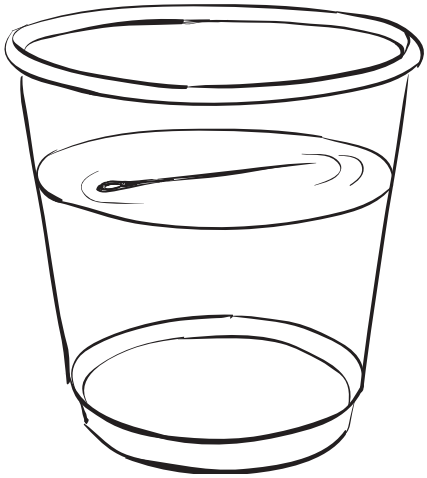
BENCHMARK ASSESSMENT

WATER



INTRODUCTION

The Existing FOSS Assessment System. The assessment system incorporated into your © 2000 or © 2005 FOSS Teacher Guide features both formative assessments and summative assessments. The formative assessments are integrated into the instructional sequence, providing opportunities to monitor student progress throughout the module. The single opportunity for summative assessment occurs at the end of the module after instruction is complete. The end-of-module assessment provides a one-time look at student achievement.

The New FOSS Assessment System. The new assessment system still uses the integrated formative assessments throughout the instructional sequence, but the summative assessment tools and procedures have been revised extensively. The summative assessments are different in form, function, and name. The new summative assessments are called **benchmark assessments**, and they include

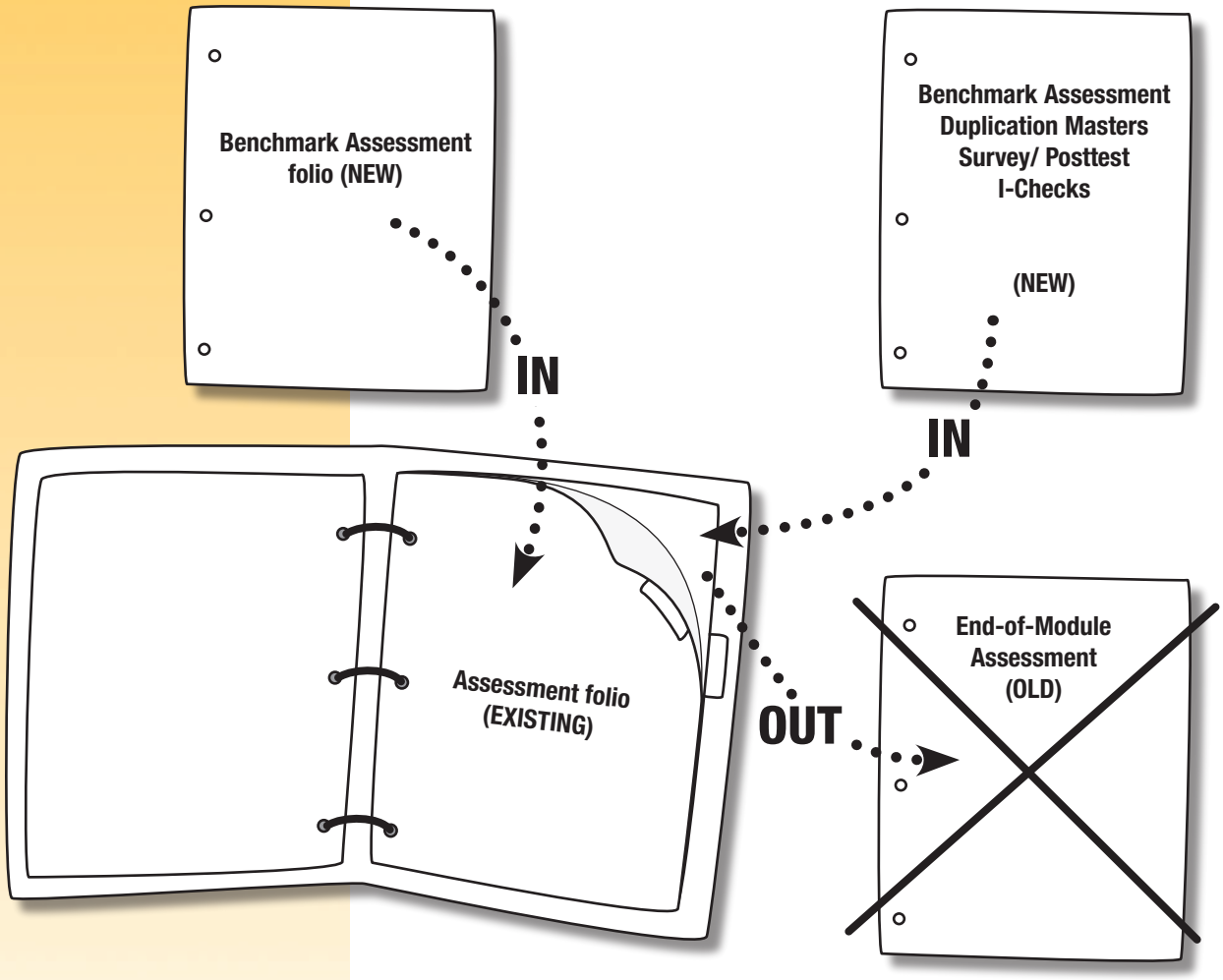
- A **survey (pretest)**, given before instruction begins.
- **I-Checks**, given at the end of each investigation.
- A **posttest**, given after instruction is complete.

BENCHMARK ASSESSMENT CONTENTS

REORGANIZE YOUR TEACHER GUIDE

This new Benchmark Assessment folio can be inserted into your teacher guide just in front of the existing Assessment folio. The formative assessment information and guidance in the existing Assessment folio is still useful and current. The summative assessment information in the existing folio, which pertains to the end-of-module assessment only, should no longer be used. The information and guidance in the remainder of this Benchmark Assessment folio should be used in its place.

The new Benchmark Assessment Duplication Masters can be inserted into the teacher guide in place of the existing End-of-Module Duplication Masters. The new Benchmark Assessment Duplication Masters include the Survey / Posttest and I-Checks.



OVERVIEW

The new FOSS assessment system features **benchmark assessments**. Benchmark assessments are short tests that are given at critical junctures throughout the teaching of a module. The benchmarks serve three functions. First, they provide summative information—achievement data that can be used for grading and accountability. Second, benchmark assessments provide formative information for teachers—diagnostic information that they can use to improve the effectiveness of their teaching. And third, benchmark assessments provide information directly to students, guiding them to think critically about their learning and to revise their thinking about the science being investigated.

This third use of the benchmark assessments is important. Research has shown that self-assessment practices are powerful *instructional* tools for enhancing student learning. These reflective practices help students understand the learning goals and expectations, and take more responsibility for their own learning. Self-assessment also helps students clarify their thinking so they can communicate their understanding of complex ideas more effectively. And self-reflection motivates students to work more thoughtfully and carefully.

Benchmark assessments occur in three places during a module.

