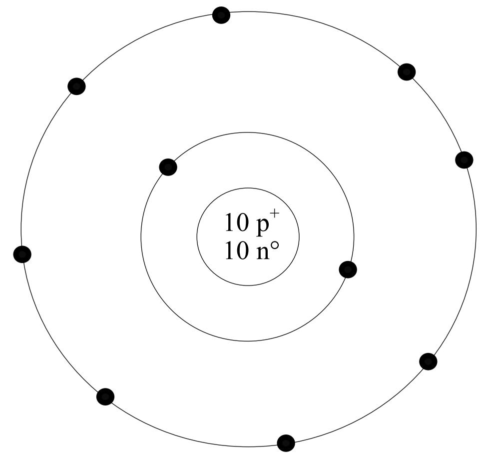
ELECTRONS LAB

Neon in the ground state 2-8 Mass 20 AMU



name: ________________________________ 80/1200

Objective: To use flame tests + bright line spectra to identify elements and compounds.

As it turns out, Niels Bohr figured out a lot about electrons and the "orbits" that they exist in. We know now that the electrons live in shells. These shells have sub-orbitals that we don't learn about in high school, but you will in college.

Bohr imagined the electrons moving in orbits, circling the nucleus, much like the planets that orbit the Sun. Science moved ahead, and although orbits are not correct, much of Bohr's work is still perfectly correct. His "orbits" were also energy levels, and electrons exist in these energy levels, now called shells.

In the first shell only 2 electrons can fit. That is the lowest energy level of all electrons. In the 2nd shell or orbital, up to 8 electrons can fit. The atom of neon above shows this simplified 2-8 electron configuration. In college it would be $1s^2 2s^2 2p^6$ which shows 2 electrons in the first shell, and 2 + 6 electrons in the second shell.

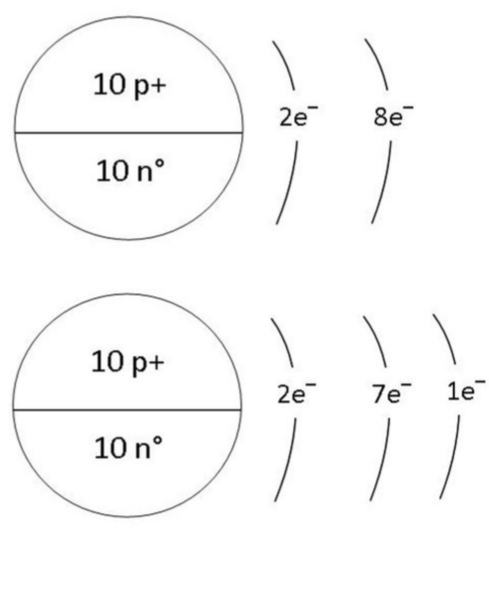
The 3rd electron shell is weird. It can be full with 8 electrons, or it can stretch, and hold up to 18 electrons. That's because of the sub-orbitals (that we do not need to worry about in high school). Shells 3, 4, 5, 6 and 7 can all stretch by using their sub-orbitals, and that's cool.

Bohr told us that electrons are normally found in the lowest energy levels possible, or the GROUND STATE. The electron configurations on the periodic table are all ground state configurations. In our class, when an electron gains energy from outside of itself (by heat or electricity or even radiation) this electron moves to a higher orbital than normal. We will be able to show only a *possible* excited state. We will not be able to know *exactly* what sub-orbitals the electrons are now in. For us it is more conceptual than detailed.

If we run energy into one type of atoms, like neon gas, or one type of compound, like CO_2 gas, the electrons will absorb only the specific amount of necessary energy to become EXCITED. This amount is unique for each substance because each atom and each compound has a unique number of protons and it's own electron configuration. To push an electron to a higher than normal level requires a specific amount of energy.

We generalize that as a QUANTUM of energy. All electrons need their own "quantum of energy" to get elevated into their excited state. The electrons can absorb energy and as long as they hold this energy, they can stay in the higher energy excited state, in orbitals further from the nucleus. These excited electrons HOLD this energy temporarily. This excited state is unstable. When these excited electrons return to the ground state, they EMIT that exact QUANTUM of energy it took to excite them in the first place. This released quantum of energy is emitted as visible colored light we see as one color, and we call it SPECTRA.

