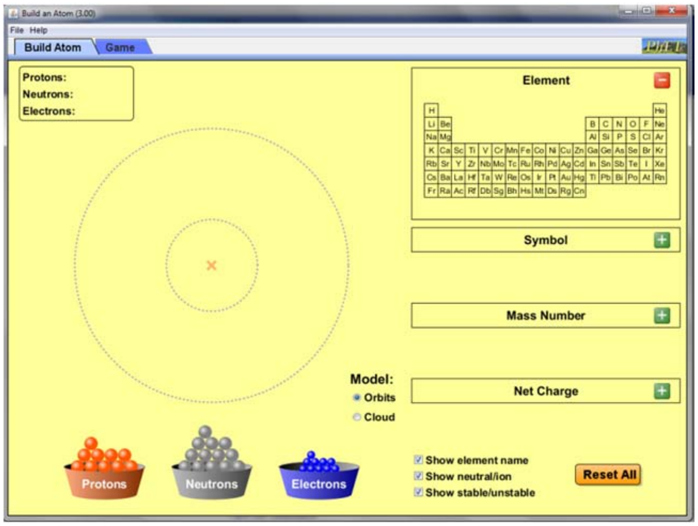
Chemistry Activity – Atoms, Isotopes and Atomic Theory

Name: ____ Date: ________________ Period: _____

Part I: Build an Atom

Go to the Build an Atom activity at the PhET simulation website (http://phet.colorado.edu/en/simulation/build-an-atom) and choose the “Run Now!” button. Once the simulation is loaded you should see the following screen:



Expand the *Symbol*, *Mass Number* and *Net Charge* windows by clicking on the expand buttons [+].

Construct the following atoms/ions in the table (Table 1.1) below and fill in the corresponding boxes.

Table 1.1

Protons	**Neutrons**	**Electrons**	**Symbol**	**Electrons in 1st Ring / Electrons in 2nd Ring**	**Mass #**	**Net Charge**	**Stable? / Unstable?**
1	0	1					
1	2	1					
3	4	3					
3	3	2					
4	3	4					

7	7	10					
2	2	2					
6	5	5					

1. Which of the three values (proton, neutron or electron) determines the symbol of the element? ____________

2. What was the maximum number of electrons you were allowed to put into the first ring? _____________

3. Did the maximum number of electrons possible in the first ring depend on the element or was it the same for all of them? __________________

4. What determined whether or not the atom had a "net charge"? _______________________________________

5. The mass number is dependent upon which particle(s)? ____

6. Which particle determines whether or not the element is stable? _______________________________________

7. For each of the "unstable" elements from Table 1.1, determine the number of particles from your answer to question 6 above that need to be added or subtracted in order to make the element stable and fill in the information below in Table 1.2

Table 1.2

Before When Unstable				**After When Stable**			
Protons	**Neutrons**	**Electrons**	**Symbol**	**Protons**	**Neutrons**	**Electrons**	**Symbol**

8. What is meant by "stable" vs. "unstable"? ____

Click on the *Game Tab* at the top of the window and play at least 2 rounds at <u>each</u> of the four difficulty levels. After you have finished, comment on your accuracy and if the simulation has helped you understand atoms.

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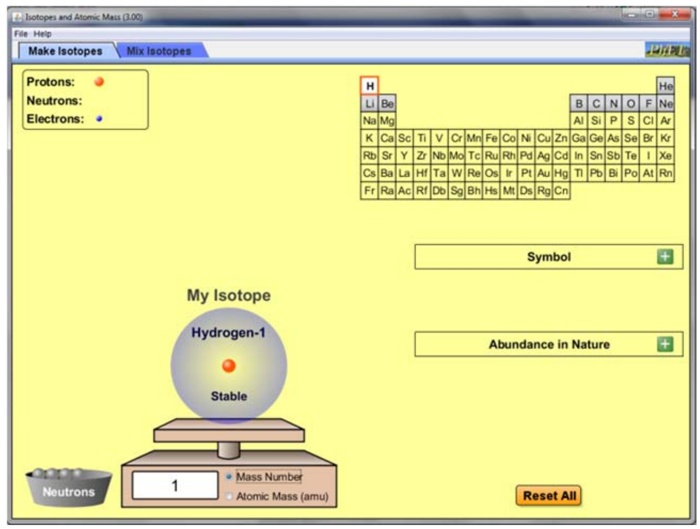
Part II: Isotopes and Atomic Mass

Go to the Isotopes and Atomic Mass activity at the PhET simulation website (http://phet.colorado.edu/en/simulation/isotopes-and-atomic-mass) and choose the "Run Now!" button. Once the simulation is loaded you should see the following screen:



Expand the *Symbol*, and *Abundance in Nature* windows by clicking on the expand buttons [+].

Click on the button on the mass balance that reads *Atomic Mass (amu)*. This will allow you to read the actual mass of a particular isotope of an element (instead of being rounded off).

In Table 2.1 below, for each of the ten elements (hydrogen through neon) available to work with, find all of the isotopes that have nonzero percent abundances in nature and record the mass values in amu's. Percentages that just say "very small" can be neglected. Elements can be chosen by clicking on them in the periodic table. Isotopes can be formed by dragging neutrons (in the bucket) onto the atom. Neutrons can also be dragged off of an atom.