- The **survey** is given before instruction begins, and includes 10–15 items, some open-response and some multiple-choice.
- **I-Checks** are given at the end of most investigations. Each I-Check consists of 5–10 items, in multiple formats. I-Checks are so named because students play an active role in checking their own understanding of the concepts being taught.
- The **posttest** is given after the module has been completed. The items are the same ones that appear on the survey.

USING BENCHMARK ASSESSMENTS

SURVEY ASSESSMENT

If you are using the benchmark assessments for school or district accountability purposes, you will need to follow specified procedures, such as those used when giving standardized tests. This means students will read and answer questions without any assistance. If you are using the benchmark assessments in your classroom only, you may want to read the questions out loud and move through the test question by question to minimize the effect of reading proficiency.

The survey is administered a few days before instruction begins. Students are often uneasy having to take a "test" when they haven't yet had the instruction they need to do well. They need to know that the survey is not graded, but will be used to help you determine what students already know and what they need to learn. Help students see the survey as a learning tool. At the end of the module they will get to compare their answers on the survey and the posttest to see how much they have learned. Students have few opportunities to see how their knowledge has changed.

When you administer the survey, encourage students to answer the questions as best they can. Even if they think they don't know the answers, they should try to think about something related that they do know and apply that knowledge. Collect the surveys, code them for diagnostic purposes, but don't make any marks on them. Hold them until after students take the posttest.

I-CHECK ASSESSMENTS

I-Check assessments are administered after you complete most investigations. To track achievement (a summative use), code all of the items using the coding guides in this folio. We recommend that you code one item at a time, across all students. Coding tends to be more consistent across students when you use this method. Even though you have to shuffle papers more, you will find that it actually takes less time to code the assessments overall. This method also allows you to think about the class as a whole and reflect on necessary next steps.

The I-Checks can also be used for formative assessment. Research has shown that students learn more when they take part in evaluating their own responses. The procedure described below has worked for many teachers using the FOSS assessment system.

1. Have students complete the I-Check either unassisted or using a read-aloud strategy with the whole class.
2. Code the I-Check item by item, but do not write codes on students' tests. Record codes in a grading program or grade book. Make notes about each item and identify important points to discuss with students.
3. Return I-Checks to students. Use one of the self-assessment strategies described later in this folio to help students reflect on and refine their thinking.

POSTTEST

Have students take the posttest after all of the investigations are completed. It can be administered in any of the ways described above for the other benchmark assessments. After coding the posttests, return them and the surveys to students. Have them compare their survey and posttest responses. Discuss the changes that have occurred.

Use the posttest for formative evaluation of the module, and make notes about things you might want to focus on the next time you teach the module.

CODING BENCHMARK ITEMS

An item is a question or statement designed to elicit evidence of learning from a student. Usually the items are presented in writing, and students respond by choosing an answer from a list (multiple choice), producing a long or short written answer, or generating another kind of artifact that provides evidence of learning. The quality and reliability of the information accrued from any assessment is directly related to the quality and reliability of the items.

The items in the benchmark assessments have been scrupulously designed and rigorously tested in 48 classrooms with more than 1000 students. As a result, we can be sure that the items will yield the kind of information about student learning that we want them to yield, and that they will produce the valued information time after time in all kinds of situations. In other words, the assessment items are valid and reliable. If they are used as intended in the context of teaching this FOSS module, they will inform you about student learning as you progress through the curriculum, and students will engage the important ideas of science in greater depth and with refreshing clarity.

Student performance on the benchmark assessments exposes the depth of their learning and the degree to which students are meeting the goals of the curriculum. To help you determine how students are performing, this Benchmark Assessment folio contains coding guides for each benchmark item. Coding guides are composed of model student responses. The responses are numbered—the higher numbers are associated with more sophisticated, complete responses—but they are not intended to be scores. Instead, they are numerical codes that refer to the depth and accuracy of a student's conceptual understanding.

Performance on the benchmark assessments can be used as a component of a student's grade, but you should not simply add up the numbers to assign a grade. Instead we suggest that you look at the frequency of the codes. If you see mostly 0s and 1s, the student needs further instruction. If you see mostly 2s, the student is developing science vocabulary and can state a number of scientific facts and simple relationships. If you see 3s, the student is developing the expected conceptual understandings. And if you see 4s, the student is able to apply conceptual knowledge to new situations. A grade should be based on multiple sources of evidence, including factors such as group participation, responsibility for learning, verbal expression, perseverance, and progress, that is, change between a student's starting knowledge and his or her knowledge after instruction.

SELF-ASSESSMENT

Self-assessment is more than reading correct answers to the class and having students mark whether or not they got the right answer. Self-assessment should provide an opportunity for students to think about their answers and to figure out how they could improve their answers. This kind of reflective process also helps students develop a better understanding of what a well-constructed response looks like.

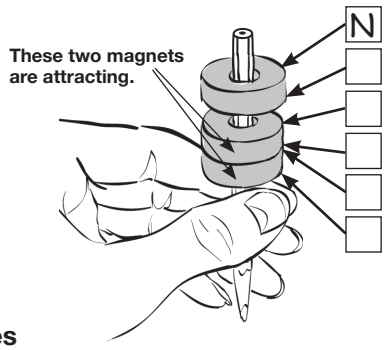
Self-assessment requires deep, thoughtful engagement with complex ideas. It involves students in whole-class or small-group discussion, followed by critical analysis of their own work. For this reason we suggest that you focus your probing discussions on two or three questions from an I-Check, rather than the entire test. The techniques described below are meant to give you a couple of strategies for entering the process of self-assessment. There is no "right way" to engage students in this process, but it seems to work best when you change the process from time to time to keep it fresh.

Review and Critique Anonymous Responses. After you have reviewed student work on an I-Check and have discovered one or more problems in student understanding associated with an item, fabricate three or four "student responses" that mirror the problems you saw in student work. Project these responses for students to read and comment on as a class. Discuss the strengths and weaknesses of each response, and when necessary, have students make suggestions for how to improve them. This is a good strategy to use during the first part of the year to help students better understand what constitutes a well-constructed response. Have students review their own answers, draw a line of learning (see page 9), and revise their answers.

Key Points. After reviewing student work on an I-Check and discovering a consistent problem in student understanding associated with an item, return the unmarked I-Checks to students. Direct their attention to the problematic item and discuss it together. After it is clear that students understand the item prompt, call on individuals or groups to suggest key points that should be included in a complete answer. Write the key points on the board as phrases, and number them.

Here is an example of an item on I-Check 1 from the **Magnetism and Electricity Module**.

20. Look at the picture on the right below. (The top two magnets are pushing apart; the bottom two magnets are stuck together.)



a. Label the poles on each magnet.

b. Explain why you labeled the poles the way you did.

During class discussion, students might generate this list of key points.

