6-8: Realm of the Atom

Curriculum Connections

Scientific Connections And Applications
- Understand and describe examples of the importance of science & technology (radioactivity and Geiger counters) and the impact that they have on our lives

Scientific Tools And Technologies
- Use technology and tools (Geiger counter) to observe and measure objects (radioactive atoms) and phenomena (Frozen Shadows)

Physical Science
- Understand the properties and changes of properties in matter (phase change)
- Understand the structure of matter at the atomic level
- Observe and describe different patterns of motion (Brownian Motion)

** Based on the New York State Elementary Science Core Curriculum and the New York City New Standards™*

National Standards

Content Standard B: Physical Science
- Properties and changes of properties in matter
- Motions and forces
- Transfer of energy

Content Standard E: Science and Technology
- Abilities of technological design
- Understandings about science and technology

Content Standard F: Personal and Social Perspectives
- Personal health
- Populations, resources, and environments
- Natural hazards
- Risks and benefits
- Science and technology in society

Content Standard G: History and Nature of Science
- Science as a human endeavor
- Nature of science
- History of science

6-8 Exhibits List

Brownian Motion
Chemistry Demonstration
One Particular Wave
Quantum Atom: Different from the "Everyday World"
Shadow Wall (Very popular)
Radioactive Atoms
Simulation of Brownian Motion
Street Light and Atoms
The Idea of the Atom
Toward an Even Smaller Realm

6-8: Realm of the Atom

Guide Theme

The theme of these guides are based on popular crime and detective show investigations on TV; a mystery unfolds, questions are asked, evidence is gathered, conclusions are drawn. This process is similar to what scientists go through with the inquiry method. For more details see About the Guides.

Begin the Investigation At School

A mystery unfolds, questions are asked...
There are several ways you can introduce the topic and start the investigation. Here are some ideas that will help students start thinking about the topic and generate questions:

- Create a mystery about how dancing pollen on water led to proof of the existence of atoms 200 years ago; a time before anyone had seen an atom. (Mystery solved at Brownian Motion exhibits)
- Create a mystery about what causes radiation and radioactive rocks! (Mystery solved at Radioactive Atoms and Gieger Counter exhibits)
- Create a mystery about what causes streetlights to give off different colors of light. (Mystery solved at Street Lights and Atoms exhibit)
- Create a mystery around the phenomena of “frozen shadows”; shadows that stay even when you leave. (Mystery is solved at Shadow Wall exhibit)
- Demonstrate one of the Laboratory Activities with no explanation-let the questions begin
- Do one of the Laboratory Activities and facilitate a probing discussion

Prepare for Investigation at the New York Hall of Science
Once students have generated questions around the topic tell them they are going to continue the investigation at the New York Hall of Science.

At this point you may want to begin one of the Continuum Activities. These activities have the following features:

- Vary in length and depth
- Provide continuity and purpose for the visit
- Provide a way of assessing student understanding

Orientation and Planning: If you do nothing else, do this!
Here are five reasons to conduct student orientation and planning before going on a field trip:

1. Students focus on exploring and investigation versus the novelty of the location
2. Students don’t have to worry about logistics like restrooms, schedule, eating etc.
3. Students who understand the plan and purpose of the visit are more likely to stay focused
4. Students who have clear goals for their visit are less likely to race from one exhibit to another with little understanding
5. Students who get involved in the planning of the visit, take ownership and are less likely to misbehave

Read more about the Orientation and Planning Process

6-8: Realm of the Atom

Investigation at the New York Hall of Science

Evidence is gathered...
Okay. The class has arrived at the next phase of the investigation. The students have questions and seek answers. Everyone knows what exhibits they should visit and why. Everyone knows the schedule for the day. Students have materials to record findings or work on a Continuum Activity if required.

If all of the above is true, congratulations on a successful Orientation and Planning.

If you are curious about what teachers can do on site, we've put together a little piece called Teacher Role.

Finish the Investigation Back at School

Conclusions are drawn...
There are several ways you can complete the investigation. Some require less time than others. Here are some ideas:

- Student or group oral or written reports on investigation questions and answers
- Student or group illustrations of visit with answers to questions or mystery
- Do one of the Laboratory Activities
- Complete the Continuum Activity

Continuum Activities

Continuum Activities are designed to carry through the entire investigation. Some activities require less time than others.