Neon in ground state, and a possible excited state.



Both of these Bohr models of neon, the ground state (top) and in the excited state (below) have 10 electrons. The "top" ground state neon has the 2-8 normal configuration. If it were to be excited (say in a gas tube with electricity) the electrons would take a higher than normal position temporarily due to this absorbed quantum of energy. Neon changes from the ground state configuration of Ne 2-8 to the excited Ne 2-7-1 configuration.

In our class a different "excited state" of 1-8-1 is possible, as is 2-6-2. We don't know the exact excited state of any atomin high school, but we see that in an excited state that 1 or 2 electrons are at higher than normal orbitals than the configuration on the periodic tables.

The excited state is unstable and temporary. When the excited electrons emit this unique amount of energy that they gained, it gives off visible light called spectra. We can see it, a neon light emits a bright orange light that looks like every OPEN sign you have ever seen (spectra at work!).

Heat, electricity, or even radiation energy can be absorbed, but energy is emitted as visible light called spectra.

As it releases this energy as visible light, the neon electrons can return to the ground state again. This can happen many times per second, to millions of atoms in a tube, so our eyes see a constant flow of orange light.

Since a unique amount of energy is required to excite each kind of atom or substance, that same amount of energy is released as a unique spectra we see with our eyes. That means each spectra is unique. For neon, this visible light released is orange. Neon lights only emit an orange colored light. If you see a "blue neon light", or a "white neon light", those lights DO NOT contain neon gas. Neon only emits an orange light when excited electrons return to the ground state. Other gases release other colors of light.

The orange color we see with our eyes is actually a mixture of colors that our eyes register as orange.

This VISIBLE COLORED LIGHT is called the SPECTRA. We see this energy as a ONE COLOR with our eyes. If we use the REFRACTIVE LENS GLASSES we can break up that mixture of light into the individual colors of light, at the specific wavelengths, and see the SPECTRA EMISSION LINES or SPECTROGRAPH that is truly unique to that element or compound. The refractive lenses allow us to see this easily.
The spectra-graph is like a fingerprint for each substance. It is a physical constant for that pure substance.

Spectra are measurable, and they are unique. Spectra can be used to help a scientist determine what an unknown substances might be. Scientists compare the spectra they can see to the spectrographs that they KNOW already, and seek a match. They can look through a telescope at a distant planet or start and by <u>comparing</u> the spectrographs we know to the mix of spectra in the telescope, the can determine what substance are there without having to go. It is measurable at a distance.

If a scientist discovers a spectra that is unknown, that scientist has discovered a new substance. Spectra for any substance is unique and the same everywhere in the Universe. Spectra is EMITTED, not absorbed.

The most common mistake students make is this: Grasping exactly when is spectra produced.
Spectra IS NOT produced when electrons get excited by absorbing energy. The energy absorbed is used to move and keep electrons in higher energy levels and to hold them there. This is unstable, so when electrons release that absorbed energy, and they can move back to the ground state; it's that released energy that IS THE VISIBLE SPECTRA.

Spectra can be seen with our eyes as colored lamp light, or as colored flames.

We can see the spectrographs or the spectra emission lines using the lamps, but not the flames. The color flames have spectrographs, but because the fire is literally jumping around, your eyes can't track the lines of the spectrograph with the refractive lenses. Lamp color and flame color are both spectra, but the lamps emit a steady light, where the fires are too wiggly to see the spectrographs.

Spectra is known and easily measurable, even by you today.

First we will see several FLAME TESTS. We will burn some methanol (a type of alcohol) on various salts, each will emit a colored flame. The flame color is the spectra.

We won't be able to see the spectrographs because the flames are too bouncy to follow, but they do in fact emit unique spectrographs, but we will eyeball measure just the different spectra.

Later, you will observe several lamps of gases, electrified while being held steady. The lamps emit different color spectra, but with the lamps we will draw the unique spectrographs (best you can).

Commercially, spectra can be used to make different color sparklers, fireworks, or flares, glo-sticks, and of course, all different color signs. Gases can be mixed as well, so they could give off mixtures of spectra which can provide many different colors of light.

