INTRODUCTION

Beauty and Charm at Fermilab

Beauty and Charm are the fanciful names of two of six fundamental particles called quarks. Part of the experimental verification for the existence of quarks occurred at Fermilab. The title, Beauty and Charm at Fermilab, however, was chosen with a second meaning also in mind. Fermilab, as any visitor will attest, is a place of beauty—a high-rise main building with architecture inspired by a French cathedral and set on a prairie-like plain reminiscent of early Illinois. And Fermilab scientists, although a competitive breed in a rigorous and esoteric field, will charm you with their animated descriptions of particles, the universe, and with their cultural interests and human concerns.

This unit and the associated kit is a result of the cultural interests and human concerns of Fermilab Friends for Science Education (FFSE), an association devoted to the promotion of Fermilab as an education resource. With U.S. Department of Energy and FFSE funding and a good amount of volunteer effort, Beauty and Charm at Fermilab was created to provide junior high and middle school students with a view and an active experience of the excitement of science in a major national research facility.

The unit's investigations were chosen to present problems similar to what particle physicists face: How do you measure small things? How do you study something you can't see? What do you imagine the world inside the nucleus of an atom to be like? What can we see that tells us the tiny world of subatomic particles really exists? What is an accelerator or detector? How do these machines help scientists as they explore the world of particle physics?

The investigations are attempts to give students some feeling for how physicists try to answer these questions. And like physicists, students learn that the search for answers is never finished—and that is precisely why science is so challenging and fascinating.

The unit and kit contain several components to aid the teacher in conducting this quest: a teacher's guide with investigation guidance and background information; student sheets with directions and questions; materials for classroom activities; copies of the Quark Quest newspaper to inform about the people, research, and facilities at Fermilab; and a videotape to explain and tour Fermilab. The appendix contains a relevant vocabulary list as well as student and teacher background reading lists.

If you feel intimidated at the prospect of teaching about particle physics, be assured that the investigations were created and piloted by junior high, middle school and high school teachers. Physicists have carefully reviewed the materials for accuracy in their relationship to scientific ideas and processes. The purpose of these materials, however, is not to instill directly the language and concepts of particle physics—some of this may happen—but to provide an experience

Please see the yellow pages at the end of this sampler for more information on Fermilab teacher workshops and field trips.

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From Section 1: "Methods of Science"

Investigation 1: Measuring Small

Teacher Pages

Purpose:
This investigation will enable students to realize the limitations of measuring devices. It will also make them aware that there is not universal understanding of nor agreement on the definition of the word *measurement*.

Objective:
Students will imitate scientists by using a variety of methods to measure the size of very small objects as accurately as possible.

Illinois State Standards:
11.A.3c, 11.A.3d, 11.A.3e, 11.A.3f, 11.A3g, 13.A.3a

Materials:
Student Investigation Sheet - Measuring Small
Clear metric rulers
Mustard seeds
Hand lenses
Overhead transparency tables

Procedure:
1. Divide the class into seven or eight groups.
2. Distribute the clear plastic 15-cm rulers to students.
3. Have each group determine the size of a mustard seed.
   Note: If students are showing signs of difficulty, suggest that they place the seeds in a straight line and determine how many make 1 cm, and then divide to find the average size of a single seed.
4. Review measuring techniques and the scale used on their rulers. Tell students that they are to take 5-10 minutes to find the smallest measurable object in the room and measure it.
   Note: It is possible to measure to 0.05 cm (0.5 mm) on a ruler with 0.10 cm (1 mm) smallest subdivisions and to estimate to 0.01 cm (0.1 mm). If students have spent 2–3 minutes at this task and have not asked for magnifying tools, suggest that they use something to help "see" these small particles. Distribute hand lenses.
5. As students work on this task, move around the room to assist and encourage "thinking small."
6. After students have completed the task, form larger teams. Tell students that they are in data-sharing teams. Their task is to describe their smallest measurable particle, how it was measured, and what size it was. Teams should determine the smallest object measured by their

data-sharing team. You may want to place these results on an overhead table to facilitate later discussion.

7. Have the students discuss their ideas of what measurement is. Have the students discuss why it might have been hard to use the ruler and why some of them estimated their measurements. Have the groups then discuss these ideas as a class.

   Note: Some of the groups will have different answers; discuss possible reasons for the differences. Topics in this discussion may include operational definitions, measurement standardization, and the use of common language.