Investigation Map

Description: Detectives will often map out related events, evidence and suspects during an investigation. This helps them get an overall picture. Students can map out their investigations with a concept map. The concept map will help you assess what students learn.

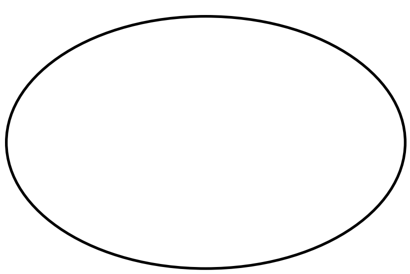
Time: (3)15-30 min. Sessions

Materials Needed:

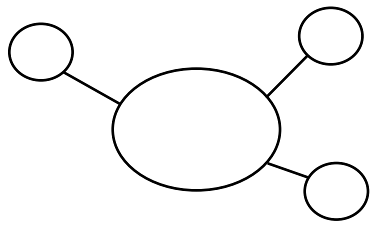
- Blank paper
- Pencils, colored markers

Procedure:

1. Begin with a center circle and write in the name of the main topic. (Students who do not write can have an adult assist or draw a representation of the main topic)



2. As students generate questions about the topic, they can add offshoot circles. They can also add circles for facts they know about prior to the visit to the New York Hall of Science.



3. When students return from their investigation at the New York Hall of Science they add additional circles of information. Their final map should reflect everything they know about the topic. Teachers can easily assess what is learned based on how the map develops.

Investigation Journals

Description: Investigation journals provide a way for students to record their questions and findings throughout the investigation.

Time: (3)15-30 min. Sessions

Materials Needed:

- Blank or lined paper
- Pencils, pens or colored markers
- On-Site Investigation Handout (print out from this web site and make copies)
- Zip-lock bags (for on-site handout only)
- Soft yarn or thick soft string (for on-site handout only)

Procedure:

1. Ask students if they have ever seen a detective take notes when trying to solve a mystery. Tell students that as “science detectives” they too will make a record of the mystery.
2. Have students begin their journal or report with questions that are generated when they Start the Investigation at School.
3. Students who do not have writing skills can make a large question mark and draw representations of their questions. If an experiment or demonstration is done, non-writing students can sketch what they observe.
4. Older students with writing skills can list their own and other students questions in their journal.
5. We strongly advise students not bring journals to the New York Hall of Science where they can get lost. We have provided an On-Site Investigation Handout that can be copied if students want to record observations or make sketches.
6. When students return from their investigation at the New York Hall of Science have them write answers to questions or draw what they observed.

Science TV- Investigative Reporters

Description:

In this activity, students plan and produce a TV show featuring investigative reports on the topic. This is a cooperative learning activity that integrates language arts, science and technology. There is a significant amount of writing involved, however students who are not prolific writers can also contribute as camera people, script supervisors, directors and on-camera reporters. Students will video tape at school and at the New York Hall of Science so pre-planning is essential for this activity.

Time: (3) 45 minute sessions (writing)
(1) video shoot at school
(1) video shoot at the New York Hall of Science
(1) 45 minute session (writing)
(1) video shoot back at school
(1) 30 minute session for viewing final TV show

Materials Needed:

- Video camera
- (1) video tape per student group
- External wired microphone for camera (optional but suggested for good audio)
- TV
- Cables to run camera to TV for viewing
- Student internet access (optional for research)
- Lined paper and pencils
- Large plain paper and markers (cue cards)

Procedure:

First Session-Planning

1. Tell students they are going to plan and produce a TV show with investigative science news stories that are 4-5 minutes in length.
2. Divide the class into groups of four or five students.
3. Have students or the teacher chose a writer/script supervisor, camera person, director and on-camera reporter for each group.
4. Tell students about the various roles in the production team:
    - Writer-writes groups ideas for script, makes revisions
    - Cameraperson-operates camera
    - Director-supervises camera person and on-camera reporter, calls for action and cuts
    - Script Supervisor-makes cue cards for on-camera reporter, makes sure script is followed
    - On-Camera Reporter-person who reports and appears in video
5. Tell students that everyone the group will work together to create the script.
6. Remind students of the topic of study and the trip to the New York Hall of Science.
7. Instruct students to begin to create questions around the topic for the news show. They may want to create questions for interviews with New York Hall of Science “Explainers” too.
8. Tell students to watch the local news on TV so they can observe how news reporters do their job.

