Earth Science Success: 50 Lesson Plans for Grades 6–9

by Catherine Oates-Bockenstedt and Michael Oates

“The art of teaching is the art of assisting discovery.”

Mark Van Doren (1894–1972)
Contents

Chapter 3: Geology ................................................................. 89
Lab G-1 Weighing In on Minerals ............................................ 91
Lab G-2 Knowing Mohs .......................................................... 97
Lab G-3 Classifying Rocks and Geologic Role ...................... 102
Lab G-4 Unearthing History .................................................. 109
Lab G-5 Drilling Through the Ages ....................................... 115
Lab G-6 Hunting Through the Sand .................................... 123
Lab G-7 Shaking Things Up .................................................. 127
Lab G-8 Mounting Magma .................................................... 133

Chapter 4: Meteorology ......................................................... 141
Lab M-1 Wondering About Water ................................ 143
Lab M-2 Dealing With Pressure ..................................... 150
Lab M-3 Phasing In Changes ........................................ 156
Lab M-4: Sweating About Science ................................ 166
Lab M-5 Lining Up in Front ............................................. 172
Lab M-6 Dewing Science ................................................... 178
Lab M-7 Deciphering a Weather Map ........................... 183
Lab M-8 Watching the Weather ..................................... 192

Chapter 5: Physical Oceanography ........................................... 199
Lab O-1 Piling Up the Water ........................................... 201
Lab O-2 Layering Around on the Beach ............................. 207
Lab O-3 Changing Lunar Tides ........................................ 212
Lab O-4 Sinking Film Canisters ....................................... 220
Lab O-5 Barging Down the River ..................................... 230
Lab O-6 Toying With Buoyancy ....................................... 237
Lab O-7 Toying With Density .......................................... 244
Lab O-8 Diving Into the Depths ....................................... 250
Appendix A: Materials List for Labs ............................................................ 259

Appendix B: Additional Activities and Strategies ......................................... 264
  Predicting the Future ........................................................................ 264
  Pretest for Earth Science Success .................................................... 265
  Earth Science Bingo ......................................................................... 268
  Panel of Five ....................................................................................... 269
  The Legend of Orion the Hunter ...................................................... 271
  Tic-Tac-Know ..................................................................................... 274
  Edible Stalactites and Stalagmites ...................................................... 275
  Vocabulary of Geology Notes ............................................................ 278
  Periodic Puns ..................................................................................... 279
  Weather Instrument Project ............................................................... 281
  Density Concept Flow Map ............................................................... 283
  Sink a Sub Project ............................................................................ 284
  Science Experiment Project ............................................................... 286
  Science Trivia ..................................................................................... 297
  The Poetry of Earth Science ............................................................... 300
  Oh, the Science-Related Places You Could Go .................................. 303
  Posttest for Earth Science ................................................................. 304

Appendix C: Student Assessment and Procedural Documents ....................... 309
  Science Safety Rules .......................................................................... 310
  Lab Notebook Front Cover Page ....................................................... 311
  Lab Report Guidelines ...................................................................... 312
  Lab Notebook Grading Rubric ........................................................... 313
  Self-Evaluation Tool .......................................................................... 314

Index .................................................................................................. 315
Preface

*Earth Science Success: 50 Lesson Plans for Grades 6–9* is a one-year Earth science curriculum with clear day-by-day lessons in the areas of astronomy, geology, meteorology, and physical oceanography. Intended for teachers of grades 6–9, *Earth Science Success* emphasizes hands-on, sequential experiences through which students discover important science concepts lab by lab and develop critical thinking skills. The 50 lesson plans mentioned in the title include 33 investigations (labs), found in the chapters of this book, and 17 detailed projects (pretest, science activities, etc.), found in Appendix B.

The National Assessment of Educational Progress (NAEP), from the U.S. Department of Education, evaluates both basic skills and critical thinking skills in education (Campbell, Hombo, and Mazzeo 2000). NAEP has found that emphasizing hands-on activities that allow students to explore theory results in meaningful science learning. In addition, NAEP has established that traditional activities—teaching the facts of science by completing worksheets and reading primarily from textbooks—have no positive effects on science learning. The Trends in International Mathematics and Science Study (TIMSS) provides further evidence of the benefits of hands-on teaching for meaning (Stigler and Hiebert 1999). By the time students reach middle school, using hands-on activities to teach meaning in science becomes critical. Increased motivation and higher levels of academic engagement are both benefits, and prerequisites, for academic success in middle school.

The topics chosen and the laboratory approach employed in *Earth Science Success* reflect *National Science Education Standards* (NRC 1996) and both *Atlas of Science Literacy* and *Science for All Americans* (AAAS 2007; 1989). Each lesson builds the scaffolding for the next, in order to promote a solid grasp of the material. Students are actively involved in a process of reflection, investigation, and concept acquisition from the start. All learners construct their own knowledge and understandings from their experiences. The academic knowledge development presented in this book is incremental. Investigations carefully sequenced and connected to previous experiences in order to enable students to successfully build their knowledge. You will find the applicable cross-references for the National Science Education Standards and Benchmarks for Science Literacy in tables at the end of this introduction.
During the development and field-testing of Earth Science Success, care was taken to produce a curriculum that would complement well-known Earth Science print materials through a research-proven investigation methodology. Among the works consulted, three held the greatest influence: the National Science Teachers Association four-volume series Project Earth Science (Ford and Smith 2000); the two-volume J. Weston Walch Hands-on Science series (Fried and McDonnell 2000); and the University of Hawaii Curriculum Research and Development Group series (Pottenger and Young 1992). Each of these would constitute a valuable resource for teachers who have chosen the lab-centered activities of Earth Science Success as their main source of lesson plans and student handouts. Along with ideas suggested during field-testing by colleagues, we are also indebted to the National Aeronautics and Space Administration. Two summers spent at NASA's Space Academy for Educators were instrumental in the decision to write this book.

**References**


Introduction

To the Earth Science Teacher

The principal author of this book is a middle school Earth Science teacher. Like you, her day is very busy with large classes, meetings and other duties, grading and correction, class preparation, answering e-mail from parents, etc. She is therefore, like you, very much in the trenches with all that the hectic life of a middle school science teacher entails. *Earth Science Success* is the result of her desire to create a ready-to-use, lab-focused, survival-guide curriculum that has been field-tested and refined at Central Middle School in Eden Prairie, Minnesota. Catherine obtained National Board for Professional Teaching Standards Certification (Early Adolescent Science, 2004) while teaching these lessons. Together with her father, an experienced writer and teacher-trainer, she has organized this curriculum into a series of investigations that emphasize the active involvement of students in a discovery process. It is the authors’ hope that you will find this book a useful tool as you plan and teach your Earth science classes.

**Supplementary activities.** Appendix B contains a number of specific activities that will help you to vary your lesson strategies, providing new choices for classroom interactions. Each of these is explained in the appendix and several of them are included in “The First Ten Days” lesson plans found in Chapter 1.

*Earth Science Success on the web.* The National Science Teachers Association website has a link to *Earth Science Success* resources. This contains an electronic version of the student handouts (part 3 of each lab) that should facilitate personalization and reproduction.

We believe that the hands-on approach to Earth science used in this book will help your students relate what they are discovering and learning to their own worlds of experience. Similarly, student misconceptions are more readily identified and dispelled when students are required, in a trusting classroom atmosphere, to reflect on what they know and to share initial hypotheses that they are encouraged to formulate.
Correlations With National Science Education Standards and Benchmarks for Science Literacy

The following tables cross-reference the 33 labs featured in this book with the National Science Education Standards and Benchmarks for Science Literacy. Supplementary projects and activities (see Appendices B and C), while not listed in the table below, meet most of the Standards, as well.

<table>
<thead>
<tr>
<th>National Science Education Standards</th>
<th>Lab Reference from <em>Earth Science Success</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Science as Inquiry</td>
<td></td>
</tr>
<tr>
<td>(1) Identify Questions That Can Be Answered Through Scientific Investigations</td>
<td>All 33 labs</td>
</tr>
<tr>
<td>(2) Design and Conduct a Scientific Investigation</td>
<td>Extension and further investigation sections of all labs, S-1, A-5, G-5, G-7, M-8, O-6, O-7, and O-8.</td>
</tr>
<tr>
<td>(3) Use Appropriate Tools and Techniques to Gather, Analyze, and Interpret Data</td>
<td>All 33 labs</td>
</tr>
<tr>
<td>(4) Develop Descriptions, Explanations, Predictions, and Models Using Evidence</td>
<td>All 33 labs</td>
</tr>
<tr>
<td>(5) Think Critically and Logically to Make the Relationships Between Evidence and Explanations</td>
<td>All 33 labs</td>
</tr>
<tr>
<td>(6) Recognize and Analyze Alternative Explanations and Predictions</td>
<td>All 33 labs</td>
</tr>
<tr>
<td>(7) Communicate Scientific Procedures and Explanations</td>
<td>All 33 labs</td>
</tr>
</tbody>
</table>
### B. Physical Science

1. **Properties and Changes of Properties in Matter**
   - S-1, G-1, G-2, G-3, M-1, M-2, M-3, M-4, M-5, M-6, O-1, O-2, O-3, and O-7.

2. **Motions and Forces**

3. **Transfer of Energy**

### D. Earth and Space Science

1. **Structure of the Earth System**

2. **Earth’s History**
   - G-4, G-5, M-1, O-2, and O-3.

3. **Earth in the Solar System**

### E. Science and Technology

1. **Abilities of Technological Design**

2. **Understandings About Science and Technology**
   - A-6, A-8, G-5, M-7, M-8, O-3, and O-8.

### F. Science in Personal and Social Perspectives

1. **Natural Hazards**
   - G-7, G-8, M-1, M-8, and O-2.

2. **Risks and Benefits**

3. **Science and Technology in Society**
   - A-8, G-5, G-7, G-8, M-4, M-7, M-8, O-3, and O-8.

