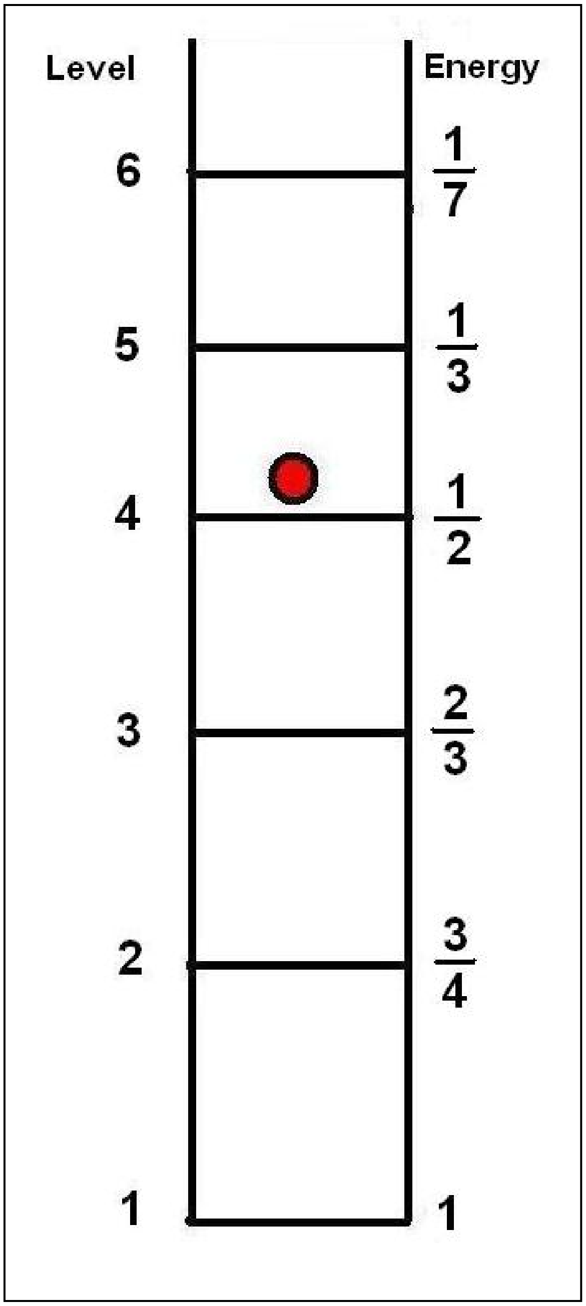
Atomic Fractions - III

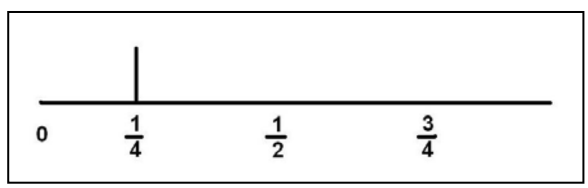


The electron inside an atom exists in one of many possible energy levels. These levels are like the rungs of a ladder. When it jumps from one level (rung) to the next, it gains or loses a specific amount of energy.

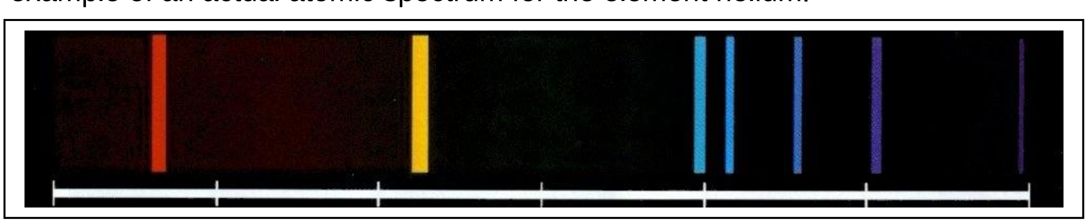
For example, if the energy of one rung is 3/4 and the energy of the next level is 1/4, the electron will lose 3/4 - 1/4 = 1/2 a unit if it jumps from the higher to the lower energy level.

Problem 1 - Suppose the energy level ladder of an imaginary element looked like the one to the left. What are all of the possible energies that an electron could lose as it jumped from a higher level to a lower one based on this ladder? (Leave your answers as simple fractions)

Problem 2 - On a number line, order the list of possible energy differences you tabulated in Problem 1, from lowest (left) to highest (right). For example, the energy difference between Level 2 and Level 1 is 1 - 3/4 = **1/4**, so draw a single vertical line at the location '1/4' on the number line. If a second energy difference is found to have the same value of '1/4' , draw the vertical line twice as tall, and so on. The graph is called a histogram.

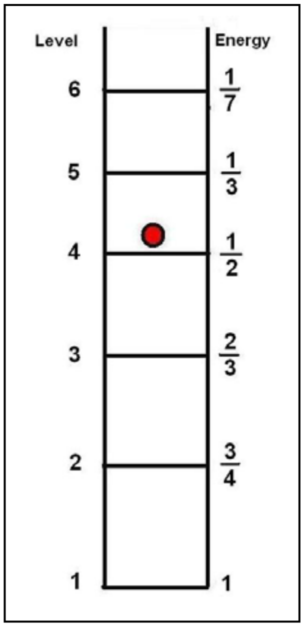


When you are finished with Problem 1 and 2, your number line will represent all of the possible ways that that atom can emit light. Every atom has its own pattern of atomic 'lines' which are based on each atom's unique energy ladder. This pattern is called a spectrum, and it is the unique fingerprint that allows scientists to identify each atom. Here is an example of an actual atomic spectrum for the element helium.



Answer Key

Problem 1 - Suppose the energy level ladder of an imaginary element looked like the one to the left. What are all of the possible energies that an electron could lose as it jumped from a higher level to a lower one based on this ladder? (Leave your answers as simple fractions)



Levels	Energy Difference	Energy Value
2 to 1	1 - 3/4	= **1/4**
3 to 1	1 - 2/3	= **1/3**
4 to 1	1 - 1/2	= **1/2**
5 to 1	1 - 1/3	= **2/3**
6 to 1	1 - 1/7	= **6/7**
3 to 2	3/4 - 2/3 = 9/12 - 8/12	= **1/12**
4 to 2	3/4 - 1/2 = 3/4 - 2/4	= **1/4**
5 to 2	3/4 - 1/3 = 9/12 - 4/12	= **5/12**
6 to 2	3/4 - 1/7 = 21/28 - 4/28	= **17/28**
4 to 3	2/3 - 1/2 = 4/6 - 3/6	= **1/6**
5 to 3	2/3 - 1/3	= **1/3**
6 to 3	2/3 - 1/7 = 14/21 - 3/21	= **11/21**
5 to 4	1/2 - 1/3 = 3/6 - 2/6	= **1/6**
6 to 4	1/2 - 1/7 = 7/14 - 2/14	= **5/14**
6 to 5	1/3 - 1/7 = 7/21 - 3/21	= **4/21**

For 6 energy levels, there are 15 possible differences.

Problem 2 - The energies calculated in Problem 2 are displayed below. Note that in this diagram the scale is not linear but is merely used to illustrate the relative placements of the lines and their tallies. Students may use a more accurate number line to give a better impression of the spectrum and the non-uniform placement of the lines horizontally.