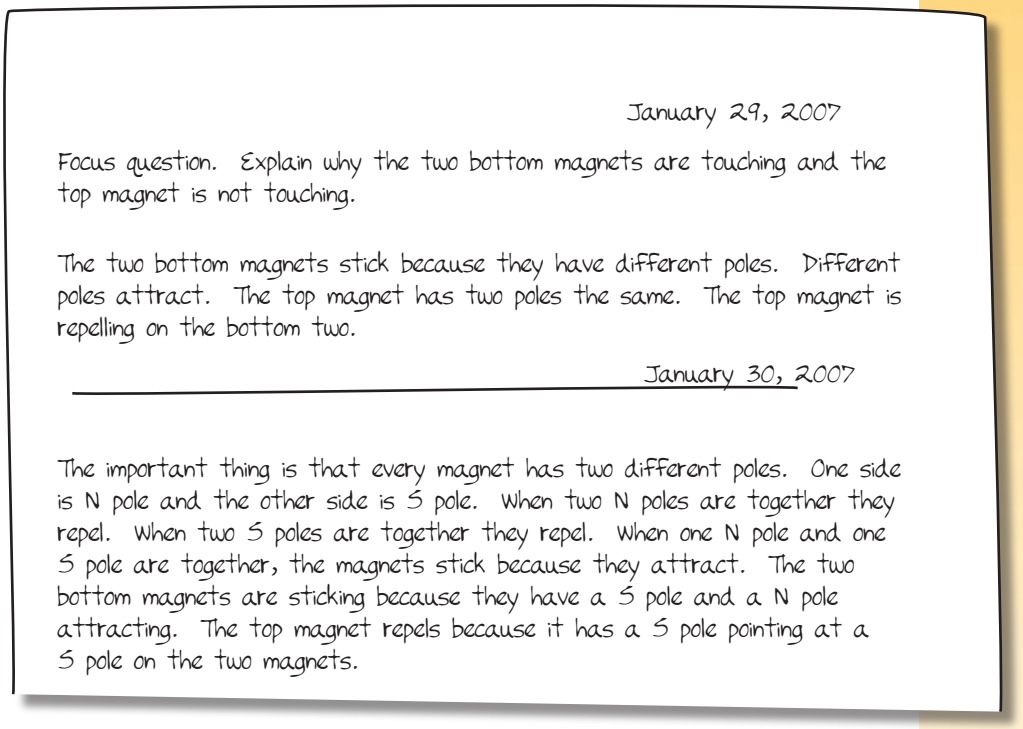
1. Every magnet has a north pole and a south pole.
2. Two north poles repel; two south poles repel.
3. A north pole and a south pole attract.

Students then turn to their own I-Checks and rework their responses to item 20b. They endeavor to *confirm* the key points that they included in their original work, *correct* parts of their responses that were wrong, and add key points to *complete* their response until they are satisfied that they have written the best answer possible.

Annotated Revision. One way students can process their work is by using the numbers associated with the key points to annotate their original writing. A number written at the start of a sentence or phrase confirms that the key point was included. Students correct and annotate sentences that don't represent key points. They add more points to the explanation, accompanied by the appropriate number.

Revision with Color. In a similar fashion, students can use color to confirm, correct, and complete the ideas in their original work. For instance, they can use green underlining to confirm key points present in the original writing. A red line through an entry can indicate wrong ideas that need correcting. They can use blue to add missing points to make the explanation complete.

Line of Learning. Many teachers have students use a line of learning to show how their thinking has changed. When students return to original work to revise their understanding of a concept, they start by drawing and dating a line of learning. This line delineates students' original, individual thinking from their thinking after a class or group discussion has helped them refine their thoughts. For example, students can use the line of learning after they use the review and critique strategy or the key points strategy. Students draw a line under their original answer and add any new information they need to make their answer complete. When you look at their responses, you will know what they wrote on their own (above the line) and what they added as a result of discussion (below the line).



January 29, 2007

Focus question. Explain why the two bottom magnets are touching and the top magnet is not touching.

The two bottom magnets stick because they have different poles. Different poles attract. The top magnet has two poles the same. The top magnet is repelling on the bottom two.

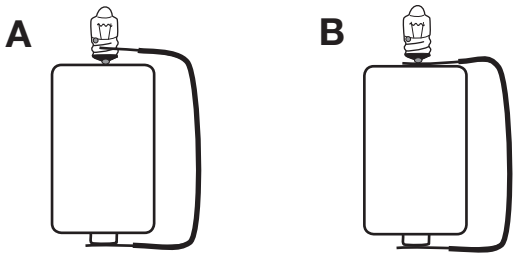
January 30, 2007

The important thing is that every magnet has two different poles. One side is N pole and the other side is S pole. When two N poles are together they repel. When two S poles are together they repel. When one N pole and one S pole are together, the magnets stick because they attract. The two bottom magnets are sticking because they have a S pole and a N pole attracting. The top magnet repels because it has a S pole pointing at a S pole on the two magnets.

Class Debate. When one student volunteers an answer to a question (usually one that many students are having trouble with or that elicits a persistent misconception), that student is in charge of the debate. He or she puts forth an answer or explanation. Other students agree or disagree, but must provide evidence to back up their thinking. Students are allowed to "disagree with themselves" if they hear an argument during the discussion that leads them to change their thinking. You can ask questions to keep the discussion on track, but otherwise you stay on the sidelines.

Critical Competitor. Use the critical competitor strategy when you want students to pay close attention to a specific detail. You need to present students with two things that are similar in all but one or two aspects. For example, if students are not considering contact points on the components of an electric circuit, you can present them with two pictures of circuits that differ only in contact points and ask them to determine which will work and why.

12. Look at the two bulb-and-battery circuits (A and B). Only one will light the bulb. Why does one circuit work, but the other doesn't?



Or if students write descriptions of how a circuit works, you can read one of them out loud and have students draw the circuit to see if the writing describes a complete circuit. The drawing becomes the critical competitor to the writing. You can use any medium; the point is to compare two pieces of communication in a way that helps students focus on the important points they are missing.

Sentence Starters. After class discussion of a response sheet or a notebook sheet, you might want to have students write a short reflection. Sentence starters can help them begin to put their reflections down on paper.

"I used to think...but now I think..."
"I should have gotten this one right, I just..."
"I know...but I'm still not sure about..."
"The most important thing to remember is..."
"Can you help me with..."
"I shouldn't have gotten this one wrong because I knew..."
"I'm still confused about..."
"Next time I will remember to..."
"Now I know..."

Multiple-Choice Discussions. Students sit in groups of three or four, depending on how many possible answers there were for a given question. You assign an answer to each student (not necessarily the answer they chose). Each student is responsible for explaining to the group whether the assigned answer is correct or not and why. Another version of this strategy is to have students meet in different corners of the classroom according to the answer they chose and come up with an argument to convince the rest of the class why that answer is correct. As in class debate, students are allowed to disagree with themselves if in the process of thinking it through they realize they should have chosen a different answer, but then they must also explain why they decided to make the change.

SURVEY/POSTTEST ANSWER SHEET—1 OF 7

WATER

Survey/Posttest

ANSWERS

1. What happens to the level of the water in the straw when the water in the bottle is *heated*?

- *(Circle the one best answer.)*

  A. The water level goes down.

  B. The water level stays the same.

  (C.) The water level goes up.