### G. History and Nature of Science

1. **Science as a Human Endeavor**
   - All 33 labs

2. **Nature of Science**
   - All 33 labs

3. **History of Science**
   - A-4, A-8, G-2, G-4, M-1, M-7, and O-3.
<table>
<thead>
<tr>
<th>Benchmarks for Science Literacy</th>
<th>Lab Reference from <em>Earth Science Success</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) The Nature of Science</td>
<td>All 33 labs</td>
</tr>
<tr>
<td>A. The Scientific World View</td>
<td>Extension and further investigation sections of all labs, S-1, A-3, A-5, A-6, G-1, G-4, G-5, G-7, M-4, M-8, O-6, O-7, and O-8.</td>
</tr>
<tr>
<td>B. Scientific Inquiry</td>
<td>S-1, A-6, A-8, G-5, G-7, M-7, M-8, and O-3.</td>
</tr>
<tr>
<td>C. The Scientific Enterprise</td>
<td></td>
</tr>
<tr>
<td>(3) The Nature of Technology</td>
<td></td>
</tr>
<tr>
<td>A. Technology and Science</td>
<td></td>
</tr>
<tr>
<td>B. The Earth</td>
<td>G-1, G-2, G-3, G-4, G-5, G-6, G-7, G-8, M-1, M-2, O-1, O-2, and O-3.</td>
</tr>
<tr>
<td>C. Processes That Shape the Earth</td>
<td></td>
</tr>
</tbody>
</table>

Copyright © 2008 NSTA. All rights reserved. For more information, go to www.nsta.org/permissions.
### E. Energy Transformations
A-5, A-8, G-7, G-8, M-1, M-2, M-3, M-5, M-7, M-8, O-3, and O-8.

### F. Motion
S-1, A-6, A-8, G-7, G-8, M-2, M-3, M-8, O-2, O-3, O-4, O-5, O-6, O-7, and O-8.

### G. Forces of Nature

### (5) The Living Environment

#### E. Flow of Matter and Energy
G-3, M-1, and O-3.

### (7) Human Society

#### A. Cultural Effects on Behavior
S-1, A-6, A-8, G-4, G-5, G-7, G-8, M-1, M-4, M-8, and O-3.

#### C. Social Change
A-8, G-5, G-7, G-8, M-8, and O-2.

#### D. Social Trade-Offs
Chapter 4

Meteorology
Note to the teacher: Students investigate Earth's atmosphere, beginning with a study of the hydrologic cycle. They examine how factors such as pressure, saturation, and air density contribute to weather. Students are introduced to concepts of air masses and the ways these masses interact to produce weather. Students examine patterns, using them to make predictions and forecasts about weather conditions.

The 10-day outline (Table 4.1), assumes that your course started with the Pretest for Earth Science, Lab S-1, and the astronomy unit. If, however, you choose to cover Meteorology first, we recommend that you still begin with the Pretest and Lab S-1 (see Chapter 1, “The First Ten Days”).

Table 4.1. Possible Syllabus for the First Ten Days of Meteorology.

<table>
<thead>
<tr>
<th>Week 1</th>
<th>Day 1</th>
<th>Day 2</th>
<th>Day 3</th>
<th>Day 4</th>
<th>Day 5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>KWL flip book, Lab M-1 (anticipation)</td>
<td>Lab M-1 (data collection)</td>
<td>“Oh, the Science-Related Places…” assigned (Appendix B), Lab M-1 (analysis)</td>
<td>“Wondering About Water” classroom work time</td>
<td>Lab M-2 (anticipation)</td>
</tr>
<tr>
<td></td>
<td>Lab M-1 (report due), Lab M-2 (Weather Watch Data Sheet preparation)</td>
<td>Lab M-2 (weather report data collection), Lab M-3 (data collection)</td>
<td>Lab M-2 (weather report data collection), Lab M-3 (data collection)</td>
<td>Lab M-2 (weather report data collection), Lab M-3 (analysis) Pop Can Implosion demo</td>
<td>Lab M-2 (report due)</td>
</tr>
</tbody>
</table>
Lab Meteorology 1: (M-1) Wondering About Water

Part 1: (Teacher’s Lesson Plan Outline)

Note: See Lesson Planning on page 32.

Anticipation Section Title: (M-1) Wondering About Water

Problem: How does the hydrologic cycle affect the world around me (see Figure 4.1)?

Prediction: Describe, in one sentence, the answer to the problem statement.

Thinking About the Problem: (See p. 148.)

Data Collection Materials and Procedures: (See p. 149.)

Figure 4.1. Hydrologic Cycle
• **Note:** The comic book template, in Data Collection Table #2, is for idea generation only. Teachers can decide whether they want to simply present this via transparency or require students to match the template completely with their comic book.

• **Note:** See Water Wonders, (Figure 4.2). This should be provided for students as part of the summary section. You may want to make a transparency of the Water Wonders story, and read it out loud while the students follow along. The following are some, but not all, of the options for you to choose from: evaporation—condensation—precipitation; precipitation—runoff—consumed by animal; snow—melting to liquid—evaporation; river—ocean—evaporation; and precipitation—groundwater—transpiration.

• **Note:** Set up Data Collection Table #1: Hydrologic Cycle Model as shown below.

Safety Requirements: goggles, aprons

Expansion and Further Investigation:

1. Investigate what types of devices are used to produce drinking water from ocean water. Write a detailed, half-page report on your findings.

2. Research the percentage of time that a typical water molecule would spend in each particular phase of the water cycle. For example, if given 100 days, how many days would the water molecule spend in the ocean, in the atmosphere, in a lake, or in a cloud?
Once upon a time, a royal family lived in a palace in the clouds. Two sisters, both water molecule princesses, were always looking for adventures. Their names were Maureen and Mary Molecule, and they were both kind-hearted, wonderful water molecules. For fun, one day, they fell to Earth as part of a raindrop with many other molecules from their kingdom.

Maureen and Mary landed in a bur oak tree, rolled over an acorn, then dripped gently to the ground. Both had many good friends with them—molecules are so very small that it took lots and lots of molecules to make up the tiny raindrop that Maureen and Mary were in.

A short time after they landed on the ground, the Sun came out. The Sun warmed the ground and all of the water molecules on it. Maureen and Mary started to feel wonderfully warm. They evaporated back into the atmosphere and eventually continued their adventures around Earth as part of the water molecule cycle.

During Maureen and Mary Molecule’s many travels in the water cycle, they spent time stored on the surface of the Earth in glaciers, melting and flowing into lakes, relaxing underground among rocks and soil, and even traveling through living things. They were able to join other water molecules to become a water droplet in a cumulus cloud, freezing and falling to Earth as a snowflake. Eventually Maureen and Mary could flow to the oceans, be transpired by plants, or be evaporated directly back up into their palace in the sky.

Throughout all of Maureen and Mary Molecule’s journeys, the amount of water on Earth and in our atmosphere remained the same—it just changed from solid to liquid to gas and did some traveling. You see, water molecules are pretty tough, and it is very hard to hurt them. Maureen and Mary were strong. As water molecules, they were made up of three atoms: two small hydrogen atoms (H₂), and one larger oxygen atom (O), tightly connected. Water molecules (H₂O) like Maureen and Mary, don’t change their appearance when they are cooled, warmed, or under pressure. In ice, water, and water vapor, water molecules stay the same.

For the Analysis section on Lab M-1, use your creativity to describe the journey of any water molecule through any three steps of the water cycle. Make your description into a five-scene comic strip.
Part 2: (Student Lab Notebook Entries)

Anticipation Section Title: (M-1) Wondering About Water

Problem: How does the hydrologic cycle affect the world around me?

Prediction:

Note: Distribute the student handout (see Part 3) after students have completed their predictions.

Thinking About the Problem: Paraphrase the three main points of the reading in your own words.

(1)

(2)

(3)

Table 4.2. Data Collection Table #1: Hydrologic Cycle Model
Table 4.3. Data Collection Table #2: Water Wonders Comic Book

<table>
<thead>
<tr>
<th>Creative Title for Your Water Wonders Comic Book Here</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scene one: Introduce your main character(s).</td>
</tr>
<tr>
<td>Scene two: Take your character(s) through any first step of the hydrologic cycle.</td>
</tr>
<tr>
<td>Scene three: Take your character(s) through any next step of the hydrologic cycle.</td>
</tr>
<tr>
<td>Scene four: Take your character(s) through any third step of the hydrologic cycle.</td>
</tr>
<tr>
<td>Scene five: Wrap up your comic book story, showing a final outcome for your comic book character(s).</td>
</tr>
</tbody>
</table>

Analysis:

Read Water Wonders, which your teacher will provide. Use this story to help give you new ideas for describing the journey of your very own water molecule through any three steps of the hydrologic cycle. Share the water molecule’s journey in a five-scene comic book.

Concluding-the-Analysis Statements:

1. I learned…
2. If I were to re-do this lab, I would change…
3. An example of a variable in this lab is…
4. An example of a control in this lab is…
Part 3: (Student Handout)

Note: Distribute to students after they complete the Prediction in Part 2.

Anticipation Section Title: (M-1) Wondering About Water

Thinking About the Problem

Where does the water in rain come from and where does it go? Our seemingly inexhaustible supply of water is actually used over and over again. Water moves from the ocean to air and land, and from the land to ocean and air. This continuous movement of water in a cyclic pattern is called the hydrologic (hudro, “water” in Greek) cycle. And it is very important in the science of meteorology (meteoron, “astronomical phenomenon” in Greek).

In nature, the Sun warms the water in the oceans, causing surface water to evaporate. As the water vapor rises in the atmosphere (atmos, “vapor” in Greek), it cools and condenses into liquid droplets. Most of these droplets continue cooling to ice crystals and snowflakes. Evaporation continues as the droplets and crystals grow in size, until they eventually fall back to Earth. Precipitation falling on Earth’s surface is dependent on the temperature changes below the clouds. The precipitation collects on the land surface and may flow back to the oceans, completing the cycle.

