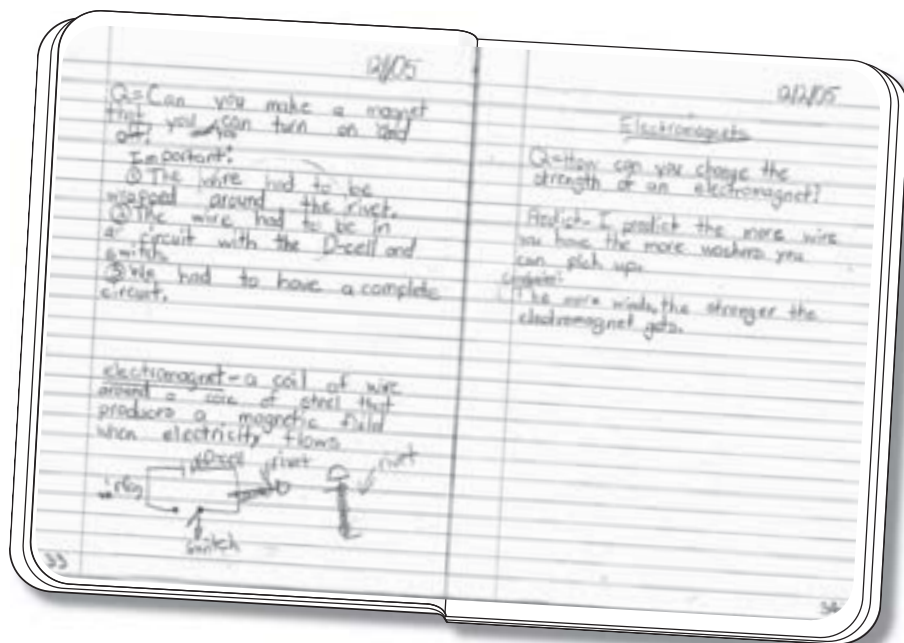


# SCIENCE NOTEBOOKS

Student notebook for  
Magnetism and Electricity  
Module



Science is an outlandishly large body of knowledge. Its domain is the natural world—the things in it, the principles that govern their behaviors, and the conceptual connective tissue that makes it all comprehensible. The process of acquiring this knowledge is complex and time-consuming. It involves observing objects, organisms, and systems; recording and organizing data; and transforming those data into ideas and models that explain how things work.

Scientists keep notebooks. The scientist’s notebook is a detailed record of his or her engagement with scientific phenomena. It is a personal representation of experiences, observations, and thinking—an integral part of the process of doing scientific work. A scientist’s notebook is a continuously updated history of the development of scientific knowledge and reasoning. FOSS students are young scientists; they are encouraged to incorporate a notebook into their science learning.

## SCIENCE NOTEBOOKS

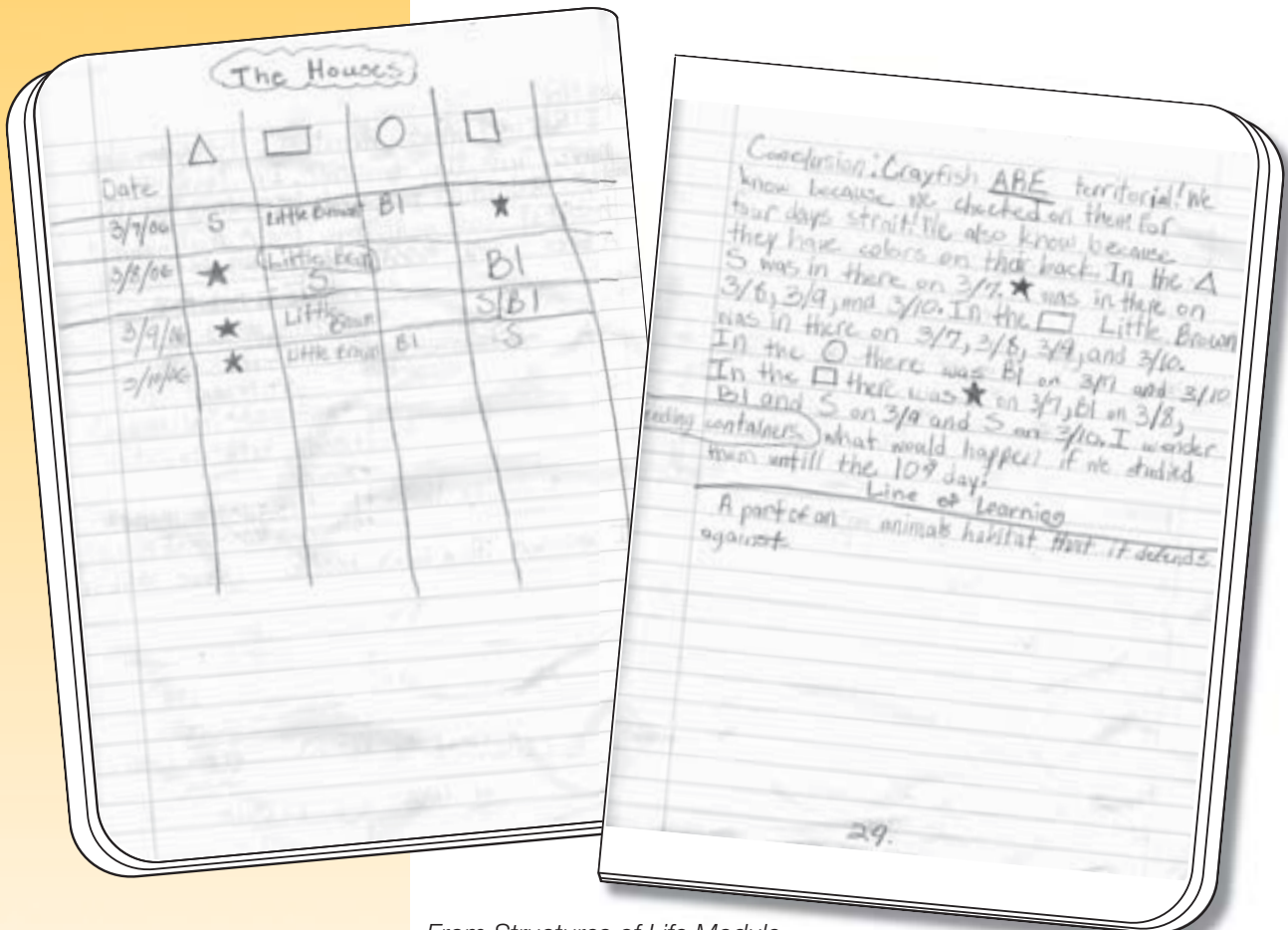
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## WHY INCORPORATE SCIENCE NOTEBOOKS INTO FOSS?

Engaging in active science is one part experience and two parts making sense of the experience. The science notebook helps students with the sense-making part. Notebooks provide two major benefits to students who are engaged in scientific inquiry: documentation and cognitive engagement.

### DOCUMENTATION: AN ORGANIZED RECORD

The science notebook centralizes the student's data. When data are displayed in functional ways, students can think about them more effectively. A well-kept notebook is a useful reference document. When students have forgotten a fact or relationship that they learned earlier in their studies, they can look it up. Learning to trust previous discoveries and knowledge structures is important.



From Structures of Life Module



## **BENEFITS TO STUDENTS**

At first, students will look at their science notebooks as little more than a collection of sheets. Each notebook sheet represents an isolated activity. In time, students will adopt a deeper understanding of the collection as an integrated record, even a story, of their learning. As students begin to use their notebooks as a personal reference text, they will value their own learning and come to rely on their own work as a source of information about science.

As students become more accomplished at keeping notebooks, their work will become better organized and efficient. Tables, graphs, charts, drawings, and labeled illustrations will become standard means for representing and displaying data. A complete and accurate record of learning allows students to reconstruct the sequence of learning events to “relive” the experience. Discussions about science between students, students and teachers, or students, teachers, and parents, have more meaning when they are supported by authentic documentation in the students’ notebooks. When students are asked to generate derivative products (summary reports, detailed explanations, posters, oral presentations, etc.) as evidence of learning, the process will be much more efficient when they have a coherent, detailed notebook for reference.

When students use their notebook as an integral part of their science studies, they think critically about their thinking. This reflective thinking can be encouraged by notebook entries that present opportunities for self-assessment. Self-assessment motivates students to rethink and restate their scientific understanding. Revising their notebook entries helps students clarify their understanding of the science concepts under investigation.

## **BENEFITS TO TEACHERS**

In FOSS the unit of instruction is the module—a sequence of conceptually related learning experiences that leads to a set of learning outcomes. A science notebook helps you think about and communicate the conceptual structure of the module you are teaching.

From the assessment point of view, a science notebook is a collection of student-generated artifacts that exhibit learning. You can informally assess student skills, such as using charts to record data, in real time while students are working with materials. At other times, you collect the notebooks and review them for insights or errors in conceptual understanding. The displays of data and analytical work provide a measure of the quality and quantity of student learning. But the notebook itself should not be graded. The student work can, however, be considered as one component of a student’s overall performance in science.

The science notebook provides an excellent medium for providing feedback to individual students regarding their work. Productive feedback calls for students to read the teacher comment, think about the issue raised by the comment, and act on it. The feedback may ask for clarification, an example, additional information, precise vocabulary, or review of previous work in the notebook. In this way, you can determine whether the problems with the student work relates to flawed understanding of the science content or a breakdown in communication.

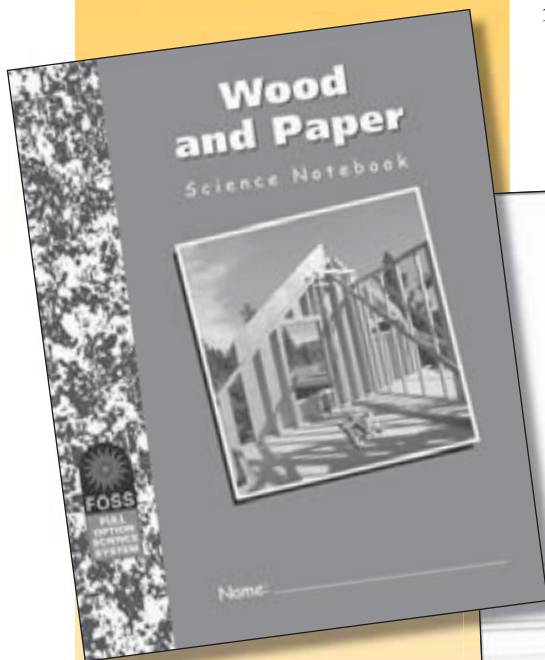
The student notebook also acts as a focal point for discussion about student learning at several levels. First, a student’s work can be the subject of a conversation between you and the student. By acting as a critical friend, you can call attention to ways a student can improve the notebook, and help him or her learn how to use the notebook as a reference source. The science notebook can also be reviewed and discussed during parent conferences. Science notebooks can be the focus of three-way discussions among students, teachers, and principals to ensure that all members of the school science community are in agreement concerning the kinds of student work that are valued and the level of performance that is expected. And science notebooks shared among teachers in a study group or other professional development environment can effectively demonstrate recording techniques, individual styles, various levels of quality work, and so on. Just as students can learn notebook strategies from one another, so too teachers can learn notebook skills from one another.

