Chapter 3

PERFORMANCE ON ITEMS WITHIN EACH SCIENCE CONTENT AREA

This chapter presents four to six example items within each of the science content areas, including the performance on these items for each of the TIMSS countries. The example items were selected to illustrate the different topics covered within each content area as well as the different performance expectations. The items also were chosen to show the range of item formats used within each area. To provide some sense of what types of items were answered correctly by higher-performing as compared to lower-performing students, the items show a range of difficulty within each content area. Finally, it should be noted that all these items and others have been released for use by the public.[1]

The presentation for each of the content areas begins with a brief description of the major topics included in the content area and a discussion of student performance in that content area. The discussion is followed by a table showing the percent correct on the example items for each of the TIMSS countries at both the seventh and eighth grades. After the table showing the country-by-country results, there is a figure relating achievement on each of the example items to performance on the TIMSS international science scale. This "difficulty map" provides a pictorial representation of achievement on the scale in relation to achievement on the items. Following the difficulty map, each item is presented in its entirety. The correct answer is circled for multiple-choice items and shown in the answer space for short-answer items. For extended-response questions, the answer shown exemplifies the type of student responses that were given full credit. All of the responses shown have been reproduced from students' actual test booklets.

WHAT HAVE STUDENTS LEARNED ABOUT EARTH SCIENCE?

Items in the earth science category measure students' knowledge of the scientific principles related to earth features, earth processes, and the earth in the universe. Table 3.1 shows the percent correct across the TIMSS countries for each of five example items (Example Items 1 - 5).

The international item difficulty map shown in Figure 3.1 presents a pictorial representation of the relationship between performance on the TIMSS international science scale and achievement on the five example items for earth science.[2] The international achievement on each example item is indicated both by the seventh- and eighth-grade international average percent correct and by the international

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[1] The IEA retained about one-third of the TIMSS items as secure for possible future use in measuring international trends in mathematics and science achievement. All remaining items are available for general use.

[2] The three-digit item label shown in the lower right corner of the box locating each example item on the item difficulty map refers to the original item identification number used in the student test booklets.

Table 3.1

Percent Correct for Earth Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 1A River on the plain: Good place for farming.		Example 1B River on the plain: Bad place for farming.		Example 2 Fossil fuels.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	83 (1.4)	86 (1.8)	60 (2.3)	57 (3.2)	67 (2.8)	70 (3.5)
† Belgium (Fr)	53 (2.2)	62 (2.8)	30 (2.4)	34 (2.3)	39 (3.0)	47 (3.2)
Canada	83 (1.2)	88 (1.1)	44 (1.9)	47 (1.8)	67 (2.6)	69 (2.4)
Cyprus	76 (1.9)	77 (1.8)	21 (1.7)	23 (1.8)	42 (3.1)	33 (2.7)
Czech Republic	80 (2.1)	84 (1.9)	35 (2.0)	42 (2.5)	41 (3.3)	60 (3.1)
†2 England	91 (1.4)	92 (1.5)	68 (2.8)	74 (2.2)	76 (2.8)	85 (2.6)
France	67 (2.0)	76 (1.8)	30 (1.9)	37 (2.4)	36 (2.7)	61 (2.1)
Hong Kong	65 (2.1)	70 (2.0)	29 (2.0)	42 (2.4)	73 (3.1)	74 (2.6)
Hungary	73 (1.9)	77 (1.7)	39 (2.1)	45 (1.9)	42 (2.4)	55 (2.9)
Iceland	71 (2.5)	81 (2.2)	24 (2.5)	26 (2.9)	42 (3.9)	46 (6.4)
Iran, Islamic Rep.	81 (2.3)	82 (1.6)	19 (3.9)	25 (2.0)	68 (3.0)	75 (2.8)
Ireland	89 (1.5)	91 (1.2)	73 (2.0)	71 (1.8)	84 (2.4)	87 (2.3)
Japan	90 (1.0)	91 (0.7)	25 (1.3)	25 (1.3)	49 (2.1)	53 (2.3)
Korea	91 (1.0)	92 (1.2)	27 (2.0)	35 (2.1)	75 (2.4)	84 (2.2)
1 Latvia (LSS)	73 (1.9)	71 (2.2)	25 (1.9)	30 (2.1)	37 (3.0)	46 (3.6)
1 Lithuania	62 (2.7)	68 (1.9)	25 (1.9)	39 (2.4)	37 (3.3)	34 (3.4)
New Zealand	87 (1.2)	89 (1.3)	62 (1.7)	68 (1.8)	46 (2.9)	60 (2.1)
Norway	83 (2.0)	86 (1.3)	39 (2.6)	42 (1.8)	55 (3.1)	69 (2.6)
Portugal	67 (1.8)	79 (1.6)	14 (1.2)	24 (1.6)	76 (2.3)	78 (2.3)
Russian Federation	70 (1.9)	74 (1.6)	34 (2.0)	39 (2.3)	56 (3.3)	62 (3.3)
† Scotland	77 (1.8)	81 (1.7)	51 (2.2)	52 (2.0)	57 (2.8)	65 (2.8)
Singapore	91 (1.4)	94 (0.8)	52 (2.4)	62 (1.9)	83 (2.3)	85 (1.6)
Slovak Republic	79 (1.6)	83 (1.8)	39 (2.0)	40 (2.1)	34 (3.0)	55 (3.0)
Spain	81 (1.3)	87 (1.2)	33 (1.5)	35 (1.8)	60 (2.6)	73 (2.2)
Sweden	80 (1.7)	83 (1.4)	34 (2.3)	44 (2.0)	64 (2.8)	70 (2.0)
1 Switzerland	79 (1.7)	81 (1.5)	45 (1.8)	53 (1.6)	48 (2.7)	52 (2.5)
† United States	88 (1.4)	91 (0.8)	56 (1.7)	58 (1.7)	65 (3.1)	71 (2.0)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	81 (1.5)	83 (1.4)	55 (1.7)	58 (1.8)	54 (2.3)	62 (2.2)
Austria	74 (2.3)	78 (2.0)	39 (2.2)	44 (2.3)	70 (2.9)	83 (2.2)
Bulgaria	70 (2.8)	65 (3.9)	28 (2.5)	36 (3.5)	65 (4.2)	68 (3.8)
Netherlands	73 (1.8)	78 (2.3)	55 (2.2)	54 (2.5)	61 (3.4)	71 (3.7)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	54 (3.0)	62 (3.0)	22 (2.1)	26 (2.0)	46 (3.5)	51 (3.7)
†1 Germany	71 (2.2)	72 (2.1)	44 (1.9)	47 (3.0)	56 (2.8)	59 (3.1)
Romania	64 (2.2)	68 (2.3)	28 (2.2)	33 (2.5)	55 (2.8)	71 (2.7)
Slovenia	86 (1.4)	90 (1.2)	46 (2.2)	49 (2.1)	64 (2.7)	82 (2.4)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	55 (2.7)	62 (2.2)	25 (2.4)	29 (2.3)	38 (3.2)	46 (3.2)
Greece	76 (1.8)	86 (1.2)	22 (1.3)	31 (1.8)	18 (1.7)	29 (2.6)
† South Africa	42 (2.7)	38 (2.5)	12 (1.8)	14 (2.0)	27 (2.3)	24 (2.4)
Thailand	94 (0.7)	95 (0.7)	72 (1.7)	75 (1.6)	44 (2.6)	58 (2.6)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	84 (2.4)	–	35 (3.8)	–	54 (4.1)
Kuwait	–	59 (4.3)	–	20 (2.6)	–	55 (3.8)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.1 (Continued)

