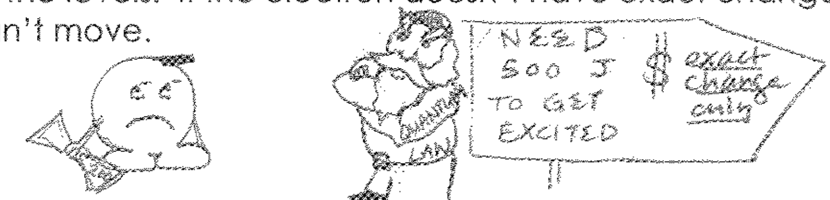
FLAME TEST LAB. (104 pts—this is equivalent to a major test grade—do well!)

According to Bohr, electrons can only move around the nucleus in orbits of certain very specific energies. This explained why the electrons didn't spiral in and collide with the nucleus. Thus, quantum (or "packet") atomic theory was born.

Quantum atomic theory is called that because electrons can only jump from one energy level to another by absorbing or releasing the EXACT (I'm not talking about *almost* exact! I mean EXACT!!!!) amount or packet of energy between the levels. If the electron doesn't have exact change, in other words, it can't move.



The following lines represent the different energy levels that are possible for an atom. Because of the conservation of energy, if an electron excites itself to a higher level, it must absorb that energy from something (usually light or heat or electrical current). Likewise, when an electron relaxes back down to a lower level, it must give up that energy (usually in the form of light or heat). Please show arrows to indicate EXCITATION and RELAXATION, showing the accompanying energy ABSORPTION or EMISSION that occurs. (8 pts)

E ↑

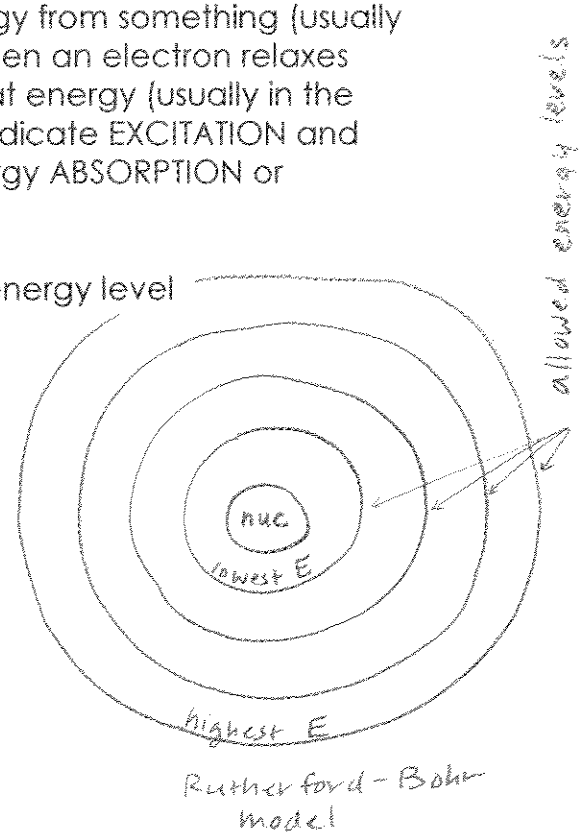
____________________ highest energy level

____

____

____

____



____________________ lowest energy level

1. (2 pts) What do you notice about the gaps between neighboring energy levels as you go from the lowest energy level to the highest energy level?

2. (2 pts) What is another name for the lowest possible energy level?

In this experiment, we will be lighting metal salts (ionic compounds) on fire. You will probably see a distinctive color given off by the flame—this is due to the excitation and relaxation of the metal's electrons as they shift between allowed energy levels (the energy gaps are fairly small).

3. (3 pts) How are you causing the metal electron's excitation—what is the energy being absorbed, and from what source?

4. (2 pts) What is the energy emission we detect as the metal electron relaxes back down?