## SCIENCE NOTEBOOKS IN GRADES K–2

Students in grades K–2 can keep records of their science investigations in an age-appropriate science notebook. The format should be simple and the information meaningful to students. The record will include student drawings, simple writing in the form of individual words and short phrases, and a variety of visual and tactile artifacts inserted into the notebook. When students turn pages in their notebooks, they will be reminded of the objects and organisms they observed and their interactions with them.

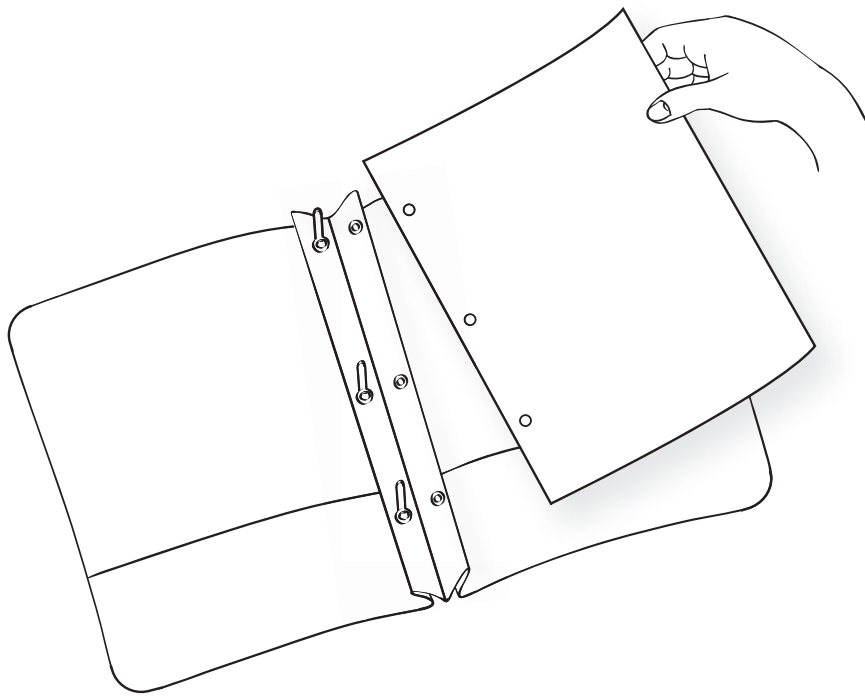
### FORMAT

Delta Education sells bound science notebooks in English and Spanish that are specific for each K–2 module. These consumable notebooks provide the most efficient, supportive approach to early-childhood notebook keeping.



*The 8.5" × 11" bound science notebook provides a high level of support for both teachers and students.*

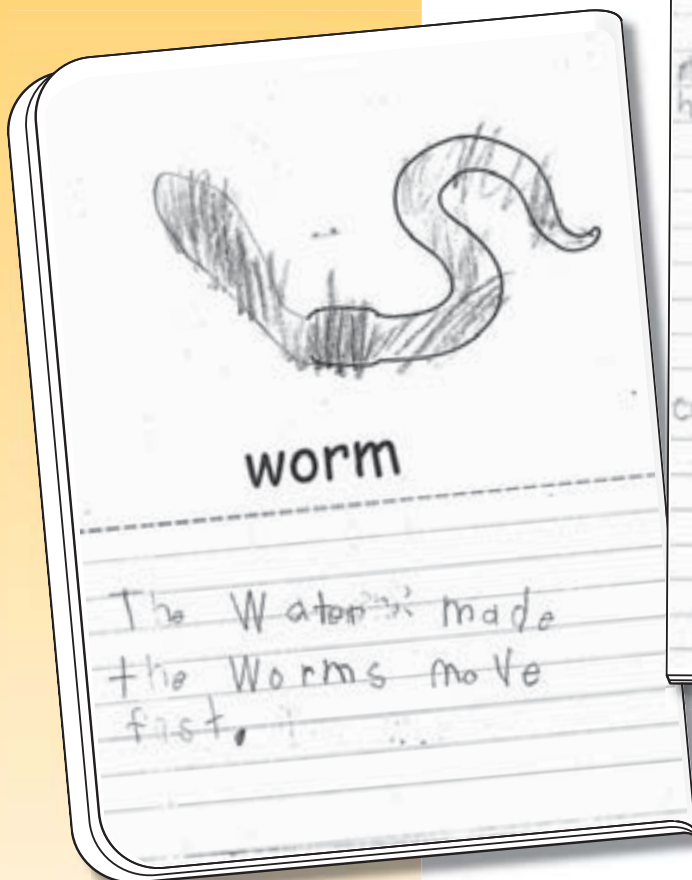
The FOSS K–2 teacher guides include duplication masters for the same science notebook sheets that are bound into the consumable notebooks. You can use these sheets to prepare an analogous notebook or to develop a customized version of your own design. Copies of the sheets can be assembled into student notebooks by three-hole punching them and inserting them into three-pronged report folders with pockets front and back. The pockets provide storage for cut-outs and paper models that form part of the record of learning. You can prepare science notebooks for each student in advance, build the notebooks as the module progresses, or make fewer notebooks to which a number of students contribute.



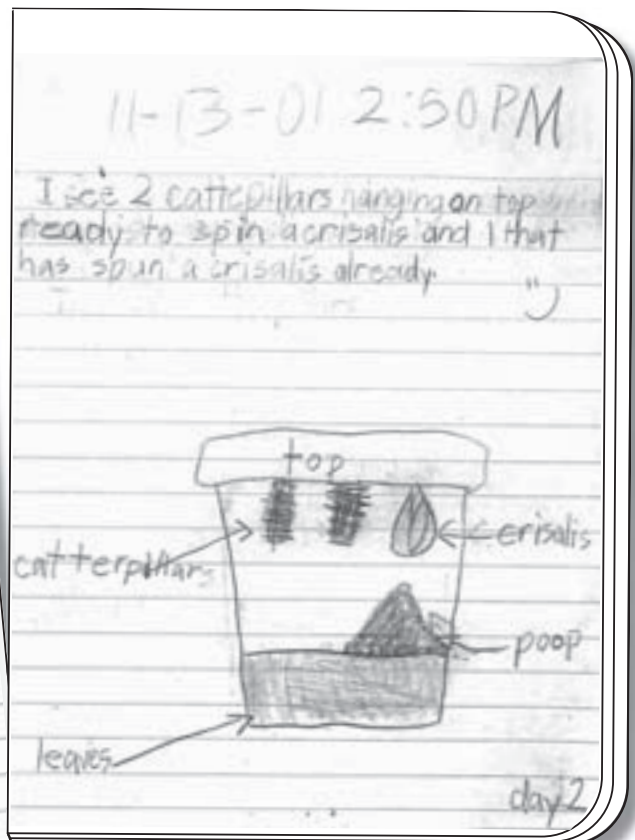
*A simple notebook made with blank paper and a pocket folder.*

### NOTEBOOK ENTRIES

The K-2 notebook typically has one or more sheets for each investigation. Students frequently respond to a focus question with a drawing or a simple written entry. Kindergartners may write single words; first and second graders will write simple observations and summary ideas, using their new vocabulary in their entries. Early-childhood students love to relive and describe their science experiences as they turn the pages in their notebooks. The pockets in the front and back covers can hold samples of materials made or used during the activities, such as representative aquarium components, model weather instruments, or mini-kites and pinwheels.



From Animals Two by Two Module




From Insects Module

From Pebbles, Sand, and Silt Module

From Balance and Motion Module

Timica 4-4-03  
Investigation 2: part 3: Sand and Silt.

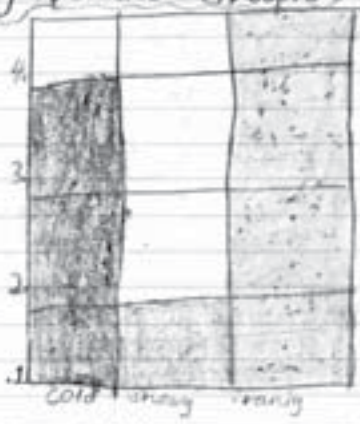
4-4-03 Sand and water	4-5-03
--------------------------	--------



3-6-06  
The twirly bird hit the <sup>water</sup> ground first. I think it hit the ground first because the paper clip on the bottom of it made it heavier so it went faster and made the top and bottom of it get a stable position.



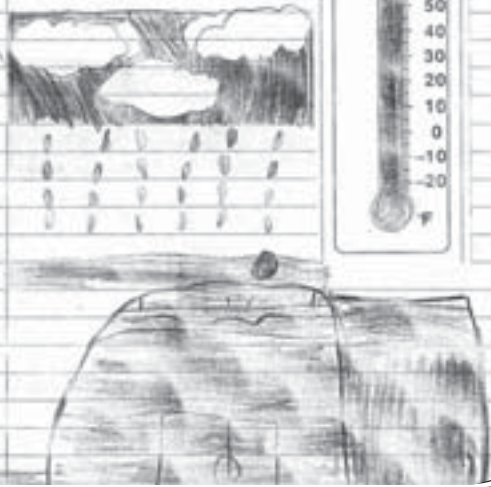
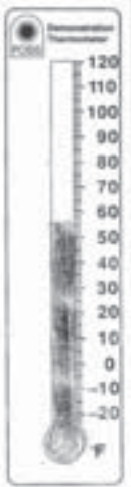
### My Weather Graph



Cold 3  
Snowy 1  
Rainy 4

1-25-02  
1:53 pm

Today is over cast & cloudy with showers.  
It is 55°  
There is no wind.  
It is calm.

From Air and Weather Module

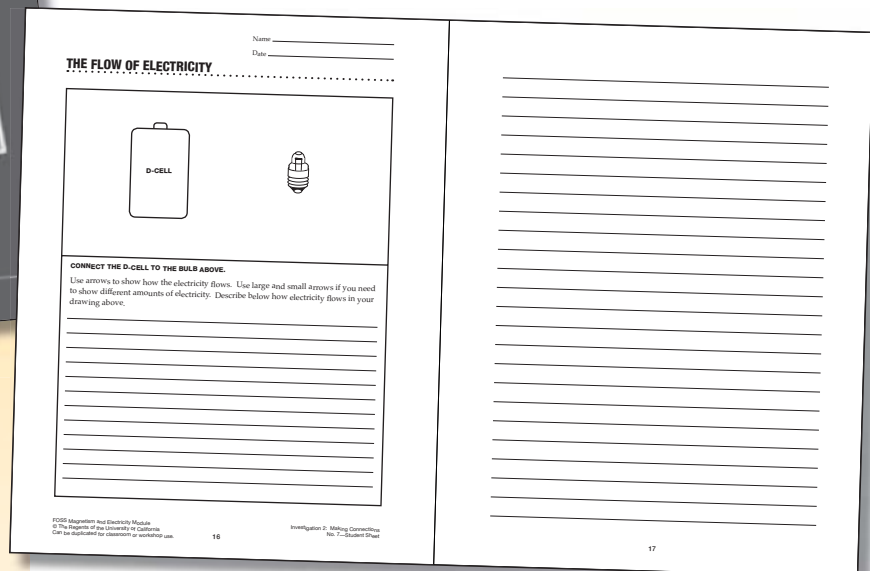
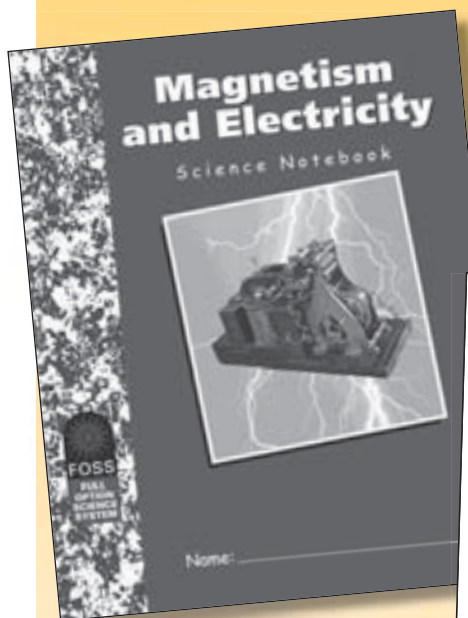
## SCIENCE NOTEBOOKS IN GRADES 3–6

Starting in grade 3, students are expected to make more detailed, thoughtful records of their science inquiries. Both teachers and students have to learn how to use science notebooks effectively. At first, use of the notebook will be stiff and mechanical, but in time, the notebook will be a natural extension of the science learning process, integrated smoothly with the other active-learning pedagogies.