Percent Correct for Earth Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 3 Ozone layer.		Example 4 Diagram of Earth's water cycle.		Example 5 Gases in air.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	40 (2.7)	47 (3.1)	56 (2.2)	60 (3.4)	10 (1.9)	17 (2.1)
† Belgium (Fr)	38 (3.2)	48 (3.5)	24 (2.1)	32 (2.0)	22 (3.1)	20 (4.5)
Canada	53 (2.5)	63 (2.2)	36 (1.8)	39 (1.7)	9 (1.0)	21 (2.0)
Cyprus	25 (2.5)	42 (3.0)	17 (1.7)	24 (2.0)	23 (2.9)	33 (3.3)
Czech Republic	62 (3.7)	74 (2.7)	22 (2.3)	27 (2.9)	55 (3.1)	38 (3.8)
†2 England	35 (2.7)	38 (3.1)	44 (2.4)	53 (2.3)	21 (3.7)	17 (2.6)
France	29 (2.7)	42 (3.0)	25 (1.7)	32 (1.9)	11 (1.8)	13 (2.0)
Hong Kong	47 (3.3)	56 (3.2)	23 (1.9)	25 (1.7)	21 (2.3)	50 (3.3)
Hungary	52 (2.5)	63 (2.7)	24 (1.8)	22 (1.6)	42 (3.0)	43 (3.0)
Iceland	47 (3.6)	56 (4.2)	25 (2.8)	33 (3.3)	3 (1.1)	14 (2.3)
Iran, Islamic Rep.	16 (2.5)	20 (3.0)	15 (4.3)	11 (1.4)	7 (1.6)	4 (1.3)
Ireland	39 (2.4)	53 (3.1)	41 (2.1)	51 (2.2)	16 (2.3)	30 (3.0)
Japan	45 (2.2)	60 (2.0)	35 (1.5)	43 (1.6)	57 (2.2)	54 (2.2)
Korea	45 (2.9)	57 (2.5)	26 (1.6)	23 (1.7)	59 (3.2)	41 (3.2)
1 Latvia (LSS)	20 (2.5)	36 (3.4)	20 (1.9)	19 (2.0)	13 (2.5)	18 (2.6)
1 Lithuania	20 (2.7)	38 (3.6)	8 (1.2)	9 (1.4)	10 (1.9)	22 (2.7)
New Zealand	53 (2.9)	64 (2.7)	25 (1.9)	29 (1.9)	6 (1.1)	18 (2.2)
Norway	54 (4.6)	71 (2.5)	40 (3.3)	55 (2.0)	4 (1.1)	27 (2.7)
Portugal	40 (3.0)	50 (2.9)	17 (1.6)	24 (1.5)	17 (2.3)	8 (1.5)
Russian Federation	30 (3.1)	39 (3.3)	56 (1.8)	59 (2.0)	21 (2.4)	27 (3.4)
† Scotland	29 (2.3)	42 (2.7)	31 (2.4)	40 (2.2)	12 (2.3)	25 (2.9)
Singapore	71 (2.9)	78 (2.4)	45 (2.3)	57 (2.4)	72 (2.9)	58 (3.1)
Slovak Republic	67 (2.3)	71 (2.0)	24 (1.9)	25 (1.8)	51 (3.2)	32 (2.9)
Spain	63 (2.6)	68 (2.4)	24 (1.8)	34 (1.8)	9 (1.6)	9 (1.5)
Sweden	54 (2.9)	69 (2.0)	34 (2.0)	49 (2.0)	10 (1.9)	25 (2.5)
1 Switzerland	39 (2.9)	51 (2.6)	26 (1.6)	38 (1.9)	9 (1.4)	20 (2.5)
† United States	40 (3.7)	52 (2.7)	35 (2.4)	40 (2.3)	20 (2.6)	20 (1.8)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	45 (2.8)	51 (1.8)	26 (1.7)	33 (1.7)	16 (2.3)	16 (1.6)
Austria	54 (2.7)	65 (3.1)	31 (2.0)	43 (2.3)	13 (1.8)	42 (3.6)
Bulgaria	64 (5.0)	67 (3.7)	21 (2.5)	19 (2.8)	31 (4.7)	45 (5.1)
Netherlands	47 (3.7)	57 (4.1)	47 (2.5)	57 (2.7)	15 (2.1)	31 (3.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	51 (3.4)	55 (4.0)	12 (1.7)	15 (1.9)	–	–
†1 Germany	53 (3.2)	64 (2.9)	29 (1.9)	35 (2.5)	23 (2.6)	27 (3.2)
Romania	31 (2.4)	41 (3.0)	18 (1.8)	21 (2.0)	27 (3.0)	40 (2.9)
Slovenia	47 (3.2)	61 (2.8)	25 (2.0)	24 (1.9)	51 (3.6)	31 (3.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	24 (3.4)	29 (3.1)	27 (2.5)	39 (2.3)	10 (2.8)	11 (1.8)
Greece	40 (2.3)	56 (2.5)	16 (1.5)	17 (1.4)	26 (2.2)	34 (2.7)
† South Africa	10 (2.3)	6 (1.8)	7 (1.3)	6 (1.2)	16 (1.6)	11 (1.5)
Thailand	32 (2.6)	45 (2.6)	13 (1.4)	16 (1.4)	19 (2.5)	18 (2.3)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	63 (4.9)	–	17 (2.3)	–	33 (4.6)
Kuwait	–	65 (4.5)	–	25 (2.7)	–	37 (3.9)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
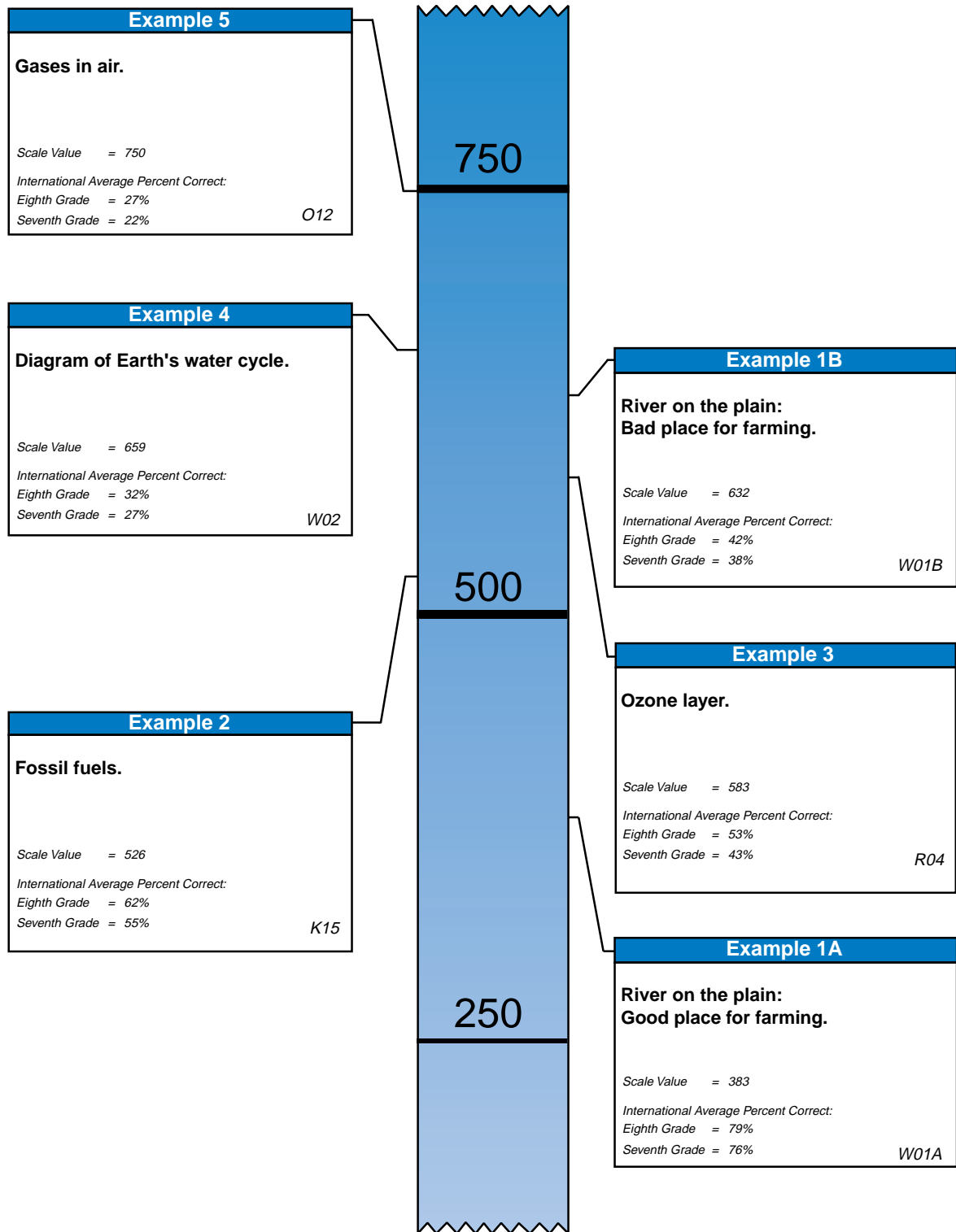
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade. Internationally comparable data are unavailable for Colombia on Example 5.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.1