Student Sheet
Investigation 1: Measuring Small

Name___________________________

Date____________________________

Purpose:
This investigation will help you to realize the limitations of measuring devices. It will also make you aware that there is not universal understanding of nor agreement on the definition of the word *measurement*.

Materials:
Student Investigation Sheet - Measuring Small
Clear metric rulers
Mustard seeds
Hand lenses
Overhead transparency tables

Procedure:
1. Your teacher will divide you into lab teams and give each group a clear plastic ruler and several mustard seeds.

2. Measure a mustard seed. Record your data.

   ____

3. Describe the method you used to measure the mustard seed.

4. Record your data on the table at the front of the classroom.

5. Find the smallest measurable object in the classroom and measure it. Be as accurate as possible, using the smallest unit on your ruler.

   ____

6. Describe the smallest object you selected to measure.

7. Why did you choose this object?

8. Record the measurements of your object:

   Length_________________ Width_________________ Height________________

9. Add these measurements to the class table at the front of the room.

10. Now that you have completed your measurements, your teacher will assign you to a discussion group where you will share your data. Your group is to explain to the other students in your data-sharing group how you found the smallest measurable object and its size.

11. List the objects that were measured by your group. What is the smallest object in your data sharing group?

12. Record the measurements of your group's smallest object.

    Length_________________ Width_________________ Height________________

Conclusions:

1. What successes and difficulties did your group experience while doing this investigation?

2. How do you think this investigation relates to the work done at Fermilab?

From Section 2: "Accelerators"

Investigation 6: Energy Tracks

Teacher Pages

Purpose:
This demonstration will help students become familiar with the difference between speed and acceleration. It will also help students understand that an increase or decrease in acceleration results in a directly proportional increase or decrease in energy.

Objective:
In this teacher demonstration, students will predict the eventual winner in a race between two marbles on two different tracks. The students need to know what acceleration is and will have the chance to learn how changes in acceleration result in changes in the amount of energy the marbles (particles) possess.

Illinois State Standards:
11.A.3a, 11.A.3b, 11.A.3c, 11.A.3d, 11.A.3f, 11.A.3g, 11.B.3c, 11.B.3d, 11.B.3e, 12.D.3a, 12.D.3b, 13.A.3a

Materials:
2 ramps – 1 straight and 1 prebent with curves
2 steel ball bearings
2 supports – See diagram.

Procedure:
1. Show the two ramps to the students and set them up on the same supports (bricks, books, or something similar). **There needs to be a slight difference in height between the supports** so that the ball bearings on the both tracks will roll. For the most effective demonstration, keep the ramps as close to even as possible.

   Steel Ball Bearings↓

2. Explain that the tracks are the same *length* (just not the same *shape*). The teacher will release the ball bearings so that they will start rolling from the top of each ramp at the same time.
3. **Have the students write down their prediction as to which ball bearing will win the race and why.**

4. Encourage discussion in which the students have to support their answers with an explanation. If time allows, it may be useful to start the discussion with the students in small groups. Each group can then report on their discussion to the class. This will engage the students and give them a personal stake in the experiment. It can also lead to a very effective discrepant event for those students who think they know what will happen.
5. After students have written their answers, try the experiment. The ball bearing that runs along the bent track will “win” easily.

   Note: The reason the ball bearing on the bent track wins, goes back to two common middle school science concepts: potential and kinetic energy. At the beginning of the experiment the ball bearings are at rest and have equal amounts of potential energy. Once the ball bearings are released, the ball bearing on the bent track accelerates faster and gains kinetic energy more quickly than the ball bearing on the straight track; this is due to the Law of Conservation of Energy. Since the ball bearing on the bent track has more kinetic energy, it’s moving faster, and will therefore get to the end of the track before the ball bearing on the straight track. Also point out to students that because of the steeper slope at the beginning of the bent track, the ball bearing on it accelerates *faster and so travels at a greater speed for the entire race. (Think about the changes in acceleration on a roller coaster.)*

6. Verify the data by replicatiing the experiment 5 to 10 times. Discuss the results. Look for any discrepant events in the data. Accept any student skepticism or questions and help students understant that real scientists often have to explain unexpected resulta in data.

7. Close with a class discussion about acceleration and energy. Encourage students to describe their observations and thoughts in their journals.

