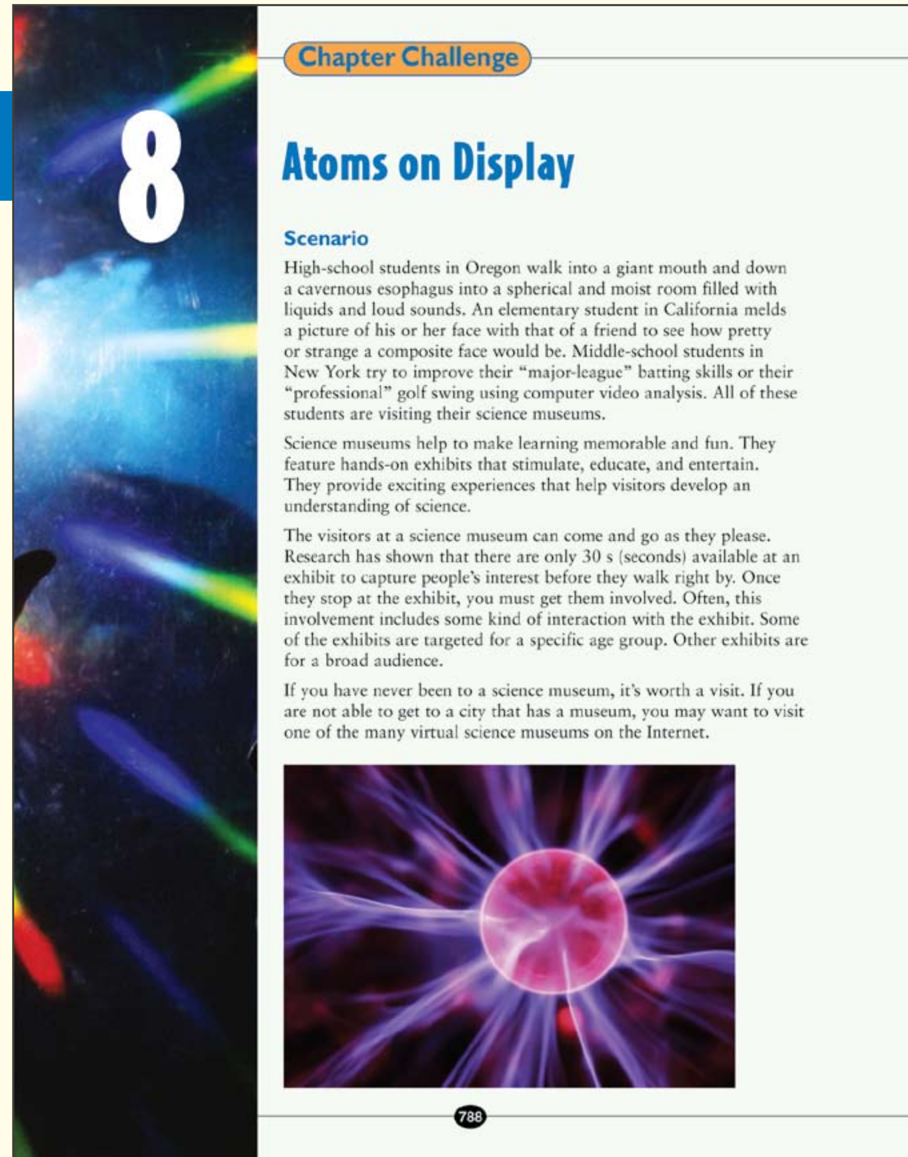
Chapter Challenge


Chapter Challenge

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Atoms on Display

Scenario

High-school students in Oregon walk into a giant mouth and down a cavernous esophagus into a spherical and moist room filled with liquids and loud sounds. An elementary student in California melds a picture of his or her face with that of a friend to see how pretty or strange a composite face would be. Middle-school students in New York try to improve their "major-league" batting skills or their "professional" golf swing using computer video analysis. All of these students are visiting their science museums.

Science museums help to make learning memorable and fun. They feature hands-on exhibits that stimulate, educate, and entertain. They provide exciting experiences that help visitors develop an understanding of science.

The visitors at a science museum can come and go as they please. Research has shown that there are only 30 s (seconds) available at an exhibit to capture people's interest before they walk right by. Once they stop at the exhibit, you must get them involved. Often, this involvement includes some kind of interaction with the exhibit. Some of the exhibits are targeted for a specific age group. Other exhibits are for a broad audience.

If you have never been to a science museum, it's worth a visit. If you are not able to get to a city that has a museum, you may want to visit one of the many virtual science museums on the Internet.

