## Assessment Package

## Introductory Physical Science

WITH FORMATIVE ASSESSMENT


Uri Haber-Schaim
Peter Gendel
H. Graden Kirksey

Harold A. Pratt

# Introductory Physical Science (IPS) Assessment Package Eighth Edition 

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## Contents

Introduction ..... v
Answers to Chapter Tests ..... 1
Comments ..... 1
A Series
Test 1 ..... 2
Test 2 ..... 3
Test 3 ..... 5
Test 4 ..... 6
Test 5 ..... 7
Test 6 ..... 8
Test 7 ..... 10
Test 8 ..... 11
Test 9 ..... 12
Test 10 ..... 13
C Series
Test 1 ..... 15
Test 2 ..... 16
Test 3 ..... 17
Test 4 ..... 18
Test 5 ..... 19
Test 6 ..... 21
Test 7 ..... 22
Test 8 ..... 23
Test 9 ..... 24
Test 10 ..... 25
Lab Tests: Notes for Teachers
Two Liquids ..... 27
Polystyrene and Styrofoam ..... 28
The Sludge ..... 30
Evaporating Water Molecules ..... 31
Masters for Chapter Tests
A Series
Test 1 ..... 33
Test 2 ..... 38
Test 3 ..... 42
Test 4 ..... 47
Test 5 ..... 52
Test 6 ..... 57
Test 7 ..... 61
Test 8 ..... 65
Test 9 ..... 69
Test 10 ..... 73
C Series
Test 1 ..... 79
Test 2 ..... 84
Test 3 ..... 88
Test 4 ..... 92
Test 5 ..... 97
Test 6 ..... 102
Test 7 ..... 106
Test 8 ..... 110
Test 9 ..... 115
Test 10 ..... 119
Masters for Lab Tests
Two Liquids ..... 125
Polystyrene and Styrofoam ..... 126
The Sludge ..... 127
Evaporating Water Molecules ..... 128

## Introduction

## General

The Chapter Tests and Lab Tests in this package are intended to help you assess the progress of your students in the course. For a discussion of the context in which the tests were written, please refer to the section on Assessing Achievement on page xvii of the Teacher's Guide and Resource Book.

## A Different Kind of Multiple-Choice Question

The multiple-choice questions in this volume are different from those you usually see. All too often, multiple-choice questions contain no explicit question; all the students are required to do is to "fill in the blank." Such "questions" provide no information about the students' thinking. However, multiple-choice questions can test for understanding and the ability to apply knowledge to new situations if they are constructed properly.

Good multiple-choice questions are bona-fide questions that do not require looking at the choices to find the answer. Students should approach each question as if it were an essay question, first composing an answer and only afterward looking for their answer among the choices. When the presented choices reflect common errors or misconceptions, then even wrong answers have a concrete diagnostic value. Consider the following example:

An empty container has a mass of 3.0 g . When it is filled with $5 \mathrm{~cm}^{3}$ of a liquid, the total mass of container and liquid is 7.0 g . What is the density of the liquid, in grams $/ \mathrm{cm}^{3}$ ?
A. $\frac{5}{3}$
B. $\frac{3}{5}$
C. $\frac{5}{4}$
D. $\frac{4}{5}$
E. $\frac{7}{5}$

A student answering the question correctly will subtract the mass of the empty container from the combined mass of the container and liquid and then divide by the volume of the liquid. Several common mistakes can be anticipated: Students may use the mass of either the empty container or the combined mass, or they may invert the fraction. Several such options are provided in the choices.

To see for yourself to what extent the IPS Chapter Tests live up to this standard, see whether the questions can be answered without reading the choices. Then ask yourself what mistakes your students are likely to make, and check to see whether at least some of these mistakes are reflected in the choices.

Multiple-choice questions take less time to answer and less time to grade than essay questions. Therefore, more material can be covered in a given time. These are their strengths; their weaknesses are that they give only indirect information about students' thinking processes, and they provide no outlet for creativity.

