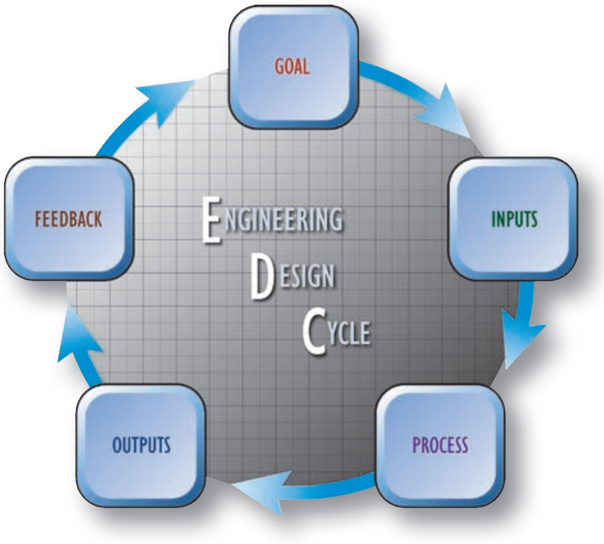
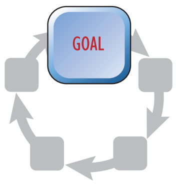
Physics

Chapter Challenge

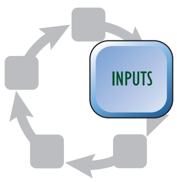
You will be completing a second process of the *Engineering Design Cycle* as you prepare for the *Chapter Challenge*. The goals and criteria remain unchanged; however, your list of *Inputs* has grown.





Goal

Your challenge for this chapter is to design an interactive museum exhibit that explains and demonstrates important facts about the atom and to create a novelty item related to the exhibit that might be sold in a museum gift shop. Review the *Goal* as a class to make sure you are familiar with all the criteria and constraints.



Inputs

You have completed all the sections of this chapter and now have more information about the atom to help you identify and address the different physics concepts that apply and that could best be demonstrated in an interactive museum exhibit. This is part of the *Input* phase of the *Engineering Design Cycle*. Your group's collective creativity will be a second major source of *Inputs*. You might visit some online science museums to get more ideas to engage your potential audience.

Section 1 In this section, you explored the nature of electrically charged objects. You also worked with a model for calculating the forces that charged objects exert on each other, demonstrating Coulomb's law.

Section 2 You applied deductive reasoning to examine the contents of a container without looking inside. This was one of the methods Millikan used to discover that electric charges only come in certain "quantized" amounts.

Section 3 You used an indirect method to measure the area of a penny to simulate how Rutherford originally measured the size of an atomic nucleus. You then compared your results to the actual value for the area of a penny and determined the ratio of the size of a nucleus to the size of an atom.

Section 4 You examined the different colors of light that are emitted by a specific atom when it is energized. You also learned how each atom can be identified by the color of light it gives off because the color, or type of light, depends on the arrangement of electrons in each particular atom.

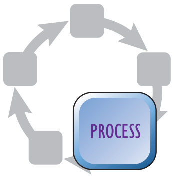
Section 5 You explored different examples to investigate the wave behavior and particle behavior of light, including the photoelectric effect. You also learned that electrons behave like waves and particles.

Section 6 You investigated the organization of the atomic nucleus by building models. The models served to demonstrate the competing forces that must exist to hold protons together in a nucleus despite the Coulomb forces working to push them apart.

Section 7 You used cubes to simulate radioactive decay. You then combined your data from the cubes with your knowledge about the structure of the atomic nucleus to create a model of radioactive decay that demonstrates half-lives, a reliable tool for determining the age of certain archeological artifacts.

Section 8 You unlocked the secret of nuclear power and the meaning of Einstein's $E = mc^2$ equation by comparing the available nuclear energy in an object to other forms of energy you have studied in physics class. You learned that nuclear energy comes from the energy required to hold pieces of the atomic nucleus together and discovered the enormous magnitude of available nuclear energy.

Section 9 You calculated the average binding energy of a particle in a nucleus and explored the two nuclear events that can release energy—nuclear fission and nuclear fusion. Your understanding of these events contributes to your everyday knowledge about the benefits and dangers of nuclear power plants.



Process

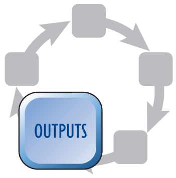
In the *Process* phase, your group must decide what information you will use to meet the *Goal*. Your group will be restricted by time and you will need to be organized to complete all of the products for your presentation.

After deciding on the physics concepts you will address, think about how they can be adapted in an interactive display to catch attention—your museum exhibit needs to pull the audience into the exhibit in the first 30 seconds. You might consider turning one of your class investigations into a game or activity for museum visitors.

The challenge requirements also include entrance and exit posters. Your posters should outline the information available in your exhibit, but can also be designed to capture attention and tease viewers' curiosity. Add some thought-provoking questions or mind-boggling facts to spark interest in your exhibit. You will want to make viewers curious about what they can learn while entering your exhibit, and as they exit, help them connect the facts they have just learned with the world they know.

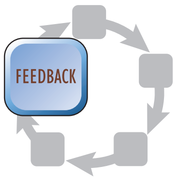
You will need to build a model that effectively communicates exactly how your exhibit might appear in a museum setting. Your model should demonstrate how people will move through the space, where the most captivating features will be located, and how people will be able to interact with the exhibit. Don't forget to include adequate safety features, as would be provided in a real museum.

The requirement to craft a novelty for the museum gift shop is another opportunity to be creative. Your exhibit souvenir could be a game, a toy, a T-shirt emblem, or anything that has a close connection with the information you present in your exhibit.



Outputs

Presenting your complete museum exhibit to the class is your design cycle *Output*. Organize your presentation to highlight the main features of your exhibit and to demonstrate your understanding of the physics concepts related to the atom. You will present your posters, your museum exhibit model, and the gift shop novelty that you created. If you made a model of your interactive idea, you might want to give a few students a chance to try it out. You should also present the facts about the atom that you will be teaching in your exhibit.



Feedback

Your classmates will give you *Feedback* on the accuracy and the overall appeal of your presentation based on the criteria of the design challenge. They will also decide whether they think your exhibit meets the 30-second challenge. Since your group will be creating a number of products for this challenge, it is likely that some of them will be more complete and accurate than others. No design is perfect; there is always room for optimization or improvement. From your experience with the *Mini-Challenge*, you should see how you could continuously rotate through the design cycle to refine your museum exhibit.