**International Difficulty Map for Earth Science Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)**

Example 5

Gases in air.

Scale Value   = 750

International Average Percent Correct:
Eighth Grade   = 27%
Seventh Grade = 22%   *O12*

Example 4

Diagram of Earth's water cycle.

Scale Value   = 659

International Average Percent Correct:
Eighth Grade   = 32%
Seventh Grade = 27%   *W02*

Example 1B

**River on the plain:
Bad place for farming.**

Scale Value   = 632

International Average Percent Correct:
Eighth Grade   = 42%
Seventh Grade = 38%   *W01B*

Example 3

Ozone layer.

Scale Value   = 583

International Average Percent Correct:
Eighth Grade   = 53%
Seventh Grade = 43%   *R04*

Example 2

Fossil fuels.

Scale Value   = 526

International Average Percent Correct:
Eighth Grade   = 62%
Seventh Grade = 55%   *K15*

Example 1A

**River on the plain:
Good place for farming.**

Scale Value   = 383

International Average Percent Correct:
Eighth Grade   = 79%
Seventh Grade = 76%   *W01A*

750

500

250

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown
at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

science scale value, or item difficulty level, for each item. Since the scale was developed based on the performance of students at both grades in all countries, the international scale values apply to both grades and to all countries.

For the figure, the items results are placed on the scale at the point where students at the corresponding achievement level were more likely than not (65% probability) to answer the question correctly. Items at higher scale values are the more difficult items. For example, students scoring at or above 383 on the science scale were likely to correctly answer the question about advantages of farming by a river (Example Item 1A) but not the question about the source of fossil fuels (Example Item 2), while students scoring at or above 526 were also likely to answer this second item.

The international average on the science scale of 516 at the eighth grade indicates that students from many countries at this grade would be likely to correctly answer the lowest-difficulty items, such as Example Item 1A, but would not be likely to answer the more difficult items. These results, however, varied dramatically across countries. In Singapore, with an average scale value of 607, students were likely to respond correctly to more of the earth science example items than did students in other, lower-performing countries. This is reflected in Singapore's average percent correct at the eighth grade for the earth science items, which was 65% compared to 55% internationally.

The five earth science example items are presented in their entirety beginning on the next page. Example Item 1 asks students to apply scientific principles of water sources and physical cycles to explain why a plain containing a river might be both a good place (Part A) and a bad place (Part B) for farming. Most seventh- and eighth-graders were able to answer the first part of this open-ended item (international averages of 76% and 79%). Students were given credit for mentioning that the soil was fertile, good, or abundant; that the river would provide irrigation or water for animals; that there was plenty of space or flat areas for farmland; or any other acceptable reason related to facilitating farming. For the majority of countries, more than 70% of both seventh- and eighth-grade students provided a correct response, and several countries had more than 90% correct responses. Substantially fewer students were able to provide a correct response to the second part of this item. Reasons given credit for Part B included the possibility of flooding, wind or water erosion, or other acceptable problems related to farming. The international average percent correct levels were 38% and 42% for seventh and eighth grade. In addition, a much broader range of performance was observed across countries for this part of the item, with the percent of correct responses at the eighth grade ranging from 14% in South Africa to more than 70% in England, Ireland, and Thailand.

Example Item 2 is a multiple-choice item requiring knowledge of the source of fossil fuels. On average, 55% of seventh-graders and 62% of eighth-graders responded correctly to this item, but the across-country differences ranged widely. Eighth-grade students in several countries had 80% or more correct responses, with Ireland and England having two of the highest performances, together with Korea, Singapore,

Austria, and Slovenia. The across-grade differences for many countries were greater for Example Item 2 than Example Item 1, with fewer than half of seventh-grade students answering correctly in 17 countries.

Example Item 3 required students to write down a reason for the importance of the ozone layer. Internationally, about half of the students in both grades provided a correct response related to protection from the sun's ultraviolet radiation. Ultraviolet radiation did not need to be mentioned specifically; responses that included the idea of the ozone layer protecting humans from sunburn or skin cancer also were given credit. The between-grade increase in average percent correct, from 43% to 53%, represents one of the larger increases among the example items.

Example Item 4 is an extended-response item that required students to apply scientific principles and use a diagram to explain the earth's water cycle. A fully-correct response to this item needed to depict or otherwise indicate all three steps in the water cycle – evaporation, transportation, and precipitation. On average, students found this item to be rather difficult, with fewer than one-third in both the seventh (27%) and eighth grade (32%) providing a fully-correct drawing or diagram. For the majority of countries, performance at the eighth grade was not substantially better than at the seventh grade. The performance across countries ranged from less than 10% to 60%, with South Africa posting seventh- and eighth-grade percentages of 7% and 6% and Belgium (Flemish), percentages of 56% and 60%.

