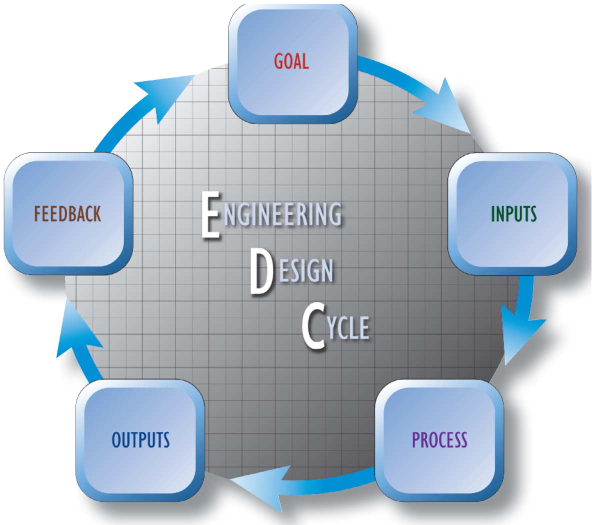
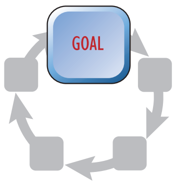
Physics Chapter Challenge

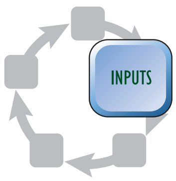
You will now be completing a second cycle of the *Engineering Design Cycle* as you prepare for the *Chapter Challenge*. The goals and criteria remain unchanged. However, your list of *Inputs* has grown.





Goal

Your challenge for this chapter is to create a toy that converts the mechanical energy of motion into electricity, or electrical energy to mechanical motion with the purpose of educating children about the use of electricity to move things. Your toy can operate with a battery powered motor or a mechanically powered generator. Review the *Goal* as a class to make sure you are familiar with the criteria and constraints.



Inputs

You now have additional physics knowledge to help you identify and analyze the various physics concepts that apply to electric motors and generators. You have completed all the sections of this chapter and learned the physics content necessary to complete your challenge.

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 your own personal experience with various toys, as well as the *Feedback* you received following your *Mini-Challenge* presentation.

Section 1 You mapped the magnetic field of a bar magnet and then compared the results to the effect of a wire carrying a direct current (DC) on a magnetic compass needle.

Section 2 You constructed a solenoid that operates as an electromagnet. You also identified the variables that control the strength of the magnetic field a solenoid produces.

Section 3 You explored the force between a current-carrying wire and a nearby magnet. You learned how to utilize that force to construct and operate a simple DC motor.

Section 4 You used a galvanometer, a device for measuring electric current. You explored the function of the galvanometer by moving a magnet in and out of an electric coil, and induced an alternating current (AC) by moving the magnet back and forth through the coil.

Section 5 You explored the technology behind AC and DC generators by considering the movement of a rotating coil in a magnetic field and the direction of the resulting induced current. You also examined the connections that are necessary to generate a direct current or an alternating current from a rotating electric generator.

Section 6 You observed how patterns in science and nature determine scientific discussions, and how patterns are used to make discoveries. You investigated the symmetry pattern of electric and magnetic fields. You also explored how the speed of light was determined, and calculated travel times using the speed of light.

Process

In the *Process* phase, you must decide what information you will use to help you meet the *Goal*. The first step is to select the physics principles you will use. Then you must decide what type of toy you will create to demonstrate those concepts. Your model from the *Mini-Challenge* should be very useful at this stage. Even if you change your design completely, the materials that you will need to create the motor or generator will probably be very similar.

Your toy can use a motor, a generator, or both. If you use a motor, you may use up to four D-sized batteries to power your toy. If you use a generator, you can turn almost any mechanical motion into electricity, but remember that you need constant motion to maintain a constant supply of electricity.

For your prototype to work properly, you may have to make many small adjustments. Remember that adding more batteries, more coils of wire, or more magnets may affect the output of your electric motor or generator. Also, if you are using a generator, you will want to include some description of how electricity is used in the toy design so children will be able to tell that it's working. Building a toy that "works" can be a lot of fun!

Your instruction manual should include all of the "how-to" steps for constructing and operating your toy, as well as information about the physics principles behind its mechanisms. Your manual should help children understand why a magnet is needed in your toy and why it has to be placed in a specific position. They should also understand the function of the wire coils and the reason connections are so important. You might also have to provide some basics about AC and DC currents to complete the explanations of your toy.

Remember, pictures and diagrams will help clarify your explanations and will increase the appeal of your manual.

Outputs

Presenting your information to the class are your design cycle *Outputs*. Create a presentation that highlights the main features of your design and demonstrates your new knowledge of electricity. Keep in mind that your audience may know as little about electric motors and generators as you did when you began this chapter, so be sure to explain everything in simple terms that listeners can understand.

You will present your toy design, the list of parts that the manufacturer will need, and the manual containing the instructions and explanations for how the toy works. As always, diagrams, charts, and drawings are helpful tools in a presentation—a sketch of your toy, with all of the significant parts clearly labeled, might be a good idea.

Feedback

Your classmates will give you *Feedback* on the accuracy and overall appeal of your presentation based on the criteria of the design challenge. Do not forget, your classmates' design solutions may present you with *Feedback* and alternative methods for solving the same problem. Remember, no design is perfect, and there is always room for optimization or improvement no matter how slight. From your experience with the *Mini-Challenge*, you should see how you could continuously rotate through the design cycle to refine your electrical-system design.