### NOTEBOOK FORMAT

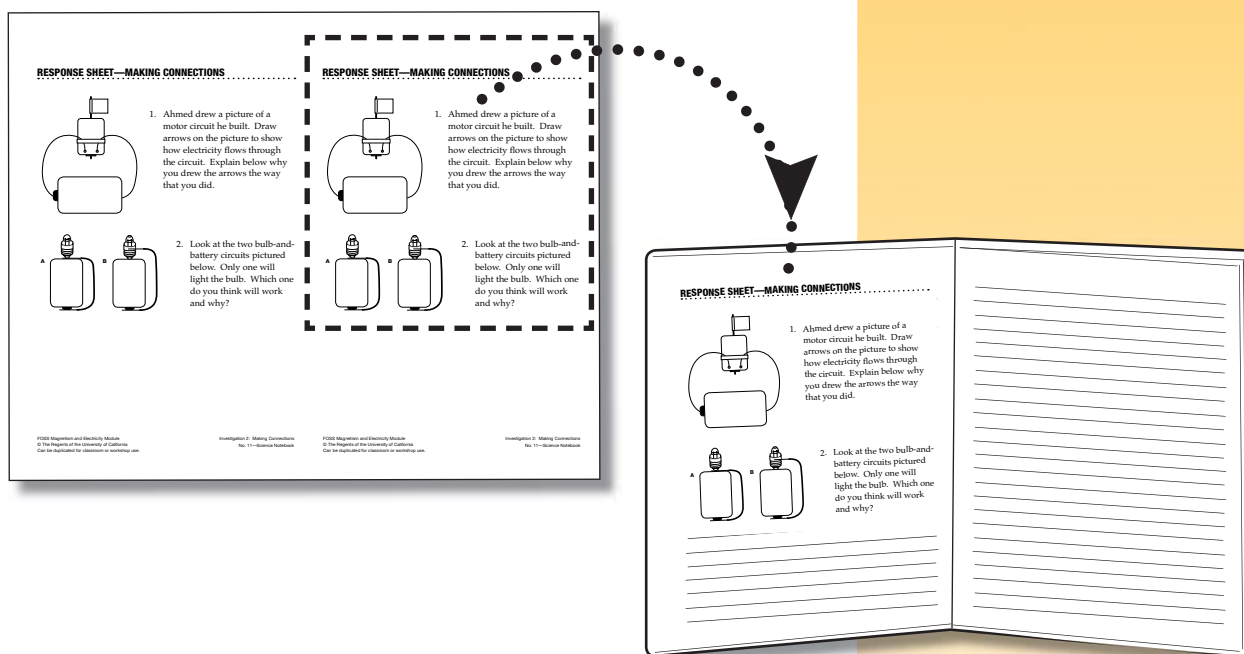
FOSS teacher guides include 8.5" × 11" investigation duplication masters, which are model science notebook sheets. You can photocopy and distribute these sheets to students as needed during the investigations. The questions, statements, graphic organizers, and space allocations provide guidance for students and scaffolding for teachers. When these student sheets are organized into a series, they constitute a highly structured precursor to a science notebook—the record of learning is documented, and the student has a body of work that can act as a reference text.

To make it easy to implement this kind of student notebook, Delta Education sells printed science notebooks in English or Spanish for all FOSS 3–6 modules. Each notebook is a bound set of the student sheets for the module plus a table of contents in front; extra blank sheets throughout the notebook for students to write focus or inquiry questions, record and organize data, and write summaries; and blank pages at the end to develop an index or glossary of science vocabulary words and phrases.



A first step toward an autonomous science notebook involves using reduced versions of the FOSS student sheets and an 8" × 10" bound composition book. In this format, you choose which sheets to duplicate, reduce them to fit side-by-side on a standard sheet of paper, and make copies accordingly. (You can download reduced-format sheets for all 3–6 modules from the FOSSweb.com website.) Students glue or tape the reduced sheets into their notebook. The sheet is fixed to the left page of a spread, leaving the right page for student writing, drawing, and other documentation. This model is often found to be the most efficient means for obtaining the most productive work from elementary students.

In an autonomous approach, students are responsible for creating their entire science notebook from blank pages in a bound composition book. Experienced students determine when to use their notebook, how to organize space, what methods of documentation to use, and how to flag important information. This level of notebook use will not be realized quickly; it will likely require systematic development by an entire teaching staff over several years.



*Photocopy the duplication master for the reduced notebook sheet, cut the two sheets apart, and give one to each student. Students use glue or tape to stick the sheet to the left-hand page in their composition books. The right-hand page is for additional writing.*

### **OWNERSHIP**

A student's science notebook can be personal or public. If the notebook is personal, the student decides how accessible his or her work is to other students. If ownership falls at the opposite extreme, everything is public, and anyone can look at the contents of anyone else's notebook at any time. In practice, most classroom cultures establish a middle ground in which a student's notebook is substantially personal, but the teacher claims free access to the student work and can request that students share notebooks with each other and the whole class from time to time.

### **RULES OF ENGAGEMENT**

Related to ownership are rules of engagement, which establish the conventions students will honor in their notebook entries. Issues of spelling, grammar, punctuation, neatness, and organization can be spontaneous at one extreme, or reviewed and corrected at the other extreme. Typically, the rules of grammar and spelling are fairly relaxed so as not to inhibit the flow of creative expression during notebook entry. When students generate products such as reports from information in the notebook, you might require more rigorous language arts conventions.

In addition to language entries, students should be encouraged to use a wide range of other means of recording and communication, including charts, graphs, drawings, graphics, color codes, numbers, and images attached to the notebook pages. By expanding the options for making notebook entries, each student will find his or her most efficient, expressive way to capture and organize information for later retrieval.

## NOTEBOOK ORGANIZATION IN GRADES 3–6

This section describes the nuts and bolts of introducing science notebooks into your standard science teaching practice. These techniques and suggestions represent methods that successful FOSS teachers have found to be effective, and that the FOSS developers agree have merit in FOSS classrooms. No one teacher will implement all the suggestions all the time, but the general topics represented by the subheads should be incorporated into everyone's notebook practice.

Four organizational components of the notebook should be planned right from the outset.

- A table of contents
- Page numbering
- Documentation
- Glossary / index

If a consumable FOSS science notebook is used, these features have been planned for or implemented already. No setup is required beyond a short orientation discussion with students to point out where these features are in the notebook.

**Table of Contents.** Students should reserve the first two pages of their notebook for the table of contents. Students will add to it systematically as you proceed through the module. The table of contents can be organized based on the names of the investigations in the module, the specific activities undertaken, the concepts learned, or some other schema that makes sense to everyone.

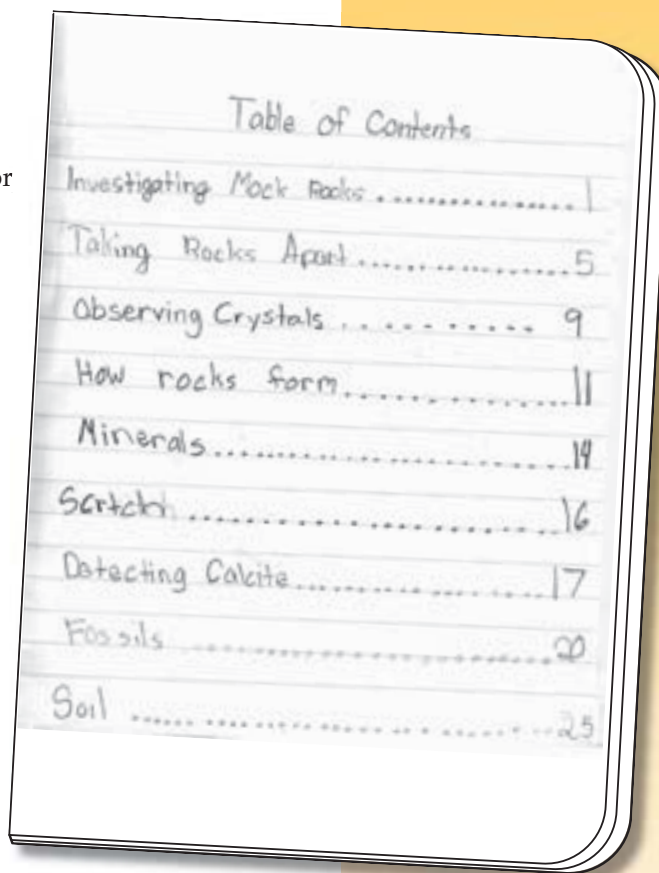
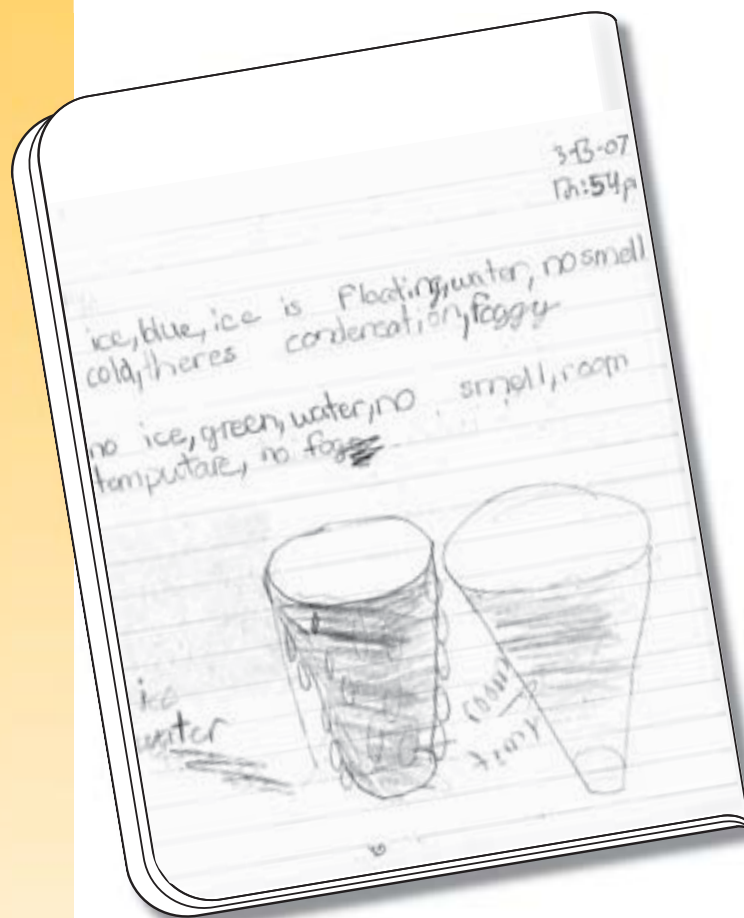


Table of Contents	
Investigating Mock Rocks .....	1
Taking Rocks Apart .....	5
Observing Crystals .....	9
How rocks form .....	11
Minerals .....	14
Scratch .....	16
Detecting Calcite .....	17
Fossils .....	20
Soil .....	25

*From Earth Materials Module*

**Page Numbering.** Each page should have a number. These can be applied to the pages and referenced in the table of contents as the notebook progresses, or small blocks can be prenumbered (pages 1–15 initially; pages 16–30 later, and so on) at appropriate times in the module.