Example Item 5, requiring students to identify the most abundant gas found in air, was the most difficult earth science item. Only about one-quarter of students at either grade could identify the correct response of nitrogen gas (international averages of 22% and 27%). The most common misconception, chosen by more than 50% of students, was that oxygen is the most abundant gas in air. Performance patterns were very inconsistent for this item. The across-country performance varied dramatically at both grades, ranging from below 10% correct in several countries to 72% correct at the seventh grade and 58% at the eighth grade in Singapore. Across-grade comparisons revealed that in several countries, the seventh-grade students out-performed those in the eighth grade by a substantial margin.

River on the plain

The diagram shows a river flowing through a wide plain. The plain is covered with several layers of soil and sediment.

Farm   River Channel
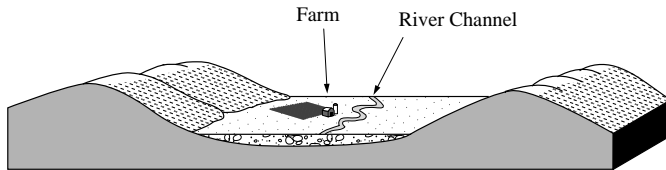
a.   Write down one reason why this plain is a good place for farming.

This is a good place because the soil is soft and fertile.

b.   Write down one reason why this plain is NOT a good place for farming.

This is not a good place because the river might flood.

Performance Category: Theorizing, Analyzing, and Solving Problems

Fossil fuels

Fossil fuels were formed from

A.   uranium

B.   sea water

C.   sand and gravel

D.   dead plants and animals

Performance Category: Understanding Simple Information

Ozone layer

Write down one reason why the ozone layer is important for all living things on Earth.

It protects a living thing from over-exposure to the sun's harmful rays.

Performance Category: Understanding Complex Information

Diagram of Earth's water cycle

Draw a diagram to show how the water that falls as rain in one place may come from another place that is far away.

wind blows clouds   clouds form

rain falls here

water evaporates

sea
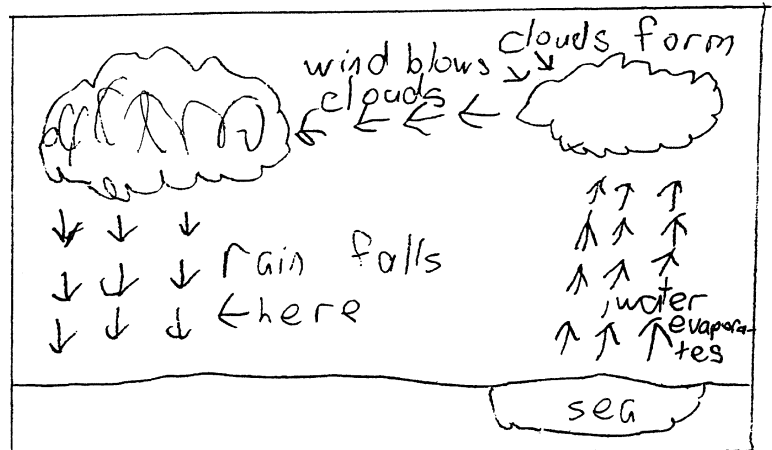
Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 5
EARTH SCIENCE

Gases in air

Air is made up of many gases. Which gas is found in the greatest amount?

A. Nitrogen

B. Oxygen

C. Carbon dioxide

D. Hydrogen

Performance Category: Understanding Simple Information

WHAT HAVE STUDENTS LEARNED ABOUT LIFE SCIENCE?

Items in the life science category cover a broad range of content areas related to the structure, diversity, classification, processes, cycles, and interactions of plant and animal life. To answer these items, students were required to demonstrate and apply their knowledge of both simple and complex information. The percent correct values for five example items (Example Items 6 - 10) illustrating the life science content area are shown in Table 3.2, and Figure 3.2 presents the international difficulty map for these items.

Nearly three-quarters of both the seventh- and eighth-grade students correctly answered Example Item 6 about the growth and development of trees (international averages of 72% and 74% at the seventh and eighth grades). Belgium (Flemish), Korea, the Slovak Republic, Austria, the Netherlands, and all three Scandinavian countries had 90% or more correct responses at both grades.

Explaining the importance of plants and light in an aquarium ecosystem in Example Item 7 was more difficult for students. On average, Part A of this item, related to the importance of plants, was answered correctly by more than half of both seventh- and eighth-grade students (58% and 64%), with the majority identifying oxygen production. However, responses that mentioned that plants clean the water, provide food for fish, or provide a place to hide or to hide eggs, or other appropriate benefits also were counted as correct. One-third or fewer of the students, on average, provided a correct explanation for the importance of light (26% and 33% for Part B), with these students most frequently referring to photosynthesis or energy production. Other more general responses, such as "it helps to keep the plants alive," also were given credit.

Example Item 8 also measures students' knowledge of photosynthesis. On average, about half of the students at both grades (50% and 54%) correctly identified the function of chloroplasts in plant cells. Students in Hong Kong, Japan, Korea, and the Russian Federation did particularly well (75% or greater in both grades). In general, there was little increase in performance between seventh and eighth grades on this item.

Internationally, fewer than half of the students at both grades selected the correct response to Example Item 9 about insect features (45% at seventh grade and 43% at eighth grade, on average). Across countries, the percent correct for eighth-graders ranged from 20% in Colombia to 82% in Japan. In many countries, seventh- and eighth-grade students performed similarly. In fact, in a few countries, seventh-grade students performed somewhat better than did eighth-grade students, most notably Belgium (Flemish).

Example Item 10 required students to design and communicate a scientific investigation in the area of human biology. More specifically, students were asked to investigate how the heart rate changes with changes in activity. Fully-correct responses described a procedure in which the pulse is measured at rest using a timer or watch, the individual does an exercise or engages in some type of physical activity, and then the pulse is remeasured during or after the exercise. Across countries, students found this item to

be quite difficult, with only 8% of seventh- and 14% of eighth-grade students, on average, providing a fully-correct extended response. A fully correct response required the student to include the use of a timer and describe the measurement of pulse rate both before and after exercise. In only seven countries did one-fourth or more of eighth-grade students receive full credit for their responses (Flemish-speaking Belgium, England, New Zealand, Scotland, Singapore, the Netherlands, and Israel).