- Why does this happen?

  Water expands when it is heated. Water takes up more space when it expands.

2. - Which of these processes is involved in causing rain?

  (Circle the one best answer.)

  A. evaporation

  B. condensation

  (C.) both evaporation and condensation

- Explain your answer.

  Water evaporates to form water vapor. Water vapor goes into the air. The water vapor condenses to form clouds. The water in the clouds falls to the ground as precipitation, including rain.

SURVEY/POSTTEST CODING GUIDES—1 OF 7

1

Code	If the student...
3	circles C; explains that the water expands or takes up more space when heated.
2	circles C; says that the water gets bigger when it is heated.
1	circles C and gives no explanation or an incorrect one; *or* circles C and writes "the water rises"; *or* circles A, B, or more than one answer.
0	makes no attempt.

2

Code	If the student...
3	circles C; explains how both evaporation and condensation are involved in causing rain.
2	circles A and explains how evaporation is involved in causing rain; *or* circles B and explains how condensation is involved in causing rain; *or* circles C and explains only evaporation or condensation.
1	circles any answer; does not provide a correct explanation.
0	makes no attempt.

WATER
Survey/Posttest

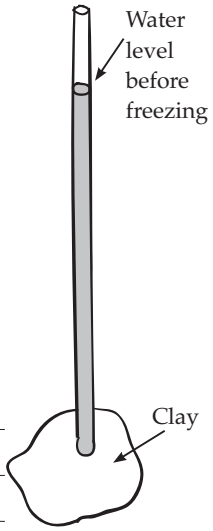
ANSWERS

3. Jack and Jill went up the hill to fetch a pail of water.
Jack fell down and broke his crown,
And Jill came tumbling after.

If the pail of water spilled on the hill, which direction did the water flow?

down the hill

4. Shanna stuck one end of a clear straw into a ball of clay. She filled the straw part way with water and marked the water level. She then placed it in the freezer.



- Which statement describes the level of the water (ice) in the straw after it froze?

  (Circle the one best answer.)

  A. The water level went down when the water froze.

  B. The water level stayed the same when the water froze.

  (C.) The water level went up when the water froze.

- Explain why you chose that answer.

The level of the water (ice) went up when it froze because water expands as it freezes.

SURVEY/POSTTEST CODING GUIDES—2 OF 7

3

Code	If the student...
2	indicates the water would flow down the hill (or down into the soil).
1	provides any other answer.
0	makes no attempt.

4

Code	If the student...
3	circles C; explains that water expands or takes up more space when it freezes.
2	circles C; explains that water goes up, gets bigger, or goes higher when it freezes.
1	circles C and gives an incorrect or no explanation; *or* circles A, B, or more than one answer.
0	makes no attempt.

WATER
Survey/Posttest

ANSWERS

5. What is precipitation?

Precipitation is water falling to Earth (from clouds) in the form of rain, snow, or hail.

6. Look at the two pictures of drops on a flat, waterproof surface. The drop on the left is soapy water, and the drop on the right is plain water.

Soapy water Plain water

a. What causes the plain water to look like it does?

Surface tension causes the plain drop to look like a bead.

b. What causes the soapy water to look like it does?

The surface tension is broken by the soap, so the soapy water drop is flat.

7. On a rainy day, Juan noticed that some raindrops moved down the window more rapidly than others.

Drops 

- Put an X through the drop you think moved the slowest.
- Circle the drop you think moved the fastest.

SURVEY/POSTTEST CODING GUIDES—3 OF 7

5

Code	If the student...
3	indicates that precipitation is water falling to Earth in the form of rain, snow, or hail.
2	indicates only that precipitation is rain.
1	provides any other answer.
0	makes no attempt.

6a

Code	If the student...
3	indicates that surface tension causes water to form a bead.
There is no level 2 for this item.	
1	provides any other answer.
0	makes no attempt.

6b

Code	If the student...
3	indicates that the soap breaks the surface tension.
There is no level 2 for this item.	
1	provides any other answer.
0	makes no attempt.

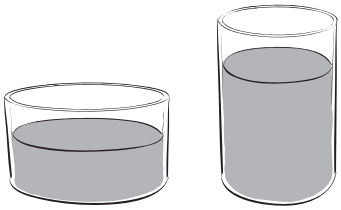
7

Code	If the student...
2	puts an X through the smallest drop; circles the largest drop.
1	provides any other answer.
0	makes no attempt.

WATER
Survey/Posttest

ANSWERS

8. Ted poured the *same amount of water* into two small containers, X and Y. He placed them together where they would not be disturbed.



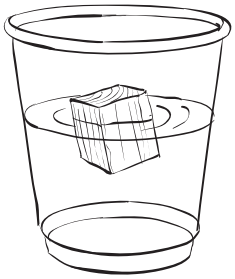
After several days, all of the water had evaporated from one of the containers. The other container still had some water.

- Which container, X or Y, was empty? X

- Explain why the water in that container evaporated more quickly than the water in the other container.

  Container X has more water exposed to the air (more surface area), so the water evaporated faster.

9. Look at the picture of a block of wood in a cup of water.



- Which statement below is true?

  (Circle the one best answer.)

  (A.) The block of wood is less dense than the water.

  B. The block of wood is the same density as the water.

  C. The block of wood is denser than the water.

- What is your evidence?

  The block of wood floats.

SURVEY/POSTTEST CODING GUIDES—4 OF 7

8

Code	If the student...
3	chooses X; explains that X has more water exposed to air or has a greater surface area.
2	chooses X and explains that X is bigger or wider in some way; *or* chooses X and just writes "surface area" without making a comparison.
1	provides any other answer, including just X or X with a wrong explanation.
0	makes no attempt.

9

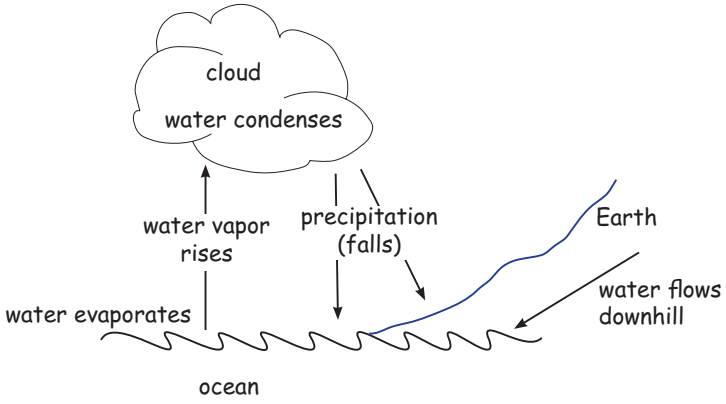
Code	If the student...
2	circles A; indicates that the evidence is that the block of wood floats.
1	circles A but does not provide the correct evidence; *or* circles B, C, or more than one answer.
0	makes no attempt.

