6-8: Science Playground

Curriculum Connections

Scientific Connections And Applications
- Understand the relationship between form and function, order and organization, change and constancy

Scientific Tools And Technologies
- Use technology and tools to observe and measure objects
- Acquire information from observation, experimentation, and print sources

Physical Sciences
- Observe and describe different patterns of motion
- Explain how energy is transferred or transformed from one form to another

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

National Standards

Content Standard A: Science as Inquiry
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

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

6-8 Exhibits List

Archimedes Screw
Ball Run
Big Ears
Energy Wave
Giant Lever
Giant Seesaw
Octascope
Palm Pipes
Periscope
Propeller/Water Wheel
Slides
Sound Steps
Speaking Tube
Standing Spinner
Stream Table
Sun Catchers and the Kinetic Sculpture
3-D Spider Web
Vertical Energy Wave
Wave Machine
Whirlpool Column

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Whirlpool Dish
Whisper Dishes
Windmill
Wobbly Bridge
Xylophones

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 a whisper can cause an avalanche or a thunderstorm set off car alarms or a storm way out in the ocean can cause beach erosion. (Mystery solved at Energy Wave and Wave Machine exhibits)
- 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

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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.

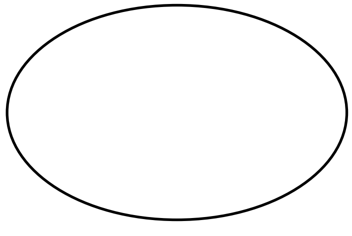
Time: (3)15-30 min. Sessions

Materials Needed:

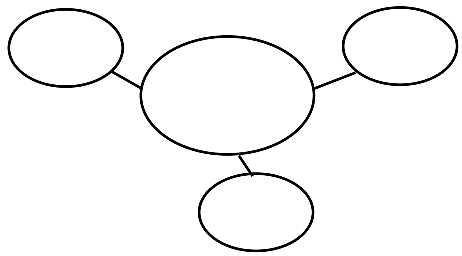
- Blank paper
- Pencils, colored markers

Procedure:

1. Begin with a center circle and write in the name of the main topic. (Students who have difficulty with writing 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. 4. 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.

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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

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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 students 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.

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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.

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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?

Newton's First Law of Motion- Inertia

Description:

Students learn about inertia and Newton's first law of motion through a quick, simple activity and demonstration. There is a touch of magic involved as students observe motion phenomena.

Time: (1) 20 minute session

Materials Needed:

- (1) Hard boiled egg
- (1) Raw egg

(Per student)

- Paper cup (medium to large)
- Index card
- Coin

Preparation:

1. Write down and display Newton's first law of motion so all students can see it. (blackboard, posterboard) "An object in motion tends to stay in motion, and an object at rest tends to stay at rest, unless the object is acted upon by an outside force."

Procedure:

1. Begin by asking students if they have ever been riding in a vehicle when the driver suddenly slammed on the brakes?
2. Ask students how their body moved as the vehicle came to a stop? (they kept moving forward)
3. Tell students when they moved forward they were experiencing Newton's first law of motion.
4. Draw student attention to Newtons' First Law—"An object in motion tends to stay in motion, and an object at rest tends to stay at rest, unless the object is acted upon by an outside force."
5. Tell students that Newton called this law inertia. It may sound complicated ,but there is an easy way to see the law in action.
6. Distribute materials.
7. Instruct students to place the index card on top of the cup.
8. Now have students place a coin in the center of the index card over the cup.
9. Instruct students to flick their finger against the index card so it shoots out horizontally.

(The coin should drop in the cup)

10. Now ask students to explain what happened using Newton's first law of motion.

"...object in motion tends to stay in motion..."- the index card

"...an object at rest tends to stay at rest..."-the coin

"...unless the object is acted upon by an outside force..."-finger flicking

11. Tell students you are going to demonstrate another phenomena that shows the law and inertia.
12. Place the hard boiled egg and the raw egg on their sides on a flat surface so everyone can see.
13. Tell students that the eggs are now "at rest".
14. Next, tell students you are going to "act upon the object with an outside force".
15. With the hard boiled egg lying on its side, spin the egg.
16. Point out that the "object tends to stay in motion unless the object is acted upon by an outside force".
17. Now spin the raw egg.
18. When the egg is going fast, gently put your fingers down on it to stop it and then move your hand off immediately when it stops.

(The egg should start to turn again.)

19. Have students guess why the raw egg kept moving.
20. Explain to students that:

The raw egg stayed in motion because the motion of the liquid within the egg is still going; the force you exerted was not enough to stop both the inertia of the shell and the inertia of the liquid inside of it. If you held the egg longer, enough force would have been exerted to stop the egg completely.

Science Friction-A Tribologist Tale

Description:
Students become Tribologists (scientists that study friction) by observing and measuring two kinds of friction, static and kinetic.