**Documentation.** Each time a new entry is made, students should record certain information. At the very minimum, they should record the date. More complete documentation might include the time, day of the week, team members, and if appropriate, weather conditions. Some teachers start each new entry at the top of the next available page. Others simply leave a modest space and apply the documentation information right before the new entry.



*From Water Module*

**Glossary/Index.** Scientific academic language is important. We strive to have students use precise, accurate vocabulary at all times in their writing and conversations. To assist with acquisition of the scientific vocabulary, students should set up a glossary or index at the end of their notebook. It is not usually possible for students to enter the words in alphabetical order, as they will be acquired as the module advances. Instead, you could assign a block of letters to each of several glossary pages (A–E, F–K, etc.); students can enter and relocate words and their definitions easily. As an alternative, students could use a single page blocked out in 24 squares, and assign one or more letters to each square (see below). Students write the new vocabulary word or phrase in the appropriate square and tag it with the page number on which the word is defined in the body of the notebook.



*From Earth Materials Module*

## NOTEBOOK ENTRIES—THE BIG PICTURE

A few large organizational structures, or phases, give the science notebook conceptual shape and direction. These structures don't prescribe a step-by-step procedure for how to prepare the notebook, but they do provide some overall guidance. The general arc of an investigation starts with a question or challenge, and then proceeds with an activity, data acquisition, and sense making. The science notebook should record important observations and thoughts along the way. It may be useful to keep these four phases in mind as you systematically guide students through their notebook entries.

- Planning the investigation
- Data acquisition and organization
- Making sense of data
- Reflection and self-assessment

**Planning the Investigation.** Typically, at the start of a new activity, the first notebook entry is a **focus question**, which students transcribe into their notebooks. The focus question establishes the direction and conceptual challenge for the investigation. For instance, when students investigate evaporation in the Water Module, they might start by writing

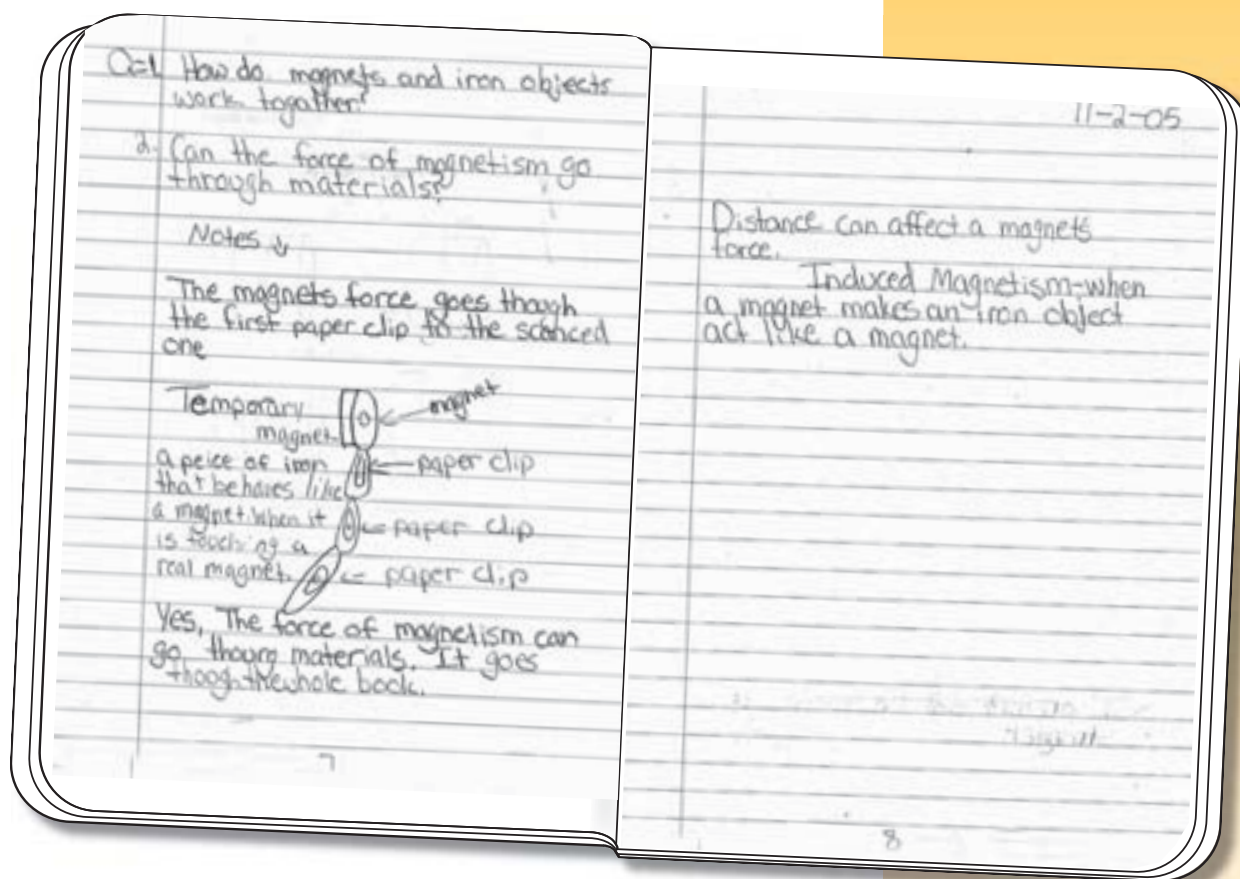
- *What conditions cause water to evaporate fastest?*

The focus question determines the kinds of data to be collected and the procedures that will yield those data. Students then formulate a plan or procedure, formally or informally, for engaging the focus question. The goal of the plan is to obtain a satisfactory answer to the focus question. The inquiry questions in the At a Glance charts on pages 2 and 3 of each K–6 investigation folio in the teacher guide are a good source for focus questions.

**Data Acquisition and Organization.** The second phase of an investigation focuses on data. Data can be acquired as a result of carefully planned experiments, random observations during a free exploration, or accidental discoveries. It doesn't matter what process produces the data: the critically important point is that data are obtained. Once obtained, it may be necessary to reorganize and display the data for efficient analysis. The data display is key to making sense of the science inquiry experience.

**Making Sense of Data.** The third phase of an investigation involves analysis of the data to learn something about the natural world. At this time students write explanatory statements that answer the focus question. You can formalize this procedure by asking students to answer the focus question using an established protocol, such as “claims and evidence” (discussed on page 27), or the explanation can be purely a creative effort by each student. The student explanations may be incorrect or incomplete at this point, but this can be remedied during the final phase of the notebook entry.

**Reflection and Self-assessment.** The final phase of an investigation brings students back to their notebooks after engaging in self-assessment and reflection (discussed on page 28). This process is the capstone on a purposeful series of experiences designed to guide students to understanding of the concept originally presented in the focus question.



From Magnetism and Electricity Module

## NOTEBOOK ENTRIES—THE SPECIFICS

This section revisits the four phases of the notebook-entry cycle, providing brief descriptions of several strategies teachers have used successfully with their students.

### PLANNING THE INVESTIGATION

Each new investigation should start with a focus question or challenge. This can be written on the board for students to transcribe into their notebooks, or prepared photocopied strips of the focus question can be taped or glued into the notebook. Some teachers look ahead, write all the focus questions on one sheet of paper, copy the sheets, and cut the question apart using a paper cutter. The focus-question strips are distributed as needed.

After the question is entered, students plan their investigation. The planning may be detailed or informal, depending on the requirement of the investigation. Some of the classes of planning include

- Narrative plans
- Lists (including materials, things to remember)
- Step-by-step procedures

**Narrative Plans.** After posing a focus question, we often ask students for their ideas about how they will engage the question. For instance, the focus question that sets up a free exploration of crayfish might be

- *What do crayfish do when they are removed from water for a short time?*

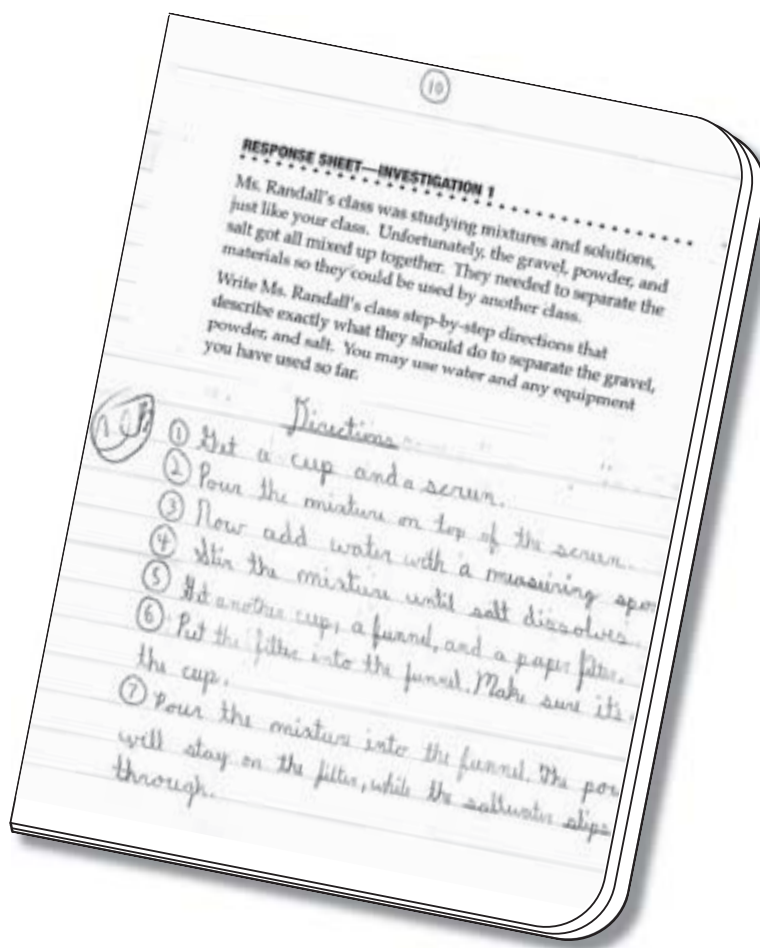
As students think about this question and formulate a plan, a short narrative description of their general approach may be what is called for. The narrative helps students consider the options available to them, and reminds them of the limits and considerations when working with living organisms.

**Lists.** Science notebooks often include lists of things to think about, materials to get, or words to remember. A materials list is a good advanced organizer, helping students anticipate actions they will take. A list of variables to be controlled clarifies the purpose of an experiment. Simple lists of dates when observations are to be made, or the people responsible for completing a given task, keep information readily available. And lists of new vocabulary words in the form of a word bank or glossary serve to reinforce and contextualize new words and organize them for easy reference in the future.