Table 3.2

Percent Correct for Life Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 6 Tree rings.		Example 7A Aquarium: Importance of plant.		Example 7B Aquarium: Importance of light.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	95 (1.2)	92 (2.2)	62 (2.2)	75 (2.5)	26 (1.6)	43 (2.1)
† Belgium (Fr)	61 (3.5)	63 (3.5)	43 (2.8)	47 (2.4)	15 (1.6)	27 (2.2)
Canada	85 (1.5)	86 (1.7)	57 (1.7)	62 (1.6)	19 (1.7)	26 (1.5)
Cyprus	49 (2.7)	62 (3.1)	56 (1.9)	57 (1.7)	42 (2.2)	38 (2.4)
Czech Republic	89 (1.8)	88 (2.5)	69 (1.8)	74 (2.0)	34 (2.5)	42 (2.9)
†2 England	78 (3.1)	79 (2.6)	64 (2.2)	69 (2.5)	14 (2.1)	22 (2.1)
France	60 (2.6)	66 (2.5)	51 (2.4)	63 (1.7)	22 (1.6)	27 (2.0)
Hong Kong	38 (2.5)	39 (2.5)	33 (1.8)	53 (2.6)	10 (1.3)	26 (2.0)
Hungary	84 (2.0)	81 (2.4)	66 (1.8)	65 (2.2)	39 (2.0)	40 (2.2)
Iceland	84 (2.7)	90 (2.4)	42 (3.1)	61 (3.9)	7 (1.6)	17 (2.2)
Iran, Islamic Rep.	77 (3.1)	81 (3.1)	37 (2.1)	44 (2.6)	23 (2.7)	32 (2.7)
Ireland	88 (1.5)	89 (1.8)	51 (2.2)	60 (2.3)	11 (1.2)	22 (2.0)
Japan	89 (1.3)	88 (1.5)	82 (1.2)	85 (1.0)	56 (1.6)	56 (1.8)
Korea	93 (1.7)	95 (1.2)	55 (2.2)	67 (1.9)	48 (2.4)	56 (1.7)
1 Latvia (LSS)	80 (2.7)	87 (2.2)	48 (2.0)	53 (2.6)	8 (1.2)	13 (1.3)
1 Lithuania	76 (3.1)	85 (2.5)	40 (2.9)	57 (2.9)	23 (2.6)	38 (2.6)
New Zealand	87 (1.9)	86 (2.0)	69 (2.1)	78 (1.4)	10 (1.5)	20 (1.9)
Norway	94 (1.3)	96 (1.0)	66 (2.5)	72 (1.6)	18 (1.9)	35 (1.9)
Portugal	46 (3.0)	45 (2.8)	55 (2.2)	56 (1.8)	27 (2.0)	27 (1.8)
Russian Federation	87 (1.3)	89 (1.6)	52 (2.5)	65 (2.4)	30 (2.4)	41 (2.6)
† Scotland	79 (2.2)	81 (2.1)	44 (1.8)	54 (2.3)	6 (1.0)	13 (1.9)
Singapore	45 (2.7)	59 (2.7)	91 (1.4)	96 (0.7)	65 (2.7)	78 (2.0)
Slovak Republic	94 (1.2)	96 (0.9)	61 (2.9)	67 (2.8)	22 (1.9)	34 (2.5)
Spain	66 (2.5)	73 (1.9)	52 (1.8)	57 (2.1)	26 (1.7)	35 (1.9)
Sweden	90 (1.7)	93 (1.1)	62 (1.9)	68 (1.6)	17 (1.5)	24 (1.4)
1 Switzerland	87 (2.2)	86 (1.9)	66 (1.7)	73 (2.1)	16 (1.1)	33 (1.8)
† United States	76 (2.7)	81 (2.1)	61 (1.9)	63 (1.6)	21 (1.9)	26 (1.3)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	60 (2.2)	67 (2.0)	55 (1.9)	63 (1.5)	12 (0.9)	24 (1.4)
Austria	91 (1.7)	92 (2.0)	80 (1.9)	85 (1.8)	45 (2.7)	45 (2.8)
Bulgaria	88 (2.4)	87 (2.7)	65 (3.0)	66 (4.5)	53 (3.7)	55 (4.7)
Netherlands	92 (1.5)	95 (1.3)	63 (4.0)	70 (2.3)	18 (2.0)	27 (3.0)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	22 (3.3)	20 (3.0)	48 (3.2)	55 (3.4)	14 (2.2)	20 (2.3)
†1 Germany	85 (2.4)	87 (2.1)	72 (2.1)	74 (2.3)	38 (2.3)	43 (2.2)
Romania	58 (3.0)	59 (2.9)	50 (2.5)	62 (2.1)	30 (2.2)	43 (2.4)
Slovenia	87 (1.8)	90 (1.6)	75 (2.0)	74 (2.0)	36 (2.5)	45 (2.2)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	92 (1.7)	91 (1.8)	62 (2.6)	69 (2.4)	21 (1.9)	32 (2.1)
Greece	61 (2.4)	62 (2.5)	46 (1.9)	47 (1.6)	28 (2.0)	33 (1.8)
† South Africa	16 (2.7)	17 (2.9)	26 (2.1)	34 (2.8)	5 (0.8)	9 (1.7)
Thailand	40 (2.5)	48 (2.7)	77 (1.6)	79 (1.6)	45 (2.1)	49 (2.5)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	63 (2.8)	–	59 (3.0)	–	29 (2.9)
Kuwait	–	31 (4.1)	–	48 (4.2)	–	22 (3.0)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.2 (Continued)

