c) Record how this spectrum is similar to and different from the hydrogen spectrum you observed in *Activity 5*.

d) Repeat *Steps (a)*, *(b)*, and *(c)* for other samples of elements as available.

2. Spectra of such elements as helium and neon are very beautiful. However, they cannot be explained by Bohr's simple theory for the single electron in the hydrogen atom. The basic idea is still true. Light is emitted when electrons jump from a higher energy level to a lower energy level. The energy levels, however, are more complex if there are additional electrons. A more elaborate labeling of electron energy levels is necessary. In this activity you will explore the pattern of electron energy levels in atoms containing more than one electron.

   When multiple electrons are present, some are easier (i.e., require less energy) to remove from the atom than others. The chart of ionization energies provides information about the amount of energy required to remove the two highest energy electrons. These are the outermost electrons and are easiest to remove. These energies are called the first and second ionization energies. They are given in units of joules. Notice that all values are multiplied by 10^{-19}.

   a) Make a graph that shows how the ionization energies vary with atomic number. Since the atomic numbers range from 1 to 36, label the x-axis with atomic numbers from 1 to 36. Since the ionization energies range from 7 to 121.2, label the y-axis with ionization energies from 0 to 130. Plot the first ionization energy data from the chart in one color, connecting the data points as you go along.

   b) Plot the values for the second ionization energies in a different color.

   c) Include a title and legend on your graph.

Atomic number	Element (symbol)	1st ionization energy J ($\times 10^{-19}$)	2nd ionization energy J ($\times 10^{-19}$)
1	H	21.8	
2	He	39.4	87.2
3	Li	8.6	121.2
4	Be	14.9	29.2
5	B	13.3	40.3
6	C	18.0	39.1
7	N	23.3	47.4
8	O	21.8	56.3
9	F	27.9	56.0
10	Ne	34.6	65.6
11	Na	8.2	75.8
12	Mg	12.3	24.1
13	Al	9.6	30.2
14	Si	13.1	26.2
15	P	16.8	31.7
16	S	16.6	37.4
17	Cl	20.8	38.2
18	Ar	25.2	44.3
19	K	7.0	50.7
20	Ca	9.8	19.0
21	Sc	10.5	20.5
22	Ti	10.9	21.8
23	V	10.8	23.5
24	Cr	10.8	26.4
25	Mn	11.9	25.1
26	Fe	12.7	25.9
27	Co	12.6	27.3
28	Ni	12.2	29.1
29	Cu	12.4	32.5
30	Zn	15.1	28.8
31	Ga	9.6	32.9
32	Ge	12.7	25.5
33	As	15.7	29.9
34	Se	15.6	34.0
35	Br	18.9	34.9
36	Kr	22.4	39.0