**Step-by-Step Procedures.** Some work with materials requires structured planning. When students start an investigation in the Mixtures and Solutions Module with the focus question

- *How can you separate a mixture of salt, powder, and gravel?*

they need to recall what they know about the individual materials, and develop a strategy for separating them. An appropriate convention for recording a sequential procedure is a numbered step-by-step plan. Once students have recorded the procedure in the science notebook, they can use it as a reference during the hands-on investigation. And to check the procedure for errors or omissions, students can trade notebooks and attempt to follow other students' instructions to complete the task.



From Mixtures and Solutions Module

## DATA ACQUISITION AND ORGANIZATION

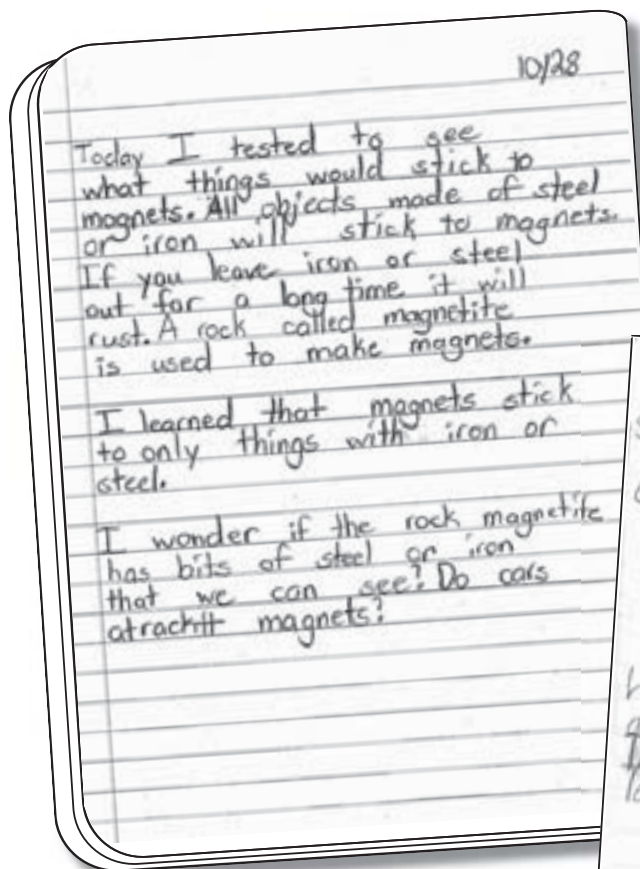
Data are the factual bits of information (observations) from which scientists construct ideas about the structure and behaviors of the natural world. Because observation is the starting point for answering the focus question, data records should be

- Clearly related to the focus question
- Accurate and precise
- Organized for efficient reference

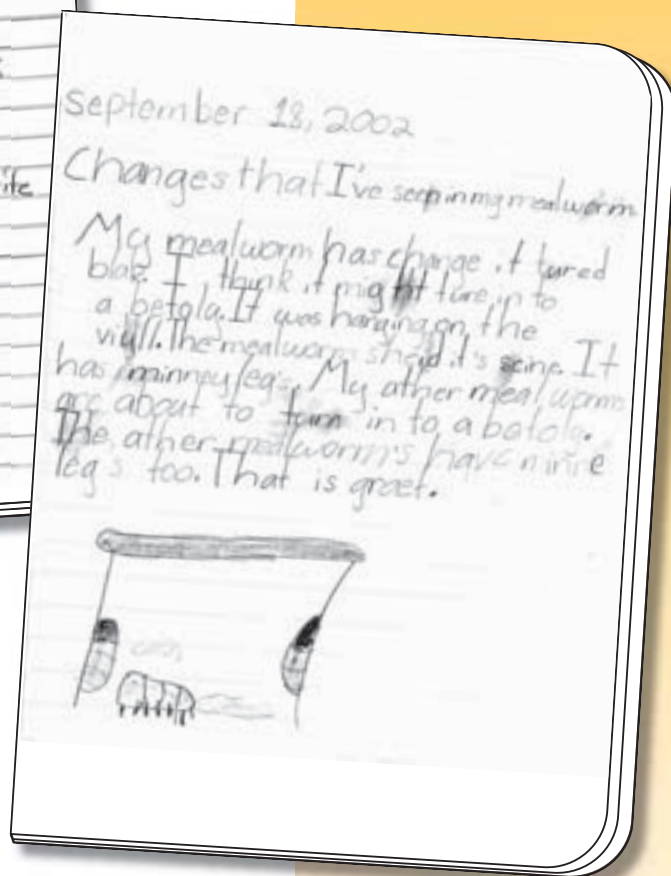
Data handling can have two phases: data acquisition and data display. Data acquisition is making observations and recording data. The data record can be composed of words, phrases, numbers, and/or drawings. Data display is reorganizing the data in a logical way to facilitate thinking. The display can take the form of a graph, Venn diagram, calendar, or other graphic organizer. Early in a student's experience with notebooks, the record may be disorganized and incomplete, and the display may need guidance. With practice, however, students will be skilled at determining what form of recording to use in various situations, and how best to display the data for analysis. Data display may take the form of

- Narratives
- Drawings
- Charts and tables (correlated data)
- Artifacts
- Graphs and graphics

**Narratives.** The most intuitive approach to recording data for most students is narrative—using words, sentence fragments, and numbers in a more or less sequential manner. As students make a new observation, they record it below the previous entry, followed by the next observation, and so on. Some observations, such as a record of the movements and interactions of a snail over time or the changes observed in a mealworm, are appropriately recorded in narrative form.

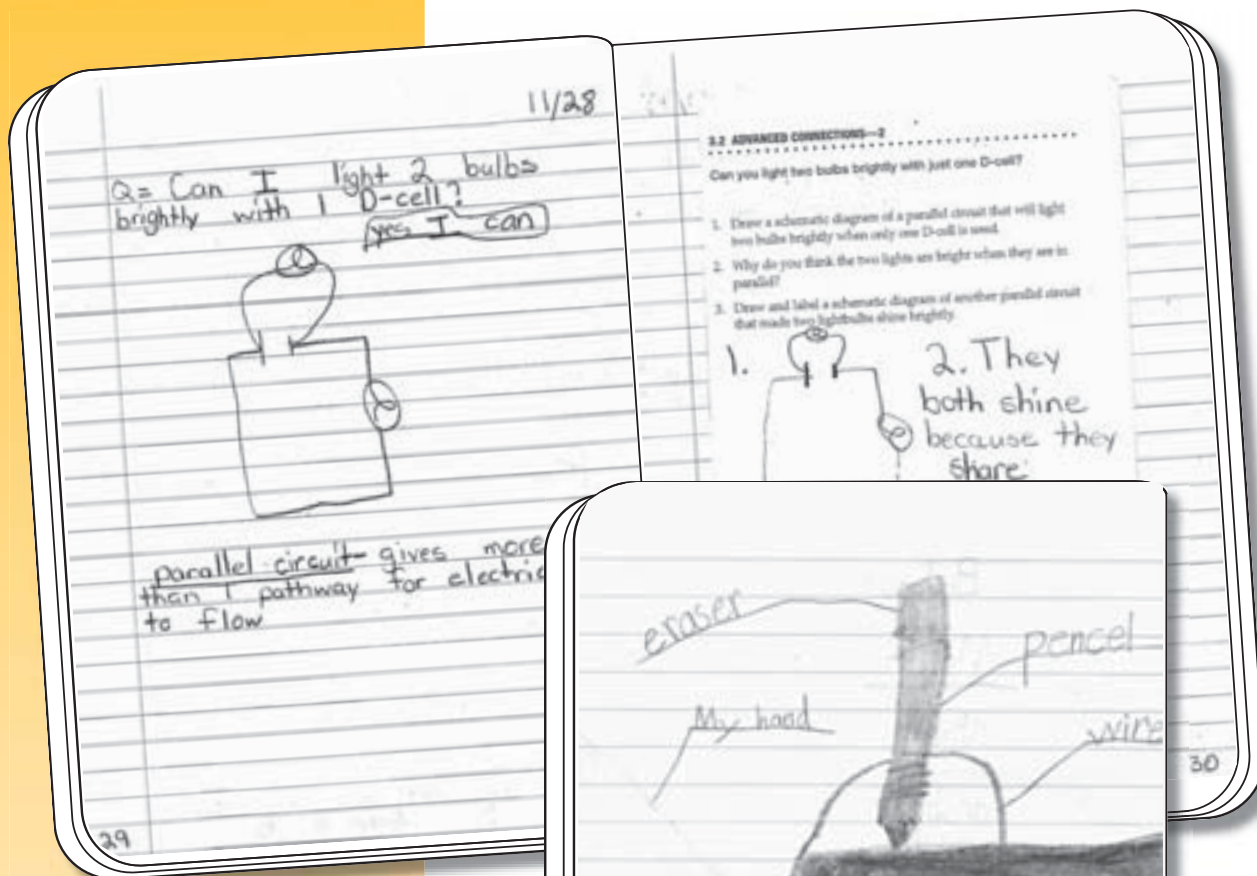


From Magnetism and Electricity Module



From Insects Module

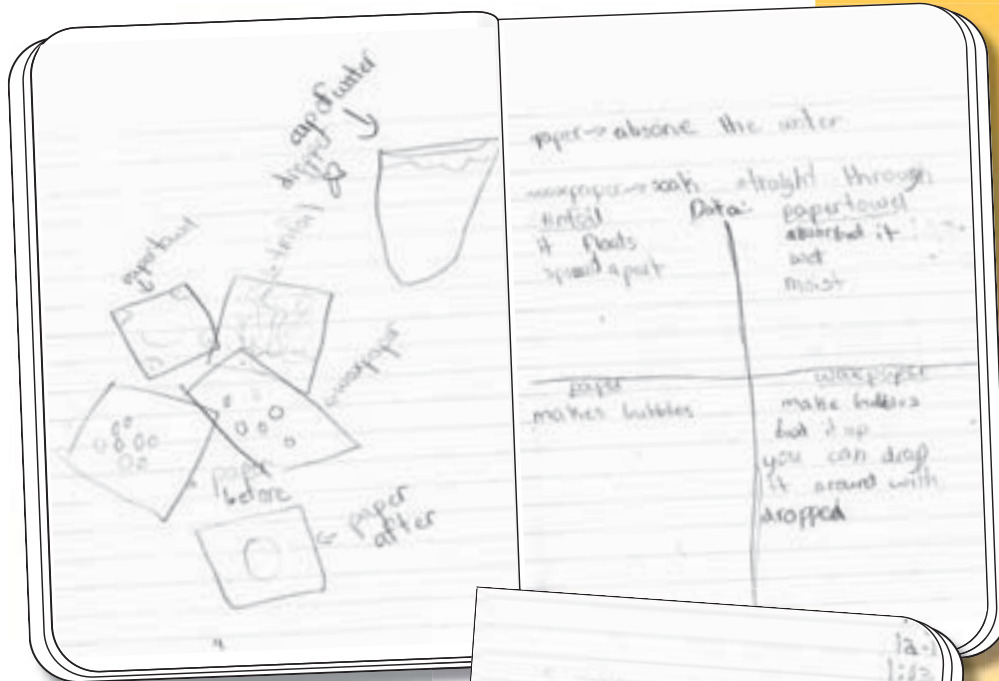
**Drawings.** When students observe the shape and distribution of crystals after evaporation, or observe and identify the parts of a system, a labeled illustration is the most efficient way to record data. A picture is worth a thousand words, and a labeled picture is even more useful.