Second Session-Location Scout and Scriptwriting

1. Tell students they are going to do a location scout of the location they will be shooting at the New York Hall of Science.

Scouting the location will help them think of more questions and give them ideas for what to shoot on location.

2. Make prints outs of the exhibits the class will visit at the New York Hall of Science OR have stu-

dents access the exhibits online themselves.

3. Once students have become familiar with the exhibits, allow time for more scriptwriting. Make sure scripts have the following components:
    - Introduction to the report (name of reporter, where they are, news headline)
    - Questions the investigative report will answer
    - Conclusion (to be done after video shoot at New York Hall of Science, comment, opinion about answers, reporter sign-off)

Third Session- Rehearsals and Final Script

1. Remind students about the various roles in the production team:
    - Writer-writes groups ideas for script, makes revisions
    - Cameraperson-operates camera, responsible for video tape
    - Director-supervises camera person and on-camera reporter, calls for action and cuts
    - Script Supervisor-makes cue cards for on-camera reporter to read, makes sure script is followed
    - On-Camera Reporter-person who reports and appears in video
2. Have groups rehearse their roles using the scripts. (Camera people can use their hands to frame shots)
3. Advise groups to make script revisions if they notice problems during rehearsal.
4. Rehearsals can be done in front of whole class or in individual groups depending on your classroom space and noise level.
5. After rehearsal have groups meet and finalize the pre-New York Hall of Science script.

Homework
Have groups give script supervisor the pre-New York Hall of Science script so they can make cue cards. (Script supervisor can ask others to help make cue cards too)

Video Shoot at School
During this session each group will shoot the introduction to their news story. Each group will have their own video tape. Make sure each group tape is labeled. If possible you may want to have groups shoot in a quiet separate location from the others or schedule group shoots during breaks in the day. If the entire class is present during shoots, make sure the others are quiet and don't distract the shooting. After shooting make sure camera people return the group tape to the teacher for safe keeping.

Video Shoot at the New York Hall of Science

1. Make the shooting schedule for the day.
2. Allow 15-20 minutes for groups to shoot in their location.
3. Choose a central location for production groups to meet the adult who will have the video camera and group tapes.
4. Make sure production groups stay together at the New York Hall of Science and Chaperones know the schedule for the day.
5. If students plan to interview a staff "Explainer", locate the Explainer in the area before shooting

and ask for their assistance and cooperation for the shoot.

6. After shooting make sure camera people return the group tape to the adult for safe keeping.

Conclusion Script Back at School

1. Production groups will need to write the conclusion to their video script after their New York Hall of Science video shoot.
2. The conclusion should include a summary or opinion of the overall story as well as the reporter sign off.
3. Allow production groups to review their video footage (if necessary) so they can form opinions or summaries.
4. Have script supervisors and others in the group make up the final cue cards and conduct short rehearsals.

Video Shoot at School
During this session each group will shoot the conclusion to their news story. If possible you may want to have groups shoot in a quiet separate location from the others or schedule group shoots during breaks in the day. If the entire class is present during shoots, make sure the others are quiet and don't distract the shooting. After shooting make sure camera people return the group tape to the teacher for safe keeping.

View the Show
Hook up the camera to the TV and run the group tapes from the beginning. Enjoy the show.

Become an Explainer

Description: Students practice observation skills and investigate one exhibit with the goal of being able to explain it when they return to the classroom. Students can choose a variety of methods to explain and make presentations.

Time: (3) 45 min. Sessions

Materials Needed:
(per student pair)

- Interesting objects for student observation that will fit in a lunch bag
- Lunch bag
- Print outs of On-Site Investigation Handout

(optional suggestions)

- Variety of craft materials (pipe cleaners, popsicle sticks, straws, string, paints)
- Variety of clean, household recyclables (meat trays, cardboard tubes, aluminum foil, plastic wrap)
- Any other odds and ends students can construct with
- Poster board or paper
- Markers, crayons, colored pencils

Preparation:
Place interesting objects for observation in lunch bags to keep hidden from student view.

Procedure:

First Session

1. Tell students as they will be investigating exhibits at the New York Hall of Science and will choose one exhibit to explain to the class when they return. (students can work in groups or individually)
2. Tell students they are going to do an activity to practice their observation and describing skills.