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Scenario

The *Scenario* focuses on how the science museums throughout the world capture the interest of visitors by combining both science content and entertainment. Visitors have the option of not stopping before an exhibit if their interest is not captured within the first 30 s. For those visitors who do remain, the science content must be stimulating, educational, and engaging. Involvement in an exhibit is often built upon interactive techniques that help the visitor to develop an understanding of science. The creation of a successful museum exhibit is a complex task and will challenge all students in your *Active Physics* classroom.

Read or have a student read the *Scenario* aloud. Ask students whether they have visited a science museum and if they have, what they remember most from their visit. Record students' responses on what a museum exhibit of an atom should display. Discuss how their display of a science exhibit could stimulate their audience and what interactive techniques might be useful in capturing a visitor's interest. Encourage students to visit science museums on the Internet if they are unable to visit one, and ask them to think of the techniques museums employ to target a specific age group or catch the interest of a broader audience. Consider sharing your own experiences of a visit to a science museum, asking students to reflect on the interactive approach of their *Investigates*, and how museums build on inquiry-based learning projects through interactive communication.

Your Challenge

While discussing the *Chapter Challenge*, review the list of requirements that students must meet to succeed at their challenge. Consider asking students to make a checklist of what their exhibit should include. Suggest that their checklist could be in the form of a table with two columns. The first column is for a brief description of each requirement and the second column is used to check off the part of the exhibit that meets the specific requirement. Emphasize that the representation of the distinct parts of an atom

Your Challenge

Your *Active Physics* class has been asked to develop an exhibit that will provide visitors to a science museum with an understanding of an atom.

The exhibit must

- *include* distinct features of the structure of an atom
- *communicate* the size and scale of the parts of an atom
- provide information on how an atom is held together
- explain the role of models in developing an understanding of an atom
- show your visitors the strengths and limitations of various atomic models
- educate visitors about the importance of indirect methods of measurement that scientists use to collect evidence about an atom
- capture the visitor's attention within 30 s
- include written matter that will further explain the concepts
- have a model, a T-shirt, a poster, a booklet, or a toy that can be sold at the museum store
- include safety features
- be interactive—visitors should not merely read
- include posters to provide an overview of what visitors are about to see and a review of what they witnessed.

Criteria for Success

You will be presenting your museum-exhibit plan to your class. As a class, decide how your work will be evaluated. Some required criteria are listed in the *Chapter Challenge*. Are there other criteria that you think are worth including?

How should each of the criteria be weighted? Should the written material be worth as many points as the item for the museum store? Should the 30-s criterion be worth more than anything else? Since the museum exhibit is supposed to educate the visitor, how much should the content be worth? Should all content criteria be equally weighted? Work with your class to agree on how many points should be assigned for each criterion. The total points should add up to 100.

Once you decide on the point allocation, you will have to decide how you can judge the assigned point value. For instance, assume that you chose the 30-s criterion to be worth 15 points. How will your class decide on whether your exhibit gets the full 15 points or only 10 points? It is worth knowing how each criterion will be judged so that you can ensure success and a good grade. You will probably want to assign some strict guidelines and also leave room for some extra points. Learning to judge the quality of your own work is a skill that all businesses expect to see in their professionals.

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should capture their audience's attention within 30 s. Brainstorm techniques that students could use to explain the parts of an atom in an interactive manner. You could also plan a school trip to a science museum and ask students to focus on how each exhibit was displayed.

As students progress through each section in the chapter and investigate the structure of an atom, tell students to keep a record of the additional physics concepts they learn in their *Active Physics* logs. Reiterate that in order to build an interactive exhibit, students should collaborate with their group members to explore ways that enhance the quality of their presentation.

Criteria for Success

Develop the criteria with your class to assess the *Chapter Challenge*. Emphasize that the list of requirements provided in *Your Challenge* in the student text should be included in the evaluation. Encourage students to come up with other criteria that would improve the quality of their presentation. Lead a class discussion on deciding how the criteria should be weighted. Record a list of students' suggestions and point out reasons why certain criteria would be worthy of more points.

Students should also understand that each criterion deserves an accurate and clear description. For instance, students might assign points to a poster that provides an overview of the exhibit. While this is a useful criterion, it should list what details need to be included, so that students know exactly how they have to develop their overview of the exhibit. Evaluation, therefore, should be based on guidelines that help students meet the requirements of their *Chapter Challenge* in the most effective manner.

When each criterion has been established, discuss and review the details that you and your class have decided. Ask students to verify if all the criteria are adding up to 100 points. Student participation in determining how much each criterion is worth should be encouraged throughout the process of developing an evaluation tool. Reading the criteria aloud in class helps

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reinforce the purpose of each feature of the exhibit and brings up other ideas that students might want to include in their evaluation.