Most of the Earth’s total amount of water is contained in the oceans, a volume estimated at 1,350,000,000 km³. Other reservoirs, for example, glaciers (27,500,000 km³), groundwater (8,200,000 km³), and lakes and streams (206,700 km³), hold significant water as well. Although it is in a continuous state of change due to evaporation and precipitation, our atmosphere is estimated to hold 13,000 km³ of water.

In this lab, you will study a model of how the hydrologic cycle occurs. As far as water is concerned, Earth is basically a closed system that, in this case, is represented by a clear plastic bin. A soil bag serves as a continent, a lamp as the Sun, and water as the oceans. A beaker of ice represents the cold regions of the upper atmosphere, where water vapor condenses into water droplets.
Data Collection Materials:

- Clear plastic bin
- Glass pitcher
- Ice cubes
- Lamp
- Resealable plastic bag with sand
- Water

Data Collection Procedures:

(1) Label each of the materials in the demonstration diagram shown in Data Collection Table #1, showing not only what they materials truly are, but also what each material represents in terms of the hydrologic cycle.

(2) Carefully observe the progression of events. Draw and label a sketch showing the movement of water through the hydrologic cycle by showing what the demonstration model actually represents.
Lab Meteorology 2: (M-2) Dealing With Pressure

Part 1: (Teacher’s Lesson Plan Outline)

Note: See Lesson Planning on page 32.

Anticipation Section Title: (M-2) Dealing With Pressure

Problem: How does the weight of the air affect you?

Prediction: Describe, in one sentence, your best answer to this problem statement.

Thinking About the Problem: (See p. 154.)

Data Collection Materials and Procedures: (See p. 155.)

Safety Requirements: goggles, aprons

Description of Pop Can Implosion Data Collection Procedures:

(1) Pour a splash of water into the bottom of an empty pop (soda) can.

(2) Using the beaker tongs, hold the pop can on a hot plate (high temp) until you hear the water boiling and you see the steam escaping.

(3) Very quickly, invert the pop can into the shallow pan of water.

(4) The rapid motion of the steam circulates and pushes a lot of molecules out of the can, so that when it is inverted (and therefore sealed off), the pressure on the outside of the can is greater than on the inside. This causes the can to implode.
Expansion and Further Investigation:

(1) Based on your observations of the pop can in step 7, in which direction(s) is air pressure being exerted? Draw and label a picture representing your explanation and explain the phenomenon of air pressure in your own words.

(2) Explain why we usually do not feel the pressure of the atmosphere around us. When do we feel air pressure? Use resources to find the exact amount of atmospheric pressure being exerted on you at sea level.
Part 2: (Student Lab Notebook Entries)

Anticipation Section Title: (M-2) Dealing With Pressure

Problem: How does the weight of the air affect you?

Prediction:

Note: Distribute the student handout (see Part 3) after students have completed their predictions.

Thinking About the Problem: Paraphrase the three main points of the reading in your own words.

(1)

(2)

(3)
Table 4.4. Data Collection Table #1: Air Pressure Data

<table>
<thead>
<tr>
<th>Procedure 1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure 2</td>
<td></td>
</tr>
<tr>
<td>Procedure 3</td>
<td></td>
</tr>
<tr>
<td>Procedure 4</td>
<td></td>
</tr>
<tr>
<td>Procedure 5</td>
<td></td>
</tr>
<tr>
<td>Procedure 6</td>
<td></td>
</tr>
</tbody>
</table>

Analysis:

(1) In procedure 2, what caused the events you observed to happen?

(2) In procedures 3–5, what happened to the index card? Explain with detail and give a reason why.

(3) Explain why the events occurred as they did in procedure 6.

(4) Explain, in your own words, why the pop can implodes.

Concluding-the-Analysis Statements:

(1) I learned…

(2) If I were to re-do this lab, I would change…

(3) An example of a variable in this lab is…

(4) An example of a control in this lab is…
Part 3: (Student Handout)

Note: Distribute to students after they complete the Prediction in Part 2.

Anticipation Section Title: (M-2) Dealing With Pressure

Thinking About the Problem

How much does air weigh? If the question seems funny at first, it’s because we have lived our whole lives exposed to the weight of the atmosphere and therefore we are usually oblivious to its effect on us. Air does have weight, yet we don’t often notice it. We are much more aware of the weight of water when we dive underwater, and deep-sea divers need to protect themselves in order to avoid the life-threatening respiratory and circulatory system condition called the bends. Divers suffer from the bends because the high pressure of the water causes the nitrogen to dissolve in their blood. If the diver rises too quickly, the nitrogen bursts out of solution.

The weight of the air on Earth’s surface produces air pressure. Pressure (pressus, “pressed” in Latin) is a measure of the force over a certain area that the air is exerting due to its weight. Without it, we would certainly notice the results. Basically, we, as well as every other closed system on Earth, would soon explode without any atmospheric pressure. The instrument used to measure atmospheric pressure is called a barometer and it is essential in weather forecasting. This lab will give you an opportunity to see that air pressure, caused by the weight of the atmosphere, can produce some amazing results.
Data Collection Materials:

- Beaker tongs
- Bucket
- Empty pop cans
- Hot plate
- Index card
- Pushpin
- Shallow pan of water
- Test tube
- Water

Data Collection Procedures:

(1) Fill your test tube to the rim with water. Make a prediction about what will happen when you turn the test tube upside down.

(2) Turn the test tube over. What did you observe?

(3) Fill it with water again. Cover it with the index card, and make a tight seal. Predict what will happen when you turn the test tube upside down.

(4) Use your finger to hold the index card on, and then flip the test tube upside down. Slowly remove your hand from the index card. What did you observe?

(5) Slowly, lean the test tube on its side and record your observations.

(6) Slowly turn the test tube so that it is upside-down again. Poke a hole in it with the pin, and record your observations.

(7) Observe the imploding pop can demo by your teacher.
Lab Meteorology 3: (M-3) Phasing In Changes

Part 1: (Teacher’s Lesson Plan Outline)

Note: See Lesson Planning on page 32.

Anticipation Section Title: (M-3) Phasing In Changes

Gas Bubble Introductory Activity

Note: This introductory activity is used to introduce layering in the atmosphere by describing densities of various gases. Supplementary resources (such as textbooks, media center, and internet) can be used to show atmospheric layers (e.g., stratosphere), so that students can include a diagram in their lab notebooks (see Figure 4.3). The tie-in to the follow-up lab for M-3 is the changes in density that water undergoes as its temperature changes. Each phase for water has a different density.

Problem: Which of five gases (air, carbon dioxide, helium, methane, and propane) is the densest?

Prediction: Give your best answer to the problem statement.
Figure 4.3. Atmospheric Layer Sample Diagram (not to scale)

- **Thermosphere** (100 km or 62 mi)
- **Mesosphere** (75 km or 47 mi)
- **Stratosphere** (45 km or 28 mi)
- **Troposphere** (8 km or 5 mi)

- **Auroras**
- **Meteors**
- **Ozone layer ($O_3$)**
- **Cumulonimbus**
- **Cumulus**
- **Contrails**
- **Stratus**
- **Sun**
### Table 4.5. Teacher Notes for Data Collection Table #1

<table>
<thead>
<tr>
<th>Gas</th>
<th>Characteristics</th>
<th>Density Ranking</th>
</tr>
</thead>
</table>
| Carbon dioxide $\text{CO}_2$       | Bubbles bounce. -110 °F  
Cloudy, due to condensation.  
Frozen “sublimes” to gas. Burning one gallon of gasoline emits 19.6 pounds of $\text{CO}_2$. | 1 (most dense) |
| Air          | Bubbles break when they hit things.  
Float and then sink.  
Medium strength. Clear. For humans to live, we need 12% to 58% oxygen in our air. | 3 |
| Propane $\text{C}_3\text{H}_8$ | Flammable. Clear. Has an odor chemical added to enable detection of leaks. Sinks. Bounces, then breaks. Strong.  
Sometimes called “liquid petroleum.” | 1 (most dense) |
| Helium $\text{He}$  | Floats. Breaks easily. No smell. Clear. Second most abundant gas in universe, after hydrogen. | 5 (least dense) |
| Methane $\text{CH}_4$ | Has an odor chemical added to enable detection of leaks. Floats. Flammable.  
Clear. Medium strength. Breaks when hits things. Sometimes called “natural gas.” One kilogram of $\text{CH}_4$ warms the Earth 23 times as much as one kg of $\text{CO}_2$. | 4 |

**Note:** Soap bubbles can be filled with each gas and allowed to drift upward or downward, depending on density. The teacher guides the students through the observations of characteristics.
Phase Changes in Water Follow-Up Lab:

Problem: What are the two things that can happen when heat is added to water?

Prediction: Answer the problem question above.

Note: Remember to have students write their predictions prior to giving them the handout.

Thinking About the Problem: (See p. 163.)

Data Collection Materials and Procedures: (See p. 164.)

Safety Requirements: goggles, aprons, and fire extinguisher nearby

Expansion and Further Investigation:

(1) Investigate what the addition of salt does to the temperature versus time graph of phase changes in water. Does saltwater have a different result?

(2) What if ice did not float on liquid water? Water is quite unique in that its solid form is less dense than its liquid form. Some scientists have hypothesized that life, as we know it, could not exist if this unique pattern were not true. Imagine and explain the ramifications for our planet.
Part 2: (Student Lab Notebook Entries)

Anticipation Section Title: (M-3) Phasing In Changes

Gas Bubble Introductory Activity

Problem: Which of five gases (air, carbon dioxide, helium, methane, and propane) is the densest?

Prediction:

Table 4.6. Data Collection Table #1: (Student should provide a title)

<table>
<thead>
<tr>
<th>Gas</th>
<th>Characteristics</th>
<th>Density Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon dioxide</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Air</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Propane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methane</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Phase Changes in Water Follow-Up Lab:

Problem: What are the two things that can happen when heat is added to water?