3. Distribute materials to student pairs.
4. Tell students that the person who is holding lunch bag will now describe the object inside to the other person without naming the object or describing what it is used for. Only descriptions of what the object looks like are allowed. The other student must guess what the object is.
5. Allow student pairs to complete activity and then switch lunch bags with another student pair. Each student pair should have a new object.
6. Repeat activity.
7. Conclude activity by telling students they will need these same skills of careful observation and detailed describing to explain exhibits they investigate.
8. Conclude the session by leading a discussion about what students can do at the New York Hall of Science to help explain and record what they see. Ideas include:
   - sketching
   - writing
   - using exhibit pictures on this web site
   - photography
9. Distribute The On-Site Investigation Handout for use at the New York Hall of Science.
10. Go to the New York Hall of Science.

Second Session

1. Upon return to class from the trip, tell students they will spend time preparing to explain one of the exhibits they saw.
2. Here are some suggestions for student presentations:
   - Verbal explanation (with or without picture-good for ESL students)
   - Labeled diagram
   - Group or individual poster showing how an exhibit worked
   - Group or individual model using materials to represent exhibit (materials can be used to substitute and represent real materials from exhibit— ex. Clear plastic wrap simulates glass, cardboard tube becomes a rocket etc.)

Third Session (optional)
Use this time for students to make their class presentations if they made posters, drawings or models.

Note: Your class may want to make their presentations to another class or younger students as well.

Science Court-Nuclear Power: Fission Vs. Fusion

Description:
In this activity students will research and debate the question:
Making Nuclear Power: Fission Method or Fusion Method?

Time: (4) 45 minute sessions
(1) trip to the New York Hall of Science (Visit Realm of the Atom)

6-8: Realm of the Atom

Materials Needed:

- Print outs of “How Fission and Fusion Power Works”, “The Case for Nuclear Fission”, “The Case for Nuclear Fusion.”
- Index cards

Procedure:

First Session

1. Tell students they will be participating in a mock court session debating the question: Making Nuclear Power: Fission Method or Fusion Method?
2. Tell students they will be divided into two groups to present both sides of the debate:
   - Fission Nuclear Power
   - Fusion Nuclear Power
3. Tell students the case will be decided by the judge (teacher) or a jury (another class).
4. Divide the class into the Fission Group and Fusion Group.

Hand out How Fission and Fusion Power Works to all students.

Hand out The Case for Nuclear Fission article to the students in the Fission Group.

Hand out the article The Case for Nuclear Fusion to the students in the Fusion Group.

Use the remaining time to let students read through the articles and discuss them in their groups.

Second Session

1. Divide class into the two groups again, Fission and Fusion.
2. Have students review the articles and highlight major points they want to use in their argument.
3. Conduct a preliminary hearing by having each group reveal one or two facts for their argument.
4. Tell students that they now have some idea about their opposition and are more likely to win their case if they have more facts than the other side.
5. Help students to see where they may need more research by asking the following questions:
   - Does your group have more facts or opinions? (opinions don’t hold much weight in a debate)
   - Does your group have enough information to oppose the other side?
   - What arguments from the opposition do you need to do more research on?
6. Discuss research sources where students can further prepare for their case. (Library, internet)
7. Assign research for homework.
8. Tell students they will prepare their case in the next session.

Third Session

1. Have students divide into their groups and discuss their research findings.
2. Have student groups choose a 2-3 representatives to present their case in court.
3. Have student groups choose 2-3 writers who will make index cards for the representatives.
4. Tell students they will have 15 minutes to present their group’s case.

5. Student groups spend the remainder of the time preparing their case for the court session.

Fourth Session

1. Court is in session.
2. Set up the room so that representatives from each student group can present their case.
3. Allow each group 15 minutes to present their case.
4. Allow 10 minutes for the other class jury to deliberate on who presented their case the best.
5. If another class jury is not available spend 10 minutes discussing who presented their case the best with the entire class. The teacher acts as judge and makes a final ruling.

6-8: Realm of the Atom

How Fission and Fusion Power Works-Print Out

About 17% of the world's electrical power comes from nuclear power plants. There are more than 100 nuclear power plants in the United States. All of today's nuclear power plants use the process of fission to make energy. The process involves a nuclear reaction where a uranium atom captures a neutron, which cause the atom to split. The splitting action of the atom causes great heat and radiation to be released. Nuclear power plants use the heat of a splitting atom to turn water into steam. The steam is used to turn a turbine, which creates electricity.