Time: (1) 45 minute session

Materials Needed:

- Spray wax or Pledge®

(per student group)

- A large rubber band (for the purposes of control, make all rubber bands the same)
- a shoe
- aluminum foil
- masking tape
- uncarpeted floor
- carpeted floor (or carpet pieces)
- rocks or other weights that fit in a shoe
- ruler
- pencil, paper

Procedure:

1. Tell students they are going to become Tribologists, (scientists that study friction).
2. Divide students into groups according to the amount of materials you have for each group. (the smaller the group the better)

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3. Have students create a measurement recording sheet like the one below or print out:

Measurement Recording Sheet

Surface	Static Measurement	Kinetic Measurement
Un-carpeted floor		
Carpeted floor		
Aluminum foil		
Aluminum foil with weight		
Aluminum foil with oil		

4. Have students cut a rubberband, so that they have a long string of rubber.
5. Have students tie one end to a shoe and set the shoe on the floor.
6. Tell students to grasp the other end of the rubberband and begin pulling. Pull gently at first and then pull harder and harder until the shoe begins to move.
7. Now use the ruler to measure how long the rubberband stretches before the shoe begins to move. Write down the measurement.
8. Tell students that before the shoe begins to move, it is experiencing static friction between the shoe and the floor. Their measurement represents static friction.
9. Now have students pull the shoe measure how far the rubberband is stretched as they keep it moving. Write down the measurement.
10. Have students compare rubberband measurements between getting the shoe moving and while moving. (Students should notice that the rubberband stretches farther when getting the shoe started)
11. Tell students that when the shoe was sitting still, they had to overcome the static friction to get it going. Once it was going, they had to contend with kinetic friction, which is less that static friction. In other words, once you get the thing moving, there is less friction to resist its movement. Their rubberband measurement while the shoe is moving represents kinetic friction.
12. Now change the amount of friction. Have students move the shoe over carpeting.
13. Have students pull the rubberband and measure the static and kinetic friction over carpet. (static measurement is length of the rubberband before shoe moves, kinetic measurement is length of rubberband during movement)
14. Now have students try using aluminum foil on the floor and place the shoe on top.
15. Did the shoe slide across the foil, or did the foil slide across the floor with the shoe?
    - If the shoe slid across the foil, they are measuring the friction between shoe and foil.
    - If the foil slid across the floor with the shoe they are measuring the friction between foil and floor.

16. Try it both ways and compare.

17. Now have students add some weight by putting some rocks into the shoe. Have students pull the shoe again and see how increased weight changes the friction.

18. Now have students tape the foil to the floor and use spray on wax or pledge to cover the surface.

19. Have students try the shoe again, measuring static and kinetic friction.

20. Ask students the following:

- What did you notice?
- Does this give you an idea of why they use oil as a lubricant in cars and other motors?
- Can you think of why the layer of oil would change the friction?

21. Conclude by telling students:

The kind of material, weight, roughness and lubricants can all have an impact on the amount of friction. Of course, Tribologists argue about these all the time. Some say that roughness is different from friction. Others say that friction is a result of chemical attractions. Some even say that friction is due to conversion of energy into sound waves, which explains why dragging something heavy always seems to make such a terrible screech. It is interesting that even something as common as friction can still cause professors to argue over how it works. Isn't it nice to know that there are still so many mysteries in science.

Adapted from Experiment of the Week #268, Robert Krampf's Science Education Company www.krampf.com

Roller Coasters in the Classroom

Description:
Students construct and experiment with a simulation roller coaster to observe potential and kinetic energy. With certain variations, students can also observe acceleration and momentum.

Time: (1) 45 minute session

Materials Needed:
(per student group)

- 12 feet of clear 1/4 or 1/2 inch vinyl tubing
- 3-4 BB's or steel ball bearings that fit in tubes
- a yard stick for measuring

Procedure:

1. Divide students into groups according to the amount of materials you have for each group. (the smaller the group the better)

2. Distribute group materials.

3. Challenge the groups to design a roller coaster with the first hill at a height of 4

feet and two more hills following.

4. Tell students that the group that is able to design a roller coaster with the most total inches in the height of the three hills wins the class contest.

5. As the students work together they can try to put side motion to the tubing to develop more

speed in the BB. As the height and angles of the roller coaster are changed the groups will understand the effects each design change has on the BB.

Adapted from a lesson plan by Michael Kneese, Snake River Junior High, Blackfoot, Idaho.

Book List

Gravity
Ardley, Neil. *The Science Book of Gravity*. Dorling Kindersley, 1992.

Forces and Motion
Friedhoffer, Robert. *Forces, Motion and Energy*. Franklin Watts, 1992.
Gardner, Robert. *Investigate and Discover Forces and Machines*. Simon and Schuster, 1991.
Taylor, Barbara. *Force and Movement*. Franklin Watts, 1990.

Balance
Taylor, Barbara. *Weight and Balance*. Franklin Watts, 1990.

Sound
Friedhoffer, Robert. *Sound*. Franklin Watts, 1992.

Solar Energy
Keeler, Barbara. *Energy Alternatives*. Lucent Books, Inc., 1990.

Matter
Friedhoffer, Robet. *Matter and Energy*. Franklin Watts, 1992.

Physics
Barr, George. *Sports Science for Young People*. Dover Publications, Inc., 1990.
Dexter. *This Book Really Sucks*. Penguin Putnam Books.
McGrath, Susan. *Fun with Physics*. National Geographic Society, 1986.
National Geographic Society. *How Things Work*. National Geographic Society, 1983.
Stwertka, Albert. *The World of Atoms and Quarks*. 21st Century Books, 1995.

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New York Hall of Science • 47-01 111th Street • Queens, NY 11368-2950 • 718 699 0005 • Fax: 718 699 1341 • www.nysci.org

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