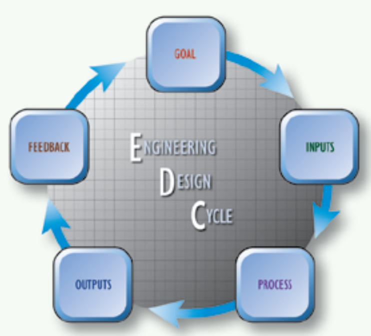
Standard for Excellence

After students have made a list of the criteria, they should develop a rough rubric that assigns a point value to each criterion. The *Standard for Excellence* table can be used as a starting point to incorporate the details that students have earlier suggested during the *Criteria for Success* discussion. Point out the benefits of a rubric and actively engage students in the decision-making process while they determine the points each criterion should carry. The rubric, as an assessment tool, should be gradually refined as students learn more about the structure of an atom. At this stage, you should emphasize that certain criteria such as the physics concepts should carry more points than the entertainment value of the exhibit. While all criteria that your have class decided upon are important, students must be clear about the different aspects of the challenge and what standards deserve more emphasis.

A sample rubric for assessment has been provided at the end of this chapter. You may want to use this rubric and modify it according to your class's feedback on evaluation criteria, or you could use this rubric as an example to build another rubric based on assessment criteria that you and your class have determined. The *Standard for Excellence* table is provided as a Blackline Master in your *Teacher Resources* CD.

Chapter Challenge

Standard for Excellence	
1. Quality of Exhibit • includes features of the structure of the atom • physics concepts from the chapter are integrated in the appropriate places • physics terminology and equations are used where appropriate • correct estimates of the magnitude of physical quantities are used • additional research, beyond the basic concepts presented in the chapter	40 points
2. Written matter	25 points
3. Entertainment value of the exhibit • capture visitor's attention in 30 s • interactive	20 points
4. Item sold at museum store	10 points
5. Challenge completed on time	5 points



Engineering Design Cycle

You have now learned about your *Chapter Challenge* to develop an exhibit that will provide visitors to a science museum with an understanding of an atom. You will use a simplified *Engineering Design Cycle* to help your group complete this design challenge. Clearly your *Goal* is the first step in the *Engineering Design Cycle,* so you have already begun.

As you experience each one of the chapter sections you will be gaining *Inputs* to use in the design cycle. These *Inputs* will include new physics concepts, vocabulary, and even equations that you will need for your exhibit. When your group prepares the *Mini-Challenge* presentation and the *Chapter Challenge*, you will be completing the *Process* step of the design cycle. During the *Process* step you will evaluate ideas, consider criteria, compare and contrast potential solutions, and most importantly, make design decisions.

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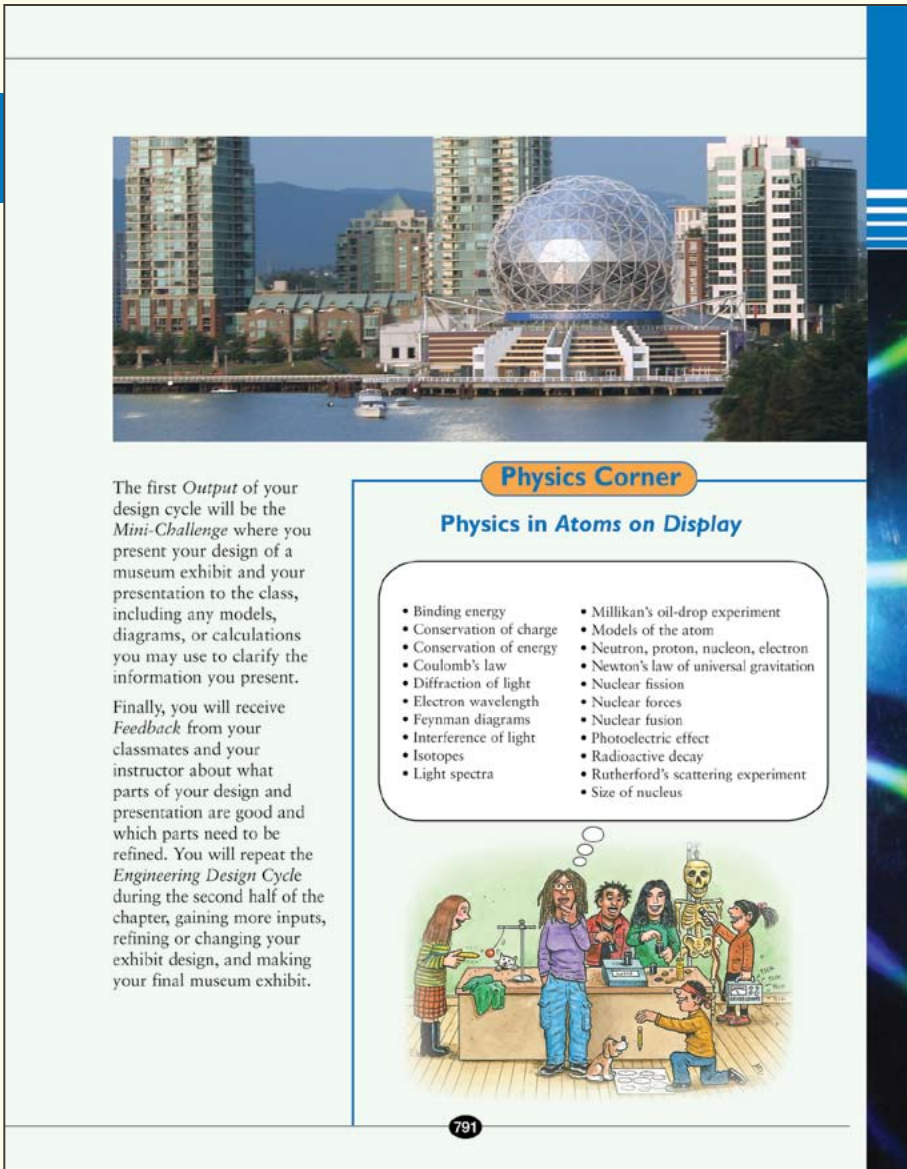
8a **Blackline Master**

