Category II Summaries for Physical Science Examples

Assisting teacher in identifying own students' ideas

Matter and Molecules

Matter and Molecules includes some specific questions and tasks for teachers to use to find out what their students think. In some lesson clusters, the *Activity Book* contains questions to elicit students' understanding of the key ideas before they are introduced. This is made clear in the introduction to the *Activity Book* (p. **T-i**).

For example, in Activity 6.1, students place hard candy into cups of hot and cold water. They are asked to predict how what happens in the two cups will be the same, how it will be different, and to explain their predictions. This is done before students encounter the idea that molecules of hot substances move faster than those of cold substances (*Activity Book*, p. **31s**) do.

In addition, teachers are supplied with two-part transparencies to encourage them to find out what their students think about the key ideas (*Science Book*, p. **T-8**)

Matter and Molecules does not make it clear whether the transparencies are to be presented before or after the scientific ideas are introduced. Hence, it is not clear whether the transparencies should be used to identify students' ideas before instruction or as tools for embedded assessment. For example, in lesson 2.3, teachers are encouraged to use Transparency 4 on page **T-35** to elicit students' ideas about how molecules are arranged and how they move in solid sugar, liquid alcohol, and oxygen gas (*Science Book*, p. **T-34**). It is not clear whether this transparency is to be used before or after students learn about the different arrangement and motion of molecules in solids, liquids, and gases.

The questions that are intended to help teachers find out what students think typically ask students to make predictions or to give descriptions or explanations of properties of substances or phenomena. They are posed in ways that are likely to be comprehensible to students who are not familiar with the scientific concepts and terms. Nevertheless, the text does not explicitly encourage teachers to use probing questions to clarify what students mean or to get more information about what students are thinking.

INTRODUCTION
WRITING DESCRIPTIONS AND EXPLANATIONS

This unit is based on a basic belief about the nature and purposes of scientific knowledge: We believe that science was developed for the purpose of describing and explaining natural phenomena. This means that an important part of teaching science consists of giving students the chance to practice their own descriptions and explanations. For that reason, this unit contains many questions that require students to write out descriptions or explanations.

Although this writing is essential for student learning, it is also a lot of work, for the students and for you. We would like to give you a few suggestions about how to make the work load manageable while still giving the students plenty of practice in developing descriptions and explanations.

You do not have to check every activity and question set yourself (though you certainly can if you want to). The last question set in each lesson cluster contains questions reviewing the content of the entire lesson cluster. If you grade those question sets, which are packaged separately so that they can be taken up or used as tests, you should be able to do an adequate job of monitoring the progress of individual students.

It is important for students to answer the remaining questions, but there are a variety of ways that they can get practice and feedback in answering these questions without your having to read every student answer. For example:

1. Students can answer their questions individually, then meet in groups of three to compare their answers and develop a group consensus answer. The group consensus answers can then be compared in a class discussion.

2. Groups of students working together on a question set or laboratory activity can develop a group consensus answer and write that group answer in their Activity Books.

3. Students can check each other's papers. It is possible for students to learn a great deal from a class discussion that focuses on what qualities make an answer acceptable or unacceptable.

4. Student answers can be used as a basis for class discussion rather than individual checking. You can solicit a variety of answers from the students, and lead the class in a discussion of the merits of each answer.

You can probably think of a variety of other arrangements that will work equally well. What is important is that students keep writing and discussing their descriptions and explanations, with enough feedback from you or from each other to help them understand their mistakes and improve the quality of their descriptions and explanations.

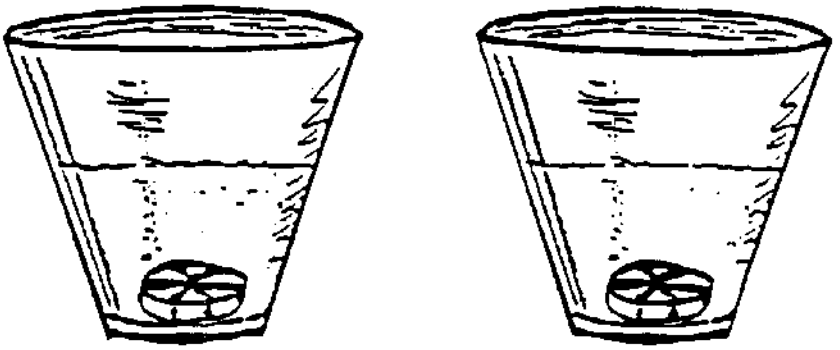
Some questions are intended primarily for the purpose of eliciting students' ideas about topics that they have not yet studied and may only partially understand. These questions should <u>not</u> be graded on a right-or-wrong basis; they should be used as a basis for discussion by small groups of students or by the whole class.