The first weakness has been significantly ameliorated through our selectivity in choosing the questions, as described above. To address the second weakness, we have included two essay questions in each of the chapter tests.

## Essay Questions

If you wish to see further expressions of your students' thought processes, the IPS testing package gives you a number of options. First, you can request that each student write a rationale for his or her choice for one or two of the multiple-choice questions. Second, you can convert selected multiple-choice questions into essay questions simply by covering the choices before you reproduce the test for class use. If you do that, be sure to announce beforehand that these questions should be answered in detail, with all the work shown, in a
sequence of complete sentences.
Of course, essay questions take more time to complete than multiple-choice questions. In their present form, the chapter tests can be completed in one period. If too many questions are changed to essay form, more time may be needed.

We recommend that the tests be given as open-book and open-notebook tests. The positive effect of open-notebook tests on students' study habits has been widely demonstrated. Any students who think that the availability of open notebooks and open books means that they will not have to study regularly will recognize their mistake after the very first test.

## The A Series and the C Series

The IPS course was designed for and is being used by a broad spectrum of students. The relative emphasis on the development of generalizations and concrete experiences varies from class to class. In some classes more emphasis is placed on developing students' ability to generalize from their experience in the classroom; in other classes the learning is directed more to the concrete.

The A Series is more in tune with the first emphasis; the C Series, with the second. As these are subtle distinctions, it should not be surprising that some questions are common to both sets of tests. Nevertheless, the C Series is considered to be easier.

Both test series were designed to provide the broadest possible spread. They were not designed to be graded on a fixed percent basis, i.e., $90 \%$ is an A, $80 \%$ is a B, etc. The best way to evaluate the test results is to use the class average for correct responses as the basis for an average grade. You may want to caution your students not to expect the same percentages of right answers as they are accustomed to with other multiple-choice tests.

## The Diagnostic Analysis Software

In principle, you can keep a handwritten record of the number of students who choose each option in any given multiple-choice question. In practice, this is so time-consuming that you will probably never do it, and will thus lose important information that the tests are able to provide. This is where the Diagnostic Analysis software can help. It provides you with a comprehensive analysis of the state of understanding of each individual in the class, as well as of the class as a whole. Since there is a test for each chapter, and the chapters progress in a logical sequence, you can also use the Diagnostic Analysis software as a tool for formative assessment. It will point out what problems students have and thus suggest how you might modify your teaching strategies.

The Diagnostic Analysis software provides individual scores, class results, and a diagnostic interpretation of many of the incorrect choices in the manner demonstrated in the example provided above under the heading "A Different Kind of Multiple-Choice Question." The output of the comments is available in two forms, as a Class Report and as an Individual Report. The Class Report will help you recognize where the trouble-spots are because it lists all the comments associated with incorrect choices made by at least $10 \%$ of the class. Individual Reports are useful in discussions with individual students or their parents.

The software prints answer sheets for each test, which makes data entry from the keyboard extremely fast. A master copy of the answer sheets for all the tests is included at the back of this Assessment Package.

As a bonus, you can also use the Diagnostic Analysis software to analyze test questions you write yourself provided that some of the options have a diagnostic value.

## The Lab Tests

Many of the questions on the Chapter Tests relate to experiments; however, no pencil-and-paper test can take the place of an authentic hands-on test. In fact, you may find that the
students who do well on the lab tests are not necessarily the same ones who do well on the Chapter Tests. Like the Chapter Tests, these Lab Tests can help you judge the effectiveness of your teaching.

A statement of the problem to be solved in the laboratory accompanies the teacher's notes on each test. Enlarged masters to be duplicated for the students are found on pages 125-128. You may wish to distribute the Lab Tests one day in advance so that students will have time to plan their investigations.

When you distribute the Lab Tests, tell your class what resources will be available to them. In addition to the standard IPS equipment and materials, students should be allowed to use their textbooks and notebooks. The investigations reflect the practices of the real world when references are available and the emphasis is shifted from memory work to practical and reasoning skills.