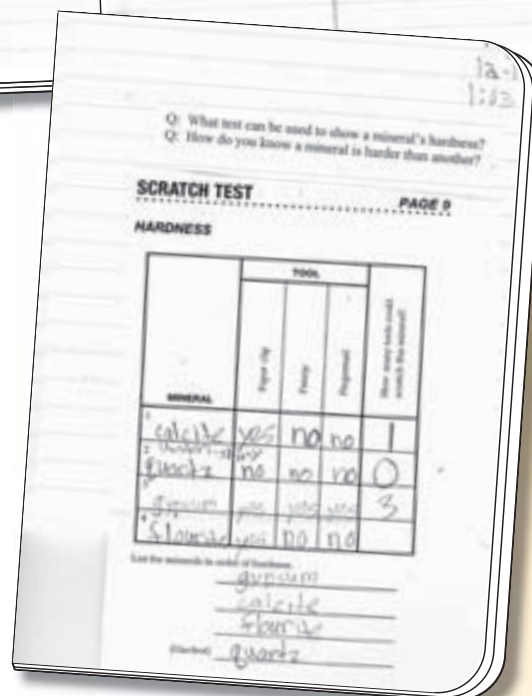
From Magnetism and Electricity Module

From Balance and Motion Module

**Charts and Tables.** With experience, students will recognize when a table or chart is appropriate for recording data. When students make similar observations on a series of objects, such as a set of minerals or powdered substances, a table with columns is efficient. The two-dimensional chart makes it easy to compare the properties of all the objects under investigation. Similarly, when students conduct an experiment, they can record data directly into a T-table. They can transform the table, presented in ordered pairs, into a graph with little effort.

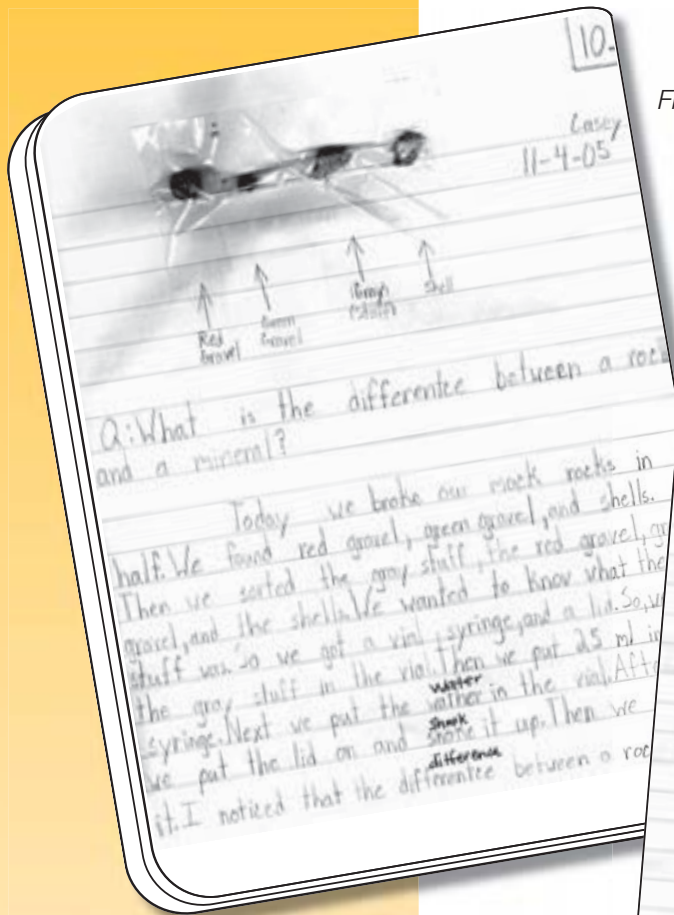


*From Water Module*

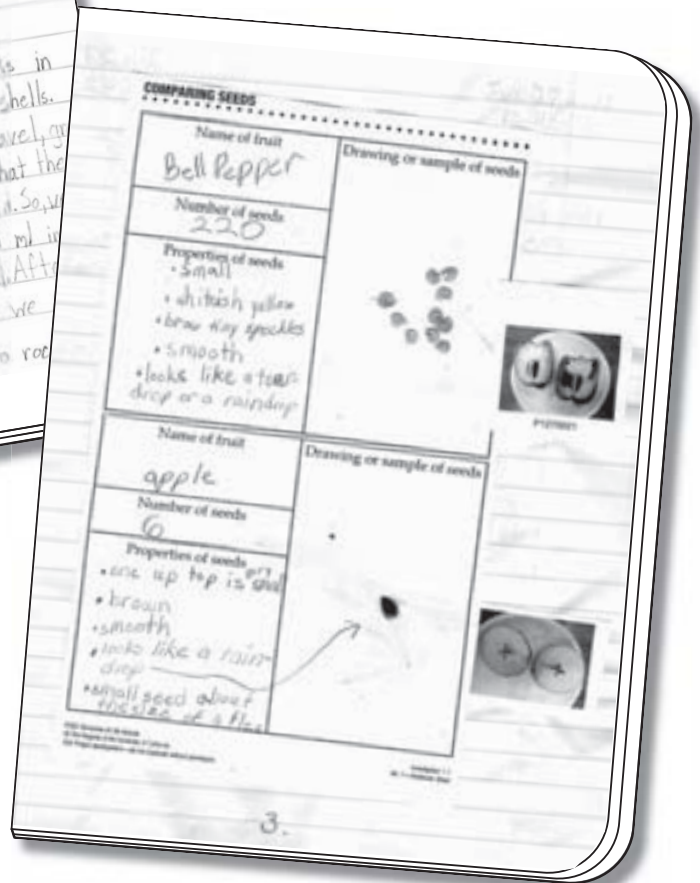


*From Earth Materials Module*

**Artifacts.** Occasionally the results of an investigation produce two-dimensional products, which students can tape or glue directly into a science notebook. Chromatography results, rubbings, disassembled fabrics, sand, minerals, seeds, and so on, can become a permanent part of the record of learning.



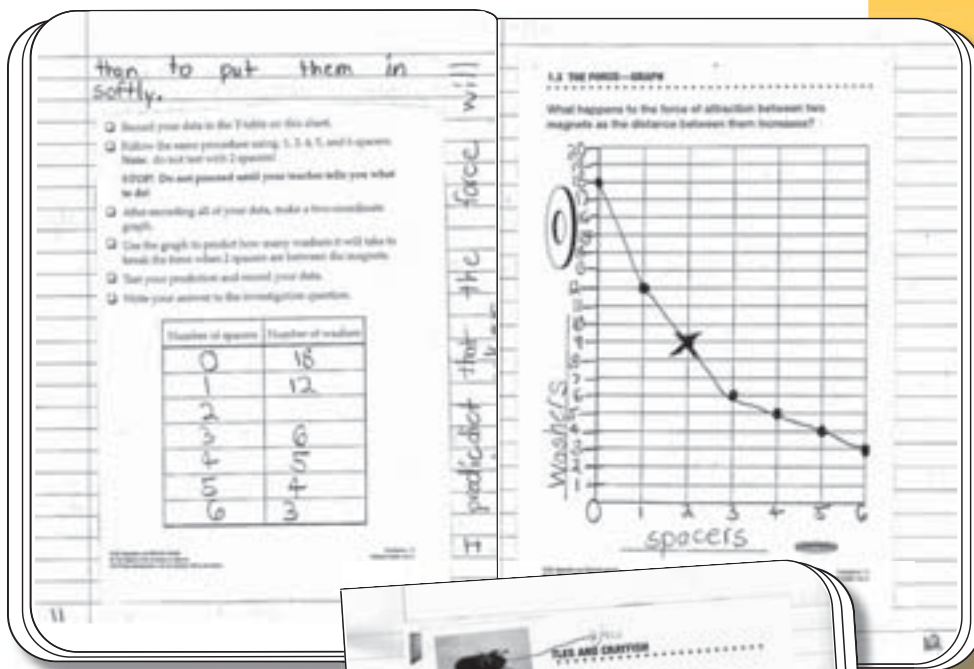
From Earth Materials Module



From Structures of Life Module

**Graphs and Graphics.** Reorganizing data into a logical, easy-to-use graphic is actually the first phase of data analysis. Graphs allow easy comparison (bar graph), quick statistical analysis of numerical data (histogram), and visual confirmation of a relationship between variables (two-coordinate graph). Additional graphic tools, such as Venn diagrams, concept maps, food chains, and life cycles, help students make connections between data accrued during investigations.

*From Magnetism and Electricity Module*



then to put them in softly.

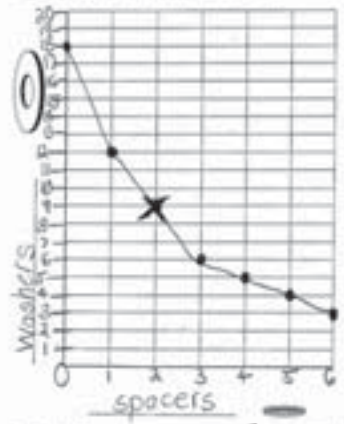
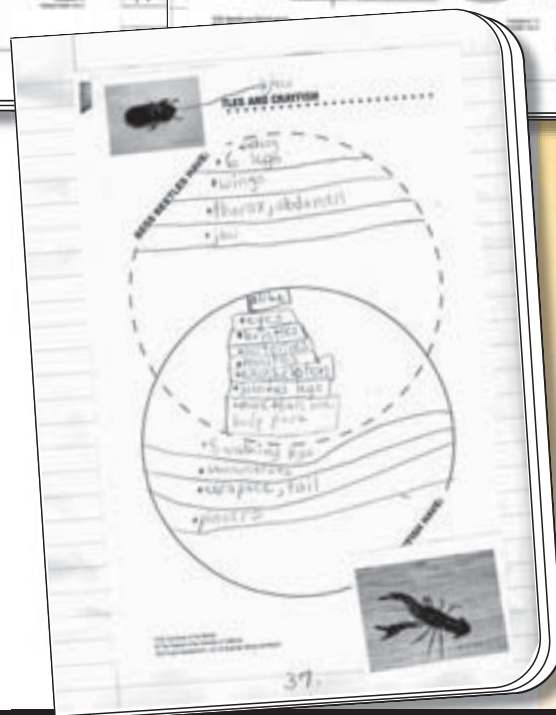
- Record your data in the T table on this chart.
- Follow the same procedure using 1, 3, 4, 5, and 6 spacers. Never do not test with 2 spacers!
- STOP! Do not proceed until your teacher tells you what to do!
- After recording all of your data, make a two-coordinate graph.
- Use the graph to predict how many washers it will take to break the force when 2 spacers are between the magnets.
- Test your prediction and record your data.
- Write your answer to the investigation question.

Number of spacers	Number of washers
0	18
1	12
2	6
3	4
4	3
5	2
6	1

I predict that the force will

1.1 THE FORCE-GRAPH

What happens to the force of attraction between two magnets as the distance between them increases?