WATER
Survey/Posttest

ANSWERS

10. a. Draw and label a picture of the general water cycle. Be sure to label all changes.

Sample answer:



b. Name three places that a water particle can be found on Earth other than in a body of water such as a lake, river, or ocean.

(1) Sample answers:

(2) animal, plant, glacier,

(3) soil, groundwater

SURVEY/POSTTEST CODING GUIDES—5 OF 7

10a

Code	If the student...
4	draws a general water cycle that shows evaporation, condensation, precipitation, and flow, including labels and arrows.
3	draws a general water cycle that shows all the parts as above but does not include all labels and arrows.
2	draws parts of the general water cycle but does not include all parts (e.g. only draws clouds with arrows up and down).
1	provides any other answer.
0	makes no attempt.

10b

Code	If the student...
3	lists any three of these places: animal, plant, soil, glacier, or groundwater.
2	lists any two of the above places.
1	provides any other answer.
0	makes no attempt.

SURVEY/POSTTEST ANSWER SHEET—6 OF 7

WATER
Survey/Posttest

ANSWERS

11. Explain why, when water freezes, the ice floats on water instead of sinking.

Water expands when it freezes. When it expands, it gets less dense. The less-dense ice floats on the denser liquid water.

12. Joanna's glasses "steamed up" when she went into the bathroom after her sister finished her shower.

- What was the "steam"? water
- What caused the "steam" to form on her glasses?

Her glasses were cool (cooler than the water vapor in the bathroom).

13.
- Does water do the same thing on all surfaces? no
- Explain your answer.

Water is absorbed by some surfaces and beads up on other surfaces.

SURVEY/POSTTEST CODING GUIDES—6 OF 7

11

Code	If the student...
4	explains that water expands when it freezes so the ice is less dense than water and floats on water.
3	indicates that water expands when it freezes but does not relate this to density.
2	indicates that ice is lighter than water.
1	provides any other answer.
0	makes no attempt.

12

Code	If the student...
3	indicates that the "steam" is water or condensation (*not* water *vapor*, because water vapor cannot be seen) and that the glasses were cool (there was a temperature difference).
2	indicates that the "steam" is water or condensation but does not explain why it forms; *or* does not correctly identify the "steam" but explains why it forms.
1	provides any other answer.
0	makes no attempt.

13

Code	If the student...
3	explains that water does not do the same thing on all surfaces; indicates that it is absorbed by some surfaces and beads up on other surfaces.
2	explains that water does not do the same thing on all surfaces; does not use appropriate vocabulary (absorb).
1	provides any other answer.
0	makes no attempt.

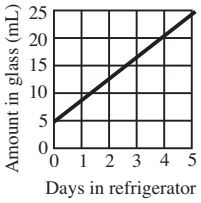
WATER
Survey/Posttest

ANSWERS

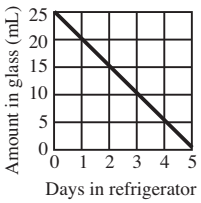
14. Mei put an uncovered glass of water in the refrigerator. Each day she measured and recorded the water left in the glass. Which graph shows what probably happened?

(Circle the one best answer.)

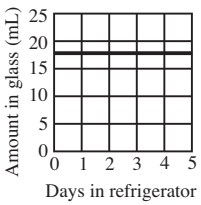
A



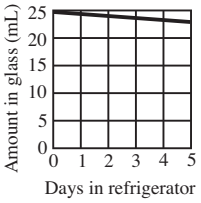
B



C



(D)



15. Hanna did an investigation to find out if adding salt to water would change the time it takes water to freeze. Her data table is shown below.

	Time to freeze (minutes)	
Solution	Trial 1	Trial 2
100 mL water	55	52
100 mL water + 10 g salt	75	70
100 mL water + 20 g salt	115	120

According to the table,

(Circle the one best answer.)

A. water cools at a rate of 4°C per minute.

B. water takes less time to freeze when salt is added.

(C.) the more salt added, the longer the solution takes to freeze.

D. the time for freezing water does not change no matter how much salt is added.

SURVEY/POSTTEST CODING GUIDES—7 OF 7

14

Code	If the student...
2	circles D.
1	circles A, B, C, or more than one answer.
0	makes no attempt.

15

Code	If the student...
2	circles C.
1	circles A, B, D, or more than one answer.
0	makes no attempt.

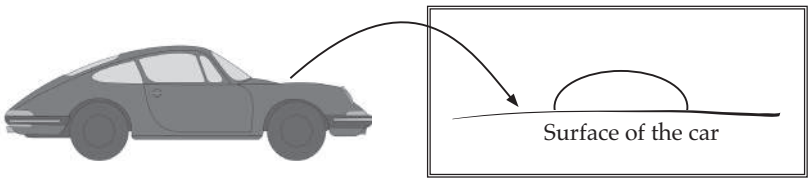
I-CHECK

ANSWERS

Investigation 1—Water Observations

16. Pam sprayed water on her mother's car. The water drops looked just like those she had seen on other surfaces that do not absorb water.

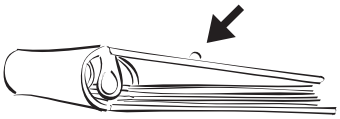
a. In the box to the right, draw a side view of a water drop on the surface of the car.



b. What property of water causes the drop to be shaped that way?

Surface tension causes the drop to form a bead shape.

17. Ron covered his notebook with waxed paper. Then he placed a small drop of water in the middle of the notebook as shown in the picture. Even though the drop was on a slope, the drop stayed where he placed it.



Describe two ways Ron can make the water move down the notebook without pushing the drop, blowing on it, or shaking the notebook.

a. He could make the drop bigger.

b. He could make the slope steeper.

INVESTIGATION 1 I-CHECK CODING GUIDES—1 OF 3

16a

Code	If the student...
2	draws the drop with a bead shape.
1	draws a top view or something other than a bead shape.
0	makes no attempt.

16b

Code	If the student...
2	indicates that the shape is caused by surface tension.
1	provides any other answer.
0	makes no attempt.

17a

Code	If the student...
2	indicates that adding water to the drop will make it move down the notebook.
1	provides any other answer.
0	makes no attempt.

17b

Code	If the student...
2	indicates that increasing the slope (making it steeper) will make the drop move down the notebook.
1	provides any other answer.
0	makes no attempt.

NOTE: *Code "making the drop bigger" as 17a regardless of whether students put this answer under 17a or 17b.*

Likewise, code "increasing the slope" as 17b regardless of whether students put this answer under 17a or 17b.

Students may use other terminology for 17b. For example, they may say "tilt the notebook more." This is a level 2 answer.

INVESTIGATION 1 I-CHECK ANSWER SHEET—2 OF 3

I-CHECK

Investigation 1—Water Observations

ANSWERS

18. A needle, which would normally sink in water, can stay on the surface of water if placed very carefully.

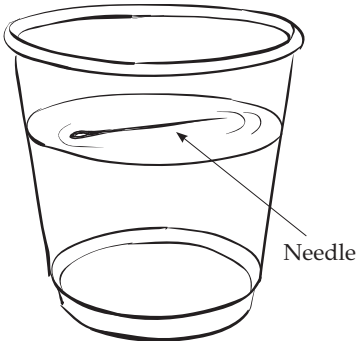
a. What property of water makes this possible?

