Name _____ Date _____ Period _____ Group _____

Conceptual Physics **Chapter 17: The Atomic Nature**
of Matter
Lab 17-2: Building an Atom (PhET simulation)

PhET INTERACTIVE SIMULATIONS
University of Colorado Boulder

PART I: ATOM SCREEN

1. *Go to the website: phet.colorado.edu. Click on HTML5 simulations on top right of screen and choose the Build an Atom simulation* (http://phet.colorado.edu/en/simulation/build-an-atom)
2. Explore the ***Build an Atom*** simulation with your group. As you explore, talk about what you find. List two things your group observed in the simulation.

   a.

   b.

2. Click on the + sign for each of the boxes (element name, net charge and mass number) to view changes as you change the number of particles in the atom.
3. What particle(s) are found in the center of the atom? protons + neutrons
4. Play until you discover which **particle(s)** determine(s) the name of the **element** you build. protons
5. What is the **name** of the following atoms?
   a. An atom with 3 protons and 4 neutrons: Lithium
   b. An atom with 2 protons and 4 neutrons: Helium
   c. An atom with 4 protons and 4 neutrons: Beryllium
6. Play with the simulation to discover which particles affect the **charge** of an atom or ion. protons + electrons
   a. What is the charge of these particles? protons +, electrons −
7. Fill in the blanks below to show your results:
   a. Neutral atoms have the same number of protons and electrons.
   b. Positive ions have more protons than electrons.
   c. Negative ions have fewer protons than electrons.
8. Develop a relationship (in the form of a single sentence or equation) that can predict the charge based on the number and types of particle.

   The number of + protons and − electrons determines the net charge of the ion or atom

9. Play with the simulation to discover what affects the **mass** number of your atom or ion. protons + neutrons
   a. What is a rule for determining the mass number of an atom or ion?

   The number of protons + neutrons = mass #.

10. Practice applying your understanding by playing 1st and 2nd levels on the game screen.

PART II: SYMBOL SCREEN

1. Using the *Symbol* readout box, figure out **which particles** affect each component of the atomic symbol and how the value of the numbers is determined.

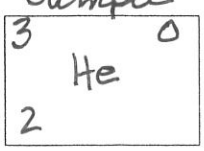
$$ {}^{d}_{c}a^{b} $$

Position in symbol box	Term to describe this information	Particle used to determine this	How the value is determined
a	Element symbol	protons	# of p will identify the element
b	net charge	protons + electrons	$p^+ + e^-$
c	Atomic number	protons	# of p
d	mass number	Protons, neutrons	$p^+ + n^0$

2. Create a definition (using a complete sentence) for each of these items based on your labels from the atomic symbol above.
   a. Element Symbol is Letter or letters used to represent the name of an element.
   b. Charge is determined by adding + protons & − electrons
   c. Atomic Number is number of protons & will identify the element
   d. Mass Number is number of particles in nucleus (p + n)

3. Practice applying your understanding by playing the 3rd and 4th game levels. Play until you can get all the questions correct on the 4th level. Fill in the information here for your last screen of the 4th game level:

Sample



protons 2

neutrons 1

electrons 2

4. In addition to atomic symbol, we can represent atoms by name and mass number. Complete the table below:

Symbol	Name
${}^{12}_{6}C^{+1}$	Carbon-12
${}^{18}_{9}F$	Fluorine-18
${}^{11}_{5}B$	Boron-11

a) Each representation (Symbol and Name) in the table above provides information about the atom. Describe the similarities and differences between the *Symbol* and *Name* representations.

Symbol has more info – atomic #, mass # + charge as well as symbol for name

Name tells name & mass # only. (Name of element is clue for atomic number) No information for charge is given.

PART III: ISOTOPES

1. Play with the simulation to determine:
   a. Which particles affect the stability of the atom? neutrons + protons
   b. Which particles do not affect the stability of the atom? electrons
2. What are the names of the stable forms of oxygen?
   a. Oxygen-16
   b. Oxygen-17
   c. Oxygen-18
3. List all of the things that are the same about these atoms (ignore the electrons).

