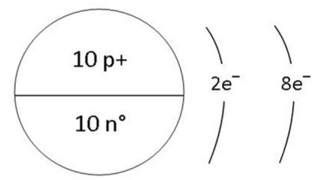
ELECTRONS LAB

name: ________________________________ 80/1200

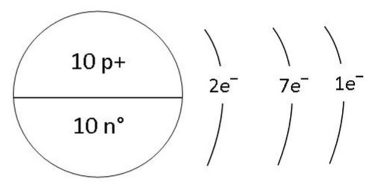
Objective: To use flame tests + bright line spectra to identify elements and compounds. This lab is to take place over 2 days, not in one double period.

Electrons are normally found in the lowest energy levels possible, or the GROUND STATE. The electron configurations on the periodic table are all the ground state configurations. In our class, when one electron moves to a higher orbital, that is a *possible* ground state. In our class we will not be able to know *exactly* what orbitals the electrons are in when excited. For us it's more conceptual than actual.

If we run energy into one type of atoms, or one type of compound, the electrons can absorb specific amounts of necessary energy to become EXCITED. It is called a QUANTA of energy. The electrons can absorb energy and jump to higher energy levels, (a higher ELECTRON ORBITALS). These excited electrons HOLD that energy temporarily. The excited state is unstable. When these excited electrons return to the ground state, they EMIT that unique amount of energy it took to excite them in the first place, and this energy is emitted as visible colored light we call SPECTRA.



This old fashioned diagram shows neon in the ground state, and then neon in the excited state. Both atoms of neon have 10 electrons. The "top" neon has two electrons in the first "orbit", with 8 electrons in the second "orbit" or energy level. If we put some neon into a glass tube, and run electricity (energy) through it, each atom of neon will be able to absorb a specific amount (a quantum of energy) and Ne 2-8 could become excited into Ne 2-7-1.



In this excited state neon still has 10 electrons, but they are no longer in the lowest energy level possible. The second orbital is no longer full, and the 3rd orbital which would not normally be needed, contains the excited electron. An outer electron is so energized it can't stay in the second orbital.

Since this is unstable for neon to remain "excited" like this for long, it will release the exact amount of energy it gained - as visible colored light - WHICH WE CAN SEE with our eyes as a color. Once it releases this energy neon has the normal amount of energy again, and it can return to the second orbital. Since a unique amount of energy is originally absorbed, that same amount of unique energy is released, that means each spectra 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.

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

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 SPECTRAGRAPH that is truly unique to that element or compound. The refractive lenses allow us to see this easily. The spectra-graph is almost like a fingerprint for a substance.

Spectra are measurable, and they are unique. Spectra can be used to help determine what an unknown substances is, spectra is used to determine what substances are on other planets, we can measure the spectra through a telescope. We photograph and measure the spectra, and we compare the spectra that we see to spectra that we know. If by chance 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 electrons into higher energy levels and to hold them there. This is unstable, so when electrons release that energy, when they move back to the ground state, it's that released energy that IS BECOMES THE VISIBLE SPECTRA.

Spectra can be seen with our eyes as colored lamp light, or colored flames. If we use refractive lenses to "break" this mixture into the individual colors at specific wavelengths, that is the "optical fingerprint" for the element or compound.

Day 1 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.

SYMBOL + NAME of gas	Spectrograph or Spectra Line Pattern The lamp is the in the middle of the diagram. Draw JUST the Spectra Emission Lines to the left and right of the lamps.
	LAMP
	LAMP
	LAMP
	LAMP
	LAMP
	LAMP

Day Two: Class Demonstration:

The teacher has 6 evaporating dishes, each containing a different salt. To each we will add some flammable alcohol and set it on fire. The alcohol burns, releasing heat and flames. The salts are not used up in any way. The excited salt electrons return to the ground state, giving off spectra we see as COLORFUL FLAMES. The individual flame colors are mixtures of the spectra emitted by the electrons as they return to their ground state 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.

salt	Salt formulas	flame color
copper chloride		
lithium chloride		
potassium chloride		
sodium chloride		
strontium chloride		
calcium chloride		

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 most of 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		

Last part: Look at the three lamps out in lab today. They contain 3 different gases. Compare the spectra they emit to what you saw yesterday in lab. What are these unknown gases? Is one of them a gas you have not yet seen? Fill in this chart too.