(Circle the one best answer.)

A. surface temperature

B. surface area

(C.) surface tension



b. How could you make the needle sink to the bottom of the container without touching the needle or the container?

(Circle the one best answer.)

A. Add more water to the container.

(B.) Add soap to the water.

C. Add salt to the water.

INVESTIGATION 1 I-CHECK CODING GUIDES—2 OF 3

18a

Code	If the student...
2	circles C.
1	circles A, B, or more than one answer.
0	makes no attempt.

18b

Code	If the student...
2	circles B.
1	circles A, C, or more than one answer.
0	makes no attempt.

INVESTIGATION 1 I-CHECK ANSWER SHEET—3 OF 3

I-CHECK

Investigation 1—Water Observations

ANSWERS

19. Dr. Moreno was studying a river. She recorded her observations once a week for three years. Her observations included how fast the water was running, the water level, and how much silt was mixed in with the water.

Scientists keep detailed records of their observations so they

(Circle the one best answer.)

A. have pictures of the places they study to include in their reports.

B. can prove that scientists spend a lot of time working.

C. can write books about science that people will want to read.

(D.) have evidence that can be used to support their explanations.

20. Kenji put 25 drops of water on a penny. He recorded his observations in his notebook. Which sentence below describes an inference that Kenji could make from his observations?

(Circle the one best answer.)

A. The drops of water are dome shaped.

(B.) If I put bigger drops on the penny, it would take fewer to cover it.

C. When two drops touched, they formed into one bigger drop.

D. When I put the 25th drop of water on the penny, it spilled onto the table.

INVESTIGATION 1 I-CHECK CODING GUIDES—3 OF 3

19

Code	If the student...
2	circles D.
1	circles A, B, C, or more than one answer.
0	makes no attempt.

20

Code	If the student...
2	circles B.
1	circles A, C, D, or more than one answer.
0	makes no attempt.

INVESTIGATION 2 I-CHECK ANSWER SHEET—1 OF 4

I-CHECK

ANSWERS

Investigation 2—Hot Water, Cold Water

21ab. List the following types of water in order, from least dense to densest.

warm water cold water ice

least dense ice

warm water

densest cold water

22. Water striders are insects that are able to "stand" on water, move about, and capture prey without sinking. What property of water allows water striders to stay on top of water?

surface tension

23. What science word describes what happens when water soaks into another material like a paper towel? absorb

INVESTIGATION 2 I-CHECK CODING GUIDES—1 OF 4

21a

Code	If the student...
3	indicates that ice is the least dense.
There is no level 2 for this item.	
1	provides any other answer.
0	makes no attempt.

21b

Code	If the student...
2	indicates that warm water is less dense than cold water.
1	provides any other answer.
0	makes no attempt.

22

Code	If the student...
2	writes "surface tension."
1	provides any other answer.
0	makes no attempt.

23

Code	If the student...
2	writes "absorb."
1	provides any other answer.
0	makes no attempt.

NOTE: *Item 21 is coded as if it is two separate questions.*

For 21a, ice must be above both warm and cold water (the least dense) for a level 3.

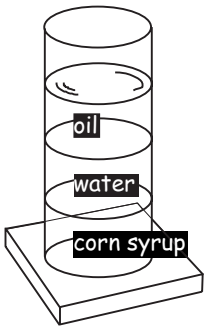
For 21b, ignore the position of the ice and look only at the relative positions of the warm and cold water. The warm must be above the cold (less dense) to get a level 2.

I-CHECK

Investigation 2—Hot Water, Cold Water

ANSWERS

24. Oil, water, and corn syrup are layered in a tall, thin container. All are at the same temperature.



- What does the layering tell you about the density of the oil compared to the corn syrup?

  Oil is less dense than corn syrup.

- Describe the evidence that supports your answer.

  The oil floats on top of the water, and the water floats on top of the corn syrup (corn syrup sinks under the water).

25. Matthew's mother left two plastic bottles in the trunk of their car. One was full of water, and the other was empty. The temperature dropped below 0°C that night. When his mother opened the trunk the next afternoon, she discovered the bottle with the water had cracked.

Explain why the bottle with the water cracked but the empty bottle did not.

The water in the bottle froze. Water expands when it freezes. If a bottle full of liquid water freezes, the bottle may break because the water (ice) needs more space.

INVESTIGATION 2 I-CHECK CODING GUIDES—2 OF 4

24

Code	If the student...
3	indicates that oil is less dense than corn syrup; explains that the oil floats on water; water floats on corn syrup (or corn syrup sinks in water), and thus, oil floats on corn syrup.
2	indicates the oil is less dense; gives vague or incomplete explanation.
1	provides any other answer.
0	makes no attempt.

25

Code	If the student...
3	indicates that the water froze and expanded (which caused the bottle to crack).
2	states that the water froze and "got bigger" (so the bottle cracked); *or* indicates that the water expanded but does not mention freezing; *or* indicates the water froze but does not mention expansion.
1	provides any other answer, including stating that the water expanded because it got cold.
0	makes no attempt.

INVESTIGATION 2 I-CHECK ANSWER SHEET—3 OF 4

I-CHECK

Investigation 2—Hot Water, Cold Water

ANSWERS

26. Pete put a marble in a cup of water as shown in the picture.

- Which statement about the marble and the water is true?

  (Circle the one best answer.)

  A. The marble is less dense than the water.

  B. The marble has the same density as the water.

  (C.) The marble is denser than the water.

- What is your evidence?

  The marble is on the bottom of the cup (under the water).

27. What happens to the level of the water in the straw when the water in the bottle is *cooled* (but *not frozen*)?

- *(Circle the one best answer.)*

  (A.) The water level goes down.

  B. The water level stays the same.

  C. The water level goes up.

- Why does this happen?

  Water contracts when it is cooled. Water takes up less space when it contracts.

INVESTIGATION 2 I-CHECK CODING GUIDES—3 OF 4

26

Code	If the student...
2	circles C; indicates that the evidence is that the marble is on the bottom of the cup or is underwater.
1	circles C and does not provide the correct evidence; *or* circles A, B, or more than one answer.
0	makes no attempt.

27

Code	If the student...
3	circles A; explains that the water contracts or takes up less space when cooled.
2	circles A; says that the water gets smaller when it is cooled.
1	circles A and gives no explanation or an incorrect one; *or* circles A and writes "the water lowers"; *or* circles B, C, or more than one answer.
0	makes no attempt.

INVESTIGATION 2 I-CHECK ANSWER SHEET—4 OF 4

I-CHECK

Investigation 2—Hot Water, Cold Water

ANSWERS

28. Donna put two cups of water in the freezer. There were 50 mL of water in cup 1, and 25 mL of water in cup 2. Which sentence below describes what will be the *same* for both cups?