Fusion power is almost the opposite of fission. Instead of splitting an atom, atoms are fused together. The sun uses fusion to create energy. Scientists are still working on ways to make fusion power. The basic process of fusion involves bringing two hydrogen atoms together and heating them at very high temperatures. Hydrogen atoms come from water so there is an almost limitless supply. When these atoms are fused, they create enormous energy and heat. Once again water is heated into steam and the steam turns a turbine that creates electricity.

The Case for Nuclear Fusion-Print Out

Cost and availability of fuel is a considerable factor when dealing with nuclear power. Fission requires uranium or plutonium. Fusion, on the other hand, uses isotopes of hydrogen atoms, that can be obtained from ordinary water.

Uranium ores occur naturally in many parts of the world but must go through a costly purification process before used as fuel. Uranium-235 is a non-renewable resource that will eventually run out, much like the fossil fuels.

The potential amount of energy produced by fusion can greatly outweigh the fission. Initially, there are some disadvantages to fusion. The time and money required to develop technology needed to initiate, contain, and sustain a profitable fusion reaction is costly, but the development is still in its early stages and will continue to advance through the next century.

Fusion can only be accomplished at temperatures similar to the centre of stars, about 100 million degrees celsius. No solid material known to man can withstand temperatures necessary for nuclear fusion, but several methods of containment are being researched, magnetic confinement and inertial confinement. Until recently, all fusion devices developed have used much more energy than produced, but the latest designs have been able to generate an equal amount of energy to that required to sustain the reaction.

Fusion will be able to create over four times the energy produced through fission of an equal mass of uranium. It is just a matter of time and development before useful amounts of electricity can be produced through fusion.

The biggest concern people have about nuclear power is the production of radioactive waste among other hazards. First, the radioactive waste produced by fission remains highly radioactive for thousands of years. Fusion produces only low levels of short lived radiation, decaying almost completely within 100 years. Secondly, neither fission nor fusion reactors produce the greenhouse gas emissions that contribute to global warming and acid rain.

A malfunction of the moderator in nuclear fission reactors almost assures a core meltdown. The unchecked reaction heating up very rapidly, eventually liquefying the protective casing, releasing catastrophic radioactive material into the environment. Fusion reactions, however, are so extremely difficult to sustain that if anything were to go wrong, the reaction would invariably stop. After examining the potential of such technologies as fusion it becomes the obvious choice over fission. In conclusion, nuclear fusion has much more potential for long term use than the current fission reactors, even though in the short term it may cost a little more to develop. The small price to pay for development of fusion technology seems trivial in comparison to the price of the planet.
Source: http://www.123helpme.com/view.asp?id=16355

The Case for Nuclear Fission-Print Out

There are a couple of very big problems that may nuclear fusion completely impractical, at least for now. First, it takes very high pressures and very high temperatures to initiate a fusion process. Despite the aspirations of “cold” fusion proponents, temperatures in the order of billions of degrees are needed to start nuclear fusion. Although this can be achieved, it is difficult and certainly is not possible for any large scale commercial venture. The high temperature makes the whole thing exceedingly difficult to deal with, simply because there is no material that can be used to withstand such temperatures. And the process itself, once initiated, is likewise difficult to control. Minor examples of the fusion process have been achieved in laboratories, but nothing feasible for useful power production.1

The central problem for physicists and engineers working on controlled nuclear fusion is due to the electrical nature of matter. Nuclei consist of positively charged protons and neutral neutrons, and are surrounded by negatively charged electrons. From basic electricity, like charges repel while opposite charges attract. As two nuclei are brought together, the force of repulsion becomes immense. This keeps matter from collapsing but makes fusion difficult. Large amounts of energy are needed to force nuclei together. When nuclei are close enough, another basic force (the “strong force”) within the nucleus itself causes them to attract, overcoming the electric (or electromagnetic) force, and they fuse into a heavier element. In fusing, some mass is converted to energy according to Einstein’s famous formula: E = mc2.2

The production of electricity through fission nuclear reactors is now a proven economic source of energy, and in this country, can be done with complete independence from foreign sources of raw materials.