   Same # of protons

4. List all of the things that are different about these atoms (ignore the electrons).

   Different # of neutrons

5. The atoms in the previous question are **isotopes** of each other. Based on this information, list the requirements for two atoms to be isotopes of each other.

   They must be the same element (same # of p) but have different #'s of neutrons

6. Test your understanding of isotopes by examining the relationships between the pairs of atoms listed below:

Atom 1	Atom 2	Relationship between atom 1 and atom 2
$^{12}_{6}C$	$^{13}_{6}C$	☑ Isotopes ☐ Same Atom, Not Isotopes of Each Other ☐ Different Element
Carbon-12	$^{12}_{6}C$	☐ Isotopes ☑ Same Atom, Not Isotopes of Each Other ☐ Different Element
Argon-40	Argon-41	☑ Isotopes ☐ Same Atom, Not Isotopes of Each Other ☐ Different Element
$^{11}_{5}B$	Boron-10	☑ Isotopes ☐ Same Atom, Not Isotopes of Each Other ☐ Different Element
An atom with 13 protons and 13 neutrons	An atom with 14 protons and 13 neutrons	☐ Isotopes ☐ Same Atom, Not Isotopes of Each Other ☑ Different Element

PART IV: REVIEW EXERCISES

1. The periodic table has a great deal of information about every atom. Using your periodic table, answer the following questions:
   a. What is the atomic number of chlorine (Cl)? 17
   b. What is the atomic number of tungsten (W)? 74
   c. How many protons are there in any Cl atom? 17
   d. How many protons are there in any Te atom? 52

2. Can you tell from your own periodic table **exactly** how many neutrons are in an atom? Explain your answer.

You can't. Mass # on our table is average mass. So we round it to whole # + use that to find mass of most common isotope + use that to find neutrons of that isotope only.

3. How will you use your periodic table to find the number of neutrons?

Round ave. mass # to whole #. Subtract atomic # (# of p) from mass # (p + n) to find number of neutrons

4. What do an atom, ion and isotope of an element have in common? same # of protons

5. How are they different? Ions of an element have different # of electrons

Isotopes of an element have different #'s of neutrons

6. Complete the following table:

Name	Symbol	Atomic number	Mass Number	Number of neutrons	Number of Electrons	Charge
hydrogen-2	^{2}H	1	2	1	1	0
hydrogen-3	^{3}H	1	3	2	1	0
sodium-22	$^{22}Na^{+}$	11	22	11	10	+1
magnesium-24	^{24}Mg	12	24	12	12	0
magnesium-25	$^{25}Mg^{+2}$	12	25	13	~~10~~	~~+2~~
titanium-46	$^{46}Ti^{-2}$	22	46	24	24	-2
silver-107	^{107}Ag	47	107	60	47	0
fluorine-19	$^{19}F^{-1}$	9	19	10	10	-1
carbon-12	^{12}C	6	12	6	6	0
carbon-13	^{13}C	6	13	7	6	0
carbon-14	^{14}C	6	14	8	6	0
carbon-12	$^{12}C^{-1}$	6	12	6	7	-1
carbon-12	$^{12}C^{+1}$	6	12	6	5	+1
Helium-4	^{4}He	2	4	2	2	0
Oxygen-16	$^{16}O^{-2}$	8	16	8	10	-2
argon-40	^{40}Ar	18	40	22	18	0
gallium-70	^{70}Ga	31	70	39	31	0
gallium-70	$^{70}Ga^{+3}$	31	70	39	28	+3
Beryllium-9	$^{9}Be^{+2}$	4	9	5	2	+2
Nitrogen-15	$^{15}N^{-1}$	7	15	8	8	-1

7. To test your knowledge of isotopes, draw arrows between all pairs of atoms in the table above that are isotopes of each other