Cosmic Chemistry: Cosmogony

Module Planning Guide

The Learning Cycle

Activity	Teacher Materials	Student Materials	Standards Addressed	Process Skills
• Cosmogony or Cosmology?	• Teacher Text			
EXPLORATION				
• Mathematical Models	• Teacher Guide	• Student Activity • Appendix A & B	**Grades 5-8** • Science As Inquiry • Physical Science • Motion and Forces • History and Nature of Science **Grades 9-12** • Science As Inquiry • Physical Science • Earth and Space Science • History and Nature of Science	• Observation • Prediction • Measurement • Communication • Collecting data • Interpreting data • Developing models
• Density and Gravity—The Push and Pull of the Universe	• Teacher Guide	• Student Activity • Student Data/ Reporting Sheet • Anticipation Guides • Student Text	**Grades 5-8** • Science As Inquiry • Earth and Space Science • Physical Science • Science and Technology • History and Nature of Science **Grades 9-12** • Science As Inquiry • Earth and Space Science • Physical Science • History and Nature of Science	• Writing procedures • Measurement • Communication • Inference
• Doppler Effect—Are you Coming or Going?	• Teacher Guide	• Student Activity • Student Data/ Reporting Sheet • Student Handout • Student Text	**Grades 9-12** • Science As Inquiry • Earth and Space Science • Physical Science • Science and Technology • History and Nature of Science	• Observation • Measurement • Collecting data • Interpreting data • Inference
• Quarks—Getting Down to Fundamentals	• Teacher Guide • Teacher Tools	• Student Activity • Student Text	**Grades 5-8** • Science As Inquiry • Physical Science • Science and Technology • History and Nature of Science **Grades 9-12** • Science As Inquiry • Earth and Space Science • Physical Science • Science and Technology • History and Nature of Science	• Observation • Classification • Interpreting data
• Tracing Origins		• Student Text • Student Handout		• Observation • Inference
• Quarks and Electrons		• Student Activity		
DEVELOPMENT				
• A Spongy Universe	• Teacher Guide	• Student Activity • Student Text • Appendix C	**Grades 5-8** • Science As Inquiry • Earth and Space Science • Physical Science	• Observation • Inference • Measurement • Communication

			• Science and Technology • History and Nature of Science **Grades 9-12** • Science As Inquiry • Earth and Space Science • Physical Science • Science and Technology • History and Nature of Science	• Classification
• Dark Matter—A Milky Way Surprise	• Teacher Guide	• Student Activity • Student Text	**Grades 5-8** • Science As Inquiry • Physical Science • Science and Technology • History and Nature of Science **Grades 9-12** • Science As Inquiry • Earth and Space Science • Physical Science • Science and Technology	• Inference • Discrepant events

INTERACTION/SYNTHESIS
Instructional Materials are incorporated into the Exploration and Development activities above

ASSESSMENT				
• Cosmic Tug of War	• Teacher Assessment Guide	• Student Assessment Activity • Student Text	**Grades 5-8** • Science As Inquiry • Science and Technology • Assessment B • Assessment C **Grades 9-12** • Science As Inquiry • Earth and Space Science • Science and Technology • History and Nature of Science • Assessment B • Assessment C	• Prediction • Research • Inference

(View a full text of the National Science Education Standards.)

Materials lists for each teacher guide in this module.

Listed below is a quick reference to all of the teacher guides included in this module along with a complete listing of each guide's materials, for your convenience.

Mathematical Models

For each student:
- Copy of Student Activity, "Mathematical Models"
- Copy of Appendix A, "Cosmology"
- Copy of Appendix B, "Assumptions, Models, and The Scientific Method"

For each team: (Measurements are approximate.)
- Several sheets of graph paper.
- A 60-cm length of ¼ or ½-inch wide elastic sewing material.
- A flat surface along which the elastic can be stretched and held in place while measurements are made. A small wooden board 1.5 inches wide, 0.75 inches thick and 36 inches long is convenient, but not necessary. (36 inches of a 1 x 2)
- Two clamps for clamping the ends of the elastic in place after it has been stretched. Small "C" clamps or binder clips can be used, depending on the surface along which the elastic is stretched. Thumbtacks might also be used.

- Two meter sticks. During pilot testing, students found that placing two meter sticks end-to-end with the stretch material placed on top eased measuring. Rulers will work, but their use introduces errors because of the necessity of repeatedly moving the ruler to measure distances of 100 cm or more. If rulers are used, emphasize the need to make very careful measurements.

Other items for the entire class:
- Thumb tacks or straight pins.

Density and Gravity—The Push and Pull of the Universe

For each student:
- Copy of Student Activity, "The Push and Pull of the Universe"
- Copy of Student Text, "The Push and Pull of the Universe"
- Copy of Appendix A, "Cosmology"
- Copy of Student Text Strategies, "The Push and Pull of the Universe Anticipation Guide"

For each team:
- Copy of "Student Reporting/Data Sheet"
- A box with a lid (shoebox is suggested) that will be completely filled by the items listed below.
- Several metal nuts, preferably large, black, and threaded.
- Several marbles.
- Some cotton balls.
- Several small wooden blocks.
- Two partially filled balloons. Ideally, the balloons should be filled with different gases. One possibility is to fill one with carbon dioxide by letting a small piece of dry ice sublime inside of the balloon and to fill the other balloon with helium. If helium is unavailable, air will suffice.
- Enough "packing peanuts" to fill the box after the other objects have been placed inside of it. With all of the objects in the box, make sure it is possible to fit the lid on the box.
- A collection of supplies that may be requested by the students for determining densities. These probably will include the following: a metric ruler and/or meter stick; a graduated cylinder or other calibrated vessel for measuring volume by water displacement; a calculator.
- A balance accurate to at least 0.01 gram.