FLY AND CRAWLER

- 6 legs
- Wings
- Hard exoskeleton
- Antennae
- Head
- Thorax
- Abdomen
- Malpighian tubules
- Body pore
- Waxing eye
- Antennae
- Malpighian tubule
- Joint

37

*From Structures of Life Module*

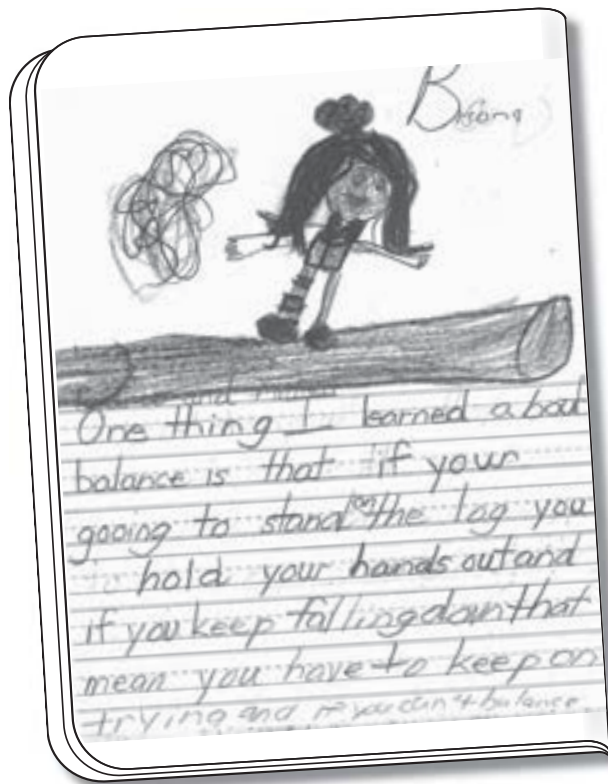
## MAKING SENSE OF DATA

The student's next job is to think about the data and the focus question together to come up with an answer to the question. Students can generate an explanation as an unassisted narrative, but in many instances you can use supports to guide the development of a coherent and complete response to the question. Samples of assistive structures include

- Frames and prompts
- Claims and evidence
- Conclusions and predictions
- I wonder...

**Frames and Prompts.** One way to get students to organize their thinking is by providing sentence starters, or frames, for them to complete.

- *I used to think...but now I think...*
- *The most important thing to remember about evaporation is...*
- *One thing I learned about...*

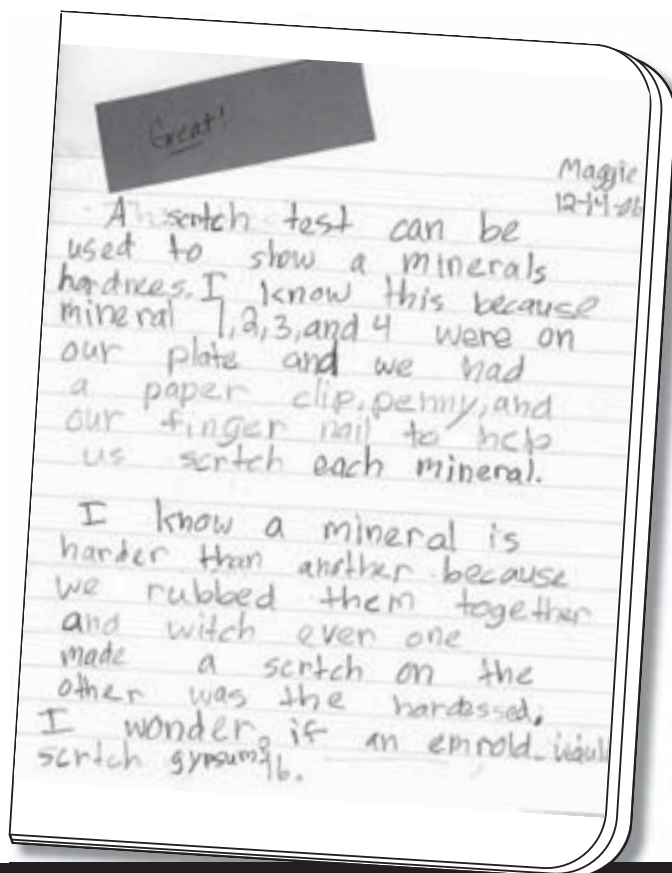


*From Balance and Motion Module*

Prompts also direct students to the content they should be thinking about, but provide students more latitude for generating responses. The prompts used most often in the prepared FOSS science notebook sheets take the form of questions for students to answer. Examples of questions that guide student thinking include

- How can you use a bulb, wire, and battery to light a bulb?
- What is the best way to heat 100 mL of water using solar energy?
- What is the best concentration of salt for hatching brine shrimp?  
Why do you think so?

**Claims and Evidence.** A claim is an assertion about how the natural world works. A student might claim, for instance, that metals stick to magnets. For the claim to be valid and accurate, it must be supported by evidence—statements that are directly correlated with data. The evidence should refer to specific observations, relationships that are displayed in graphs, tables of data that show trends or patterns, dates, measurements, and so on. A claims-and-evidence construction is a sophisticated, rich display of student learning and thinking.



From Earth Materials Module

**Conclusions and Predictions.** At the end of an investigation (major conceptual sequence), it may be appropriate for students to generate a summarizing narrative to succinctly communicate what they have learned. When appropriate, this is where students can make predictions based on their understanding of a principle or relationship. For instance, after completing the investigation on evaporation, a student might predict the order in which the water will completely evaporate from various containers, based on surface area exposed to air. Or a student might predict how long to make a pendulum to produce a second timer. The prediction will frequently indicate the degree to which a student can apply the new knowledge to real-world situations. And a prediction can be the spring board for further inquiry by the class or individual students.

**I wonder...** Does the investigation connect to a student's personal interests? Or does the outcome suggest a question or pique a student's curiosity? The notebook is an excellent place to capture students' musings and record thoughts that might otherwise be lost.

### **REFLECTION AND SELF-ASSESSMENT**

The goal of the FOSS curriculum is for students to develop accurate, durable knowledge of the science content under investigation. Students' initial conceptions are frequently incomplete or confused, requiring additional thought to become fully functional. Use the science notebook to guide reflection and revision.

Typically students commit their understanding in writing in three locations.

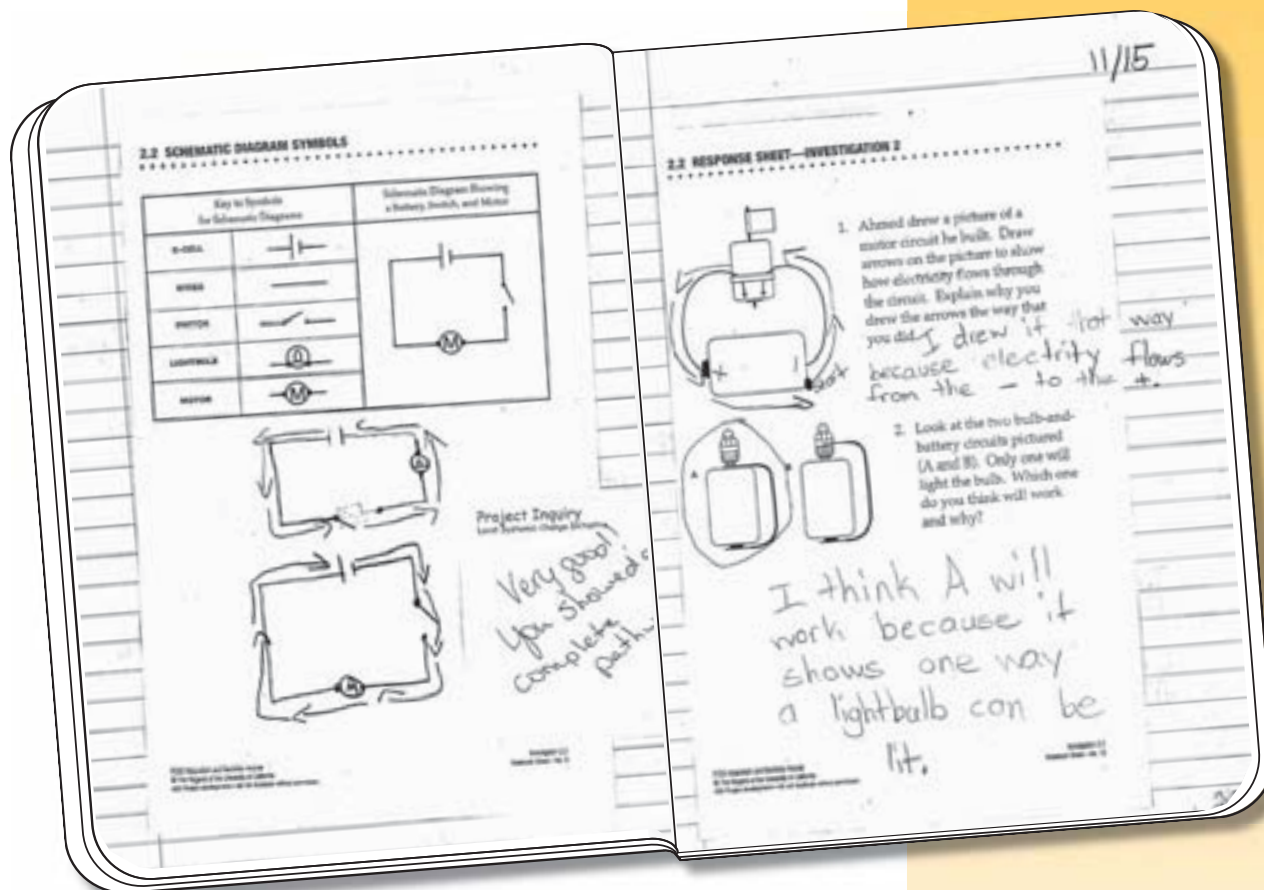
- Explanatory narratives in notebooks (claims and evidence; conclusions)
- Response sheets incorporated into the notebook
- Written work on benchmark assessments (available from Delta Education)

These three categories of written work provide information about student learning to you *and* a record of thinking that students can reflect on and revise. Elements of this reflective process may include

- Teacher feedback
- Self-assessment
- Line of learning

**Teacher Feedback.** Student written work often exposes weaknesses in student understanding—or so it appears. But it is important for you to know for sure if the flaw is the result of poor understanding of the science or imprecise communication. You can use the notebook to provide feedback to the student asking for clarification or additional information. Jot a note directly in the notebook, or attach a self-stick note, which can be removed after the student has taken appropriate action.

- You claim that water condensed on the glass of ice water. Where did the water come from?
- Tell me why you think lightbulb A will light. Hint: Check the contact points on the two lightbulbs.



From Magnetism and Electricity Module

The most effective forms of feedback relate to the content of the work. Non-specific feedback, such as stars, smiley faces, and “good job!” and ambiguous critiques, such as “try again,” “put more thought into this,” and “not enough” are less effective. Feedback that guides students to think about the content of their work and gives suggestions for how to improve are productive instructional strategies. Some generic feedback comments include

- Use the science vocabulary in your answer.
- Include an example to support your ideas.
- Include more detail about...
- Check your data to make sure this is right.
- Include units with your measurements.