Flame Test Demonstration:

You will see 6 evaporating dishes containing copper (II) chloride, potassium chloride, sodium chloride, strontium chloride, calcium chloride and lithium chloride. To each we will add some flammable methanol alcohol (poison) to use heat to excite some electrons. These excited electrons will return to the ground state and emit spectra, which we see as colored flames. LOOK and record some data. configurations. We will list the flame color names in this table. The color flame cannot be broken apart into a spectrograph, it is moving too much to see that way.

List names, formulas and flame colors produced in the table.

salt name	salt formulas	flame color

Student FLAME TESTS

There are 3 aqueous salt solutions. Sample them one at a time with half a Q-Tip, and see what color flame is emitted when you heat up this Q-Tip in the Bunsen burner flame. Attempt to match the flame's color to the colors recorded above. You should be able to determine which of the salts are in the solutions. Check your answers to the actual solution formulas.

The flame colors, and the lamps, both emit spectra. A different type of energy is put into the gases (electricity) and the salts (heat), but both release visible light as the spectra we see. The lamps are "steady" so it's easy to see the actual spectra emission lines. Flames are too bouncy - if we were to look at the flames with our refractive lenses, we'd get dizzy because the flame moves around so much. The spectra is there, we just can't see the spectrograph clearly. We only see the spectra as one color of flame.

solution	Flame Color	Probable Aqueous Salt
A		
B		
C		

Lamps Procedure

The lines under the word “emission” is the lamp itself.

When viewing the lamps straight on, you will see, to each side, in mirror image, several lines, of various colors, that are the actual SPECTRA LINES which are the light that makes up the “mixture” of light you see without the lenses. Your job is to draw these SPECTRA LINES that you will see while wearing the refractive lenses on both sides, at approximately the same distance from he lamp. Only put in 4-6 matching lines on each side of the lamp for each. Use colored pencils. You will not be graded on your art work.

Names/symbols		Spectra emission lines	
1			
2			
3			
4			
5			
6			

Using your drawings above as your guide, which of them are unknowns 1, 2 and 3?			
3 Unknowns		Spectra emission lines	
?			
?			
?			

Lab Questions:

1. Explain why the neon and the helium lamps give off different color light. Be sure to use these words: electrons, ground state electron configuration, excited state electron configuration, mixture of color, refractive lenses, and spectra lines in your answer.

2. Draw 2 Bohr, or planetary models (like the diagrams on the bottom of page 1 of the lab handout) of two magnesium atoms, one in the ground state, and one in the excited state.

3. Draw 2 more Bohr models of 2 phosphorous atoms, one in the ground state, and one in the excited state.

4. Explain how spectra is produced and EXACTLY when spectra is produced.

5. How many protons are neutrons & electrons are in each of these isotopes of iron? Copy this chart (bigger) into your work.