Teaching Tip

The effects of gravity in determining what direction is "up" can be observed with a mass suspended from the ceiling of a car (plumb bob). Take students out for a ride and have them observe the plumb bob when the car accelerates, goes around a corner, and when it stops. Ask them to interpret the motion of the car relative to the plumb bob and explain the role of gravity in determining the behavior of the plumb bob. It will be interesting as well for you to have them observe a helium-filled balloon tethered to a string under the same conditions.

PART 2
- Scale that could measure a person's mass in Kg.

Doppler Effect

For each student:
- Copy of Student Activity: "Are You Coming or Going?"
- Copy of Student Text: "Doppler Effect"

In addition, for Part 1:
- A 15 ft. long (minimum) track along which balls can be rolled. This might be a section of ¾ x ¾ -inch wooden corner protector (or corner moulding), available in 16 ft. lengths at any store that sells lumber. A plastic interior wall corner protector might also work, as long as it is supported so that it is straight. Other tracks also will work, including gutter material, chalkboard trays, etc. You simply need to use something open on the top that will contain spherical objects as they roll down the track. The longer the track, the better.
- Approximately 20 marbles or other spherical objects, such as ball bearings, that are consistent with the track that you are using. Golf balls might work well in a gutter. The Student Activity, "Are You Coming or Going?" is written as if marbles will be used. If this is not the case, advise the students of the change that you have made.
- A stopwatch.

- Area where the track can be placed at waist to chest height of the students and supported on both ends and elsewhere, as necessary, to make it straight. A ring stand support attached to the upper end would be very helpful in making adjustments in height.
- Copy of Part 1 of Reporting/Data Sheet for "Are You Coming or Going?" for each team.

In addition for Part 2:
- An old sock.
- A small and inexpensive, but loud, battery operated buzzer. Models that require either 1.5 or 3 volt batteries are preferred. (Radio Shack offers several different models.)
- Battery for operating the buzzer.
- A piece of strong cord about 10 feet long.

In addition for Part 3:
- Copy for each student of Student Handout: "Spectral Data"
- Copy for each student of Part 3 of Student Reporting/Data Sheet "Are You Coming or Going?"

Teaching Tip

An activity that provides an elementary introduction to the Doppler Effect by using a vacuum cleaner hose and a slinky can be found at the URL:

http://near.jhuapl.edu/Education/lessonDoppler.

Quarks—Getting Down to Fundamentals

For each pair of students:
- In an envelope,
  3 squares labeled "red up" and 3 labeled "red down"
  3 squares labeled "blue up" and 3 labeled "blue down"
  3 squares labeled "green up" and 3 labeled "green down"
  (See Teacher Tools)

For each student:
- Copy of Student Activity, Part I "Quarks--Getting Down to Fundamentals"
- Copy of Student Activity, Part II "Tracing Origins"
- Copy of Student Activity, Part III "Quarks and Electrons"
- Copy of Student Text, "Quarks—Getting Down to Fundamentals"
- Copy of Student Text, "Thought Experiments: Tracing Origins"
- Copy of Student Handout, "Thought Experiments: Tracing Origins"

A Spongy Universe

For each student
- Copy of Student Activity/Report Sheet, "A Spongy Universe"
- Copy of Student Text, "A Spongy Universe"
- Copy of Appendix C, "Selected Noteworthy Events in Cosmology"

For each pair of students:
- One household sponge that measures about 3 cm x 8 cm x10 cm
- This set of sponges may all be alike so that you obtain similar responses or
- You could use a variety of sponges to obtain different responses.
  It is preferable to use sponges that have relatively large and irregular spaces. Avoid those types of sponges that have pores too regular to model the structures of the universe.

  Another alternative is to use similar sponges for the activity and to have different types of sponges with different size pores to introduce during the feedback sessions.
- Meter sticks for measuring distance between observer and partner in #6.

Teaching Tip

During pilot testing the color of the sponges made a difference when students were measuring the distances at which homogeniety was observed. Try sponges of different colors and similar types of pore structure.

Dark Matter—More Than Meets The Eye

For each student
- Copy of Student Activity, "Dark Matter—More Than Meets The Eye"
- Copy of Student Text, "Dark Matter—More Than Meets The Eye"
- Copy of Appendix C, "Selected Noteworthy Events in Cosmology"

or

For a class
- A transparency of Figure 1 for "Dark Matter—More Than Meets The Eye

Cosmic Tug of War

For each student
- Copy of Student Activity, "Cosmic Tug of War"

Note to teachers: This "at-a-glance" planning guide is the result of classroom pilot test data. Please contact us at genesisepo@mcrel.org with further suggestions for improving this guide to best meet you classroom needs.