Worksheet No. 1

Name ____________________

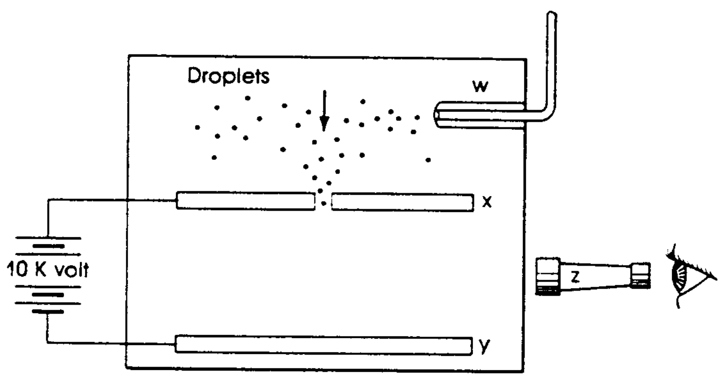
Class ____________ Date ____________

CHAPTER 8 WORKSHEET

Composition of the Atom

A. Millikan Oil-Drop Experiment

In 1909, the American physicist Robert Millikan measured the charge of an electron. Using the apparatus illustrated below, he introduced a fine mist of oil into a closed chamber. The droplets of oil passed between two electrically charged plates through which he was able to influence their rates of descent. Observing the individual droplets through a microscope, Millikan was able to adjust the electrical force so that the drops moved away from whichever plate had the same charge. He timed the drops' rate of movement. From this information, he was able both to determine the charge of an electron and to suggest a value for its mass. Study the diagram below and answer the following questions. Write the letter of each answer in the space provided on the left.



b 1. To cause a negatively charged oil droplet to move upward; plate Y should have ______.

a. a positive charge
b. a negative charge
c. an excess of protons
d. an excess of neutrons

c 2. The purpose of device Z is to ________.

a. observe the electrical potential difference (voltage) between the plates
b. separate spectral emissions
c. magnify droplets of liquid
d. locate positively charged particles

c 3. If a droplet was momentarily suspended between the electric plates, ________.

a. the number of protons in the droplet equaled the number of electrons
b. there was no charge on the plates
c. the droplet weight was exactly balanced by forces of electrical repulsion/attraction
d. the mass of the electrons in the droplet equaled the mass of the protons

d 4. The function of device W is to ________.

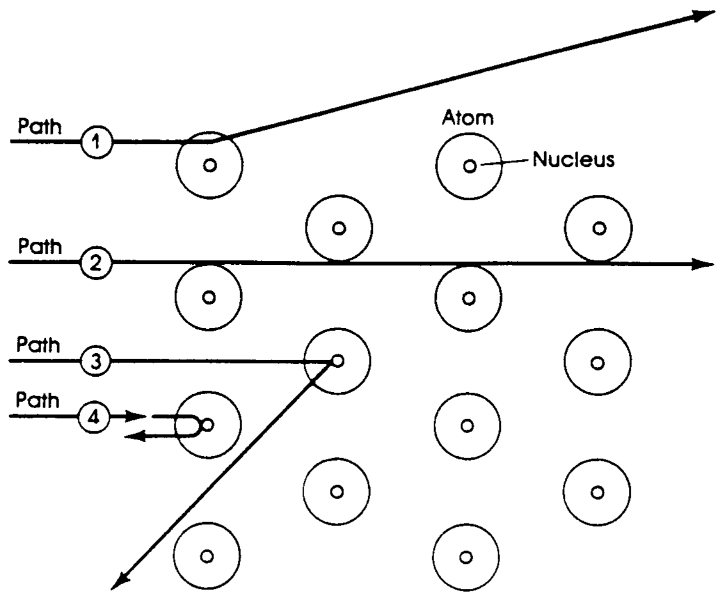
a. remove excess mist
b. supply protons
c. monitor relative humidity
d. produce a mist from liquid oil

b 5. If the electrical leads to plates X and Y were reversed, negatively charged oil droplets that had been moving upward would ________.