Prediction:

Note: Distribute the student handout (see Part 3) after students have completed their predictions.

Thinking About the Problem: Paraphrase the three main points of the reading in your own words.

(1)

(2)

(3)

Table 4.7. Sketch for Procedure #2
Table 4.8. Sketch for Procedure #3

Analysis:

(1) Does the addition of heat always raise the temperature of water? Give examples.

(2) Describe exactly what is happening when the water changes phase.
   (a) From liquid to gas:
   (b) From solid to liquid:

(3) Give a working definition of heat.

(4) Give a working definition of temperature.

Concluding-the-Analysis Statements:

(1) I learned…

(2) If I were to re-do this lab, I would change…

(3) An example of a variable in this lab is…

(4) An example of a control in this lab is…
Part 3: (Student Handout)

Note: Distribute to students after they complete the Prediction in Part 2.

Anticipation Section Title: (M-3) Phasing In Changes

Thinking About the Problem

What happens when you heat water? There are two main things that happen when heat is added to water. The first is that the temperature of the water rises, or increases. The second is that a “change of phase” may occur. A phase change refers to whether a substance, like water, is a solid (ice), liquid (water), or a gas (water vapor).

Several familiar terms are associated with changes of phase. Freezing refers to a change from liquid to solid. Melting refers to a change from solid to liquid. Boiling refers to a change from liquid to gas. Condensing refers to a change from gas to liquid. In the introductory activity, you saw that sometimes a substance, like carbon dioxide (its solid form is called dry ice because it does not melt into a liquid) may skip a step. Sublimation refers to these cases, when a substance goes directly from solid to gas.

In each phase change, it is the spacing between the molecules that make up the substance that changes. In a solid, the molecules (molecula, “small bit” in Latin) are packed very closely together. The molecules are still moving, in a shivering fashion, vibrating back and forth. In a liquid (such as water or steam), the space between molecules increases to the point where they can flow around one another. In a gas, like the invisible water vapor in our air, the molecules dart around freely, occasionally colliding with each other.

A graph of your data from this lab will show that temperatures stop increasing when phase changes are occurring. There is a leveling out of the temperature because all of the heat energy is going into the motion of the molecules. Once the molecules have separated to the distance needed for the substance to become a different phase, the temperature begins to measure this new molecular motion.
Data Collection Materials:

- Air
- Apron
- Beakers
- Bunsen burner
- Bunsen burner
- Dry ice (solid carbon dioxide)
- Gloves
- Goggles
- Helium
- Ice (or snow, as a substitute)
- Metal thermometer
- Methane
- Propane
- Small aquarium
- Soap-blown bubbles
- Water

Data Collection Procedures:

(1) Create two of your own data collection tables, giving them titles. One should show temperature versus time for water boiling. The other should show temperature versus time for ice/snow melting. Time should be recorded in 30-second intervals.

(2) Begin to measure water going from room temperature to a rolling boil. Record data on temperature every 30 seconds. The water should be allowed to boil for three minutes.

(3) At the same time, measure water with ice cubes, or snow, going to water with all the ice/snow melted. The water should continue to be measured for temperature until all the ice has been melted for three minutes.

(4) Make a line graph showing the data from both experiments with temperature versus time.

(5) Draw and label two sketches, showing your apparatus for both experiments.
Figure 4.4. Graph Title for Procedure #4
Lab Meteorology 4: (M-4) Sweating About Science

Part 1: (Teacher’s Lesson Plan Outline)

Note: See Lesson Planning on page 32.

Anticipation Section Title: (M-4) Sweating About Science

Problem: Is there a difference between indoor humidity and outdoor humidity?

Prediction: Give a working definition of relative humidity.

Thinking About the Problem: (See p. 170.)

Data Collection Materials and Procedures: (See p. 171.)

Expansion and Further Investigation:

(1) Research the relative humidity of Colorado Springs, Colorado, and Phoenix, Arizona, during the past 20 years. How does construction of residential areas, landscaping around businesses, and city development affect or influence relative humidity?

(2) Some people’s hair curls when the relative humidity is high. Think of a way to use this fact to measure relative humidity. Include a labeled sketch of the device you would use with your explanation.
Part 2: (Student Lab Notebook Entries)

Anticipation Section Title: (M-4) Sweating About Science

Problem: Is there a difference between indoor humidity and outdoor humidity?

Prediction:

Note: Distribute the student handout (see Part 3) after students have completed their predictions.

Thinking About the Problem: Paraphrase the three main points of the reading in your own words.

(1)

(2)

(3)

Table 4.9. Data Collection Table #1: Relative Humidity Data

<table>
<thead>
<tr>
<th>Location</th>
<th>Time</th>
<th>Dry Bulb Temp (°C)</th>
<th>Wet Bulb Temp (°C)</th>
<th>Difference (°C)</th>
<th>Relative Humidity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Analysis:

(1) What did you notice about the wet bulb temperature while you were swinging the sling psychrometer (p. 171)?

(2) Give a good explanation for what you observed in question #1 above.

(3) Was there a difference between the indoor and outdoor relative humidity? Explain.

Concluding-the-Analysis Statements:

(1) I learned…

(2) If I were to re-do this lab, I would change…

(3) An example of a variable in this lab is…

(4) An example of a control in this lab is…
Table 4.10. Data Collection Table #2: Percentage of Relative Humidity

| Dry Bulb Temp (°C) | 5   | 6   | 7   | 8   | 9   | 10  | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19  | 20  | 21  | 22  | 23  | 24  | 25  | 26  | 27  | 28  | 29  | 30  | 31  | 32  | 33  | 34  | 35  |
|-------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1                 | 86  | 86  | 87  | 87  | 87  | 88  | 88  | 89  | 89  | 90  | 90  | 90  | 90  | 91  | 91  | 92  | 92  | 92  | 92  | 92  | 92  | 92  | 93  | 93  | 93  | 93  | 93  | 93  | 93  | 93  | 93  |
| 2                 | 72  | 73  | 74  | 75  | 76  | 77  | 78  | 79  | 79  | 80  | 81  | 81  | 82  | 82  | 83  | 83  | 83  | 83  | 84  | 84  | 84  | 85  | 85  | 85  | 86  | 86  | 86  | 86  | 87  | 87  | 87  |
| 3                 | 58  | 60  | 62  | 63  | 64  | 66  | 67  | 68  | 69  | 70  | 71  | 71  | 72  | 73  | 74  | 74  | 75  | 76  | 76  | 77  | 77  | 78  | 78  | 79  | 79  | 80  | 80  | 80  | 80  | 80  | 81  |
| 4                 | 45  | 48  | 50  | 51  | 53  | 55  | 56  | 58  | 59  | 60  | 61  | 63  | 64  | 65  | 66  | 67  | 68  | 69  | 69  | 70  | 71  | 71  | 72  | 72  | 73  | 73  | 74  | 74  | 75  | 75  | 75  |
| 5                 | 33  | 35  | 38  | 40  | 42  | 44  | 46  | 48  | 50  | 51  | 53  | 54  | 55  | 57  | 58  | 59  | 60  | 61  | 62  | 62  | 63  | 63  | 64  | 65  | 65  | 66  | 67  | 67  | 68  | 68  | 69  |
| 6                 | 20  | 24  | 26  | 29  | 32  | 34  | 36  | 39  | 41  | 42  | 44  | 46  | 47  | 49  | 50  | 51  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 60  | 61  | 61  | 62  | 63  | 63  | 64  | 64  |
| 7                 | 7   | 11  | 15  | 19  | 22  | 24  | 27  | 29  | 32  | 34  | 36  | 38  | 40  | 41  | 43  | 44  | 46  | 47  | 48  | 49  | 50  | 51  | 52  | 53  | 54  | 55  | 56  | 57  | 58  | 59  | 59  |
| 8                 | 8   | 12  | 15  | 18  | 21  | 23  | 26  | 27  | 30  | 32  | 34  | 36  | 37  | 39  | 40  | 42  | 43  | 44  | 44  | 47  | 48  | 49  | 50  | 51  | 51  | 52  | 53  | 54  | 54  | 54  | 54  |
| 9                 | 6   | 9   | 12  | 15  | 18  | 20  | 23  | 25  | 27  | 29  | 31  | 32  | 34  | 36  | 37  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 49  | 49  | 49  | 49  | 49  | 49  |
| 10                | 7   | 10  | 13  | 15  | 18  | 20  | 22  | 24  | 26  | 28  | 30  | 31  | 33  | 34  | 36  | 37  | 38  | 39  | 40  | 41  | 42  | 43  | 44  | 45  | 46  | 47  | 48  | 48  | 48  | 48  | 48  |
| 11                | 6   | 8   | 11  | 14  | 16  | 18  | 20  | 22  | 24  | 26  | 28  | 29  | 31  | 32  | 33  | 35  | 36  | 37  | 38  | 39  | 40  | 40  | 40  | 40  | 40  | 40  | 40  | 40  | 40  | 40  | 40  |
| 12                | 7   | 10  | 12  | 14  | 17  | 19  | 20  | 22  | 24  | 26  | 27  | 28  | 30  | 31  | 32  | 33  | 35  | 36  | 37  | 38  | 39  | 40  | 40  | 40  | 40  | 40  | 40  | 40  | 40  | 40  | 40  |
Part 3: (Student Handout)

Note: Distribute to students after they complete the Prediction in Part 2.

Anticipation Section Title: (M-4) Sweating About Science

Thinking About the Problem

Why do we seem to perspire more when it is humid? This is actually a misconception that many people share. The truth has to do with evaporation. In dry air, it is easier for water to evaporate and enter the air as water vapor. On very humid days, the air is already holding as much water vapor as it can, so perspiration is unable to evaporate as easily. The perspiration sits on our skin, rather than evaporating off, as it does on a dry day.