Percent Correct for Life Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 8 Chloroplasts in cells.		Example 9 Insect features.		Example 10 Heart rate changes.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	46 (3.1)	65 (4.9)	62 (2.8)	50 (3.5)	16 (1.8)	27 (1.7)
† Belgium (Fr)	38 (2.6)	49 (3.2)	39 (3.4)	53 (3.2)	8 (1.6)	13 (1.4)
Canada	44 (2.0)	50 (1.9)	47 (1.8)	49 (2.3)	12 (0.9)	21 (1.6)
Cyprus	51 (2.4)	52 (2.5)	42 (2.4)	36 (3.1)	2 (0.6)	6 (1.1)
Czech Republic	51 (2.5)	64 (2.6)	52 (2.7)	47 (3.0)	12 (1.6)	19 (1.6)
†2 England	55 (3.2)	58 (3.3)	47 (3.7)	50 (3.4)	17 (1.9)	26 (2.3)
France	46 (3.4)	48 (3.0)	42 (2.7)	35 (2.8)	5 (0.9)	10 (1.2)
Hong Kong	85 (1.9)	86 (1.8)	62 (2.5)	57 (2.7)	5 (0.8)	6 (0.9)
Hungary	25 (2.5)	26 (2.9)	50 (2.8)	53 (2.6)	5 (0.8)	8 (1.1)
Iceland	42 (3.6)	63 (3.2)	37 (3.6)	31 (3.4)	4 (0.9)	8 (1.5)
Iran, Islamic Rep.	43 (4.3)	38 (3.5)	29 (3.3)	28 (3.0)	4 (0.9)	4 (1.1)
Ireland	41 (3.0)	47 (2.6)	29 (2.3)	35 (2.7)	8 (1.1)	16 (1.5)
Japan	85 (1.3)	89 (1.3)	69 (1.9)	82 (1.6)	15 (1.1)	20 (1.4)
Korea	78 (2.3)	86 (2.0)	79 (2.2)	74 (2.4)	23 (2.0)	23 (1.9)
1 Latvia (LSS)	33 (3.2)	39 (3.4)	29 (2.6)	44 (2.8)	2 (0.6)	3 (0.6)
1 Lithuania	55 (3.4)	66 (2.8)	19 (2.5)	41 (3.3)	2 (1.0)	5 (0.9)
New Zealand	42 (3.0)	48 (2.3)	52 (3.0)	56 (2.6)	16 (1.8)	26 (1.9)
Norway	37 (3.0)	43 (2.6)	51 (3.5)	57 (2.3)	9 (1.2)	24 (1.8)
Portugal	36 (2.6)	39 (2.2)	20 (2.1)	27 (2.5)	1 (0.3)	3 (0.6)
Russian Federation	75 (2.1)	79 (1.3)	34 (2.5)	53 (2.2)	3 (0.7)	5 (1.2)
† Scotland	40 (2.9)	49 (2.7)	34 (3.2)	36 (3.0)	14 (1.4)	25 (2.4)
Singapore	56 (2.8)	57 (2.7)	61 (2.7)	68 (1.9)	19 (1.9)	32 (1.8)
Slovak Republic	43 (2.5)	55 (2.3)	40 (2.2)	47 (3.0)	9 (1.1)	12 (1.4)
Spain	46 (2.2)	54 (2.4)	29 (2.5)	30 (2.1)	5 (0.8)	10 (1.1)
Sweden	50 (3.1)	67 (2.2)	51 (2.9)	61 (2.1)	7 (1.0)	18 (1.6)
1 Switzerland	47 (2.8)	48 (2.7)	47 (2.7)	49 (2.2)	8 (0.8)	14 (1.2)
† United States	52 (3.0)	54 (2.3)	45 (3.6)	44 (2.1)	11 (1.4)	14 (1.2)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	49 (2.7)	54 (1.9)	52 (2.7)	52 (2.3)	8 (0.8)	15 (1.2)
Austria	50 (3.2)	54 (3.2)	56 (2.9)	52 (3.1)	6 (1.0)	9 (1.3)
Bulgaria	57 (4.2)	58 (4.2)	34 (4.7)	42 (4.3)	8 (1.9)	7 (2.6)
Netherlands	68 (4.2)	72 (3.6)	55 (2.9)	53 (4.5)	13 (1.6)	25 (3.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	38 (3.6)	31 (2.8)	18 (2.6)	20 (2.5)	3 (1.0)	6 (2.1)
†1 Germany	48 (3.1)	60 (3.4)	47 (3.1)	54 (3.1)	10 (1.6)	16 (2.0)
Romania	54 (2.9)	48 (3.0)	30 (2.3)	33 (2.7)	4 (0.7)	9 (1.6)
Slovenia	67 (2.4)	72 (3.1)	38 (2.7)	45 (3.2)	15 (1.6)	20 (1.9)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	50 (3.4)	60 (3.3)	32 (2.7)	41 (3.4)	3 (0.9)	12 (1.8)
Greece	48 (2.7)	52 (2.8)	49 (2.8)	44 (2.6)	5 (0.7)	10 (1.0)
† South Africa	26 (2.0)	30 (2.4)	26 (2.7)	27 (2.5)	2 (0.6)	5 (1.4)
Thailand	48 (2.5)	47 (2.2)	44 (2.6)	43 (2.5)	4 (0.6)	18 (1.7)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	42 (4.4)	–	36 (4.0)	–	26 (3.0)
Kuwait	–	37 (3.6)	–	37 (3.8)	–	8 (1.1)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
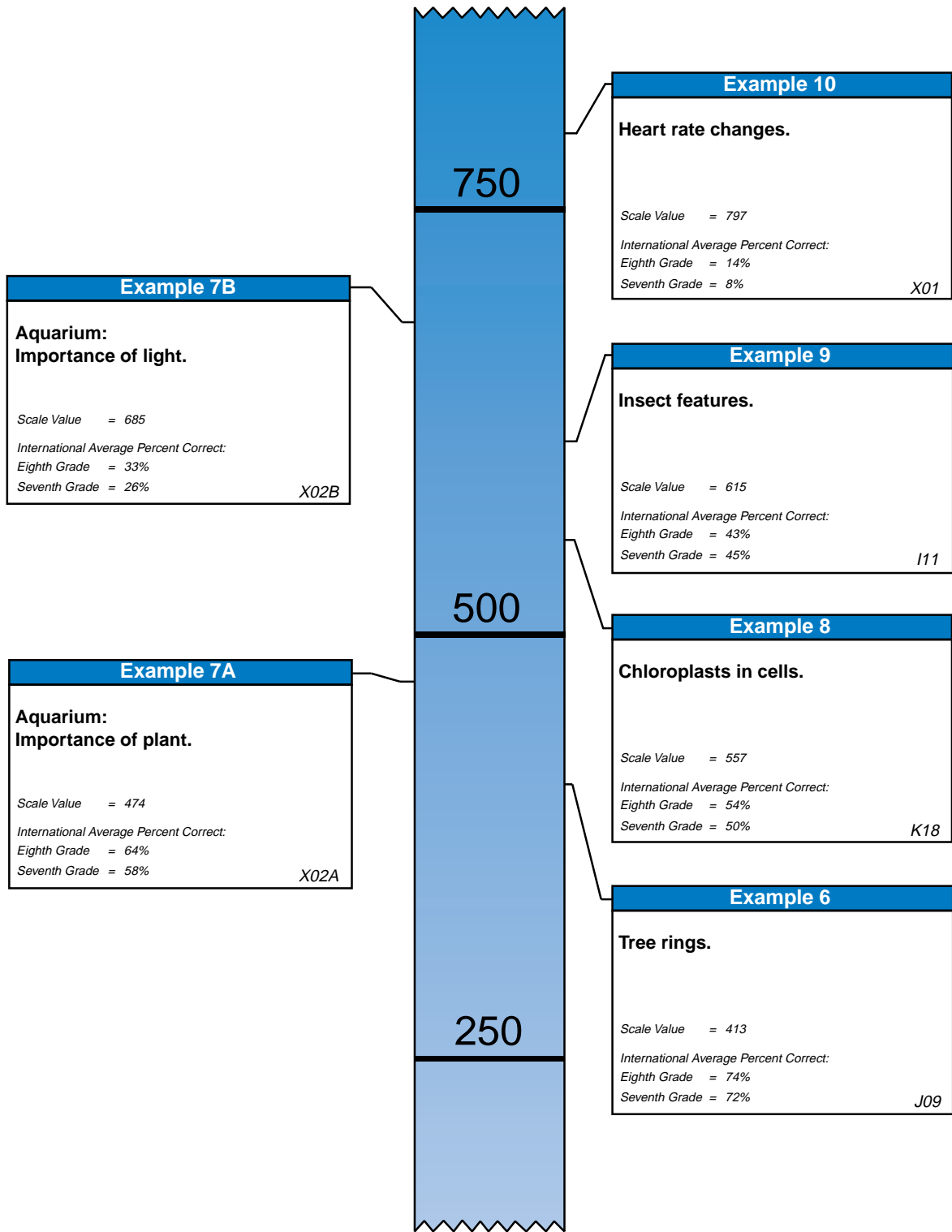
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.2

**International Difficulty Map for Life Science Example Items
Lower and Upper Grades (Seventh and Eighth Grades*)**

750

500

250

Example 10

Heart rate changes.

Scale Value   = 797

International Average Percent Correct:
Eighth Grade   = 14%
Seventh Grade = 8%   *X01*

Example 7B

**Aquarium:
Importance of light.**

Scale Value   = 685

International Average Percent Correct:
Eighth Grade   = 33%
Seventh Grade = 26%   *X02B*

Example 9

Insect features.

Scale Value   = 615

International Average Percent Correct:
Eighth Grade   = 43%
Seventh Grade = 45%   *I11*

Example 8

Chloroplasts in cells.

Scale Value   = 557

International Average Percent Correct:
Eighth Grade   = 54%
Seventh Grade = 50%   *K18*

Example 7A

**Aquarium:
Importance of plant.**

Scale Value   = 474

International Average Percent Correct:
Eighth Grade   = 64%
Seventh Grade = 58%   *X02A*

Example 6

Tree rings.

