ELECTRONS LAB

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, or "orbitals", but he imagined them living in neat orbits, circling the nucleus like planets that orbit the Sun. Science moved ahead, but much of Bohr's work is still perfectly correct. His "orbits" were energy levels, and they still understood that way.

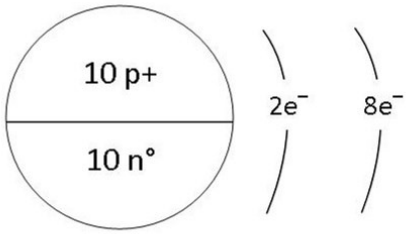
In the first shell or orbital only 2 electrons can fit. That is the lowest energy level of all electrons. In the 2nd shell or orbital, up to 8 electrons can fit. The 3rd shell is weird, it can "feel full" at 8 electrons, or it can stretch out, and be full with 18 electrons. That's because of the sub-orbitals that we do not learn about in high school. Shells 3 through 7 all can 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.

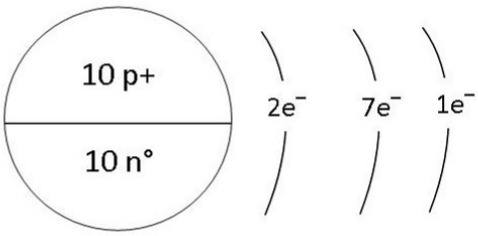
If we run energy into one type of atoms, like neon gas, or one type of compound, like CO_2 gas, the electrons will absorb only the specific amount of necessary energy to become EXCITED. This amount is unique for each substance because each atom and each compound has a unique number of protons and it's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

These Bohr, or Planetary diagrams, shows neon in the ground state (top) and in the excited state (below). Both atoms of neon 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 atom in 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.



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



Since this is unstable for neon to remain "excited" like this for long, it will release the exact amount of energy it gained, that quantum of energy, as visible colored light - WHICH WE CAN SEE with our eyes as a color. Neon releases orange light, which we will see in lab. The orange color light is the spectra which our eyes see as one color we call orange.

As it releases this energy the neon electrons have the normal amount of energy again, the excited 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.

Spectra are measurable, and they are unique. Spectra can be used to help determine what an unknown substances are. Spectra is used to determine what substances are on other planets by comparing the spectrographs we know. To the mix of spectra we see. If we can match up the lines, we know this stuff is on that planet.

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.

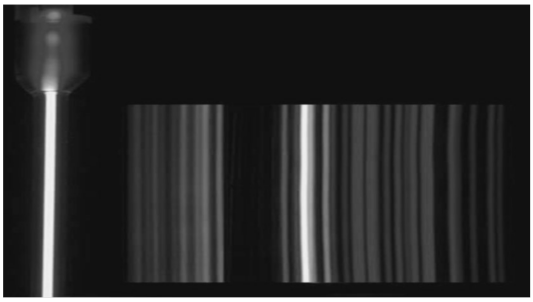
Spectra can be seen with our eyes as colored lamp light, or as colored flames.

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.

Below is a (boring) black and white spectrograph of neon. The lamp is at left, we are only seeing the "right hand side" of this spectrograph. The same lines would be seen on both sides of the lamp.

From the left: there is the obvious lamp containing neon gas. Then there's a black space, and some thin green lines. More black space, followed with a couple of yellow lines, and some orange, and some red lines.

You will see both sides of this spectrograph (both sides) in lab, with the refractive lenses.
The neon—orange light is really a mixture of these specific colors that your eyes blur into one color.
This spectrograph is unique for neon.



Commercially, spectra can be used to make different color sparklers, fireworks, or flares, glo-sticks, and of course, all different color signs.

Lamps Procedure: 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 the 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			

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

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	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

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.