Table 2.1 – Isotopes Masses and Percent Abundances

Isotope name	Protons	Neutrons	Percent Abundance	Mass (in amu)
Hydrogen-1				

For each of the ten elements you just explored, in Table 2.2 below, calculate the "weighted average" (i.e. the value that would be listed on the periodic table) for that element using the following formula:

Weighted Average = (isotope mass 1 x decimal percent abundance) + (isotope mass 2 x decimal percent abundance) + …

Table 2.2 – Calculation of Weighted Average of the Elements

Element	Calculation Area	Mass (amu)
Hydrogen		
Helium		
Lithium		
Beryllium		
Boron		
Carbon		
Nitrogen		
Oxygen		
Fluorine		
Neon		

Click on the *Mix Isotopes* tab at the top of the window. Make sure that the *Percent Composition* and *Average Atomic Mass* windows are expanded using the [+] button.

Click on the *Nature's Mix of Isotopes* button, then by clicking on the periodic table for each of the elements you explored in Table 2.2, compare the *Average Atomic Mass* listed in the window with the value you calculated in Table 2.2. Comment below on how well the values agree.

____

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The *Mix Isotopes* tab gives you an additional eight elements to explore. Of the eighteen elements available, give the element symbols for:

a. Elements with only one naturally occurring isotope? ________________________________

b. Elements with two naturally occurring isotopes? __________________________________

c. Elements with three naturally occurring isotopes? _________________________________

Click on the *My Mix of Isotopes* button and explore how the average atomic mass changes for different ratios of isotopes of the elements. Comment below on how well you feel you understand the concept of isotopes and weighted averages.

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Part III: The Bohr Model of the Atom

Go to www.dfeebeck.com and follow the link to the *Chemistry* page. Under the Chapter 5 section, click on the *Bohr Model Tutorial* link. Complete the animated tutorial and answer the associated questions below.

1. Describe the structure of a Bohr model atom. ____

____

2. What holds the electron in its orbit? ____

3. What was the "radical proposal" in Bohr's model? ____

____

4. What is the relationship between an electron's energy and its proximity to the nucleus? ______________

____

5. What does an electron need in order to jump from a lower orbit to a higher orbit? __________________

____

6. What happens when an electron "jumps" from a higher orbit to a lower orbit? ______________________

____

7. What law governs your answer to question six above? ____

8. For an electron to jump from a lower orbit to an upper orbit, the energy difference between the levels must

______________________________ the energy of the photon that the electron absorbs.

9. The equation that relates energy to wavelength is given by ___________________________________.

10. The visible emission spectra (Balmer series) of the hydrogen atom is produced by _________________

____

11. What is the difference between an "excited" electron and one in its "ground state"? ______________

____

12. The tutorial gives the wavelengths for the four spectral lines known as the Balmer series for hydrogen. Using the equation from your answer to question 9 and the speed of light equation (3.00×10^{8} m/s = wavelength (in meters) x frequency (in Hz)), calculate the energy (in joules) and the frequency (in Hertz) for each of these lines in Table 3.1 below. The first one has been done for you as an example.

Useful constants: 1 nanometer (nm) = 1×10^{-9} m, h = 6.626×10^{-34} Js, c = 3.00×10^{8} m/s

Table 3.1 – Energy and Frequency of Balmer Spectral Lines

Wavelength (nm)	Calculations	Frequency (Hz)	Energy (J)
410.2	Frequency = ($3.00x10^{8}$m/s) / ($4.102x10^{-7}$m) = **$7.314x10^{14}$Hz** Energy = ($6.626x10^{-34}$Js)($3.00x10^{8}$m/s) / ($4.102x10^{-7}$m) **= $4.846x10^{-19}$J**	**$7.314x10^{14}$Hz**	**$4.846x10^{-19}$J**
434.1			
486.1			
656.3			

13. Of the four wavelengths given in **Table 3.1**, the one with the greatest energy is the one with the

________________________ (shortest/longest) wavelength and the ________________________________

(highest/lowest) frequency. Its color is ____.

The Bohr Model vs. The DeBroglie Wave Model

Go to the Isotopes and Atomic Mass activity at the PhET simulation website (http://phet.colorado.edu/en/simulation/hydrogen-atom) and choose the "Run Now!" button.

When you first start the program a reminder will come down and direct you to "turn on the gun", but don't do this quite yet. Instead make sure that *white light* under light controls is selected then turn the "knob" to *Prediction (what the model predicts)*.

Select the *Bohr Model* from the Atomic Model window, and then turn on the light gun. The colored dots floating by represent photons of different color (wavelength) being emitted by the light gun and in the center is a hydrogen atom with an electron going around. Observe the behavior of the electron for a while and take note of any patterns you observe.

Now switch the Atomic Model to the DeBroglie Model and observe for a while.

1. Describe the similarities and differences between the two models: _________________________________

____

____

2. How does the behavior of the electron differ depending on the "color" of the photon absorbed?

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