From Section 3: “Seeing the Unseen”

Investigation 7: Studying Things You Can’t See

Teacher Pages

Purpose:
Scientists often employ methods of indirect observation to investigate objects so small that they cannot be seen with the naked eye. In this investigation, students will use indirect observation on a set of small hidden objects to infer the identity of the objects.

Objective:
In this investigation, students will use methods of indirect observation to ascertain the “internal structure” of a mystery box.

Illinois State Standards:
11.A.3a, 11.A.3b, 11.A.3c, 11.A.3d, 11.A.3f, 11.A.3g, 12.D.3a, 12.D.3b, 13.A.3a

Materials:
Scale or balance, preferably metric
1 empty mystery box
8 mystery boxes in which you have placed objects (See note below.) Label the boxes A–G.
8 directional compasses
8 strong ring magnets
8 metric rulers
Student Investigation Sheet - “Studying Things You Can’t See”

> *Note: Scientists perform experiments involving indirect observation in their quest to understand the internal structure of the atom and subatomic particles. These elementary particles of matter are so small that methods which rely on direct observation (eyesight) invariably fail. Despite their inability to observe directly, scientists can gather indirect data from many different kinds of experiments, thus collecting enough “circumstantial evidence” to develop theories about the structure of matter.*
>
> *Before the investigation begins, place the following five objects in each of the eight mystery boxes: a rubber stopper, a wooden block, a piece of steel wool, a small steel ball bearing and a cedar ball. (Substitute other objects if desired such as a pencil, coins, a wooden roler, glass marbles, a paper clip, a strong-flavored fruit gum, etc.) If you wish, seal the boxes with masking tape so that the students cannot gain access to the contents. You should have a collection of possible items that could be in the box available in case a student group wants to place it in an empty box for further investigation. Do not just give out these items. Students must ask for them. Also be prepared to make ring compasses, magnets and an ampty box and scale available to your students.*

In a sense, the box is a simulation of an atom, a nucleus, a proton, or some other object with "internal structure." The quest to describe and identify the contents of the box simulates the physicists' quest to find out more about matter by "seeing" through experiment what their eyes will never be able to see.

Procedure:

1. Divide the class into research teams. There should be no more than one team per mystery box.
2. Be sure to have an empty box available for student use, should they choose to do some observational comparisons (e.g., massing the mystery box and the empty box to find the difference).
3. Distribute one labeled mystery box to each team. You need to decide whether all of the boxes are identical or different. You also need to decide if or when you will reveal this to the students. Students need to record the letter of their mystery box on the line at the top of the data chart.
4. Tell the students to follow the directions on their student sheet entitled "Studying Things You Can't See," and remind them that they are not to open the boxes. You need to explain to your students how to fill out the chart.

   Under the column titled, "What tool did you use?" they would list items like my fingers, my nose, a magnet, my ears, etc.

   Under the column titled "What did you do with this tool?" they would write, "I slowly dragged the magnet across the bottom of the box," or "I shook the box gently with my fingers placed under the bottom of the box," etc. Their statements should carfefully describe **HOW** they used the tool.

   Under the column titled "What evidence did you collect using this tool?" they would write, "
   I
   felt a **smooth, round, light** object roll **evenly** across my fingertips," or "I heard a **long** object slide **smoothly to the end of the box, but it did not slide very far**." Push your students to use multiple, descriptive adjectives. Remind students that they are NOT making guesses in this column, just gathering data.

5. Have the students investigate the boxes for a full class period. Collect the boxes. During the next class period, be sure each team receives the same box. Have each team review the data they collected for five minutes. Then collect the boxes. Discuss as a class what they think is in the boxes. Students should collectively offer evidence from their recearch. If the class comes to consensus on a particular object, and they are correct, you should show the students the object they are describing. You should plan your classtime so that class ends before all the objects can be identified. This simulates the analogy between this investigation and the work of particle physicists who often are unable to find all of the answers. Explain that there are some things of which no one is ever sure. As scientists develop better instruments and find new evidence, they improve their ideas about things unseen, but can never be certain they have the final answer.

Note: Here are some ideas for adjusting the difficulty of this investigation. It is fairly flexible.