a. remain suspended
b. move downward to plate Y
c. move upward to plate X
d. acquire a positive charge

B. The Rutherford Experiment

Our modern view of atomic structure is based to a large extent on the work that British scientists Rutherford and Geiger did in 1911. In the classic experiment, positive alpha particles bombarded a sheet of gold foil. The paths followed by those particles are illustrated in the following figure. Study the diagram and answer the questions below.



b 1. Which of the four paths was most common?
a. 1 b. 2 c. 3 d. 4

d 2. Which of the four paths was least common?
a. 1 b. 2 c. 3 d. 4

c 3. Path 2 was a straight line because of the alpha particles' ________.
a. magnetic repulsion
b. high velocity
c. distance from gold nuclei
d. interaction with electrons

c 4. Path 4 will most likely ________.
a. never be observable
b. be characteristic of only the fastest-moving alpha particles
c. be characteristic of alpha particles that move directly toward a nucleus
d. result in an atomic reaction

d 5. When Rutherford analyzed his results, he suggested that ________.
a. the atom was mostly empty space
b. atoms contained a small, dense center
c. the atomic center was positive in charge
d. all of the above were true

C. Atomic Theorists

The modern concept of atomic structure is based upon the work and ideas of numerous scientists. Match each of the statements below with the name of the scientist most closely associated with the achievement described. Fill in each blank with the correct name.

Becquerel	Crookes	Dalton	Joliot-Curie	Rutherford
Chadwick	Curie	Geiger	Millikan	J.J. Thomson

1. proposed first atomic model that accounted for the electrical nature of the atom — J.J. Thompson
2. measured the charge of an electron — Millikan
3. suggested that alpha particles may rebound at an angle approaching 180° after coming close to a nucleus — Geiger
4. proposed that an atom was a sphere that was equally dense throughout — Dalton
5. discovered a neutral beam that had high penetrating power — Joliot - Curie
6. used metallic foil as a target for alpha bombardment — Rutherford
7. developed the cathode-ray tube (CRT) — Crookes
8. is credited with the discovery of radioactivity — Becquerel
9. discovered the radioactive element polonium — Curie
10. was first to identify the neutron — Chadwick

D. Nuclear Symbols

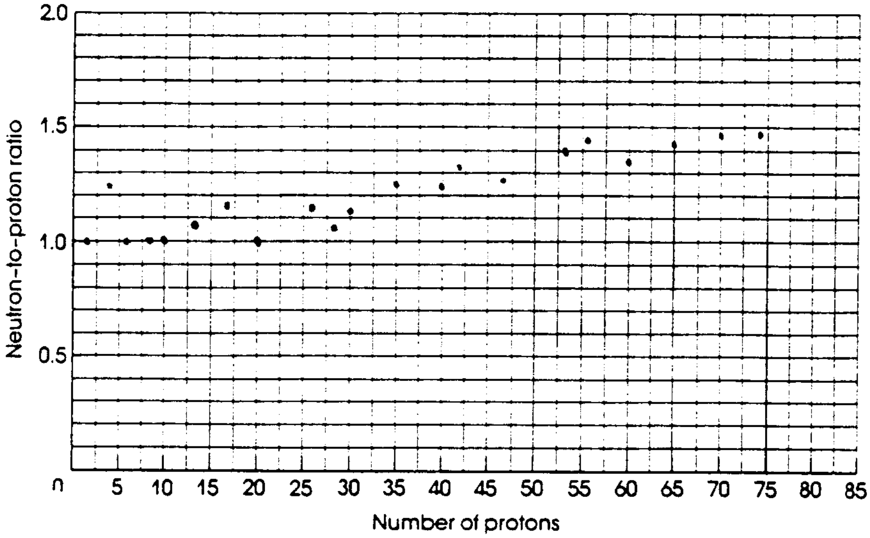
Atomic symbols are often accompanied by notation that gives information on atomic composition. The subscript, written to the lower left of an atomic symbol, represents the atomic number. The superscript, written to the upper left of the symbol, represents the mass number, or total number of protons and neutrons. Using this information, complete the following table. Assume that the atomic mass of one neutron or one proton equals 1 amu.