(Circle the one best answer.)

(A.) The temperature at which the water freezes.

B. The time it takes for the water to freeze.

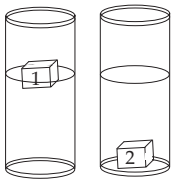
C. The volume of frozen water in each of the cups.

D. The mass of the frozen water in each of the cups.

29. Mateo had two blocks that were the same size. He dropped each block into a container of water.

Why did block 1 float and block 2 sink?

(Circle the one best answer.)



A. Block 1 contained more air bubbles than block 2.

B. Block 2 absorbed more heat than block 1.

C. Block 1 weighed more than block 2.

(D.) Block 2 is made of a different material than block 1.

INVESTIGATION 2 I-CHECK CODING GUIDES—4 OF 4

28

Code	If the student...
2	circles A.
1	circles B, C, D, or more than one answer.
0	makes no attempt.

29

Code	If the student...
2	circles D.
1	circles A, B, C, or more than one answer.
0	makes no attempt.

INVESTIGATION 3 I-CHECK ANSWER SHEET—1 OF 4

I-CHECK

Investigation 3—Water Vapor

ANSWERS

30. Where does water go when it changes to water vapor?

(Circle the one best answer.)

A. into clouds

B. onto cool surfaces

(C.) into the air

31. • Does water flow faster moving down a mountain or through a valley?

down a mountain

• Explain your answer.

Water flows faster on steeper slopes. The mountain slope is steeper than the valley, so water would flow faster there.

32. Anna spilled half of her cup of water on the kitchen floor. The other half was still in the cup. When she came back hours later, all of the water on the floor had evaporated, but most of the water in the cup was still there. (Anna knew that no one had wiped up the water on the floor.)

Explain to Anna why the water that spilled on the floor had all evaporated, but most of the water in the cup had not.

The water on the floor had a much larger surface area (area exposed to the air) than the water in the cup.

INVESTIGATION 3 I-CHECK CODING GUIDES—1 OF 4

30

Code	If the student...
2	circles C.
1	circles A, B, or more than one answer.
0	makes no attempt.

31

Code	If the student...
3	indicates that water will flow faster down a mountain because the slope is steeper.
2	indicates that water will flow faster down a mountain; gives vague or incomplete explanation.
1	provides any other answer.
0	makes no attempt.

32

Code	If the student...
3	indicates that the water on the floor had a larger surface area or area exposed to the air than the water in the cup.
2	indicates that the water on the floor is bigger in some way; does not specifically mention surface area or surface exposed to air.
1	provides any other answer.
0	makes no attempt.

INVESTIGATION 3 I-CHECK ANSWER SHEET—2 OF 4

I-CHECK

Investigation 3—Water Vapor

ANSWERS

33. Maria weighed a small, wet sponge. It weighed 38 grams. She left the sponge on the balance.

The next day the sponge weighed 22 grams.

Why did the mass change?

Some water evaporated from the sponge (between the time Maria weighed it and the next day).

34. Johnny drove to the store with his father one cold night. They had only driven a short distance when the windows fogged up on the inside.

- What was the "fog"? water

- What was it about the windows that caused the "fog" to form on them?

The windows were cool (cooler than the water vapor in the air, causing it to condense).

35. Angie wrote in her science notebook,

Evaporation only happens when water is heated to high temperatures.

Explain why you agree or disagree.

I don't agree with Angie. Evaporation can occur at any temperature.

INVESTIGATION 3 I-CHECK CODING GUIDES—2 OF 4

33

Code	If the student...
2	indicates that the masses were different because the water in the sponge evaporated; uses some form of "evaporate."
1	provides any other answer.
0	makes no attempt.

34

Code	If the student...
3	indicates that the "fog" is water or condensation (*not* water *vapor* because water vapor cannot be seen), and that the windows were cold (there was a temperature difference).
2	indicates that the "fog" is water or condensation but does not explain why it forms; *or* does not correctly identify the "fog" but explains that it formed because the windows were cold.
1	provides any other answer, including water vapor.
0	makes no attempt.

35

Code	If the student...
3	does not agree with Angie; indicates that evaporation occurs at any temperature.
2	either agrees or does not agree with Angie; gives vague or incomplete explanation.
1	provides any other answer.
0	makes no attempt.

INVESTIGATION 3 I-CHECK ANSWER SHEET—3 OF 4

I-CHECK

Investigation 3—Water Vapor

ANSWERS

36. Which of the following is true when ice melts?

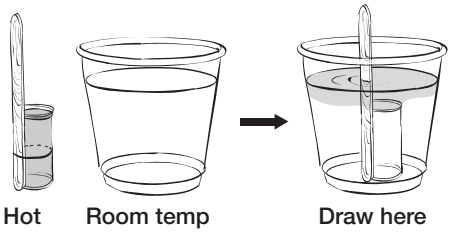
(Circle the one best answer.)

(A.) The meltwater takes up less space than the ice.

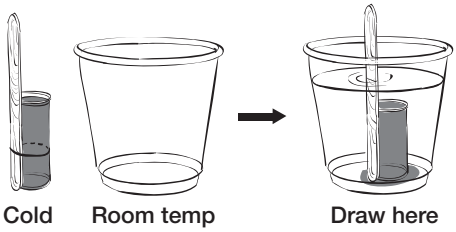
B. The meltwater takes up more space than the ice.

C. The meltwater takes up the same amount of space as the ice.

37. • Draw a picture of what happens when you lower a vial of hot water into a cup of room-temperature water.



• Draw a picture of what happens when you lower a vial of cold water into a cup of room-temperature water.



NOTE: Students may draw the cold water in the vial or layered on the bottom of the room-temperature water.

- Which is denser, *hot* water or *cold* water? cold
- How does what happens in the cups help you answer which is denser?
  If something is less dense than water, it floats; if it is denser than water it sinks. Because the hot water floats on room-temperature water but the cold water sinks, the cold water must be denser.

INVESTIGATION 3 I-CHECK CODING GUIDES—3 OF 4

36

Code	If the student...
3	circles A.
There is no level 2 for this item.	
1	circles B, C, or more than one answer.
0	makes no attempt.

37

Code	If the student...
3	indicates that the cold water is denser; provides an explanation based on the cold water sinking (or staying in the vial) and the warm water floating.
2	reverses relationship between density and location of water in the cup (less dense sinks and denser floats).
1	provides any other answer, including just "cold" or "hot."
0	makes no attempt.

NOTE: *The drawings are included to help the students think through this question. They also help you know whether students remember what happened in class. However, the drawings do not by themselves indicate an understanding of sink/float behavior and are not coded.*

INVESTIGATION 3 I-CHECK ANSWER SHEET—4 OF 4

I-CHECK

Investigation 3—Water Vapor

ANSWERS

38. Which of the following is an example of water vapor condensing?

(Circle the one best answer.)

