Understanding by Design*

The *Understanding by Design* template focuses on the three stages of backward design:

- **Identify desired results**
- **Determine acceptable evidence**
- **Plan learning experiences**

What overarching understandings are desired?

One of our civilization's greatest achievements is the recognition that all matter is composed of atoms. Sharing science through museum exhibits requires understanding of content, creativity in determining how to communicate ideas and the need to engage people in learning.

- Our model of the atom is a tiny nucleus surrounded by electrons.
- The negative electrons are held to the atom by an electrostatic attraction to the positively charged nucleus.
- The nucleus is composed of positively charged protons and neutrons with no charge.
- The nucleus is held together by a strong, attractive nuclear force between protons and protons, neutrons and neutrons, and protons and neutrons.
- Some nuclei are unstable and can decay and become other nuclei.
- The energy of the nuclei can be released during fusion and fission reactions.

What will students understand as a result of this chapter?

- Electric charges can attract and repel each other. The force of attraction holds atoms together. The force decreases by the square of the distance between charges.
- Electric charges have only been observed to have certain, specific values.
- The size of the "invisible" nucleus can be determined by indirect observations as performed by Rutherford's scattering experiment.
- Bohr was able to create a model of the hydrogen atom that was consistent with the observed evidence of the specific light that hydrogen emits.
- Evidence from the photoelectric effect required Einstein to create a new model of light that was inconsistent with the previously accepted "wave" model of light.
- The positively charged protons in the nucleus repel each other through the Coulomb force but are attracted by the much stronger nuclear force.
- Some nuclei are not stable and can decay and become different nuclei.
- The energy released during nuclear fission and nuclear fusion is determined by calculating the average binding energy of the nucleons in the nucleus.

What are the overarching "essential" questions?

- How can you create a model of the atom and nucleus that is consistent with experimental observations?
- How can you determine the size of the nucleus?
- How can you measure the charge on a single electron?
- What is radioactivity?
- What is the nature of light? Is a wave model or a particle model consistent the experimental observations?
- What creates the large energy release during nuclear fission and nuclear fusion?

What "essential" questions will focus this chapter?

- What determines the strength of the electrostatic force between positive and negative charges?
- What is the charge on an electron?
- How does one determine the size of the "invisible" nucleus?
- How can the discrete wavelengths of light given off by hydrogen be observed and explained?
- What is the photoelectric effect?
- How can the protons in the nucleus be held together given the large repulsive electrostatic force among them?
- How can radioactive decay explain one nuclei becoming another? How can radioactive decay be used to determine the age of objects?
- What is nuclear fission?
- What is nuclear fusion?
- How can we determine the energy release during fusion and fission?

* Grant Wiggins and Jay McTighe, *Understanding by Design* (Merrill/Prentice Hall, 1998), 181.

CHAPTER 8