SYMBOL	ATOMIC NUMBER	ATOMIC MASS (amu)	NUMBER OF PROTONS	NUMBER OF NEUTRONS	NUMBER OF ELECTRONS
$^{12}_{6}C$	6	12	6	6	6
$^{40}_{18}Ar$	18	40	18	22	18
$^{127}_{53}I$	53	127	53	74	53
$^{23}_{11}Na$	11	23	11	12	11
$^{20}_{10}Ne$	10	20	10	10	10
$^{48}_{22}Ti$	22	48	22	26	22
$^{40}_{20}Ca$	20	40	20	20	20
$^{238}_{92}U$	92	238	92	146	92

E. Nuclear Stability

The stability of a nucleus is dependent upon the ratio of its component particles. In the stable isotopes of lighter nuclei, the ratio of neutrons to protons approximates a value of one. The ratio in the stable isotopes of heavier nuclei approaches a value of 1.5. Ratios falling outside this "belt" of stability correspond to radioactive, or unstable nuclei.

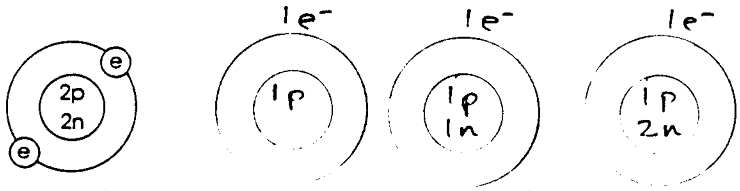
Complete the following table of representative stable nuclei. Determine the neutron-to-proton ratio of each by dividing the number of neutrons by the number of protons. Plot the resulting points on the grid provided on the next page.



ISOTOPE	NUMBER OF NEUTRONS	NUMBER OF PROTONS	NEUTRON-TO-PROTON RATIO
$^{4}_{2}He$	2	2	1
$^{9}_{4}Be$	5	4	1.25
$^{12}_{6}C$	6	6	1
$^{16}_{8}O$	8	8	1
$^{20}_{10}Ne$	10	10	1
$^{27}_{13}Al$	14	13	1.08
$^{37}_{17}Cl$	20	17	1.18
$^{40}_{20}Ca$	20	20	1
$^{56}_{26}Fe$	30	26	1.15
$^{58}_{28}Ni$	30	28	1.07
$^{64}_{30}Zn$	34	30	1.13
$^{79}_{35}Br$	44	35	1.26
$^{90}_{40}Zr$	50	40	1.25
$^{98}_{42}Mo$	56	42	1.33
$^{107}_{47}Ag$	60	47	1.28
$^{127}_{53}I$	74	53	1.40
$^{138}_{56}Ba$	82	56	1.46
$^{142}_{60}Nd$	82	60	1.37
$^{158}_{65}Tb$	93	65	1.43
$^{174}_{70}Yb$	104	70	1.49
$^{184}_{74}W$	110	74	1.49

F. Hydrogen Isotopes

Atoms are made up of subatomic particles, such as protons, neutrons, and electrons. The nuclei of atoms that make up isotopes of an element differ. There are three known isotopes of the element hydrogen. Make a drawing representing each of these isotopes. (A drawing of a helium isotope is shown below as an example.)



Helium, $^{4}_{2}He$ Protium, $^{1}_{1}H$ Deuterium, $^{2}_{1}H$ Tritium, $^{3}_{1}H$

1. Explain why the atomic mass of hydrogen is 1.0079 and not a whole number.

Atomic mass is a weighted average mass based on the different isotope masses and their relative abundances.