A. Water leaking from a garden sprinkler.

B. Water melting when it is heated.

C. Water in a puddle changing to gas as the day grows warmer.

(D.) Water beads forming on tree leaves on a cool morning.

39. The energy source that causes water in the ocean to change into water vapor is

(Circle the one best answer.)

A. underwater earthquakes.

B. clouds in the sky above the ocean.

(C.) the Sun.

D. a reaction between the water and the animals that live in it.

INVESTIGATION 3 I-CHECK CODING GUIDES—4 OF 4

38

Code	If the student...
2	circles D.
1	circles A, B, C, or more than one answer.
0	makes no attempt.

39

Code	If the student...
2	circles C.
1	circles A, B, D, or more than one answer.
0	makes no attempt.

INVESTIGATION 4 I-CHECK ANSWER SHEET—1 OF 3

I-CHECK

Investigation 4—The Water Cycle

ANSWERS

40. a. In order for water vapor to leave the atmosphere, it must first change to liquid water; that is, it must condense .

b. The water might then fall to the earth as rain, hail, sleet, or snow. Each of these is a type of precipitation .

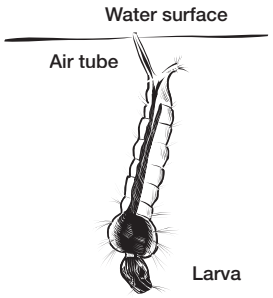
c. If the water falls into a river, it might then flow into the ocean.

d. From the ocean, the water might evaporate and return to the atmosphere.

41. Surface tension allows mosquito larvae to hang by their air tubes at the surface of a pond.

Describe what could be done to stop the larva from being able to hang from the surface.

Soap (or another appropriate substance) could be added to the water to break the surface tension.



INVESTIGATION 4 I-CHECK CODING GUIDES—1 OF 3

40a

Code	If the student...
2	writes "condense" (or "condensation").
1	provides any other answer.
0	makes no attempt.

40b

Code	If the student...
2	writes "precipitation" (or "precipitate").
1	provides any other answer.
0	makes no attempt.

40c

Code	If the student...
2	writes "flow" or "runoff."
1	provides any other answer.
0	makes no attempt.

40d

Code	If the student...
2	writes "evaporate" (or "evaporation").
1	provides any other answer.
0	makes no attempt.

41

Code	If the student...
3	indicates that soap (or another appropriate substance) could be added to the water to break the surface tension.
2	indicates that something could be added to the water to break the surface tension; does not name a specific substance.
1	provides any other answer.
0	makes no attempt.

INVESTIGATION 4 I-CHECK ANSWER SHEET—2 OF 3

I-CHECK

Investigation 4—The Water Cycle

ANSWERS

42. Why does a coin sink in the water when you throw it into a wishing well?

The coin sinks because it is denser than the water.

43. Which changes are involved in the water cycle?

(Circle all that apply.)

(ice to water) (water to ice)

(water to water vapor) (water vapor to water)

INVESTIGATION 4 I-CHECK CODING GUIDES—2 OF 3

42

Code	If the student...
2	indicates that the coin would sink in the water because it is denser than water.
1	provides any other answer.
0	makes no attempt.

43

Code	If the student...
3	circles all of the changes.
2	circles "water to water vapor" and "water vapor to water" only; *or* circles "water to ice" and "ice to water" only.
1	circles any other combination.
0	makes no attempt.

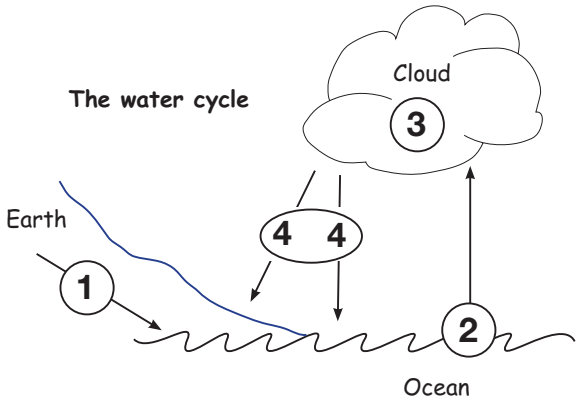
NOTE: *Students may circle only one of a pair, for example, "water to ice" or "ice to water." They do not receive credit for this because the important point here is that these changes can and do go in both directions.*

I-CHECK

Investigation 4—The Water Cycle

ANSWERS

44. Answer questions 44a and 44b based on the diagram of the water cycle you see here.



a. Which process is happening at (4)?

(Circle the one best answer.)

A. condensation

B. flow (or runoff)

C. evaporation

(D.) precipitation

b. Which process is happening at (2)?

(Circle the one best answer.)

A. condensation

B. flow (or runoff)

(C.) evaporation

D. precipitation

INVESTIGATION 4 I-CHECK CODING GUIDES—3 OF 3

44a

Code	If the student...
2	circles D.
1	circles A, B, C, or more than one answer.
0	makes no attempt.

44b

Code	If the student...
2	circles C.
1	circles A, B, D, or more than one answer.
0	makes no attempt.

	Survey Post	Inv 1	Inv 2	Inv 3	Inv 4
CONTENT KNOWLEDGE					
• Water has several observable properties, including transparency, shapelessness, and movement or flow. • Water beads up on some materials and is absorbed by other materials. • Surface tension is the skinlike surface of water that pulls it together into the smallest possible volume. • Drops of water form domes on pennies because of surface tension. • Surface tension can be disrupted by the addition of some other substances. • Water flows downhill. • Larger amounts of water flow more quickly. • Increasing the slope over which water flows makes it flow more quickly.	3 6a 6b 7 13	16a 16b 17a 17b 18a 18b	22 23	31	41
• Water expands when heat is added; water contracts when heat is taken away. • Warm water is less dense than room-temperature water; cold water is denser than room-temperature water; cold water is denser than warm water. • A material that floats in water is less dense than the water; a material that sinks is denser. • Water begins to expand when its temperature reaches 4°C. • Water is densest at 4°C. • Ice is less dense than liquid water. • A solid has definite volume and shape; a liquid has only definite volume.	1 4 9 11		21a 21b 24 25 26 27	36 37	42
• Evaporation is the process by which liquid water changes into water vapor, a gas. • Temperature affects the rate of evaporation. • The surface area of a volume of water affects the rate of evaporation. • Condensation occurs when water vapor touches a cool surface and changes into liquid. • Evaporation and condensation contribute to the movement of water through the water cycle.	2 5 8 10a 10b 12			30 33 35 38 39	40a 40b 40c 40d 43 44a 44b
• Some earth materials, like soils, absorb more water than other earth materials. • Water flows more easily through some earth materials than through others. • Flowing water can be used to do work. • Waterwheels are a kind of machine powered by flowing water. • Water contains different materials that affect its quality. • Evaporation can be used to detect materials dissolved in water.					
CONDUCTING INVESTIGATIONS and BUILDING EXPLANATIONS					
• Planning investigations					
• Gathering and organizing data		19 20			
• Interpreting data and building explanations	14 15		28 29	32 34	