

Chemistry

Name \_\_\_\_\_

Date \_\_\_\_\_ Per \_\_\_\_\_

### Quantum Mechanics Internet Lab

**I. Quantum Zone:** Go to [www.colorado.edu/physics/2000/quantumzone](http://www.colorado.edu/physics/2000/quantumzone)  
Read up to the menu where you can choose an element.

1. Spectral lines: Draw a line spectrum for hydrogen, boron, and one element of your choice. Draw the lines and indicate what color each line is:

Hydrogen:

Boron:

Your Choice: \_\_\_\_\_

2. Do elements of higher atomic number tend to have simpler or more complicated line ?  
(Compare hydrogen and neon, for example.) \_\_\_\_\_

a. Why do you think this is the case? \_\_\_\_\_

\_\_\_\_\_

**II. Spectra :** Go to [www.colorado.edu/physics/2000/quantumzone/spectra\\_evidence.html](http://www.colorado.edu/physics/2000/quantumzone/spectra_evidence.html)  
Read the entire article.

1. Where were spectral lines first seen? \_\_\_\_\_

2. Who first performed experiments by putting various substances in Bunsen burners and observing the light that was emitted?

\_\_\_\_\_ and \_\_\_\_\_

3. What elements did these two men discover in the 1860's? \_\_\_\_\_

**III. Bohr:** Go to [www.colorado.edu/physics/2000/quantumzone/bohr.html](http://www.colorado.edu/physics/2000/quantumzone/bohr.html)  
Read the entire article.

1. What was it about the Bohr model that was considered so radical? \_\_\_\_\_

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2. Click on the blue “already seen” and see if you can get an electron to circle around the nucleus. It’s not easy! Clicking on the “show force” button might help.

a. Could you do it? \_\_\_\_\_

b. How many electrons did you get going around the nucleus? \_\_\_\_\_

WARNING: Don’t spend more than a couple minutes on this! (It’s addictive...)

c. What pulls the electron in to the nucleus? \_\_\_\_\_

3. Go back to “Bohr’s Atom” and read down to the the interactive model.

a. Click on an orbit larger than the one the electron currently orbits. Does the energy go into the electron or out of the electron? \_\_\_\_\_

b. Now click on an orbit smaller than the one the electron’s in. Does the energy go into the electron or out of the electron? \_\_\_\_\_

c. Which of these represents the colored lines of the line spectra? \_\_\_\_\_

4. What does the “quantum” in quantum mechanics mean? \_\_\_\_\_

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5. What’s ironic about the term “quantum leap”? \_\_\_\_\_

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**IV. DeBroglie:** Go to [www.colorado.edu/physics/2000/quantumzone/debroglie.html](http://www.colorado.edu/physics/2000/quantumzone/debroglie.html)  
Read the entire article.

1. Who came up with the idea that matter actually consists of waves? \_\_\_\_\_

2. You have to have mass in order to have momentum. So how is it that photons can be said to have momentum? \_\_\_\_\_

3. Click on the blue “double slit experiment” and turn the machine on. Move the “slit separation” bar back and forth. If the light was acting like particles (like little BB’s) how many

green lines would you expect to see on the screen? \_\_\_\_\_ So is the light acting like particles or like waves? \_\_\_\_\_ How do you know? \_\_\_\_\_

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4. Go back (to [www.colorado.edu/physics/2000/quantumzone/debroglie.html](http://www.colorado.edu/physics/2000/quantumzone/debroglie.html)). Read from where the prof is saying "Well, it's both -- or it's neither".

a. What does the "wave/particle duality" of light mean? \_\_\_\_\_

\_\_\_\_\_

b. According to deBroglie, what else has a wave/particle duality? \_\_\_\_\_

5. Read down to the interactive model, play with changing the wavelength and the diameter of the circle. .

a. What does it mean when the wave that's around the circle is red? \_\_\_\_\_

\_\_\_\_\_

b. What about when it's green? \_\_\_\_\_

\_\_\_\_\_

c. The point: waves with certain wavelengths only fit at certain \_\_\_\_\_

As it turns out, the electrons that travel with only certain wavelengths and therefore at only certain distances from the nucleus don't necessarily travel in circles. They travel in strange shapes called orbitals. To see what these orbitals look like, continue on:

**V. Orbitals:** Go to [www.colby.edu/chemistry/OChem/DEMOS/Orbitals.html](http://www.colby.edu/chemistry/OChem/DEMOS/Orbitals.html)

Click anywhere on the black box to get into the program. Do the first two subjects: "What are Orbitals?" and "Atomic Orbitals". Answer the following as you go.

1. What is an orbital? \_\_\_\_\_

\_\_\_\_\_

2. What is the maximum number of electrons that may reside in each orbital? \_\_\_\_\_

3. Draw a 1s orbital:

4. Draw the 2s orbital next to the 1s orbital above (don't worry about the "inner lobe" or "phase sign"). Which is larger, the 1s or the 2s? \_\_\_\_\_

5. Draw a 2p orbital:

6. The two lobes of a p orbital are separated by a \_\_\_\_\_

7. There are \_\_\_\_\_ 2p orbitals, each occupying different \_\_\_\_\_ of space. They are called the \_\_\_\_\_ orbital, the \_\_\_\_\_ orbital, and the \_\_\_\_\_ orbital.

**VI. Shapes:** Go to <http://library.thinkquest.org/3659/structures/shapes.html> (If you have trouble getting to this page, do a Google search on “dot density diagram” and choose the “CHEMystery” choice.) Read the entire page (you don’t need to click the arrow at the bottom).

1. What is a dot-density diagram? \_\_\_\_\_

a. Draw one for an s orbital:

2. How many d orbitals are there at any particular energy level? \_\_\_\_\_

a. Draw two of them (your choice which ones):

**VI The Rest of the Orbitals:** There are a few other higher orbitals that have pretty bizarre shapes. They all make sense mathematically, of course, but they’re pretty complicated. And kind of beautiful, too. To see them, go to <http://www.shef.ac.uk/chemistry/orbitron/index.html>

1. Click on the 4f in the “Level 4” blue box on the left. There are essentially two different shapes in this orbital. Describe the two:

First shape: \_\_\_\_\_

Second shape: \_\_\_\_\_

2. Now click on the 6f or 7f orbital. Besides being different colors, how are these different from the 4f orbital? (Look closely.)

3. Finally, the weirdest of them all: the g orbitals. Click on one of them (5,6,or 7). The little bit of information at the top of the page says

For any atom, there are \_\_\_\_\_ 5 (or 6 or 7) f orbitals. These orbitals are \_\_\_\_\_ in the sense that no \_\_\_\_\_ are known in which the 5 (or 6 or 7) orbitals are occupied in their \_\_\_\_\_ states. However, these orbitals may be occupied in some \_\_\_\_\_ states. (Like when they’re zapped with electricity.)

**VII** So where is this all going? For a preview of what’s to come, go to <http://www.colorado.edu/physics/2000/applets/a2.html> Click on things and see if you can figure out what’s going on. It’ll all become crystal clear the next time this class meets!

You’re done! Turn in your paper and relax. If there’s still more time left in the class period, please follow the school rules as you have some free time. And, no sound, please (it’s distracting to people who are still working on this). I hope this all made some sense to you!