- *Instead of a box with several items for each team, set up boxes with one item in each box and have the teams swap boxes until each team has examined four.*
- *List the following, and any other items on the chalkboard: battery, roll of tape, rubber stopper, washer, audiocassette, pencil, moth balls, wooden block, paper clip, safety pin, steel ball, steel wool, piece of chalk, magnet, penny, marble. Teams can try to figure out which items from the list are in the box.*
- *For a more difficult investigation, or possibly as a supplemental follow-up, set up a new box for each team, but do not put the same items in every box. Include items that will be very hard to detect, such as cotton balls or rubber bands.*

Student Sheet Investigation 7: Studying Things You Can't See

Name__________________________

Date__________________________

Purpose:
Scientists often investigate objects so small that the objects cannot be seen. To do this, they must use indirect observation. In this investigation you will use indirect methods, just like the scientists, to observe small hidden objects and infer what they are. Your team's job will be to identify the contents of a mystery box.

Materials:
Scale or balance, preferably metric
1 empty mystery box
8 mystery boxes in which you have placed objects (See note below.) Label the boxes A–G.
8 directional compasses
8 strong ring magnets
8 metric rulers
Student Investigation Sheet - "Studying Things You Can't See"

Procedure:
1. You may use any nonviolent, nonintrusive way you can think of to investigate the mystery box to determine what the objects are inside.
2. Obtain a mystery box from your teacher.
3. Place the ID letter on your box on the line at the top of your data chart.
4. Read carefully through the column descriptions to see what you are going to do. Your teacher will be giving you specific examples of things you might write in each column. Listen very carefully to these statements.
5. Remember that the purpose of the chart is to record indirect evidence – NOT TO GUESS THE IDENTITY OF THE ITEMS. That will happen later in the activity.
6. Here are some ideas for things you might try to help you discover what is in the box. YOU MAY NOT OPEN THE BOX FOR ANY REASON.
   - Probe the box with your senses. Use your fingers, hands, nose, eyes and ears. DO NOT TASTE ANYTHING.
   - Use a magnet. You may have to ask for this tool from your teacher.
   - Use a directional compass. You may have to ask for this tool from your teacher.
   - Find the mass of the box. You may have to ask your teacher for a balance and an empty box.

7. Can you think of any other ways to try to find what's in the box? List them.
   Note: Check with your teacher before you try them.

8. Complete the chart below by listing each tool you use in your investigation, how you used it, and what you learned by using it.

Box ID ________________

	What tool did you use?	What did you do with this tool?	What evidence did you collect using this tool?
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

Conclusions:

1. In the spaces below, list the items you believe are in the box, and the evidence you have collected that suggests the presence of each item. Depending on the number of items your teacher has put in the box, you may not use all of these spaces, or you may need more than are here. The fact that there are seven spaces here does not mean that there are seven items.

   One item in the box is a/an:____________________

   The evidence that supports this conclusion is:

   A second item in the box is a/an:____________________

   The evidence that supports this conclusion is:

   A third item in the box is a/an:____________________

   The evidence that supports this conclusion is:

   A fourth item in the box is a/an:____________________

   The evidence that supports this conclusion is:

A fifth item in the box is a/an:____________________

The evidence that supports this conclusion is:

A sixth item in the box is a/an:____________________

The evidence that supports this conclusion is:

A seventh item in the box is a/an:____________________

The evidence that supports this conclusion is:

Discuss the following questions with your lab team and record your answers.

2. Describe other ways to investigate things without seeing them.

3. What other equipment or tools might have helped you guess what was in your mystery box?

4. Describe indirect observation in your own words.

5. Describe instances in your everyday life where you use indirect evidence to learn about something you can’t see.

6. Describe examples of situations in which scientists use indirect observation.

7. How do Fermilab scientists use indirect observations to learn more about particles?

From Section 4: "Ideas"

Investigation 14: Powers of Ten

Teacher Pages

Purpose:
Powers of Ten is a short video that takes students across the vast distances of our universe and back again to the depths of subatomic structure. Through the video they will explore the mathematical concept of exponents (powers of ten); helping them to understand the distances that exist between particles that make up the world around us.

Note: It is a very short video and can be shown more than once during a class period. Be sure to have the students read through the questions before showing the video. The teacher should also involve the students in a follow-up discussion.

Objectives:
1. Students will develop an appreciation of relative size and orders of powers of ten.
2. Students will be able to compare the macrocosm of outer space to the microcosm of inner space.

