Unit 4 Review
Basics and Structure of Atoms

Name Answer Key
Period_____ Date_____

Topics:

- protons, neutrons, electrons, atomic number, mass number, symbols & properties
- Calculations of average atomic mass of an element given % abundance data.
- Evidence for structure of atom—Thomson CRT, Millikan Oil Drop, Rutherford Gold Foil, Rutherford Protons Chadwick Neutron,
- Mass spectrometer (mass & percent abundance of isotopes)

1) Fill in all missing information for each question: All symbols must have atomic # & mass #

Isotope	Symbol	Number of Protons	Number of Neutrons	Mass Number
a. Helium-3	$^{3}_{2}He$	2	1	3
b. Lithium-6	$^{6}_{3}Li$	3	3	6
c. Fluorine-20	$^{20}_{9}F$	9	11	20
d. Nickel-61	$^{61}_{28}Ni$	28	33	61
e. Thorium-232	$^{232}_{90}Th$	90	142	232
f. Rhodium-103	$^{103}_{45}Rh$	45	58	103

2) Determine the average atomic mass of iron (Fe) on Mars if it were to have the following % abundance of Fe isotopes on Mars: 20.0% ^{54}Fe (53.940 amu), 75.0% ^{56}Fe (55.935 amu), and 5.0% ^{58}Fe (57.933 amu). Why is this value different from what is listed on the periodic table?

$$\text{Mass}_{Fe} = 53.940\text{ amu}\times\frac{20.0\%}{100\%} + 55.935\text{ amu}\times\frac{75.0\%}{100\%} + 57.933\text{ amu}\times\frac{5.0\%}{100\%}$$

$$= 10.79\text{ amu} + 41.95\text{ amu} + 2.90\text{ amu} = \boxed{55.6\text{ amu}}$$

This is different from the value on the periodic table because the % abundance values are different than those on earth.

3) In nature, copper exists as two different isotopes, ^{63}Cu and ^{65}Cu. If one looks at the periodic table, one finds that the average atomic mass of copper is 63.55.

a. Which isotope must be more abundant in nature? ^{63}Cu is more abundant

b. Explain reasoning.
Since the average atomic mass of Cu is closer to 63 than to 65, it is more heavily weighted toward isotope ^{63}Cu, which must be more abundant.

4) Element Z is composed of the following four isotopes: 1.40% Z-204 (203.973 amu), 24.10 % Z-206 (205.974 amu), 22.10% Z-207 (206.976 amu) and 52.40% Z-208 (207.977 amu). Determine the average atomic mass of Z and identify it.

$$\text{Mass}_{Z} = 203.973\text{ amu}\times\frac{1.40\%}{100\%} + 205.974\text{ amu}\times\frac{24.10\%}{100\%} + 206.976\text{ amu}\times\frac{22.10\%}{100\%} + 207.977\text{ amu}\times\frac{52.40\%}{100\%}$$

$$= 2.856\text{ amu} + 49.640\text{ amu} + 45.742\text{ amu} + 108.98\text{ amu}$$

$$= \boxed{207.2\text{ amu; Z is Pb}}$$

5) What property of electrons ("cathode rays") did Thomson determine? charge/mass ratio

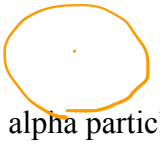
6) How did Thomson know that electrons had a much lower mass than H atoms?
Their deflection in the CRT was much larger than observed for charged H atoms.

7) Describe JJ. Thomson's model of the atom.
In the Plum Pudding model, the electrons were particles of negative charge evenly distributed throughout a matrix of evenly distributed positive charge of equal amount to the negative charge.

8) What two things were determined by the Oil Drop Experiment? charge and mass of the electron

9) Describe the basic results of the oil drop experiment and explain how the results support the conclusion.
Falling oil drops had electrons attached to them from air ionized by x-rays and their falling was counteracted by an electric field. By comparing the forces of gravity and the electric field, the charge on the particle was determined. It was found that the charges were all a multiple of a smallest charge, which was determined to be the charge on a single electron. Knowing the charge and the charge/mass ratio, the mass could then be determined.

10) In the gold foil experiment, why had Rutherford predicted that all of the alpha particles should go straight through the gold foil?
According to the Plum Pudding model, the charge and mass of the atom should have been evenly distributed, so there would have been no net force on the alpha particles passing through it.



11) Why did most of the alpha particles go straight through the foil and a small number were deflected? (Must answer both parts!)
The atom is mostly "empty" space with nothing for the alpha particles to collide with, but about 1 in 10,000 particles collided with and were deflected by the positively charged, small, massive, dense nucleus.

12) How did Rutherford realize that the ^{1}H atom must be a proton (^{1}p)?
Every α particle-N collision created a ^{1}H atom (the lightest element) in addition to another product, so Rutherford surmised that the ^{1}H atoms must have come from each nucleus, and thus was the fundamental positively charged particle of the nucleus, which he called the proton.

13) What particle was ejected by Be when it was struck with α particles? How did Chadwick know its mass and charge?
The neutron was ejected from Be. He knew its mass because it had to have enough mass/energy to eject a proton when it struck the wax target, and he knew it had no charge because it was not deflected by an electric or magnetic field.

14) How does a mass spectrometer separate isotopes?
A beam of atoms is ionized and passed through a magnetic field. The particles are deflected according to their charge/mass ratio, but since most particles have a +1 charge, they are separated by mass, with the least massive being deflected most. Analyzing the data, the location of the signal gives the mass, and the height gives the relative amount, or % abundance, of the isotope.