2. Do the numbers of electrons for neutral isotopes of the same element differ? No

3. Do the numbers of protons for such isotopes differ? No

4. Do the numbers of neutrons for such isotopes differ? Yes

5. Do the atomic numbers of such isotopes differ? Explain.

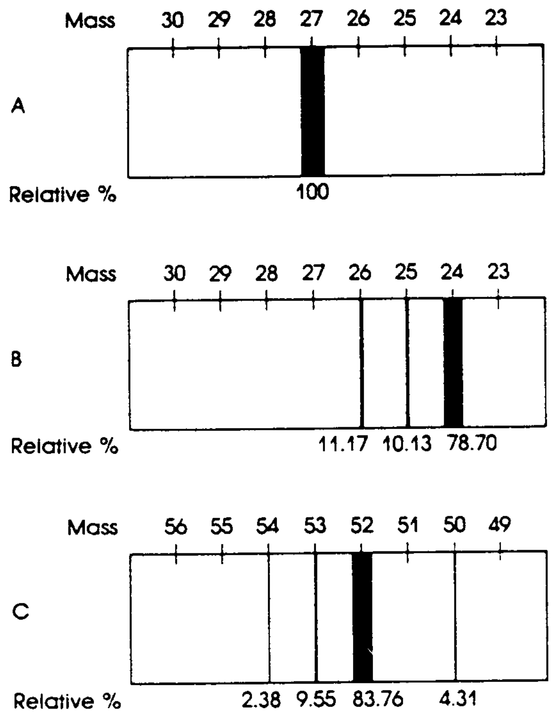
No. Atomic number = the number of protons, which is equal for isotopes.

6. Do the mass numbers of such isotopes differ? Explain.

Yes. Mass number = the total number of neutrons and protons. Since isotopes have equal numbers of protons but different numbers of neutrons, their mass numbers must be different.

G. Analyzing a Spectrograph

A mass spectrograph (or a mass spectrometer) is an instrument used to separate an element's isotopes and to measure their relative abundances. Within this device, beams of an element's ions are passed through a strong magnetic field. As they are passed through, they respond to the magnetic force. Ions of greater mass possess more inertia, or more of a tendency to continue to move in a straight line, and so deviate only slightly from their projected path. Ions of lesser mass are more greatly influenced by the field and demonstrate greater deviation. Examine the three mass spectrograph readings illustrated on the next page and answer the questions that follow. Note that the upper scale of each spectrograph shows atomic mass (in amu). Below each spectrograph, the percents of the various isotopes present are given.



1. a. What is the atomic mass of the isotope of the element represented by spectrum A? 27 amu

   b. What are the name and atomic symbol of element A? (Consult a periodic table or table of atomic masses.) aluminum, Al

2. a. What are the atomic masses of the isotopes in spectrum B? 24, 25, 26

   b. Based on the experimentally obtained values of atomic mass and percent, calculate the average atomic mass of this element. Show your work.

   0.1117 × 26.0 amu = 2.90

   0.1013 × 25.0 amu = 2.53

   0.7870 × 24.0 amu = 18.9

   24.3

   24.3 amu

   c. What are the name and symbol of this element? magnesium, Mg

   d. What are the symbols, including superscripts and subscripts, of the isotopes of this element? $^{24}_{12}Mg$, $^{25}_{12}Mg$, $^{26}_{12}Mg$

   e. Which isotope deviated most from its straight-line path? $^{24}_{12}Mg$

3. a. What are the atomic masses of the isotopes in spectrum C? 50, 52, 53, 54

   b. Calculate the average atomic mass of this element.

   0.0238 × 54.0 amu = 1.29

   0.0955 × 53.0 amu = 5.06

   0.8376 × 52.0 amu = 43.56

   0.0431 × 50.0 amu = 2.155

   52.1

   52.1 amu

   c. What are the name and symbol of this element? chromium, Cr

   d. What are the symbols, including superscripts and subscripts, of the isotopes of this element? $^{50}_{24}Cr$, $^{52}_{24}Cr$, $^{53}_{24}Cr$, $^{54}_{24}Cr$

   e. Which isotope deviated most from its straight-line path? $^{50}_{24}Cr$