Illinois State Standards:
12.F.3b, 12.F.3c, 13.B.3a, CC.5.NBT.2

Materials:
Powers of Ten video (or online source)
Student Investigation Sheet: *Powers of Ten*

> *Note: The video can assist students in understanding real life measurements in the study of matter.*
>
> *This investigation includes a worksheet containing questions designed to focus student thinking, as well as a teacher answer key. Reading over these questions with students prior to viewing the video will enhance their understanding of the material in the video. Student understanding of just how much of matter is composed of empty space should be a definite goal for the unit.*

Procedure:
1. Hand out the student investigation sheet.
2. Read through the questions in order to prepare the students.
3. Show the *Powers of Ten* video.
4. Have students answer questions on worksheet.
5. Determine ahead of time how students will be accountable for the video content.
6. Follow up with small group or class discussion of video content.

Student Sheet Investigation 14: Powers of Ten

Name________________________
Date_________________________

1. What is pictured at 10° meters?

2. What is the greatest distance that we can currently “see” into outer space? What power of ten?

3. What is located at this distance?

4. What is the smallest distance that we can currently “see” into inner space? What is the power of ten?

5. What is located at this distance?

6. How many powers of ten is it from the smallest to the largest things that we can currently “see” in our universe?

7. What characteristic do inner and outer space have most in common?

8. What is a light year?

9. How fast does light travel?

10. What is the distance of one light year?

From Section 5: "Human Element"

Investigation 20: A Sense of Scale

Teacher Pages

Purpose:
One of the more challenging aspects of this unit is to help students gain the perspective that scientists are real people doing a job that they enjoy. The lab work, activities, and discussion questions simulate how scientists discover new knowledge about things that they cannot see. This new video will help students view these discoverers from a fresh, quite human point of view. It is important for students to realize these men and women choose their careers because they are excited about searching for the missing pieces that will someday help complete the Standard Model.

Objectives:
1. Students will realize that discovery and learning, although time-consuming and expensive at times, can be very rewarding.
2. Students will hear scientists discuss how they got interested in their various fields of study and what they have gotten out of it.
3. Students will gain the perspective that scientists are real people doing a job that they enjoy.

Illinois State Standards:
12.F.3b, 12.F.3c, 13.B.3a, CC.5.NBT.2

Materials:
A Sense of Scale video
Student Investigation Sheet - *A Sense of Scale*

> *Note: Discussion questions and a teacher key are available in the teacher manual for this video. This aspect of this unit is an extremely important one on which to spend some time. Students will be solving problems for their entire lives, and realizing that problem-solving is an ability that all people in all walks of life need is a valuable lesson. They will also be working with all kinds of people and they must begin to build the respect for those relationships now. Being able to work successfully with many different types of people is a required skill in our society today.*

Procedure:
1. Discuss with your students why they think that people choose the careers they do.
2. Then ask them specifically why someone might want to become a physicist.
3. Discuss with your students what they think is meant by the "human element" of Fermilab. (We use it to refer to the variety of people here as it concerns their strengths and weaknesses, their likes and dislikes, etc.) How does it affect the work that the physicists do on a daily basis?

4. Read through the activity sheet with your students to prepare them better for what they will see in the video.
5. Watch *A Sense of Scale* video.
6. Determine ahead of time how the students will be held accountable for the video content. Will they take notes during the presentation, individually after the presentation, in small groups after the presentation?

Student Sheet Investigation 22: Name that Career!

Name______________________
Date_______________________

Purpose:
One of the more challenging aspects of this unit is to help you as a student gain the perspective that scientists are real people doing a job that they enjoy. The lab work, activities, and discussion questions do a very good job of simulating how scientists discover new knowledge about things that they cannot see. This new video will help you view these discoverers from a fresh, quite human point of view. It is important for you to realize these men and women actually chose their careers because they are excited about searching for the missing pieces that will help complete the Standard Model someday.

Materials:
A Sense of Scale
Student Investigation Sheet - *A Sense of Scale*

Procedure:
After watching the video, follow your teacher's instructions regarding how you are to report on the content. It may be individually on this worksheet, through class discussion, through a small group effort on the worksheet, or in a completely different way. The major sections of the video are listed in capital letters.

Conclusions:
1. "To understand nature, we have to break it down into its constituent components." How are scientists at Fermilab trying to do this?