Light is a form of energy with a unique wavelength, frequency, and energy associated with it. If you can determine either the wavelength or the frequency, the energy can be calculated. Since the wavelength is associated with the color of the light, you will be recording the color of the light given off by each flame test to try and eventually figure out the energy of the light you observed. The range of visible light is from 400 nm (blue-violet) to 700 nm (red).

COLOR	**WAVELENGTH**
Purple	380 nm
Blue	420 nm
Green	500 nm
Yellow	540 nm
Orange	620 nm
Red	700 nm

Define the variables in the following equations (with units!!!) (10 pts)

$\Delta E = h\ v$

$c = \lambda v$

$\Delta E =$

$v =$

$\lambda =$

c = speed of light

=

h = Planck's constant

=

Don't forget to give the numerical values for c and h! DON"T FORGET UNITS!

5. (3 pts) Solve for ΔE in terms of λ instead of in terms of v.

6. (3 pts) Show how you would convert x nanometers into meters:

7. (2 pts) What color has the greatest energy associated with it?

PROCEDURE

1. Take some presoaked wooden sticks—one for every two tests (you will use both ends). Put them in a beaker filled with distilled water to keep them wet. The wooden sticks are presoaked to prevent fires. The dampness also helps to pick up the salt crystals.
2. Take ANOTHER beaker for extinguishing lit sticks and fill it with tap water.
3. Light the Bunsen burner.
4. Dip a stick in the metal salt you are testing.
5. Place the stick at the top of the inner blue cone, and record the color .
6. Dunk the lit end in the tap water beaker to extinguish it.
7. Use the other end of the stick or a clean stick and repeat steps 4-6 with a new metal salt.
8. Discard used sticks (after extinguished) in the trash.
9. Continue Steps 4-8 until all metal salts have been tested.
10. Dump the quenching water down the drain and clean up.

NOTE: There will probably be some contamination. To lower this risk, MAKE SURE YOU USE DIFFERENT BEAKERS FOR HOLDING THE FRESH WOODEN STICKS AND FOR QUENCHING THE USED WOODEN STICKS.

Once you are done observing the colors, you may fill in the rest of the chart. Pay attention to units. Show ONE **sample** (that means, use part of your actual data) calculation for

- wavelength conversion (3 pts)
- frequency determination (4 pts)
- energy calculations. (4 pts)

SAMPLE CALCULATIONS:

DATA: OBSERVATIONS OF LIGHT EMISSION

Give your observations of the colors resulting from each sample. If the color observed is an average of two of the colors given, average the wavelengths---do not fudge the data!!! (e.g. orange-red = 660 nm):
•Note that wavelength is in METERS!!!!

Metal	Color	Wavelength (m)	Frequency (Hz)	Energy (J)
Li^{+}				
Na^{+} See #12				
K^{+} See #12				
Ca^{2+}				
Ba^{2+}				
Sr^{2+}				
$Cu^{1+/2+}$				

Filling in chart: 28 pts

8. (2 pts) Which metal has the most energetic electronic transitions?

9. (2 pts) Which metal has the least energetic electronic transitions?

10. (8 pts) Using Fig 4.15 from your book, list the different types of electromagnetic radiation in order (abbreviations, within reason, are fine):

High λ Low λ
Low ν --→High ν
Low E High E

DISCUSSION

11. (5 pts) Sometimes an electronic transition may occur, but we may not be aware of it. With reference to question 10, give a plausible reason why the colors we observe are being attributed to the metal and not the other part of the salt.

12. (4 pts)Flame tests are sometimes used for identification. Certain metals have similar color flames (for example Na and K). In this case, you would use a cobalt (blue) glass square to distinguish between the two. Record your observations (w/ full sentences and detail).

Na^+ w/ cobalt glass:

K^+ w/ cobalt glass:

13. (4 pts) A student was testing some unknowns. #1 had a yellowish green flame. # 2 had a scarlet, reddish flame. Give some possible id's for the metals in the salt:

#1:

#2:

14. (5 pts) A spectroscope (See Fig 4:16) splits light up into the different wavelength lights that make it up. How would this help you get a more accurate answer for unknown #2 in problem 13?