LESSON CLUSTER 6

Heating and Cooling, Expansion and Contraction

Activity 6.1: Candy in Hot and Cold Water

Try doing this experiment: Fill two cups half full with water, one with hot water and one with cold water. Both cups should have the same amount of water. Drop identical pieces of hard candy into each cup. Do not stir the water. Wait and watch for about 10 minutes.



While you are waiting try making some predictions:

1. a. How do you think what happens in the two cups will be the same?

b. How do you think what happens in the two cups will be different?

c. Explain your predictions.

Continue on next page

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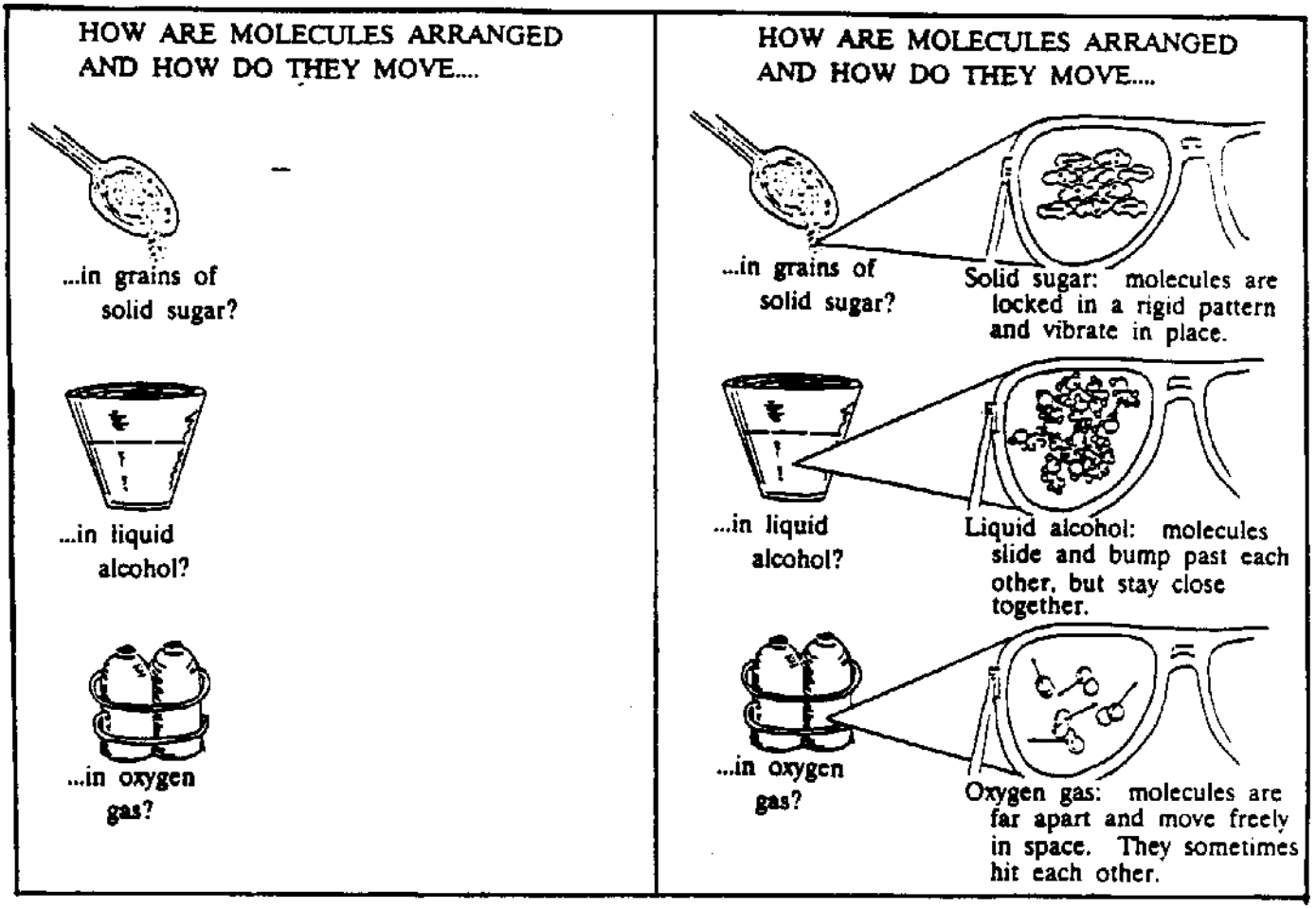
Lesson Cluster Review Questions and Tests: Monitoring and feedback. The last question set in each lesson cluster contains questions reviewing the content of the entire lesson cluster. If you grade those question sets, which are packaged separately so that they can be taken up or used as tests, you should be able to do an adequate job of monitoring the progress of individual students.

