed by \_\_(7)\_\_. It was later proposed that the atom was not indivisible, but is made up of smaller particles, each of which is called a(n) \_\_(8)\_\_. These particles include the negatively-charged \_\_(9)\_\_, discovered by \_\_(10)\_\_; the positively-charged \_\_(11)\_\_; and the uncharged \_\_(12)\_\_, discovered by \_\_(13)\_\_. The latter two particles are present in the \_\_(14)\_\_, or center, of the atom, which was discovered by \_\_(15)\_\_ in his gold foil experiment. The number of positively-charged particles in an atom is called its \_\_(16)\_\_. The sum of the positively-charged particles and the uncharged particles is called the \_\_(17)\_\_ of the atom. Atoms that have the same number of positively-charged particles but different numbers of uncharged particles are called \_\_(18)\_\_. The Danish physicist \_\_(19)\_\_ proposed a model of the atom in which the electrons orbit the nucleus without losing energy. He called each possible orbit a(n) \_\_(20)\_\_.

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