	Fe—54	Fe—56	Fe—59
# protons			
# electrons			
# neutrons			

6. How many protons, neutrons and electrons in each of these isotopes? Copy this chart (bigger) into your work.

	Au—197	Sc—44	Ir—193
# protons			
# electrons			
# neutrons			

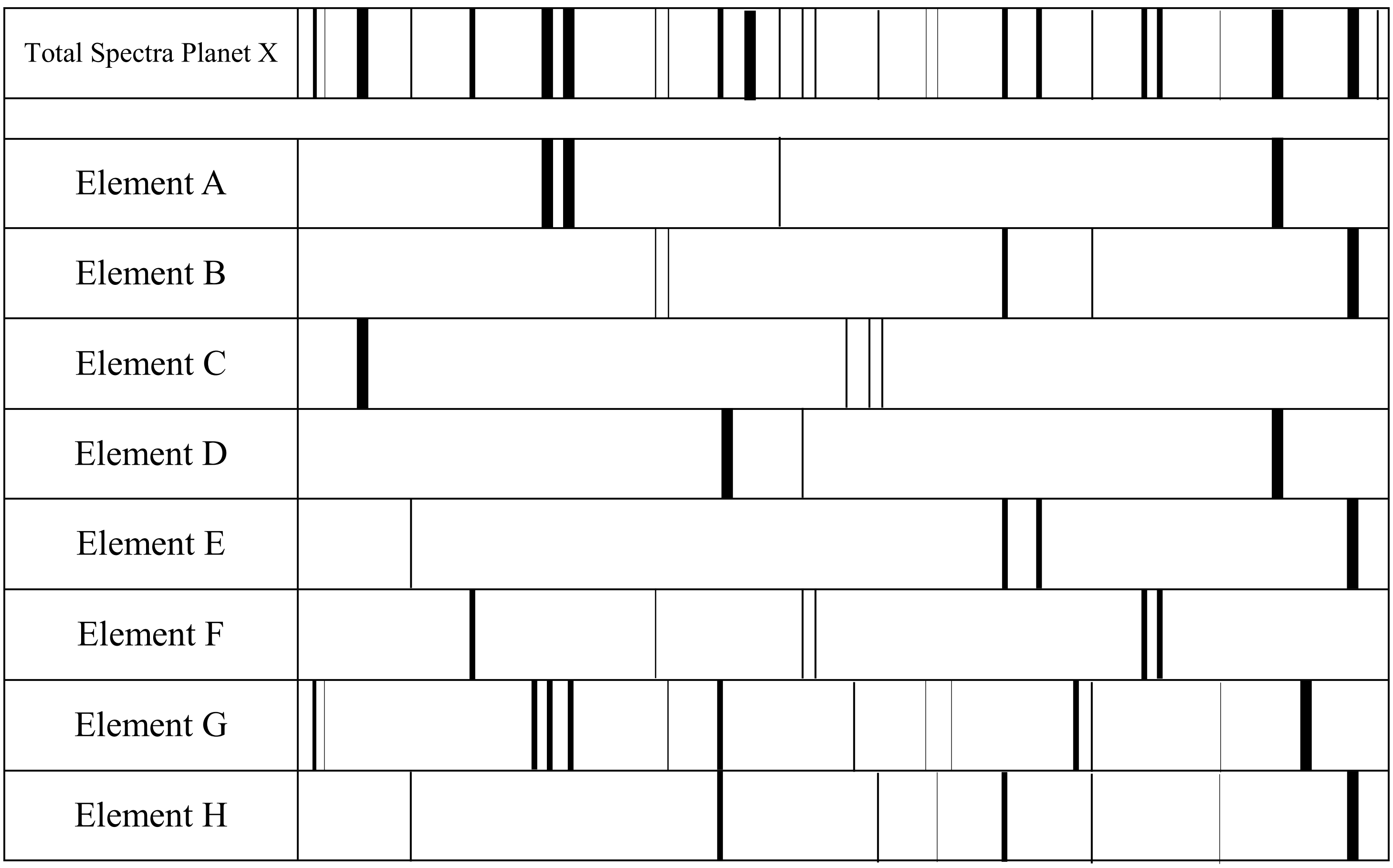
7. What is the ground state electron configuration for cobalt? What is a possible excited state for cobalt? How many electrons in an atom of cobalt metal in the ground state? How many in the excited state?

8. What six elements on the periodic table have ONLY FULL ORBITALS? List there symbols and their ground state electron configurations. What group are they in and what is this group called?

One more on the next page…

10. If an astronomer focuses her telescope on the distant Planet X, she could photograph all of the spectra she sees through a refractive lens. Her photograph would contain many spectra at once, and to figure out what was on that planet, she would have to compare the spectra she knows, to the spectra she sees in the mix.
She could determine exactly what substances were on that planet or star without having to go there.

Planet X's total spectra is on top line, and several known spectra are below. Compare them, and LIST all of the elements found on Planet X.



The Big Chart of Electron Configurations						
atomic number	atom name	atomic symbol	Total number of electrons	Ground state configuration	Possible excited state electron configuration *some have more than one possibility*	Number of e^- in the excited state
8	oxygen	O	8	2-6	2-5-1 1-7	8
9	fluorine	F	9	2-7	2-6-1	9
10						
12						
5						
18						

Your lab report	includes	points
Cover page	Title, optional funny sub-title, 2 sentence introduction: Why are we doing this lab?	2
pages 3	this lab handout and the spectra drawings on page 3	2
Page 4	Lab questions on white paper and then fill in the electron configuration tables.	10 + 2
Page 6	BIG Conclusion (much of this is a repeat from above) What you did in lab, then... 1. Clearly state how and when spectra is produced. 2. Why are spectra unique to each kind of atom and compound? 3. How do doctors and astronomers use spectra in the real world? 4. Why is it hard to use the flame tests to accurately determine all the salts solutions? 5. What are 2 commercial applications of spectra used in the "real world"?	9
this lab is due on:		25 points