Your materials also include two tests, one covering Lesson Clusters 1-4, the second covering Lesson Clusters 5-9. Since each lesson cluster builds on ideas from previous lesson clusters, you should review or reteach ideas that your students are having trouble understanding, as revealed by their performance on the review question sets or the tests.

Overhead Transparencies: Discussing important questions. The unit also contains a set of overhead transparencies that are designed to help you develop class discussions about key ideas in the unit. These transparencies are listed immediately after the Table of Contents of this Teacher's Guide. Each transparency is illustrated and discussed at the lesson where we feel that it could appropriately be introduced. (Although we encourage you to use transparencies whenever you feel appropriate, several times, if necessary.)

Each of the transparencies has two layers. The bottom layer poses a question about a situation. You should encourage students to express their ideas about that situation and the answer to the question. After your students have tried to answer the question and you are aware of how they think, you can flip down the overlay to give them a scientific answer to the question.

You will find that your students' answers are sometimes very different from those in the science book. These differences are often the result of misconceptions that a surprisingly large number of students firmly believe. For the students to see the differences, it is essential for the students to have a chance to answer the questions and discuss the contrasts. Students must



TRANSPARENCY 4: HOW ARE MOLECULES ARRANGED AND HOW DO THEY MOVE?

Bottom Layer

Even though students have learned about how molecules move and how molecules are arranged in water, they often cannot transfer these ideas to other substances. Also, many students still have difficulty with movement of molecules in solids.

Overlay

You should contrast students' naive thinking with the overlay, which gives a scientific view of molecules. Emphasize that even though the molecules of one substance (like sugar) may be different than the molecules of another substance (like ice), the molecules are still arranged and move in the same way in the solid state. This is what makes substances solids, liquids, or gases. Pay particular attention to movement of molecules in solids, as student have difficulty with this concept.

Supplemental Activities

1. Look up the molecular formulas of other pure substances, such as propane gas, ammonia, salt, baking soda, and make or draw models of a molecule of each.
2. You can show that milk (and other substances) are mixtures by freezing them. The water freezes before other substances in the mixture freeze.

Teaching Suggestions:

Solid: Some students may think that molecules in solids are not moving or that molecules themselves are hard. You should help these students distinguish observable properties of substances from invisible properties of molecules. Use the transparency to elicit the students' ideas about the arrangement and movement of molecules before you use the overlay. Then contrast the students' thinking with the overlay.

In discussing the molecules of a solid, you might want to use the analogy of students in their seats in your class. The students are in their chairs (fixed position) but they are constantly moving within this place. They do not move past each other.

Liquid: You might want to continue the analogy by comparing the movement of molecules of a liquid with the students moving around the room before or after class. Students are not in a definite array or pattern but moving past each other in a random manner.

Gas: The student analogy of a gas would be students moving very far apart after school is out. They move freely in all directions. (School buses are not a good analogy.)