Nuclear-produced electricity has proven to be a godsend to smaller, developing countries as well to those with developed technological economies. For example, as of the early 1990’s, England, whose supply of coal is dwindling, has 37 nuclear power plants and 1 more in development. Canada is making extensive use of nuclear-produced electricity in spite of having ample deposits of coal. France, a country with very limited coal or oil, is working towards a goal of producing approximately 80% of its electricity in its nuclear power plants. As of 1990, it was meeting 75% of its demand with nuclear generation.

The operations of nuclear power plants themselves in this country give off no toxic emissions of either a chemical or a biological nature. The average annual radiation exposure to members of the U.S. public resulting from the generation of electricity by nuclear power, is in the order of 0.3 millirem, This is only about a tenth of one percent of the average exposure from the naturally occurring radiation to which everyone in the public is subject. It includes the entire nuclear power program, involving the mining, milling, and refining of the uranium for fuel, construction of the fuel elements, operation of the power reactor, handling and transportation of low- and high-level nuclear wastes, fuel reprocessing, and the ultimate disposal, storage, or recycle of waste materials.3

Sources:

1. http://users.stargate.net/~dfeucht/Fusion.htm
2. http://www.mhhe.com/physsci/astronomy/arny/student/webtutor/solar_energy/questions.htm
3. http://www.umich.edu/~radinfo/introduction/needtoknow/lstpart3-6.htm

6-8: Realm of the Atom

Laboratory Activities

Laboratory Activities are designed for the classroom and generally require simple materials. These activities can be done before or after a visit to the New York Hall of Science. To help students use higher-level thinking and generate questions, facilitate discussion with these types of questions:

- What do you notice here?
- Tell me about this.
- What do you see?
- Why do you suppose this happens?
- What can you conclude from the evidence?

Don't Buy Dented Cans-An Atomic Mystery

Description: Why is it a bad idea to buy dented cans? Because they don't look as nice? Because some of the food inside might be dented too? To find out, do this experiment and discover why electrons contribute to food spoiling in dented cans.

Time: (2) 30 minute sessions

Materials Needed:
(per student or student group)

- A penny or other copper coin
- Roll of aluminum foil
- Ketchup packet per group or a brand new bottle of ketchup for entire class
- A plate or saucer
- A dented can
- Volt meter (optional)

First Session

1. Show students the dented can.
2. Ask students why they think people should not buy dented cans? (students respond, encourage students to dig deeper into why questions)
3. Tell students they are going to do an experiment and discover how electrons from atoms can effect the food in dented can.
4. Distribute pennies and aluminum foil to students.
5. Have students tear a strip of foil about an inch wide and 3 inches long.
6. Have students place the foil on a plate.
7. Have students put the penny on one end of the strip.
8. Distribute ketchup around the room and instruct students to squirt a blob of ketchup on top of the penny.
9. Have students fold the other end of the foil over, so that it squishes into the ketchup.
10. Make sure students crease the fold enough so that it will stay in place. This should give them sort of a foil and penny sandwich. Looking from the side, there should be foil on the bottom, with a penny on top of that, then ketchup and then the other end of the foil.
11. Have students set the plate in a warm place where it will not be disturbed.

6-8: Realm of the Atom

Second Session

1. Have students collect plates from last session.
2. Have students rinse the catsup off the foil and examine it carefully.
3. Ask students what they observe? (In the area where the foil was touching the ketchup, it is full of holes!)
4. Ask students to guess what may have caused holes? (students may guess acid)
5. Tell students you're now going to explain the mystery and the solution. Tell students the following:

   What caused the holes in the foil? Acid. ACID???? Don't get too excited. The acid is vinegar. Read the label and you will see. How did vinegar do that? Well, the acid is not responsible, or at least, not directly. The culprit is electricity.

   Electricity? This experiment makes its own electricity. The copper penny and the aluminum foil, connected by a conducting solution (ketchup) form an electric cell, which will produce about 1/2 of a volt of electricity. You can't light a light with it, as the amperage is very small, but it does produce an electric current.

   Note: If you cut through the foil strip in the center and connect a probe from a volt meter to each piece of foil, you should be able to measure about 1/2 of a volt.

   In the process of producing the electric current, the penny is stealing electrons (tiny, negatively charged pieces of atoms) from the aluminum. This changes the aluminum and lets it dissolve in the acid in the ketchup.