Hot, dry air is normally more comfortable than warm, humid air. Similarly, cold, dry air is often more comfortable than cool, damp air. While there is always at least a small amount of moisture in the air we breathe, the amount makes a big difference on our comfort level. Why? Temperature plays the primary role in determining the amount of water vapor present in the air at any given time. Warm air can hold more water vapor than cool air. But every temperature has its limit and once the air is saturated, it can hold no more water vapor. Saturated air has a relative humidity of 100% and clouds or fog begin to form. When relative humidity is high, our perspiration cannot evaporate quickly, it is much harder for us to cool down, and we become uncomfortable.

Relative humidity is a measure of how much water vapor is actually in the air compared to the amount the air could possibly hold. In desert areas, relative humidity is low, but in jungles it is high. Relative humidity can be measured with two different instruments. One is called a hygrometer (hugros, “wet, moist” in Greek); the other is called a sling psychrometer (psukhros, “cold” in Greek). Since the sling psychrometer is easily portable, that is the one we will use in this lab.
Data Collection Materials:

- Data Table: Percentage of Relative Humidity
- Sling psychrometer
- Thermometer

Data Collection Procedures:

1. Read and record the “dry bulb temperature” on the metal thermometer.
2. Carefully swing the sling psychrometer around for two to three minutes and record the lowest temperature reached by its thermometer. Record this “wet bulb temperature.”
3. Subtract the wet bulb temperature from the dry bulb temperature, and record.
4. From your calculation in step 3, determine the relative humidity using Data Collection Table #2.
5. Use this same method to determine the relative humidity in four more locations around the school.
Lab Meteorology 5: (M-5) Lining Up in Front

Part 1: (Teacher’s Lesson Plan Outline)

Note: See Lesson Planning on page 32.

Anticipation Section Title: (M-5) Lining Up in Front

Problem: How do warm and cold fronts influence the weather you see?

Prediction: Answer the problem question above.

Thinking About the Problem: (See p. 176.)

Data Collection Materials and Procedures: (See p. 177.)

Expansion and Further Investigation:

(1) Research the four different types of clouds and the type of weather that is generally associated with each. Write a detailed half-page report on your findings. Include pictures or diagrams of each type.

(2) Research and report on the weather proverb, “Mackerel skies and mares tales make tall ships carry low sails.” What does the proverb mean, and exactly what would the cloud conditions be if it was applicable?

(3) Research “cloud in a jar” demonstrations on the internet. Using the simple materials required, prepare a demonstration for the class in which you generate a cloud in a jar.
Part 2: (Student Lab Notebook Entries)

Anticipation Section Title: (M-5) Lining Up in Front

Problem: How do warm and cold fronts influence the weather you see?

Prediction:

Note: Distribute the student handout (see Part 3) after students have completed their prediction.

Thinking About the Problem: Paraphrase the three main points of the reading in your own words.

(1)

(2)

(3)
Chapter 4

Figure 4.5. Data Collection Table #1: Front Lines Data Page

City of Science Rules

150 kilometers

A

B

Copyright © 2008 NSTA. All rights reserved. For more information, go to www.nsta.org/permissions.
Analysis:

(1) Describe what the clouds looked like during the first few hours.

(2) What did the clouds look like after 24 hours, when it was raining?

(3) Why did the warm air mass rise up over the cold air mass?

(4) Describe the types of clouds present as the cold front moved into the city after 48 hours.

(5) If you saw wispy clouds followed by lower, layered clouds, what type of weather might you expect in the next 24 hours?

Concluding-the-Analysis Statements:

(1) I learned…

(2) If I were to re-do this lab, I would change…

(3) An example of a variable in this lab is…

(4) An example of a control in this lab is…
**Part 3: (Student Handout)**

*Note:* Distribute to students after they complete the Prediction in Part 2.

**Anticipation Section Title:** (M-5) Lining Up in Front

---

**Thinking About the Problem**

What is a weather front? When a warm air mass meets a cool air mass, two distinct bodies of air are brought in contact, each with its own temperature and relative humidity. Normally, when this “collision” happens, the warm air mass rides up and over the cool air mass, because warm air is less dense. A front is, then, the boundary, or line, between these two air masses.

When a weather front results in warm air getting pushed above cool air, the warm air mass swells as it goes higher and higher. This happens because the air pressure is lower at higher altitudes. As the warm air rises and expands, it begins to cool and the moisture it contains condenses to form clouds and, often, rain, ice, or snow. Clouds come in different shapes and sizes and this is a factor that meteorologists use to help predict the weather.

Dew is the result of air reaching a certain temperature at which it becomes saturated. As you learned in Lab M-4, saturation occurs when the air can hold no more water vapor. This vapor will begin to change to liquid, as, for example, often happens in early morning when moist air condenses on cooler grass, rocks, and trees. If the temperature of the grass, etc., is below freezing, the condensation (*densare*, “to thicken” in Latin) is known as frost. The temperature at which the processes of evaporation and condensation are equal is called the dew point.
Data Collection Materials:

- Front lines data page (Figure 4.5)
- Glue
- Notebook paper
- Scissors

Data Collection Procedures:

1. Find the data page. Separate the three strips, cutting along the lines. Also cut out the “city” (the smaller box on top).
2. Shade in the cold air masses, so they are easier for you to see.
3. Glue the three strips together by matching up the letters.
4. To make the viewer, fold a piece of notebook paper in half and make two 6 cm cuts that are vertical, as shown in Figure 4.6.

Figure 4.6. Frame for Viewer

5. Glue the city below the two cuts.
6. Feed the strip through the two cuts so that it passes over the city, starting with Zero Hrs.
Lab Meteorology 6: (M-6) Dewing Science

Part 1: (Teacher’s Lesson Plan Outline)

Note: See Lesson Planning on page 32.

Anticipation Section Title: (M-6) Dewing Science

Problem: How does the dew point of our air influence us?

Prediction: Give a working definition of *dew point*.

Thinking About the Problem: (See p. 181.)

Data Collection Materials and Procedures: (See p. 182.)

Note: You may want to conduct this experiment outside if you teach in an air-conditioned building.

Expansion and Further Investigation:

1. When air rises, it expands and cools about 1°C for every 100 m of altitude, up to about 10 km. If the air in our classroom were to rise, at what height would the water vapor begin to condense and form clouds? Explain your answer. (Assume that the air outside has the same temperature as inside.)

2. At what time of day are you most likely to find dew? Why? Where would you normally find dew? Describe the situations when you might find frozen dew.
Part 2: (Student Lab Notebook Entries)

Anticipation Section Title: (M-6) Dewing Science

Problem: How does the dew point of our air influence us?

Prediction:

Note: Distribute the student handout (see Part 3) after students have completed their predictions.

Thinking About the Problem: Paraphrase the three main points of the reading in your own words.

(1)

(2)

(3)

Table 4.11. Data Collection Table #1: Dewing Science Experiments

<table>
<thead>
<tr>
<th>Trial</th>
<th>Air Temp. (°C)</th>
<th>Dew Point (°C)</th>
<th>Descriptive Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Average Dew Point (°C)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Analysis:

(1) Under what weather conditions would both the air temperature and the
dew point be the same number?

(2) Imagine that you are doing this activity again, on a day with similar air
temperature. If you found that the dew point had increased, would this
indicate that there was more moisture in the air, or less? Explain.

(3) By how many degrees would the air temperature have to cool in order
to reach the average dew point determined in Data Collection Table #1?
Explain.

Concluding-the-Analysis Statements:

(1) I learned…

(2) If I were to re-do this lab, I would change…

(3) An example of a variable in this lab is…

(4) An example of a control in this lab is…
**Part 3:** (Student Handout)

*Note:* Distribute to students after they complete the Prediction in *Part 2.*

**Anticipation Section Title:** (M-6) Dewing Science

---

**Thinking About the Problem**

Can the dew point influence how we feel? On muggy days, meteorologists often include the dew point in the facts and figures that they share. Why? The answer is that the dew point is a good indication of how much moisture (invisible water vapor gas) is in the air. The closer the dew point is to the actual air temperature, the more moisture the air is holding. We are most likely to notice water vapor on very humid, warm days, when we feel clammy or sticky because, as you learned in Lab M-4, all the water vapor surrounding us prevents our perspiration from evaporating easily.

On days when the air temperature and the dew point are very close to each other, we say the air is “humid.” If, for example, the air temperature is 31°C and the dew point is 29°C, this means that there is much more water vapor in the air than on a day when the temperature is the same but the dew point is only 10°C.

As you learned in Lab M-1, most of the water in the atmosphere got there by evaporation, largely from the ocean but also from lakes, rivers, ponds, and even puddles. Temperature is a major factor in determining how much and how rapidly water will evaporate from these places. When the air is cool, it cannot hold as much water vapor as when the air is warm, and therefore, less water will evaporate. Because of this, at any location, there will probably be more water vapor in the air during warm weather than during cold weather. In this lab, you will investigate the relationship between air temperature and dew point.
Data Collection Materials:

- Empty soup can
- Ice
- Metal thermometer
- Water

Data Collection Procedures:

1. Measure and record the air temperature.

2. Fill the can half full with water. Allow the can to sit for three minutes. If condensation forms on the outside of the can, replace the water with slightly warmer water. Repeat until no condensation forms on the outside of the can.

3. Place the thermometer in the can with the water.

4. Slowly, add small pieces of ice to the can while carefully stirring with the thermometer. Watch the outside of the can for the first sign of condensation.

5. When condensation begins, immediately record the “dew point” temperature of the water in the can.

6. Repeat steps 2 through 5 twice more and record. Find the average and record.
Lab Meteorology 7: (M-7) Deciphering a Weather Map

Part 1: (Teacher’s Lesson Plan Outline)

Note: See Lesson Planning on page 32.

Anticipation Section Title: (M-7) Deciphering a Weather Map

Problem: What do all the symbols mean on a standard weather map?

Prediction: Describe what types of information a weather station collects.

Thinking About the Problem: (See p. 189.)

Data Collection Materials and Procedures: (See p. 189.)