Engineering Design Cycle

A simplified *Engineering Design Cycle* helps students to complete their challenge. The *Goal* is central to the *Chapter Challenge* and should be clearly outlined before students proceed with other steps of the cycle. Reiterate that the purpose of the *Goal* is to develop an exhibit that educates the audience about the structure of an atom and captures their interest in the same way as



The first *Output* of your design cycle will be the *Mini-Challenge* where you present your design of a museum exhibit and your presentation to the class, including any models, diagrams, or calculations you may use to clarify the information you present.

Finally, you will receive *Feedback* from your classmates and your instructor about what parts of your design and presentation are good and which parts need to be refined. You will repeat the *Engineering Design Cycle* during the second half of the chapter, gaining more inputs, refining or changing your exhibit design, and making your final museum exhibit.

Physics Corner

Physics in *Atoms on Display*

- Binding energy
- Conservation of charge
- Conservation of energy
- Coulomb's law
- Diffraction of light
- Electron wavelength
- Feynman diagrams
- Interference of light
- Isotopes
- Light spectra
- Millikan's oil-drop experiment
- Models of the atom
- Neutron, proton, nucleon, electron
- Newton's law of universal gravitation
- Nuclear fission
- Nuclear forces
- Nuclear fusion
- Photoelectric effect
- Radioactive decay
- Rutherford's scattering experiment
- Size of nucleus

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visitors to a museum are curiously drawn to an exhibit in a science museum. Emphasize that *Inputs* or information from each section will be used to meet the challenge. Consider asking students to record new physics concepts, equations, and vocabulary that they will need to prepare for their *Chapter Challenge*.

The *Process* step is also an essential part of the *Engineering Design Cycle* that enables students to consider new ideas, test potential solutions, and decide which design will meet the criteria of the challenge. Students need to know that the *Process* step is built into different components of each inquiry-based section. Learning new information, or the *Input* stage, and deciding what do with it, the *Process* step, are interconnected. An outcome of the *Process* step is the *Output*. The *Mini-Challenge* presentation is the first time students get a chance to design.

This is their first *Output*. Once students present their design of a museum exhibit, they should receive feedback from you and their classmates on which parts of their initial design need to be refined.

Physics Corner

The illustration accompanying the list of scientific terms presented in the *Physics Corner* is designed to elicit students' curiosity and stimulate an interest in concepts that they will be investigating in this chapter. Encourage students to note which physics terms they might already be familiar with. Consider using an overhead of the illustration to outline images in the *Physics Corner* that the artist has used to convey essential physics concepts. Point out that the *Physics Corner* is not only a preview of the physics terms students will learn, but also an indication of the inquiry-based technique that will integrate new concepts with prior knowledge. Make students aware that they will need to have a thorough understanding of these concepts to complete the *Chapter Challenge* successfully. Remind them that you will be referring to the *Physics Corner* from time to time to track the concepts covered through each section of this chapter.