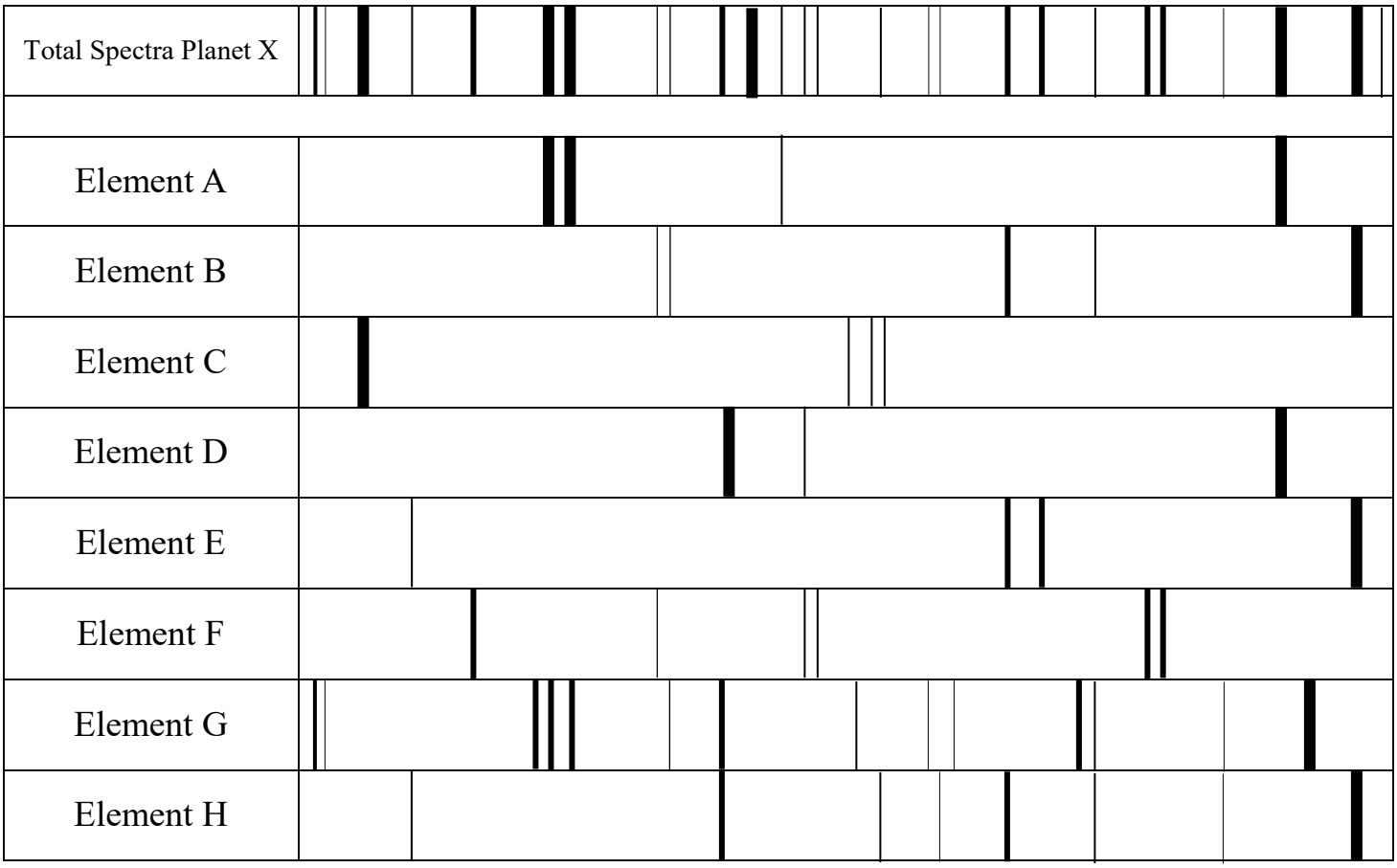
2. Draw 2 Bohr, or planetary models (like the diagrams on page 1 of the lab) of two magnesium atoms, one in the ground state, and one in the excited state.

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

4. Explain EXACTLY when spectra is produced. Is it when the electrons gain energy and move to the excited state, or when the electrons go to the ground state by emitting energy?

5. How many protons are neutrons and electrons are in each of these three isotopes of iron?
   Iron-54, Iron-56. and Iron-59 (this third one is not naturally occurring).

6. If an astronomer focuses her telescope on the distant Planet X, she could photograph through a refractive lens and see all of the planet's spectra. If she compares what she sees with the known spectra, she could determine by comparison what is up there. Planet X's total spectra is on top of several known spectra. Compare them, and LIST all the substances shown below that are on Planet X.



7. How many protons, neutrons and electrons in each of these isotopes? Au197, Sc-44, and Ir 193.

8. How many electrons can fit into the first, the second shell or orbital of an atom? Any exceptions allowed?

9. What elements on the periodic table have ONLY FULL ORBITALS, and remind us of exactly how may electrons fit into any orbital? (give the correct group or period number, and list the symbols of the elements that have only full electron orbitals too)

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 + fill in the tables.	12
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