RUNNING THE RING

2. The Tevatron is a ring almost four miles in circumference containing one thousand twenty-ton superconducting magnets buried thirty feet underground. The machine directs one trillion protons around the ring in a beam thinner than a human hair while electric fields are used to push the particles to higher energies. The energy in each proton and antiproton in the Tevatron is equal to that of six semi-trucks moving down a highway at 60 mph. Why do scientists need such an enormous machine that creates so much energy?

3. What is the main challenge for the physicists today as they operate this machine, parts of which were made in the 1970s?

STARTING THE BEAM

4. What is the purpose of each succeeding accelerator at Fermilab?

A PERFECT IDEA

5. "We are fascinated by the challenge of understanding the real world. We have a love of trying to figure things out. The more you think about something, the more you want to explore it." What qualities, personality traits and values do you think it takes to be a Fermilab scientist?

COLLISIONS

6. How long has it been since collisions like the ones occurring at Fermilab now have happened naturally?

7. Do you think it is important to spend money to create these collisions and study them? Why or why not?

DETECTORS

8. Fermilab's detectors are so massive and monitor so many collisions per second that it takes as many as 400 physicists to build and operate one. Yet, according to two of the physicists in the video, getting people to work together is as interesting a problem as getting the equipment to work correctly. Reflect on these two statements. How can so many diverse people make something like this work?

9. List and briefly describe the advantages of current electronic detectors when compared to older detectors such as the bubble chamber.

THE STANDARD MODEL

10. Name the six quarks and the six leptons that are part of the current Standard Model.

11. What is peer review? How can it benefit any science experiment?

UNFINISHED BUSINESS

12. “The whole idea in science is to make links between different phenomena.” How does this statement relate to the work that is done at Fermilab?

13. Summarize at least three of the remaining questions that face scientists at Fermilab. Areas for discussion can include: top quark, antiprotons, neutrinos, calculations

14. Fermilab scientist Chris Quigg said, “Ideas that I did not even know that I had came together.” What do you think he meant?

15. Have you ever had an experience like Dr. Quigg’s before? Describe it.

16. “The curiosity of children is why so many physicists work so hard.” How curious are you about the world around you? What do you wonder about?

From Section 6: "Human Element"

Investigation 24: *Beauty and Charm* Student Tour

Teacher Pages

Seeing firsthand where science is done can be a powerful and meaningful experience for students. It is important that you make every effort to prepare them for this important part of the program. Student preparation begins in the classroom and will be completed on site.

> *Note: The Beauty and Charm student tour is constantly being updated to reflect current discoveries, research and changes at Fermilab.*
>
> *Students will see some of the machines and meet the men and women who build, operate and understand these machines and the secrets the machines reveal.*
>
> *Students may wish to bring paper or journal and pencil to take notes.*
>
> *Cameras are welcome on tours.*
>
> *Students need to dress for safety. This includes sturdy, close-toed shoes and clothing that cannot catch on machinery during the walking tour.*
>
> *Name tags need to be worn so that they are visible to the docents.*

1. Before leaving on the field trip to Fermilab, explain to students that Fermilab is a working laboratory. The machines students will see are being used in experiments even as they are there. The men and women at the Lab are involved in current research and the students' visit is a rare chance to glimpse what it is like to be a scientist in this decade.
2. Stress that the students must stay with the group and follow all directions given by the Fermilab docents (tour guides). Safety is of prime importance, so the students should not touch anything nor should they enter any areas unless they are directed to do so.
3. Upon arrival, the docents will give some reminders of safety procedures and general group directions. Please make sure the students listen.
4. Students will visit the Lederman Science Center with docents and have an opportunity to work with the exhibits in this center. Docents will provide details of this portion of the visit.
5. Students may visit areas of Fermilab such as the Cockcroft-Walton and the Linear Accelerator, or "Linac." If time permits, the students may also see a Control Room.
6. The students will go to the 15^{th}-floor exhibits in Wilson Hall with docents. Here they will have an overview of the entire Fermilab property and the accelerator complex, which the docents will explain.

7. Students will meet with a scientist at the Lab. Here they will be able to ask questions they have prepared in advance, as well as any that have occurred to them during the day.
8. A very good follow-up activity is to have the students process what they saw and heard about when they get back to school. Some teachers may prefer a journaling activity, while others will prefer a verbal discussion. In any event, it is good practice to let the students sort through the information they have acquired when they get back to school.