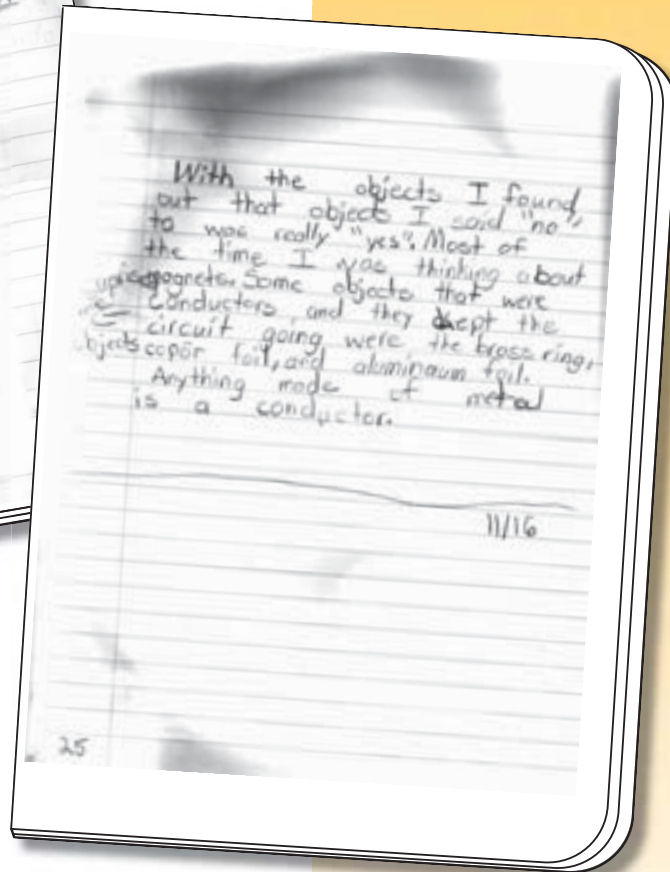
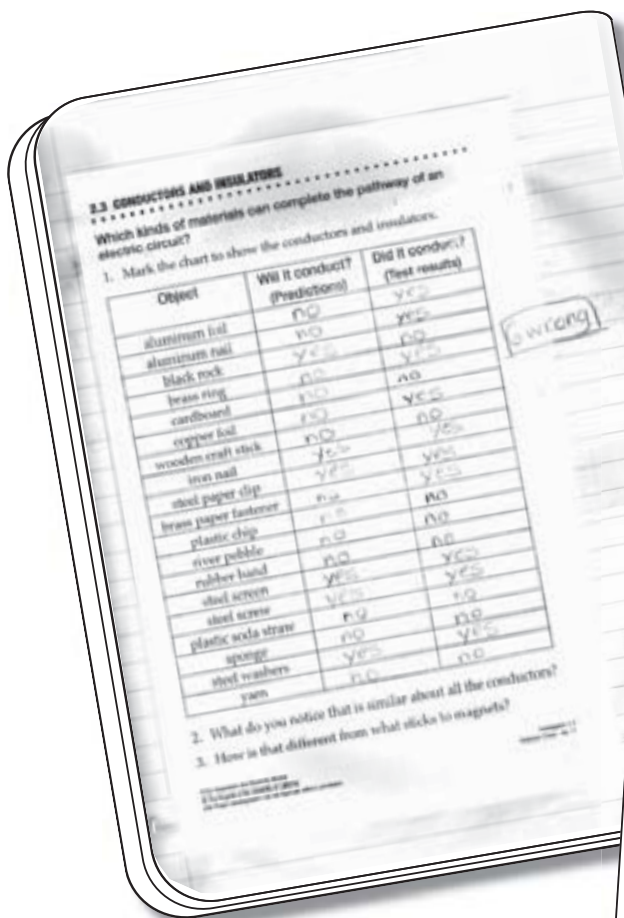
When students return to their notebooks and respond to the feedback, you will have additional information to help you discriminate between learning and communication difficulties.

**Self-assessment.** Scientists constantly refine and clarify their ideas about how the natural world works. They read scientific articles, consult with other scientists, and attend conferences. They incorporate new information into their thinking about the subject they are researching. This reflective process can result in deeper understanding in one case, or completely revised thinking in another case.

Self-assessment occurs after students receive additional instruction or information *after completing* one of the expositions of knowledge mentioned previously—a conclusion, response sheet, or benchmark assessment. Students then review their original written work, make judgments about its accuracy and completeness, and write a revised explanation. You can use any of a number of techniques for providing the additional information for students, including group compare-and-share discussion, pair/share reading, whole-class critique of an anonymous “student” explanation, identifying a class list of key points, and whole-class discussion of a presentation by one student.

After one of the information-generating processes, students compare the consensus “best answer” to theirs and rework their explanation. The revised statement of the science content can take one of several forms. Students might literally revise the original writing, crossing out extraneous or incorrect bits, inserting new or improved information, and completing the passage to reflect as complete a

statement as possible. Another approach to revision is to apply the three Cs—confirm, correct, complete—to their original work. Students indicate ideas that were correct with a number or a color, code statements needing correction with a second number or color, and assign a third number or color to give additional information that makes the entry complete. At other times, students might reflect on their original work, and then, after drawing and dating a line of learning (see page 32), they redraft their explanation from scratch, producing their best explanation of the concept.

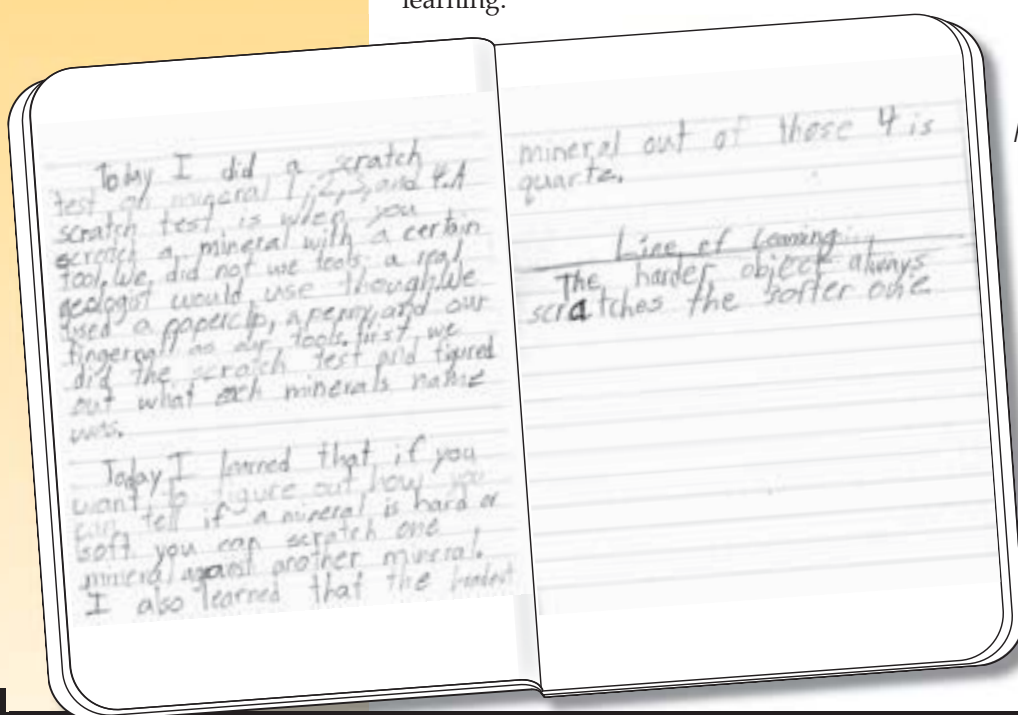


*From Magnetism and Electricity Module*

By engaging in any of these self-assessment processes, students have to think actively about every aspect of their understanding of the concept and organize their thoughts into a coherent, logical narrative. The learning that takes place during this process is powerful. The relationships between the several elements of the concept become unified and clarified.

**Line of Learning.** One technique many teachers find useful in the reflective process is the line of learning. After students enter their initial explanation, followed by discussion, assessment, reading, and/or teacher feedback, they draw and date a line under their original work. They make a new entry under the line of learning, adding to or revising their original thinking. If the concept is elusive or complex, a second line of learning, followed by more processing and revising, may be necessary.

The line of learning stands as a reminder to students that learning is an ongoing process and, the products of the process are imperfect. The line of learning is a marker that points out places in that process where a student made a stride toward full understanding. And the psychological security provided by the line of learning reminds students that they can always draw another line of learning and revise their thinking once again. The ability to look back in the science notebook and see concrete evidence of learning gives students confidence and helps them become critical observers of their own learning.



From Earth Materials Module

## LAST THOUGHTS

One thing that you will recognize immediately is the individuality of each student's science notebook. They don't look alike. Some will look like works of art; others like works of despair. But if you have created an environment where students have the freedom to develop their own recording style, appearance is secondary in importance compared with the intelligence the pages convey. Remember, the primary consumer of the information in the science notebook is the creator. The pressure exerted on the process by you is the insistence that the notebook entries be sufficiently complete and scrupulously accurate so that it performs as a thinking/reference tool for the writer.

You may have to be patient and persistent to create first a space for the notebook in your students' science activities, and finally a reliance on the notebook as essential for full engagement with the science ideas. Whereas early in their introduction to notebooks, you will constantly be reminding students to record and asking them if there is anything in their earlier entries that may be of use. In time the notebooks will automatically come out and take their place close at hand when an activity starts, and serve their owners continuously throughout the investigation as needed without any intervention on your part.

### DEVELOPING NOTEBOOK SKILLS

An efficient way to record many kinds of data is in a chart or table. How do you introduce this skill into the shared knowledge of the classroom? One way is to call for attention at the need-to-know juncture in an investigation, and demonstrate how to perform the operation. On the other hand, you can let students record the data as they will, and observe their methods. There may be one or more groups that "invent" an appropriate table. During processing time, you can ask the group to share their method with the rest of the class. If no group has produced an effective table spontaneously, you might challenge the class to come up with an "easier" way to display the data, and turn the skill-development introduction into a problem-solving session.

Initially, student notebooks will be more teacher centered. Students will need more guidance from you. You will find it necessary to describe what and when to record, and to model organizational techniques. As the year advances, the notebook work will become increasingly student centered. As the body of work in the notebook grows, students will have more and more examples of useful

techniques for reference. This self sufficiency reduces the amount of guidance you need to provide and reinforces the students' appreciation of their own record of learning.

This gradual shift toward autonomous use of the notebook applies to any number of notebook skills, including developing headers for each page (day, time, date, partners, etc.); using space efficiently on the page; preparing graphs, graphic organizers, and labeled illustrations; and attaching two-dimensional artifacts (chromatography strips, precipitates, dried flowers, photographs). For instance, when students first display their data in a two-coordinate graph, the graph might be set up completely for students, requiring them to only plot the data. As the year progresses, they will be expected to produce graphs with less and less support, until they are doing so without any assistance from you.

### **PRODUCING DERIVATIVE PRODUCTS**

On occasion, students may be asked to produce science reports of various kinds: summary reports, detailed explanations, end-of-module projects, oral reports, or posters. Students should use their record of learning as a reference when developing their reports. They might be asked to make a checklist of science concepts and pieces of evidence, with specific page references, extracted from their notebooks. The checklist can then be used to assess the derivative work (report or poster) to ensure that all important points have been included.

The process of developing the report has feedback benefits, too. You can have a discussion with students regarding changes they would make to their notebooks next time to make it easier to find and extract useful information when they are called on to develop a science report.

#### *Acknowledgments*

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