Biochemistry Literacy for Kids, Daniel Fried

Lesson 3 outline

Preparation:
Hand out lesson worksheets.
Obtain different metal samples including one light metal such as aluminum and another sample of equal size of a denser metal. Iron or copper are options, but tungsten offers the most dramatic density difference. You can obtain somewhat expensive samples of tungsten here:

https://midwesttungsten.com/tungsten-shapes-toys/
The 1.5 square inch, 1kg tungsten cube gives a very memorable experience for the students when compared with the 1.5 square inch aluminum cube.

Overview:

The atomic nucleus
Students learn that the atomic numbers correspond to proton numbers in each element.

Tactile experience with metals
Students feel and compare the weights of different metal samples to experience different nuclear sizes.

Electron configurations and the 4, 3, 2, 1, 0 rule of bonding
Students learn how to build atom orbitals and realize that the number of lone electrons corresponds to the number of bonds made by the atom.

Predicting 3rd row element electron configurations.
Students will use the electron-filling rules they have learned to predict the electron configurations (and number of bonds) for larger elements.

Lecture sequence:

The atomic nucleus
Begin by reviewing the 4, 3, 2, 1, 0 rule of bonding that the students discovered in the previous class. We then move to the atomic nucleus. Let students view and discuss the different sized nuclei. Most valuable metals tend to have larger nuclei since they are generally rarer.

Tactile experience with metals
If you have density cubes or other element samples, let each student compare the metals by holding the samples one in each hand. I usually begin by bringing a couple kids to the front of the room so that the class can get excited by their facial expressions when they feel the big weight difference. The idea with this demonstration is to connect the atom nucleus size (number of protons) to what we can actually feel. I ignore neutrons until later lessons.

Electron configurations and the 4, 3, 2, 1, 0 rule of bonding

We use a Bohr-like atom model for drawing electron orbitals and configurations. For some grades, it may be necessary to use the planet analogy, but you can tell the students that this model is a simplification and used only in the beginning of teaching chemistry. For a more modern understanding of electron orbitals, more study is needed.

As you flip through the orbital drawing slides, tell them that each row of the periodic table represents an orbital. The first row holds only 2 elements, so the first orbital holds only 2 electrons. The second row of the periodic table holds 8 elements, so the second orbital holds 8 electrons. I emphasize two things in these lessons, regarding “electron behavior”— I tell the students that they are learning how electrons behave. 1: Electrons like to spread out if they have room in the orbital. 2: Electrons pair up when they run out of room in the orbital. To make this clear, I show them H and He first, then skip to Ne. They see that He contains 2 electrons, so they must be paired. They then see that Ne has 10 electrons, 8 from the second row, so there must be 4 pairs in the outer orbital. As we back track through the periodic table, I ask the class to guess the orbital arrangements for each element. Oxygen is the trickiest element, but many students will quickly understand why there are 2 lone pairs and 2 single electrons—because there is “space” in the orbital for the electrons to “spread out”. This is why there are not 3 pairs of electrons. I ask the students, if they were sitting in an empty movie theater, would they expect a stranger to sit right next to them? No, because there is “space to spread out”. Eventually when the movie theater fills up, there will be a need for people to buddy up and sit next to one another.

I include orbital pictures of boron, but if students are interested in Li and Be, you can tell them that Li makes 1 bond and Be makes 2 bonds. This should make sense based on what they see in the rest of the lesson.

At the end of the orbital configuration sequence, as the students, what about the atom models they now know how to draw corresponds with the 4, 3, 2, 1, 0 rule? Some students will realize that “what is 4 about carbon” is its 4 lone electrons. “What is 3 about nitrogen” is its 3 lone electrons. Neon makes no bonds because it has no lone electrons. We don’t know why this pattern corresponds with bonds yet; this happens in the next lesson.

Predicting 3rd row element electron configurations.

After showing students the example of sulfur, students can usually easily draw and predict orbital patterns and bonding behavior of 3rd row elements. You can give more examples if you have time.