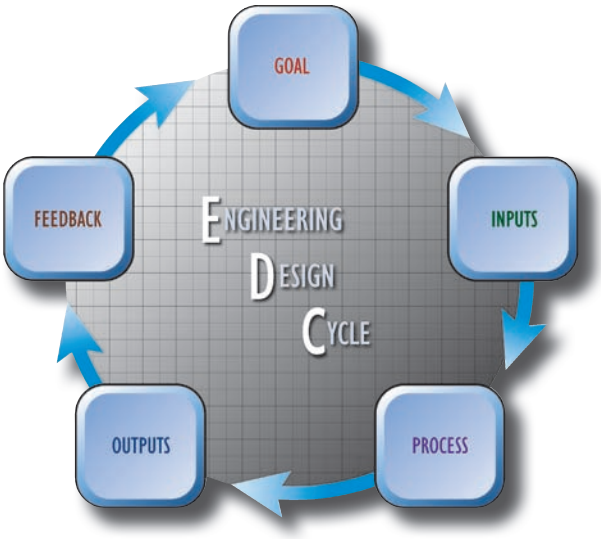
Physics

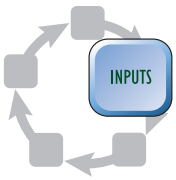
Chapter Challenge

You will now be completing a second cycle of the *Engineering Design Cycle* as you prepare for the *Chapter Challenge*. The goals and criteria remain unchanged. However, your list of inputs has grown.



Goal

Your challenge for this chapter is to create an entertaining sound and light show for students your age. The *Mini-Challenge* presentations that were given earlier by your class should give you a good idea of the types of shows your classmates find entertaining. Now you must determine how to incorporate one of those ideas with some of the lighting and sound effects you learned in this chapter, and explain the physics concepts behind them. Review the *Goal* as a class to make sure you are familiar with all the criteria and constraints.



Inputs

You have learned all the physics content you need to complete your challenge. You have completed all the sections of this chapter and now have additional information to help you identify and analyze the various physics concepts that apply to lighting and sound effects. This is part of the *Inputs* phase of the *Engineering Design Cycle*. Your group needs to apply these physics concepts to put together your presentation. You also have the additional *Inputs* of feedback you received following your *Mini-Challenge* presentation.

Section 1 You created sounds of different pitch by independently changing the length and tension of a vibrating string.

Section 2 You produced both transverse and longitudinal (compression) waves in a spring. You also learned to characterize many wave properties including amplitude, wavelength, wave speed, and frequency.

Section 3 You explored the relationship between wave speed, wavelength, and the frequency of vibration for a vibrating string. You also considered a human model for that relationship and learned that the relationship could be expressed in the equation $v = f\lambda$.

Section 4 You examined the sounds produced by vibrating air in a tube. You learned that you could change the pitch by changing the length of the straw or by covering one end of the straw. Both methods resulted in a change in the wavelength of the sound you produced. You also learned about the bending of sound waves, called diffraction.

Section 5 You used ray diagrams to explain the size and shape of shadows and learned that light travels in straight lines to create shadows. You also examined the parts of a shadow— the darker umbra toward the center, and the fuzzy, lighter edges called the penumbra.

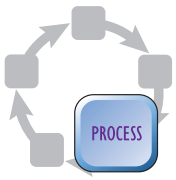
Section 6 You studied images reflected in a plane mirror and determined that the angle of incidence for a light ray is equal to the angle of reflection for the reflected ray. You learned that both of those angles are measured relative to the normal line, perpendicular to the mirror's surface.

Section 7 You looked at images created by convex and concave mirrors. You also used ray diagrams to find the focal point and measured the focal length for both types of mirror to help explain how the virtual images were formed.

Section 8 You observed refraction, the bending of light. You also used ray diagrams to trace the path that light traveled and measured the angles of incidence and angles of refraction. You also discovered an interesting phenomenon known as total internal reflection when you shined your light at an angle greater than the critical angle for the block material.

Section 9 You discovered why refraction is a key physics principle as you explored the effect of lenses on light. By observing the relationship between the locations of an object, a lens, and the resulting real image, you realized the basic technology behind many optical devices.

Section 10 You observed shadows generated by multiple bulbs of different colors.

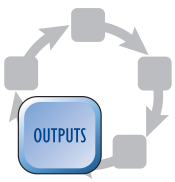


Process

In the *Process* phase, you need to decide what information you have that you will use to meet the *Goal*. Decide on a format for your presentation. Will your group play a song, perform a play or show, or create some other type of presentation? Creativity is encouraged and will make your project memorable. Once you have that focus determined, it will be easier to decide how to proceed. You can organize your creative process in a number of ways, but make sure that every member of your group is included and knows how he or she can contribute to the presentation.

Your experience with the *Mini-Challenge* and with the investigations will provide you with some ideas regarding techniques that were found to be entertaining. Now you can concentrate on optimizing some of those effects. Start with a technique you used in class and see if you can make it more impressive by changing one or more of the features. You can anticipate what feature to change and estimate the amount of change that might produce the result you want. For example, in the case of stringed instruments, you would change lengths and tensions to adjust the sound. For projecting images, you could alter the distances between the light, the object, the lens, and the screen to change the effect. In all cases, it will be useful to record the trials you conduct and the results you obtain. This information will help you recreate the successful trials and you can share this information as part of your physics explanation.

Remember that the sound-producing devices and the light effects in your presentation must be based on classroom investigations. Be sure to include a script for your show, a written explanation of the physics concepts behind the effects, and any additional props that can enhance your presentation. If your class prepares a rubric to go along with the criteria for this challenge, make sure you refer to it often to ensure that you address each category without leaving out any important information.



Outputs

Your presentation to the class are your design-cycle *Outputs*. Entertain your classmates for two to four minutes with a show using sounds and lights that your group creates, and be sure you accurately convey the physics concepts you exploited to make it all happen. A combination of creativity, good analysis, solid project development and presentation skills are required to create a successful *Chapter Challenge*.

Feedback

Your classmates will give you *Feedback* on the accuracy and overall appeal of your presentation based on the criteria of the design challenge. This feedback will likely become part of your grade but could also be useful for additional design iterations. No design is perfect; there is always room for further improvement in any design. Your experience with the *Mini-Challenge* should demonstrate how you could continuously rotate through the design process to refine almost any idea.