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 (enduring) understandings are desired?

Music, theater, movies and concerts are filled with auditory and visual effects that can be explained using some basic physics principles. Appreciation for the arts can be enhanced by an appreciation of the physics principles behind the art.

- All musical sounds can be modeled with the concept of standing waves on strings and in air columns and on surfaces.
- Light and vision allows us to create all sorts of images.
- Physics principles can be adapted by engineers to create technologies such as mirrors and lenses.
- Shadows and color are additional optical effects that can productively be used in art when they are understood.

What are the overarching "essential" questions?

- How can a vibrating string produce sound?
- How can an air column produce sound?
- How can different pitch sounds be produced by strings and wind instruments?
- How do mirrors produce images?
- How do lenses produce images?
- How can we use color and shadows to create an exciting visual display?
- How can sound and light be used to create an entertaining show?

What will students understand as a result of this chapter?

- The frequency of a vibrating string can be increased by shortening the string or increasing its tension.
- As the length of an air column increases, there is a decrease in the frequency produced.
- Standing waves (transverse and longitudinal) can be set up on strings or air columns producing specific frequencies of sound.
- Light travels in straight lines. If an opaque object is placed in the path, the object will form a shadow.
- When light reflects off a mirror, the angle of incidence is equal to the angle of reflection (law of reflection).
- The law of reflection can explain why a plane mirror produces images which are the same size as the object and also why concave and convex mirrors can produce larger and smaller images.
- Light traveling from one medium to another changes speed and can refract (bend) as it enters the new medium.
- A lens is shaped so as to have all parallel rays of light converge at a single point—the focal point.
- An image is formed when the light from an object travels through a lens. The image can be larger or smaller than the object.
- Colors that you see are due to reflected light.
- When lights of different colors are added together, a new color is produced.

What "essential" questions will focus this chapter?

- What is the effect of string length on the pitch of sound produced?
- What is the effect of tension on the pitch of sound produced?
- How can a standing wave model explain the frequency of sound produced by strings?
- How can a standing wave model explain the frequency of sound produced in an open pipe?
- What causes a shadow to be formed?
- How does a plane mirror produce an image?
- How can a curved mirror produce images that are larger and/or smaller than the object?
- Describe the bending of light as it travels from one medium to another.
- How do lenses produce images?
- What is the effect of adding different colors of light?

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