Inform your students that their work will be evaluated on the basis of the skills they show in the laboratory and the reasoning they apply to the investigation. Make it clear that the evidence they offer to support their conclusions is far more significant than any lucky guess.

The tests on Two Liquids and Polystyrene and Styrofoam are best given after Chapter 3. We recommend using only the Two Liquids for grading purposes. The Polystyrene and Styrofoam test is more suitable as an extra-credit assignment. (See the Teacher's Notes for Polystyrene and Styrofoam.) In any case, we do not recommend assigning both of these tests to the same students.

The Sludge test may be administered any time after the end of Chapter 5, or as part of a mid-year exam. If you administer The Sludge test after Chapter 8, some students may wish to use the flame test as a tool. The remaining lab test, Evaporating Water Molecules, may be given after Chapter 9. Depending on how far you proceed in the course, you may wish to use either of the last two tests as part of a final examination.

July 2005
Uri Haber-Schaim
Peter Gendel
H. Graden Kirksey

Harold A. Pratt

# Answers to Multiple-Choice Questions and <br> Suggestions for Evaluating Answers to Short Essay Questions 

This section contains the answer key to all of the multiple-choice questions, as well as a brief rationale for answers. The interpretation of many of the wrong choices is provided by the Diagnostic Analysis Software.

As many of the short essay questions are open-ended, attention is called to the main points that should be covered in the answers.

## A Special Note on Test 1 in Both the A Series and the C Series:

To accommodate the users of single-pan balances and electronic balances, Test 1, in both series, contains technical questions directed specifically at users of each kind of balance. If your students use only one kind of balance, you may wish to advise them to skip the questions provided for users of the other two kinds. The specific questions are listed below:

A Series
12, 13 for users of single-pan balances
11, 14 for users of electronic balances
C Series
12 for users of single-pan balances
13 for users of electronic balances

Some general questions related to mass have purposely not been included in this short list, although they may contain references to an IPS balance or a single-pan balance.

# Introductory Physical Science (IPS) Lab Tests for the Eighth Edition 

## Two Liquids

## TO THE STUDENT:

You are given two samples of liquids. Are they the same substance? Give as much evidence as you can to support your answer.

## Teacher's Notes

The conceptual part of this test is rather straightforward: That two samples constitute different substances requires only that they differ in one characteristic property. The two properties that come to mind here are density and boiling point. The challenge is in the execution of the measurements because the differences are small.

The two recommended substances are the following solutions:
A: 5.0 g of table salt in $100 \mathrm{~cm}^{3}$ of water
B: $\quad 17.5 \mathrm{~g}$ of table salt in $100 \mathrm{~cm}^{3}$ of water
Both solutions can be colored in the same way, making the test more exciting without affecting the results. You can add between one and four drops of food coloring (McCormick green works well) or about $0.2-0.4 \mathrm{~g}$ of potassium dichromate to $100 \mathrm{~cm}^{3}$ of the solutions.

Prepare enough material to give each station $20 \mathrm{~cm}^{3}$ of each sample. However, to encourage individual work, do not give all stations a sample of each liquid. Give some stations two samples of liquid A; others, two samples of liquid B; and some, one of each.
Sample Data
Liquid A Liquid B
Mass
9.55 g
9.80 g

Volume
$9.2 \mathrm{~cm}^{3}$
$8.8 \mathrm{~cm}^{3}$
Density
Boiling point
$1.04 \mathrm{~g} / \mathrm{cm}^{3}$
$101^{\circ} \mathrm{C}$

The density is calculated to three significant digits because the volume is known to almost $1 \%$, and giving the density to only $10 \%$ would be throwing away information. The boiling point will vary with atmospheric pressure.

Since the liquid is a solution, the boiling temperature is going to rise slowly as the water boils away. However, for a reduction in the volume of liquid of $10 \%$, the effect will be very small.

What to look for in students' papers