Notes on Weather Symbol Information:

(1) Atmospheric Pressure: This is the air pressure measured in millibars (mb). Average air pressure at sea level is 1013 mb. This is equivalent to 760 mm Hg (Metric Standard) and to 29.92 in Hg (used by some meteorologists). On the weather map, “056” refers to 1005.6 mb.

(2) Wind Speed: Small lines represent the wind speed. Each full line represents 10 knots (1 kt = 1.15 mph). Shorter lines represent 5 knots. Add the lines to get the total wind speed.

(3) Wind Direction: The line points in the direction from which the wind is blowing. For example, wind is blowing “from the south” for the city of Science Rules.
(4) **Temperature:** Temperature is measured in °F.

(5) **Dew Point:** This is the temperature, in °F, that the air would have to be cooled down to in order for the air to become saturated and condense. In other words, the closer the dew point is to the actual temperature, the more humid it feels.

(6) **Cloud Cover:** The amount of cloud cover is represented by the amount of the circle that is darkened.

(7) **Precipitation:** These symbols show the current type and level of precipitation.

**Expansion and Further Investigation:**

(1) Why is it important to be informed about weather conditions? Describe 10 careers that rely on forecasted weather conditions.

(2) Describe any weather conditions that could occur in your community that pose threats to life and/or property.
Part 2: (Student Lab Notebook Entries)

Anticipation Section Title: (M-7) Deciphering a Weather Map

Problem: What do all the symbols mean on a weather map?

Prediction:

Note: Distribute the student handout (see Part 3) after students have completed their predictions.

Thinking About the Problem: Paraphrase the three main points of the reading in your own words.

(1)

(2)

(3)

Table 4.12. Sketch for Analysis #14
Chapter 4

Figure 4.7. Data Collection Table #1: Weather Station Symbol

Figure 4.8. Data Collection Table #2: Weather Symbols for Wind Speeds

Figure 4.9. Data Collection Table #3: Weather Symbols for Wind Direction
Figure 4.10. Data Collection Table #4: Weather Symbols for Cloud Cover

Table 4.13. Data Collection Table #5: Weather Station Symbols for Precipitation

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Precipitation</th>
<th>Symbol</th>
<th>Precipitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>•</td>
<td>Intermittent rain</td>
<td>•</td>
<td>Intermittent drizzle</td>
</tr>
<tr>
<td>• •</td>
<td>Continuous rain</td>
<td>• •</td>
<td>Continuous drizzle</td>
</tr>
<tr>
<td>△</td>
<td>Hail</td>
<td></td>
<td>Thunderstorms</td>
</tr>
<tr>
<td>△•</td>
<td>Sleet</td>
<td>=</td>
<td>Fog</td>
</tr>
<tr>
<td>*</td>
<td>Intermittent snow</td>
<td>▼</td>
<td>Slight showers</td>
</tr>
<tr>
<td>**</td>
<td>Continuous snow</td>
<td>▼</td>
<td>Heavy showers</td>
</tr>
</tbody>
</table>

Analysis:

(1) What is the current precipitation in Pueblo, Colorado?

(2) What is the atmospheric pressure in Miami, Florida?

(3) Describe the wind direction and wind speed in Winnipeg, Manitoba.

(4) What is the temperature in San Antonio, Texas?

(5) What is the cloud cover in Boston, Massachusetts?

(6) What is the atmospheric pressure in Phoenix, Arizona?

(7) What is the precipitation in Chicago, Illinois?

(8) What is the cloud cover in Seattle, Washington?
(9) Describe the wind direction and wind speed in Los Angeles, California.

(10) Describe the precipitation in Minneapolis, Minnesota.

(11) Describe the region of the map that appears to be generally cloudy.

(12) Describe the region of the map that appears to be generally clear.

(13) Describe a region in the map that fits your ideal weather, and explain why.

(14) In the city Science Rules, the weather has changed to the following conditions: atmospheric pressure is 1015 mb; temperature is 54ºF; dew point is 40ºF; wind is 25 knots from the southeast; and cloud cover is 50%. Draw and label the current weather symbol for Science Rules.

Concluding-the-Analysis Statements:

(1) I learned…

(2) If I were to re-do this lab, I would change…

(3) An example of a variable in this lab is…

(4) An example of a control in this lab is…
Part 3: (Student Handout)

Note: Distribute to students after they complete the Prediction in Part 2.

Anticipation Section Title: (M-7) Deciphering a Weather Map

Thinking About the Problem

What do we need to know to interpret weather maps? These maps report meteorological data collected from several weather stations at a specific point in time. Weather stations can be in many places, including airports, TV and radio broadcasting stations, schools, private homes, and remote areas maintained by the National Oceanic and Atmospheric Administration (NOAA).

Normally weather maps show an outline of a specific area (local, state, national), the cities where the reporting stations are located, and symbols to show what the weather is. By including information from a number of different stations, the map will give a good idea of what the weather is across the whole area represented.

Data Collection Table #1 shows an example of a weather station’s symbol and the information given by each part of the symbol. Although this current system may change, weather station symbols in the United States are still expressed with the English Standard units of measurement, rather than the metric system. Data Collection Tables #2, #3, #4, and #5 show examples of specific information presented by weather station symbols.

Data Collection Materials:

- Data collection tables of weather station symbols (Figures 4.7–4.10; 4.12)
- Weather map (Figure 4.11)

Data Collection Procedures:

(1) Refer to the data collection tables and to the weather map in answering the Analysis questions.
Figure 4.11. Weather Map
Figure 4.12. Weather Station Symbols for Each City on the National Map

<table>
<thead>
<tr>
<th></th>
<th>Seattle</th>
<th>Los Angeles</th>
<th>Phoenix</th>
<th>Pueblo</th>
<th>San Antonio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td></td>
<td>56</td>
<td>69</td>
<td>81</td>
<td>58</td>
<td>023</td>
</tr>
<tr>
<td></td>
<td>077</td>
<td>056</td>
<td>059</td>
<td>970</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td>46</td>
<td>50</td>
<td>42</td>
<td>63</td>
<td>65</td>
</tr>
<tr>
<td>Winnipeg</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
<td>![Symbol]</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>40</td>
<td>50</td>
<td>37</td>
<td>067</td>
</tr>
<tr>
<td></td>
<td>968</td>
<td>972</td>
<td>930</td>
<td>922</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>36</td>
<td>50</td>
<td>35</td>
<td>61</td>
</tr>
</tbody>
</table>

Copyright © 2008 NSTA. All rights reserved. For more information, go to www.nsta.org/permissions.
Lab Meteorology 8: (M-8) Watching the Weather

Part 1: (Teacher’s Lesson Plan Outline)

Note: See Lesson Planning on page 32.

Anticipation Section Title: (M-8) Watching the Weather

Problem: What is the connection between North American and your local weather patterns?

Prediction: Describe, in one sentence, your answer to the problem question.

Thinking About the Problem: (See p. 197.)

Data Collection Materials and Procedures: (See p. 198.)

Note: You may want to make copies of the Watching the Weather data sheet for students to glue into their lab notebooks. I select the cities to record daily high temperature and precipitation forecasts. This gives a good idea to students about where the air masses that might be affecting their hometown are coming from. The daily newspaper can be used to obtain this information, in addition to numerous online sources. We have a WeatherBug Weather Station in our classroom for use with all of the rest of the daily data. You can access weather stations such as this through www.weatherbug.com.
Expansion and Further Investigation:

(1) Describe, in a detailed half-page report, what the connection is between front movements and the precipitation that comes to your area.

(2) Research South American, European, African, or Asian weather patterns and report on how they are similar to, and different from, your own weather patterns.
Part 2: (Student Lab Notebook Entries)

Anticipation Section Title: (M-8) Watching the Weather

Problem: What is the connection between North American and your local weather patterns?

Prediction:

Note: Distribute the student handout (see Part 3) after students have completed their predictions.

Thinking About the Problem: Paraphrase the three main points of the reading in your own words.

(1)

(2)

(3)
Table 4.14. Data Collection Table #1: Watching the Weather

Today’s Day and Date: ________________________

<table>
<thead>
<tr>
<th>Watching the Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cloud types</strong></td>
</tr>
<tr>
<td>Morning:</td>
</tr>
<tr>
<td>Noon:</td>
</tr>
<tr>
<td>Evening:</td>
</tr>
<tr>
<td><strong>Precipitation</strong></td>
</tr>
<tr>
<td>Type:</td>
</tr>
<tr>
<td>Total amount:</td>
</tr>
<tr>
<td>Duration:</td>
</tr>
<tr>
<td><strong>Temperature</strong></td>
</tr>
<tr>
<td>High:</td>
</tr>
<tr>
<td>Temp at noon:</td>
</tr>
<tr>
<td>Low:</td>
</tr>
<tr>
<td><strong>Air pressure</strong></td>
</tr>
<tr>
<td>Morning:</td>
</tr>
<tr>
<td>Noon:</td>
</tr>
<tr>
<td>Evening:</td>
</tr>
</tbody>
</table>
Chapter 4

Analysis:

(1) Find one of your Watching the Weather data sheets that shows some form of precipitation. Describe the kinds of clouds you observed on that day.

(2) On that same day, look at the North American weather map. Where in the continent were the major fronts and what types of fronts were they?

(3) Follow the movements of a front to see how it moves each day. Describe the direction in which it moved.

(4) What is the general direction of weather movement over North America?

(5) If you could spend a lot of time watching the weather, where would you discover that most of your hometown’s weather comes from?

Concluding-the-Analysis Statements:

(1) I learned…

(2) If I were to re-do this lab, I would change…

(3) An example of a variable in this lab is…

(4) An example of a control in this lab is…
Part 3: (Student Handout)

Note: Distribute to students after they complete the Prediction in Part 2.