Unknown gases	Probable gas in the tube
1	
2	
3	

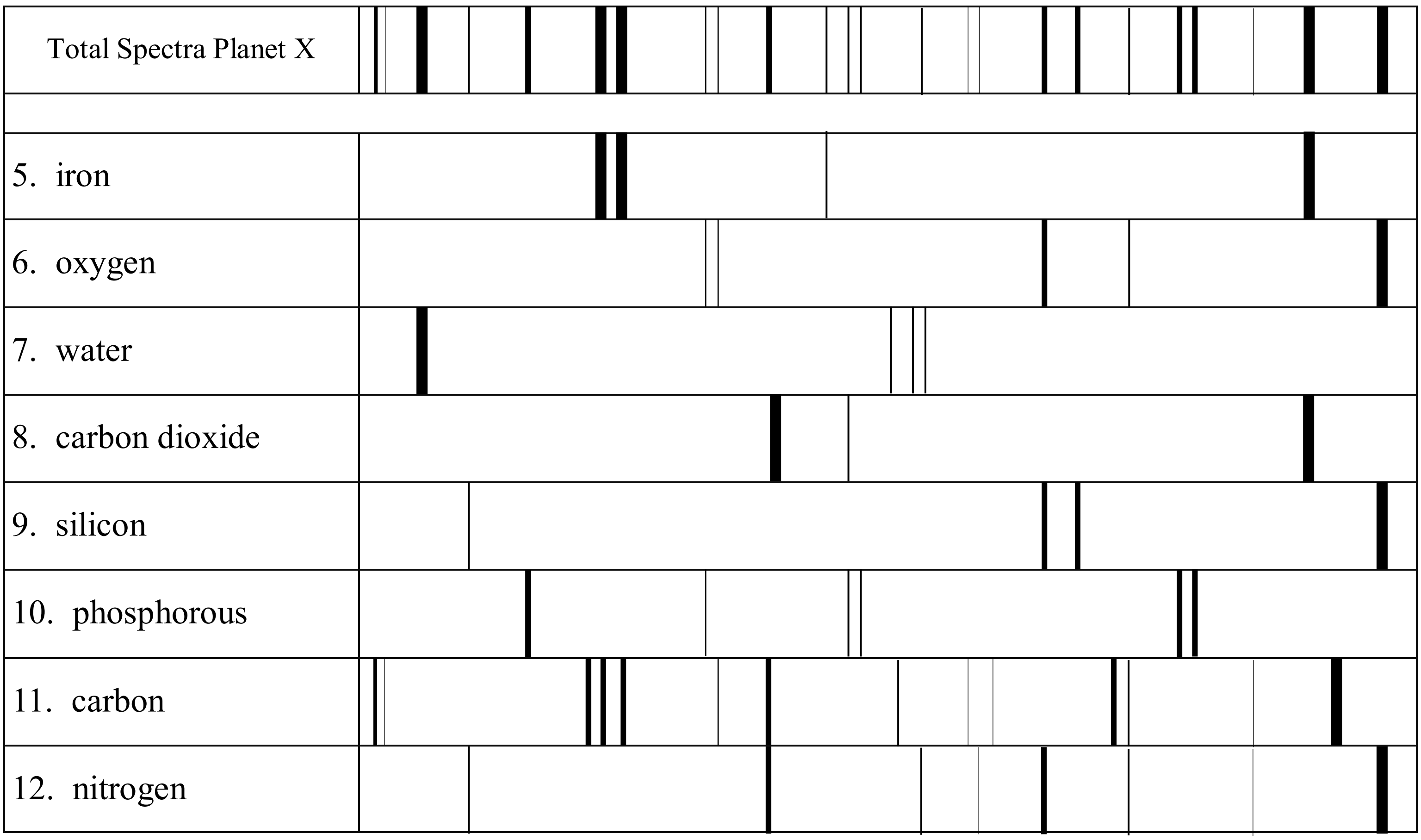
Five Lab Questions:

1. Explain why the neon and the hydrogen 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 of magnesium atoms, making sure to indicate the number of p^+, n° and e^- in each. One in the ground state, one in an excited state . Also indicate the Electron Configuration for each.

3. Draw 2 more Bohr models of phosphorous, one in the ground state, and one in the excited state. Show electron configurations, and protons and neutrons in nucleus.

If an astronomer focuses her telescope on the distant Planet X, she could photograph through a refractive lens of all the planet's spectra. If she compares what she sees with what spectra she knows, she could know what is up there. Compare these known spectra to the Total Spectra from Planet X, and list any substances that are on Planet X. State if each atom or compound is PRESENT or ABSENT.



14. Explain EXACTLY when spectra is produced. Is it when the electrons gain energy and get excited, or when the electrons go to the ground state by emitting energy? Say what you think in a clear sentence.

15. How many protons are neutrons and electrons are in each of these three isotopes of iron?

    Iron-54, Iron-56. and Iron-59 (this last one is not naturally occurring).

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
6						
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						
17						
18						

Your lab report	includes	points
Cover page	Title, optional funny sub-title, 2 sentence introduction: Why are we doing this lab?	1
pages 2 - 3	this lab handout and the spectra drawings	1
Page 4	Lab questions	14
Page 5	The big chart of electron configurations	4
Page 6	Conclusion (much of this is repeated again here in paragraph form) 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"?	5
this lab is due on: ________________________		25 points

How, why and when SPECTRA is produced.

Starting point	Neon Gas in a tube In the GROUND STATE Ne 2-8	Lithium Chloride salt in the ground state There is no reaction between the salt and the alcohol.
Energy is added	Electricity is run through the tube. ENERGY IN	Alcohol burns, creating HEAT energy. ENERGY IN
Energy is HELD	Neon in the EXICITED STATE. Electrons HOLD onto the energy to stay in the excited state. No spectra yet.	Lithium chloride is in the EXICITED STATE. Electrons HOLD onto the energy to stay in the excited state. No spectra yet.

This excited state is unstable, the electrons "prefer" to be stable, in the ground state. In order for them to return to the lower energy ground state, the must RELEASE the specific amount of energy it took to excite them in the first place.

The release of energy comes out as visible light called spectra.

Energy is released	The light that comes out of the neon lamp, that you see orange with your eyes, is the SPECTRA	The colored FLAME that comes from the burning alcohol on the salt., that you see as magenta with your eyes, is the SPECTRA

This happens over and over, many times per second.
Only a specific amount energy (either electricity or heat) is absorbed by the neon and the lithium chloride. Each substance requires a specific amount of energy, called a QUANTA of energy, to excite the electrons in that substance.

The reason it is unique is that every substance has unique numbers of protons and electrons that are held in place. To move electrons in any substance requires a unique amount of energy.

A unique amount of energy is absorbed, so that same unique amount is released, as SPECTRA. That's why all spectra are different.
Unique amounts of energy released creates UNIQUE visible spectra.

What can we do with this "SPECTRA" once we see it?	The lamp is "steady", so we can use the REFRACTIVE lenses (prisms) the break this mixture of light. The "orange" lamp light of neon is made up of several colors, at specific wavelengths, which are measurable and quantifiable. The glasses turn spectra into a SPECTRAGRAPH.	The flame is moving at all times. The color flame, which is spectra, is also made up of a unique spectrograph, but it is NOT visible because we can't move our heads and eyes in synch with the flame. The spectrograph makes up the color of the flame, but we can't see it because the flame is constantly moving around.