Scale Value   = 413

International Average Percent Correct:
Eighth Grade   = 74%
*Seventh Grade = 72%*   *J09*

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown
 at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

EXAMPLE ITEM 6
LIFE SCIENCE

Tree rings

How could you find out how old a tree is after it is cut?

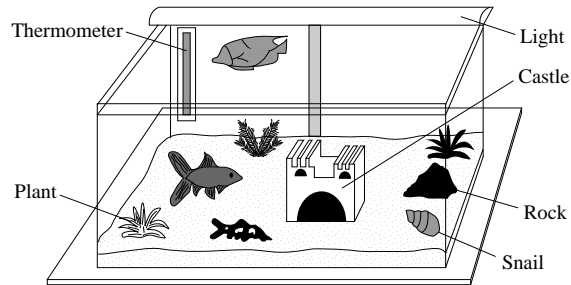You could find out how old a tree was after it is cut by counting the rings. Every ring equals one year
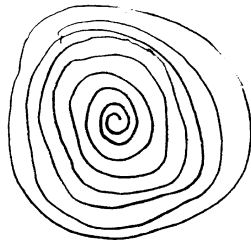
Performance Category: Understanding Complex Information

EXAMPLE ITEM 7
LIFE SCIENCE

Aquarium

In the picture of an aquarium, six items are labeled.

Thermometer — Light — Castle — Plant — Rock — Snail

Explain why each of the following is important in maintaining the ecosystem in the aquarium.

(a) the plant

to give off oxegn and take in carbon dioxide which the animals breath out

(b) the light

to help the plant make photosynthesis and make its own food

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 8
LIFE SCIENCE

Chloroplasts in cells

What is the main function of chloroplasts in a plant cell?

A.   To absorb light energy and manufacture food

B.   To remove waste materials by active transport

C.   To manufacture chemical energy from food

D.   To control the shape of the cell

Performance Category: Understanding Simple Information

EXAMPLE ITEM 9
LIFE SCIENCE

Insect features

What features do all insects have?

	Number of LEGS	Number of BODY PARTS
A.	2	4
B.	4	2
C.	6	3
D.	8	3

Performance Category: Understanding Complex Information

EXAMPLE ITEM 10
LIFE SCIENCE

Heart rate changes

Suppose you want to investigate how the human heart rate changes with changes in activity. What materials would you use and what procedures would you follow?

materials: stopwatch

procedures: I would have a person sit
and then take their pulse.
I would have the person walk, then take
their pulse again.
Finally, I would to have the person run
and take their pulse.
Each time I took their pulse times
I would time how many beats
per minute their heart was beating

Performance Category: Investigating the Natural World

WHAT HAVE STUDENTS LEARNED ABOUT PHYSICS?

Major topics covered by the physics items include different energy forms, physical transformations, forces and motion, and the properties of matter. Students were asked to solve problems and demonstrate their knowledge of scientific principles. Six example items (Example Items 11 - 16) are included to illustrate the range of item types and content areas as well as student performance in physics. The percent correct results for these items are shown in Table 3.3. The international difficulty map showing the physics example items is shown in Figure 3.3. The item positions and the international averages for correct responses indicate that for most countries, the majority of students had considerable difficulty on the more complex physics items.

Example Item 11 required extrapolating from a simple linear distance-versus-time graph, which proved to be an easy problem for most students. On average, more than three-fourths of the students across countries at both grades answered correctly (78% and 83%). Students' performance was quite high in most countries, with only three countries having performance below 50% at either grade – Kuwait (45%) at the eighth grade as well as Iran (47%) and Colombia (46%) at the seventh grade.

Students also did well on Example Item 12, which measured their knowledge of complete electronic circuits and conductive materials. The international average percent correct values of 69% and 78% at the seventh and eighth grades indicate a somewhat larger average between-grade difference than was generally observed. Several countries had a between-grade increase of 10% or more; the most notable was the increase from 48% to 74% for Portugal.

Student performance across countries on Example Item 13, measuring knowledge about the transmission of sound waves, averaged nearly 70% correct responses for both grades (67% and 70%). The variability across countries was moderately low on this item, with very few countries having percent correct levels below 60%. Korea and Japan had very high performances, with 88% to 90% correct at both grades.

Fewer students across countries demonstrated a knowledge of gravitational force as measured by Example Item 14. On average, only approximately half the students at either grade responded correctly (49% and 55%). The most commonly chosen incorrect option (B) reflected the misconception that the earth's gravitational force does not act upon a stationary object when it is on the ground. The top-performing country was the Czech Republic, where more than 80% of the students responded correctly at both grades.

Example Item 15 asked students to interpret data presented in a table to determine which of two machines would be more efficient. This is a relatively complex problem that required understanding the concepts of energy conversion and efficiency, recognizing and calculating the appropriate ratios, and explaining the results. In their explanations, students needed to choose machine A because it uses less gas per hectare, or to document this fact with the idea that 3/8 is less than 1/2, or a similar expression. On average, only 29% of seventh-grade and 36% of eighth-grade students answered correctly, and in only nine countries did half or more of the eighth-grade students give a fully-correct response.

Internationally, students also found Example Item 16 to be very difficult. This is a practical problem related to the nature of light requiring students to apply scientific principles to provide an explanation. Essentially, students needed to communicate that the same amount of light reaches the wall regardless of the distance the flashlight is from the wall. They may or may not have included the idea that the light becomes more or less spread out. On average, fewer than one-fourth of the students across countries correctly answered this item (18% and 23%). For most countries, performance at the eighth grade was not better than at the seventh grade. A common misconception identified in more than 30% of the student responses was that a larger area of illumination means there is more light.