Anticipation Section Title: (M-8) Watching the Weather

Thinking About the Problem

What is the weather like outside right now? Can you answer the question without looking out the window to check? What type of cloud cover was in the sky when you woke up this morning? If you have trouble answering these questions, you are not alone. Most people today do not pay very much attention to the weather until it interferes with something they plan to do. Rain can cancel a soccer game. Snow can make a commute unbearable. When these things happen we notice the weather, but much of the time we ignore it.

This is not the case, of course, for everyone. Receiving proper amounts of rain and sun is vital for those who grow the food we eat. Sailors, pilots, truck drivers, and a number of other professions depend on accurate weather reports to be able to safely carry out the work they do. “Red sky at night, sailor’s delight; red sky in the morning, sailors take warning” is only one of the many sayings in our language that prove that our ancestors were very concerned with the weather and that they knew how to read natural signs in order to predict what the weather would be.

By not paying attention, we miss many of the interesting things that go on in the atmosphere. For example, it is possible to predict short-term weather changes with some accuracy just by looking at the clouds. The purpose of this lab is to help you observe the weather around you more carefully and to help you relate the weather you’re experiencing to weather in other parts of the country. One way to predict weather changes is to look at the weather in nearby places. You can become an excellent forecaster by carefully observing what is happening around you.
Data Collection Materials:

- Classroom weather station
- Internet sites for monitoring current and forecasted weather
- North American weather maps from local newspapers
- Watching the Weather data collection tables (4.14)

Data Collection Procedures:

1. Create one Watching the Weather data collection table for each day, for 10 days total. Glue in the 10 North American maps and draw one data table beneath them per page.

2. Record the information from the internet/newspaper weather maps onto your weather map data sheet each day. Include the temperatures in major cities across North America, as well as the various types and locations of fronts.

3. Record the daily weather conditions at your location.
Index

Page numbers in boldface type refer to tables or figures.

A
Accountability, 6, 10
Ages of rock layers, 115–121, 117–118, 122
Albedos of solar system objects, 63–71, 66–68
Analysis, 2, 4
Anticipation, 2, 3
Anticipatory question, 2, 3
Astronomy unit, 35–88
“Hunting for Space Flight History,” 84–87, 84–88
“Keeping Your Distance,” 50–55, 53
“Landing on the Moon,” 72–77, 74–75
“Orbiting Snowballs,” 78–83, 80, 82
“Reflecting on the Solar System,” 63–71, 66–68
“Sizing Up the Planets,” 18–22, 37–42
Atmospheric layers, 156, 157
Atmospheric pressure, 150–155, 153
Atoms, 278

B
“Barging Down the River”
student handout for, 235–236
teacher’s lesson plan outline for, 230–236, 233
Beaches, 201–211, 209
“Becoming a Scientist,” 8, 9, 13–17, 21
student handout for, 30–31
teacher’s lesson plan outline for, 23–31, 28
Behavioral expectations, 10–11
Benchmark for Science Literacy, ix, xiii, xv–xvi, 3
Bingo game, 9, 268
Bloom’s Taxonomy, 4, 274
“Break the ice” activities, 9–10
Buoyancy, 220–228, 221–223, 237–242, 239
density and, 244–249, 247

C
“Changing Lunar Tides”
student handout for, 217–218, 219
teacher’s lesson plan outline for, 212–218, 214–215
“Classifying Rocks and Geologic Role”
student handout for, 106–107, 108
teacher’s lesson plan outline for, 102–108, 103–104
Clicker Technology, 15
Cold and warm fronts, 172–177, 174, 177
Collaborative websites, 5
Comets, 78–83, 80
“Community Connection Assignment,” 296
“Comparing Planetary Compounds”
student handout for, 61–62
teacher’s lesson plan outline for, 56–62, 58–59
Concept map on density, 283, 283
Concepts, defining of, 2, 3–4
Concluding-the-analysis statements, 4
Course management software, 5

D
Data collection, 2, 2
technologies for, 6
Data collection tables, 13
for “Barging Down the River,” 233
for “Becoming a Scientist,” 13, 28, 28
for “Changing Lunar Tides,” 214–215
for “Classifying Rocks and Geologic Role,” 104
for “Comparing Planetary Compounds,” 58–59
for “Dealing With Pressure,” 153
for “Deciphering a Weather Map,” 186–187
<table>
<thead>
<tr>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>for “Dewing Science,” 179</td>
</tr>
<tr>
<td>for “Diving Into the Depths,” 254</td>
</tr>
<tr>
<td>for “Drilling Through the Ages,” 117–118</td>
</tr>
<tr>
<td>for “Estimating With Metrics,” 45–46</td>
</tr>
<tr>
<td>for “Hunting for Space Flight History,” 86–87</td>
</tr>
<tr>
<td>for “Hunting Through the Sand,” 125</td>
</tr>
<tr>
<td>for “Keeping Your Distance,” 53</td>
</tr>
<tr>
<td>for “Knowing Mohs,” 98–99</td>
</tr>
<tr>
<td>for “Layering Around on the Beach,” 209</td>
</tr>
<tr>
<td>for “Lining Up in Front,” 174</td>
</tr>
<tr>
<td>for “Mounting Magna,” 136</td>
</tr>
<tr>
<td>for “Orbiting Snowballs,” 80</td>
</tr>
<tr>
<td>for “Phasing In Changes,” 160</td>
</tr>
<tr>
<td>for “Piling Up the Water,” 203</td>
</tr>
<tr>
<td>for “Reflecting on the Solar System,” 66–68</td>
</tr>
<tr>
<td>for “Sinking Film Canisters,” 221–223</td>
</tr>
<tr>
<td>for “Sizing Up the Planets,” 20, 39</td>
</tr>
<tr>
<td>for “Sweating About Science,” 167, 169</td>
</tr>
<tr>
<td>for “Toying With Buoyancy,” 239</td>
</tr>
<tr>
<td>for “Toying With Density,” 247</td>
</tr>
<tr>
<td>for “Unearthing History,” 111–112</td>
</tr>
<tr>
<td>for “Weathering,” 195</td>
</tr>
<tr>
<td>for “Watching the Weather,” 195</td>
</tr>
<tr>
<td>for “Weighing In on Minerals,” 92–93</td>
</tr>
<tr>
<td>for “Wondering About Water,” 146–147</td>
</tr>
<tr>
<td>“Dealing With Pressure” student handout for, 154–155 teacher’s lesson plan outline for, 150–155, 153</td>
</tr>
<tr>
<td>“Deciphering a Weather Map” student handout for, 189, 190–191 teacher’s lesson plan outline for, 183–189, 186–187</td>
</tr>
<tr>
<td>Defining concepts, 2, 3–4</td>
</tr>
<tr>
<td>Differentiation opportunities, 2, 4–5 “Diving Into the Depths” student handout for, 256–257 teacher’s lesson plan outline for, 250–257, 251–254 “Drilling Through the Ages” student handout for, 120–121, 122 teacher’s lesson plan outline for, 115–121, 117–118</td>
</tr>
<tr>
<td>F Family visits to science-related places, 303 Feedback, 6 First ten days, 9–22 Floating and sinking, 220–228, 221–223 density and, 244–249, 247 “Sink a Sub” project, 2, 284–285 Focusing student lab work, 4 Forecasting the weather, 192–198, 195</td>
</tr>
</tbody>
</table>
syllabus for, 90
“Unearthing History,” 109–114, 111–112
“Weighing In on Minerals,” 91–96, 92–93
Glossary, 7
Grading
  of lab reports, 6, 21
rubric for lab notebooks, 8, 313
rubric for Science Experiment Project, 291

Hardness of minerals, 97–101, 98–99
Humidity, 166–171, 167, 169
“Hunting for Space Flight History” student handout for, 88
teacher’s lesson plan outline for, 84–87, 84–88
“Hunting Through the Sand” student handout for, 125
teacher’s lesson plan outline for, 123–126, 125
Hydrologic cycle, 143, 143–149, 145–147

Index card information for students, 9
Interactive whiteboards, 5
Introductions in classroom, 9

“Keeping Your Distance” student handout for, 54–55
teacher’s lesson plan outline for, 50–55, 53

“Knowing Mohs” student handout on, 101
teacher’s lesson plan outline for, 97–101, 98–99
KWL Flip Book on Astronomy, 12, 12

Lab materials list, 259–263
“Lab Notebook Grade Record Sheet,” 8, 8
“Lab Notebook Grading Rubric,” 8, 313
Lab notebooks, 5, 6, 7, 13
  books used for, 7
  extra-credit points for, 8
  front cover of, 7, 311
  grading of, 8, 313
  graphs in, 8

page 1: Taxonomy of Science Words, 7, 7
page 2: Grade Record Sheet, 8, 8
page 3: Individual Lab Report, 8
  storage of, 8, 21
  student entries in, 2, 3, 33
  table of contents framework for, 7, 7
taking home, 8
“Lab Report Guidelines,” 6, 16, 312
Lab reports, 6
  framework for, 6
  grading of, 6, 21
  providing feedback on, 6
  student self-evaluation of, 6
“Landing on the Moon” student handout for, 76–77
teacher’s lesson plan outline for, 72–77, 74–75
“Layering Around on the Beach” student handout for, 210–211
teacher’s lesson plan outline for, 207–211, 209
Learning environment, 10
“Lining Up in Front” student handout for, 176–177, 177
teacher’s lesson plan outline for, 172–177, 174
Low albedo devices, 63–71, 66
Lucky Bucket Creation and Drawing, 9–10, 11
Lunar tides, 212–218, 214–215, 219

Materials list for labs, 259–263
Meteorology unit, 141–198
  “Dealing With Pressure,” 150–155, 153
  “Dewing Science,” 178–182, 179
  “Lining Up in Front,” 172–177, 174, 177
  “Sweating About Science,” 166–171, 167, 169
  syllabus for, 142
  “Watching the Weather,” 192–198, 195