   OK, so now we know how to dissolve holes in aluminum. So what does that have to do with dented cans?

   Cans are made of steel.

6. Ask students what happens when steel comes in contact with water and oxygen? (rust)
7. Now tell students:

   Since most of the foods that we put into cans are wet, they would quickly rust the steel can. To solve this, the steel cans were plated inside with a thin coating of the metal tin. Tin is not strong enough to make a good can, but it does not rust. The tin coating on the inside keeps the can from rusting and the steel give the can its strength.

8. Now can anyone guess what happens if a can becomes dented? (students respond)
9. Tell students:

   If a can is dented, the tin layer can be cracked, letting the liquid come in contact with the steel. Now you have two metals (steel and tin) in contact with a conducting solution (the liquid in the can). The can of food begins to produce electricity. It also starts to oxidize (rust) the metal in the can, producing a hole and letting the food inside spoil. That is why we don't buy dented cans.

Adapted from Experiment of the Week #288, Robert Krampf's Science Education Company www.krampf.com

6-8: Realm of the Atom

Your Probability Cloud!

Description: Students will be able to make a model to represent the characteristics of electron movement on the atomic level.

Time: (1) 45 minute session

Materials Needed:
(per student)

- Map of your neighborhood
- Three colored markers of the same color from dark to light

Procedure:

1. Distribute student materials.
2. Have students determine places on their map where they are most likely to be found (your home, school, etc.). Color these places in with the darkest color marker.
3. Have students determine places on their map where they might be found (local library, areas you walk through to get to school or home, etc.). Color these places in with the middle color marker.
4. Have students determine places on their map where they are not likely to be found, but the possibility still remains. Color these places with the lightest color marker.
5. Have students lightly color over the entire map because it's possible for you to be found anywhere within your neighborhood.
6. As students look at their maps explain:

   Atoms are made up of smaller particles called protons (positive charge), neutrons (no charge) and electrons (negative charge). Protons and neutrons make up the nucleus of the atom and electrons are pictured as "probability clouds" (this means that scientists can predict where electrons probably are at any given time) around the center of the atom.

7. Tell students that:

   On your map, places of darker color are places where you are more likely to be found. As the coloring gets lighter, these locations are places where you are least likely to be found. In creating this map you have made a "probability cloud" for yourself. A probability cloud for you is like a map of all the possible locations for the electron. Even the single electron of the hydrogen atom could be in many places around the nucleus, it forms a cloud of probable locations.

Book List

Atoms
Berger, Melvin. *Atoms, Molecules and Quarks*. G.P. Putnam's Sons, 1986.
Berger, Melvin. *Our Atomic World*. Franklin Watts, 1989.
Mebane, Robert C. *Adventures with Atoms and Molecules Book 2.* Enslow Publishers, Inc., 1987.

Structure of Matter
Time Life Editors. *Structure of Matter*. Time Life Publishing, 1992.

Radioactivity
McGowen, Tom. *Radioactivity: From the Curies to the Atomic Age*. Franklin Watts, 1986.
Milne, Lorus J. and Margery. *Understanding Radioactivity*. Atheneum, 1989.

Heat
Jennings, Terry. *Heat*. Children's Press, 1988.

Wood, Robert W. *Physics for Kids 49 Experiments with Heat*. Tab Books, 1990.

Light

Anderson, L.W. *Light and Color*. Raintree Children's Book, 1978.
Ardley, Neil. *The Science Book of Light.* Harcourt Brace Jovanovich, 1991.
Aust, Siegfried. *Light! A Bright Idea.* Lerner Publication, 1985.
Baines, Rae. *Light*. Troll Associates, 1985.
Jennings, Terry. *Light and Color*. Children's Press, 1989.
Lafferty, Peter. *Energy and Light*. Gloucester Press, 1989.
Lyon, Sue. *Science in Action: Light and Sound*. Marshall Cavendish, 1989.
Murphy, Bryan. *Experiment with Light*. Lerner Publication, 1991.
Taylor, Kim. *Flying Start Science: Light*. John Wiley & Sons, 1992.
Ward, Alan. *Experimenting with Light and Illusions.* Dryad Press Limited, 1985.
Watson, Philip. *Light Fantastic.* Walker Books, Ltd., 1982.