Copyright © 2008 NSTA. All rights reserved. For more information, go to www.nsta.org/permissions.
“Wondering About Water,” 143, 143–149, 145–147
Metric system, 43–49
Mimio projectors, 5–6
Minerals, 278
density of, 91–96, 92–93
hardness of, 97–101, 98–99
periodic puns, 279–280
Misconceptions, 2, 2, 3
Modifications for special-needs students, 5, 7
Mohs’s hardness values, 97–101, 98–99
Molecules, 278
“Moodle,” 5
Moon landings, 72–77, 74–75
“Mounting Magna”
student handout for, 138–139
teacher’s lesson plan outline for, 133–139, 136
Multiple intelligences, 5, 274
“My Job/Your Job,” 10–11, 11

N
National Assessment of Educational Progress (NAEP), ix
National Science Education Standards, ix, xiii–iv, 3

O
Opportunities for applications of technologies, 5–6
Opportunities for differentiation, 2, 4–5
“Orbiting Snowballs”
student handout for, 81–83, 82
teacher’s lesson plan outline for, 78–83, 80
Organization of investigation lesson plans, 2–8, 3

P
Panel of Five game, 22, 269, 269–270
Periodic puns, 279–280
Periodic table of elements, 278
“Petals Around Roses,” 19, 20
“Phasing In Changes”
student handout for, 163–164, 165
teacher’s lesson plan outline for, 156–164, 157–158, 160
Physical oceanography unit, 199–257
“Barging Down the River,” 230–236, 233
“Diving Into the Depths,” 250–257, 251–254
“Layering Around on the Beach,” 207–211, 209
“Piling Up the Water,” 201–206, 203
“Sinking Film Canisters,” 220–228, 221–223, 227, 229
syllabus for, 200
“Toying With Buoyancy,” 237–242, 239, 243
“Toying With Density,” 244–249, 247
“Piling Up the Water”
student handout for, 205–206
teacher’s lesson plan outline for, 201–206, 203
Planet sizes, 37–42
Planetary albedos, 63–71, 66–68
Planetary compounds, 61–62
Planetary distances, 50–55, 53
Planner notes, 16–17
Poetry writing, 300–302
Posttest for Earth science, 304–307
“Predicting the Future,” 10, 264
Pretest for Earth Science Success, 10, 265–266, 265–267
Promethean Activboard, 5

R
Reading assignments, 17
Recall of prior knowledge, 2, 2, 3
“Reflecting on the Solar System”
student handout for, 70–71
teacher’s lesson plan outline for, 63–71, 66–68
Relative humidity, 166–171, 167, 169
Reporting results, 4. See also Lab reports
Respect, 10
Rocks, 102–108, 103–104, 278
ages of rock layers, 115–121, 117–118, 122

S
Safety rules, 10, 310
Sand, 123–126, 125
Science Experiment Project, 286–296
“Community Connection Assignment” for, 296
consumer science product ideas for, 293–295
due dates for, 288
multiple-choice verbal questions for audience, 292–293
parent explanation cover letter for, 286–287
presentation grading rubric for, 291
presentation poster for, 288–290
“Science Safety Rules,” 10, 310
Science trivia, 297–299
Scientific inquiry process, 2, 2, 13
SciLinks
Air Masses and Fronts, 171
Albedo, 64
Atmospheric Pressure, 151
Buoyancy, 220
Comets, 78
Composition of Rock, 102
Density of Water, 244
Earthquake Measurement, 128
Earthquakes, 128
Earth’s Moon, 73
Earth’s Structure, 128
Fluids and Pressure, 252
Geologic Time Scale, 103
How Have People Explored Space?, 85
Identifying Minerals, 91
Identifying Rocks, 102
Igneous Rock, 103
Inner Planets, 57
Layers of the Atmosphere, 159
Mass, 236
Mass and Volume, 236
Metamorphic Rock, 103
Metric System, 44
Outer Planets, 57
Phase Change, 159
Planets, 37
Properties of Ocean Water, 201
Properties of Water, 201
The Rock Cycle, 102
Sedimentary Rock, 103
Soil Types, 123
Solar System, 51
Tides, 211
Types of Volcanoes, 134
Volcanoes, 134
The Water Cycle, 144
Weather Forecasting, 193
Weather Maps, 184
Weather Patterns, 171
“Self-Evaluation Tool,” 6, 17, 314
“Shaking Things Up”
student handout for, 131–132
teacher’s lesson plan outline for, 127, 127–132, 130
“Sink a Sub” project, 2, 284–285
“Sinking Film Canisters”
student handout for, 225–228, 227, 229
teacher’s lesson plan outline for, 220–228, 221–223
“Sizing Up the Planets,” 18–22, 18–19, 22
student handout for, 41–42
teacher’s lesson plan outline for, 37–42, 39
SMART Board, 5
Solar system
albedos of objects in, 63–71, 66–68
distances within, 50–55, 53
Space travel, 84–87, 84–88
Special-needs students, 5, 7
Stalactites and stalagmites, 2, 275–276, 277
Start of school year, 9
Student assessment and procedural documents, 309
Student handouts, 2, 3, 6, 33
for “Barging Down the River,” 235–236
for “Becoming a Scientist,” 30–31
for “Changing Lunar Tides,” 217–218, 219
for “Classifying Rocks and Geologic Role,” 106–107, 108
for “Comparing Planetary Compounds,” 61–62
for “Dealing With Pressure,” 154–155
for “Deciphering a Weather Map,” 189, 190–191
for “Dewing Science,” 181–182
for “Diving Into the Depths,” 256–257
for “Drilling Through the Ages,” 120–121, 122
for “Estimating With Metrics,” 48–49
for “Hunting for Space Flight History,” 88
for “Hunting Through the Sand,” 125
for “Keeping Your Distance,” 54–55
for “Knowing Mohs,” 101
for “Landing on the Moon,” 76–77
for “Layering Around on the Beach,” 210–211
for “Lining Up in Front,” 176–177, 177
for “Mounting Magna,” 138–139
for “Orbiting Snowballs,” 81–83, 82
for “Phasing In Changes,” 163–164, 165
for “Piling Up the Water,” 205–206
for “Reflecting on the Solar System,” 70–71
for “Shaking Things Up,” 131–132
for “Sinking Film Canisters,” 225–228, 227, 229
for “Sizing Up the Planets,” 41–42
for “Sweating About Science,” 170–171
for “Toying With Buoyancy,” 241–242, 243
for “Toying With Density,” 248–249
for “Unearthing History,” 113–114
for “Watching the Weather,” 197–198
for “Weighing In on Minerals,” 95–96
for “Wondering About Water,” 148–149
“Student Lab Notebook Entries,” 2, 3
Student Response Systems, 15
Students
behavioral expectations for, 10–11
index card information for, 9
“Self-Evaluation Tool” for, 6, 17, 314
visits to science-related places, 303
“Sweating About Science”
student handout for, 170–171
teacher’s lesson plan outline for, 166–171, 167, 169

T
Taxonomy of Science Words, 7, 7
Teacher notes for statements, 308
Teacher’s lesson plan outlines, 2, 3, 4, 5, 32–33

“Barging Down the River,” 230–236, 233
“Becoming a Scientist,” 23–31, 28
“Classifying Rocks and Geologic Role,” 102–108, 103–104
“Dealing With Pressure,” 150–155, 153
“Dew Science,” 178–182, 179
“Diving Into the Depths,” 250–257, 251–254
“Drilling Through the Ages,” 115–121, 117–118, 122
“Hunting Through the Sand,” 123–126, 125
“Keeping Your Distance,” 50–55, 53
“Knowing Mohs,” 97–101, 98–99
“Landing on the Moon,” 72–77, 74–75
“Layering Around on the Beach,” 207–211, 209
“Lining Up in Front,” 172–177, 174, 177
“Mounting Magna,” 133–139, 136
“Orbiting Snowballs,” 78–83, 80, 82
organization of, 2–8, 3
“Piling Up the Water,” 201–206, 203
“Reflecting on the Solar System,” 63–71, 66–68
“Sinking Film Canisters,” 220–228, 221–223
“Sizing Up the Planets,” 37–42, 39
“Sweating About Science,” 166–171, 167, 169
“Toying With Buoyancy,” 237–242, 239
“Toying With Density,” 244–249, 247
“Unearthing History,” 109–114, 111–112
“Watching the Weather,” 192–198, 195
“Weighing In on Minerals,” 91–96, 92–93
“Wondering About Water,” 143, 143–149, 145–147
Technologies, 5–6
“The Legend of Orion the Hunter,” 22, 269, 271–273
Theory of Multiple Intelligences, 5, 274
Thinking About the Problem, 3–4
Tic-Tac-Know Options Board, 274, 274
Tides, 212–218, 214–215, 219
TIMSS (Trends in International Mathematics and Science Study), ix
“Toying With Buoyancy”
student handout for, 241–242, 243
teacher’s lesson plan outline for, 237–242, 239
“Toying With Density”
student handout for, 248–249
teacher’s lesson plan outline for, 244–249, 247
Trends in International Mathematics and Science Study (TIMSS), ix
Trivia questions, 297–299
U
“Unearthing History”
student handout for, 113–114
teacher’s lesson plan outline for, 109–114, 111–112
V
Vernier LabPro probe, 6
Visiting science-related places, 303
“Vocabulary of Geology Notes,” 278
Volcanoes, 133–139, 136
W
Warm and cold fronts, 172–177, 174, 177
“Watching the Weather”
student handout for, 197–198
teacher’s lesson plan outline for, 192–198, 195
Water
phase changes of, 156–164, 157–158, 160, 165
properties of, 201–206, 203
Water cycle, 143, 143–149, 145–147
Weather forecasting, 192–198, 195
Weather fronts, 172–177, 174
“Weather Instrument” project, 2, 281, 282
Weather maps, 183–189, 186–187, 190–191
Websites, collaborative, 5
“Weighing In on Minerals”
student handout for, 95–96
teacher’s lesson plan outline for, 91–96, 92–93
Whiteboards, 5
“Wiki,” 5
“Wondering About Water”
student handout for, 148–149
teacher’s lesson plan outline for, 143, 143–149, 145–147