Table 3.3

Percent Correct for Physics Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 11 Distance versus time graph.		Example 12 Light bulb in circuit.		Example 13 Sound in space.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	93 (1.5)	84 (5.2)	86 (2.0)	87 (2.8)	64 (3.4)	62 (3.3)
† Belgium (Fr)	86 (2.3)	86 (2.6)	54 (3.7)	62 (3.0)	66 (3.1)	74 (2.6)
Canada	88 (1.9)	92 (1.2)	76 (1.9)	79 (1.9)	71 (2.4)	72 (1.7)
Cyprus	53 (3.4)	64 (2.5)	64 (3.2)	73 (2.6)	57 (2.5)	62 (2.4)
Czech Republic	88 (2.0)	90 (1.7)	87 (1.6)	89 (1.4)	73 (1.9)	76 (2.8)
†2 England	87 (2.4)	88 (2.2)	89 (2.6)	90 (1.9)	76 (2.8)	76 (3.0)
France	90 (1.9)	97 (0.9)	67 (2.6)	79 (1.9)	70 (2.3)	72 (2.4)
Hong Kong	86 (2.2)	89 (1.7)	78 (2.7)	88 (1.7)	77 (2.1)	81 (2.2)
Hungary	81 (2.1)	83 (1.9)	74 (2.4)	85 (2.0)	73 (2.5)	82 (2.2)
Iceland	79 (3.6)	86 (3.1)	60 (4.3)	66 (4.2)	68 (4.3)	65 (4.8)
Iran, Islamic Rep.	47 (4.6)	65 (3.4)	59 (3.7)	59 (3.0)	62 (4.0)	65 (4.1)
Ireland	84 (2.1)	92 (1.4)	56 (2.4)	69 (2.6)	75 (2.4)	75 (2.3)
Japan	92 (1.0)	94 (0.9)	88 (1.6)	92 (1.1)	88 (1.4)	90 (1.2)
Korea	88 (1.7)	90 (1.7)	86 (1.9)	93 (1.3)	90 (1.7)	90 (1.5)
1 Latvia (LSS)	75 (2.6)	82 (2.6)	54 (3.3)	60 (3.5)	65 (3.2)	80 (2.9)
1 Lithuania	69 (3.1)	77 (2.9)	50 (3.4)	64 (3.0)	65 (3.3)	64 (2.9)
New Zealand	81 (2.2)	92 (1.6)	74 (2.5)	82 (1.7)	67 (2.8)	74 (2.0)
Norway	81 (2.9)	89 (1.8)	65 (3.6)	74 (2.4)	70 (2.7)	74 (2.6)
Portugal	72 (2.4)	89 (1.5)	48 (2.3)	74 (2.3)	57 (3.6)	71 (2.1)
Russian Federation	82 (2.2)	83 (2.4)	61 (2.5)	74 (2.3)	60 (3.3)	69 (2.4)
† Scotland	87 (1.7)	92 (1.5)	70 (2.4)	82 (2.6)	68 (2.6)	77 (2.2)
Singapore	94 (1.2)	96 (1.0)	95 (1.1)	97 (0.8)	66 (2.9)	86 (1.9)
Slovak Republic	78 (2.3)	86 (1.9)	83 (2.2)	91 (1.5)	71 (2.7)	73 (2.2)
Spain	78 (2.0)	85 (1.7)	77 (2.3)	82 (1.8)	63 (2.3)	69 (2.8)
Sweden	81 (2.4)	88 (1.6)	75 (2.7)	88 (1.8)	72 (2.3)	71 (2.3)
1 Switzerland	83 (2.2)	90 (1.5)	67 (2.4)	77 (2.1)	77 (2.2)	76 (2.3)
† United States	83 (1.6)	87 (1.8)	75 (2.3)	78 (2.0)	59 (3.0)	65 (2.6)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	87 (1.5)	90 (1.2)	73 (2.2)	83 (1.4)	69 (2.3)	73 (2.0)
Austria	78 (2.4)	87 (2.0)	84 (2.4)	91 (1.7)	76 (2.6)	80 (2.5)
Bulgaria	75 (4.5)	78 (2.5)	72 (2.9)	75 (3.1)	85 (3.2)	74 (4.4)
Netherlands	94 (1.3)	95 (1.7)	74 (3.0)	81 (4.1)	49 (3.4)	58 (3.4)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	46 (3.6)	59 (3.9)	47 (3.9)	63 (3.2)	51 (3.7)	52 (4.0)
†1 Germany	79 (2.6)	84 (2.3)	78 (2.5)	83 (2.7)	78 (2.1)	74 (2.4)
Romania	64 (2.3)	67 (2.6)	60 (3.0)	69 (2.6)	51 (2.7)	53 (2.8)
Slovenia	87 (2.0)	92 (1.4)	78 (2.2)	88 (1.7)	71 (2.5)	76 (2.5)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	80 (2.6)	86 (2.0)	60 (3.1)	74 (2.9)	61 (3.4)	60 (3.0)
Greece	60 (2.3)	71 (2.3)	62 (2.5)	69 (2.4)	72 (2.1)	82 (1.8)
† South Africa	57 (2.8)	59 (2.8)	28 (2.1)	42 (3.2)	29 (1.9)	32 (2.6)
Thailand	81 (2.2)	83 (1.6)	73 (1.9)	78 (1.7)	65 (2.1)	70 (2.0)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	83 (3.6)	–	86 (1.9)	–	76 (3.4)
Kuwait	–	45 (4.1)	–	65 (3.3)	–	64 (3.2)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.3 (Continued)

Percent Correct for Physics Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 14 Falling apple.		Example 15 More efficient machine.		Example 16 Flashlight shining on wall.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	63 (2.6)	62 (2.3)	44 (2.8)	49 (2.3)	22 (2.1)	31 (3.1)
† Belgium (Fr)	48 (3.4)	52 (3.3)	37 (3.3)	42 (3.2)	14 (2.8)	15 (2.2)
Canada	59 (2.4)	63 (2.7)	42 (2.2)	49 (2.2)	23 (2.1)	29 (1.7)
Cyprus	25 (2.2)	36 (2.6)	22 (2.1)	36 (2.6)	7 (1.6)	6 (1.4)
Czech Republic	84 (2.0)	81 (2.6)	34 (3.0)	48 (3.2)	12 (1.9)	23 (2.7)
†2 England	51 (3.4)	51 (3.4)	42 (3.3)	51 (4.1)	23 (3.3)	35 (3.6)
France	36 (2.7)	51 (3.0)	21 (2.7)	29 (2.4)	11 (1.9)	19 (2.3)
Hong Kong	69 (2.8)	74 (2.2)	17 (2.2)	26 (2.5)	14 (1.7)	17 (2.2)
Hungary	69 (2.6)	72 (2.3)	22 (2.3)	36 (3.0)	38 (3.0)	40 (2.7)
Iceland	41 (3.0)	40 (5.0)	22 (2.7)	33 (4.4)	11 (2.1)	14 (2.6)
Iran, Islamic Rep.	51 (4.5)	51 (3.6)	28 (2.7)	25 (3.4)	40 (3.0)	37 (2.8)
Ireland	49 (3.1)	55 (2.7)	41 (3.0)	54 (2.7)	18 (1.9)	21 (2.1)
Japan	59 (2.0)	58 (2.2)	30 (2.0)	36 (2.0)	27 (1.9)	37 (2.0)
Korea	63 (2.6)	72 (2.6)	46 (2.8)	47 (2.6)	38 (3.1)	37 (2.5)
1 Latvia (LSS)	35 (2.8)	41 (3.3)	10 (1.8)	18 (2.5)	15 (2.3)	20 (2.4)
1 Lithuania	46 (3.4)	61 (3.1)	6 (1.4)	13 (2.1)	8 (1.8)	13 (2.5)
New Zealand	47 (3.0)	54 (2.7)	37 (2.5)	49 (2.6)	28 (2.4)	31 (2.5)
Norway	43 (3.8)	49 (2.9)	20 (2.4)	37 (2.4)	19 (2.6)	25 (2.4)
Portugal	43 (3.0)	53 (2.7)	20 (2.3)	21 (2.4)	9 (1.5)	17 (2.1)
Russian Federation	48 (3.3)	42 (2.4)	21 (2.1)	25 (2.8)	11 (2.3)	10 (1.6)
† Scotland	39 (3.2)	48 (2.6)	40 (3.0)	51 (2.7)	19 (2.2)	22 (2.6)
Singapore	50 (2.8)	59 (2.4)	41 (3.5)	48 (2.7)	20 (2.4)	28 (2.4)
Slovak Republic	77 (2.4)	72 (2.5)	34 (2.6)	48 (2.8)	29 (2.4)	28 (2.4)
Spain	48 (2.5)	55 (2.4)	17 (2.0)	24 (2.1)	19 (2.2)	20 (2.2)
Sweden	37 (2.7)	59 (2.6)	25 (2.2)	42 (2.8)	26 (2.9)	29 (1.8)
1 Switzerland	42 (2.8)	53 (2.9)	33 (2.2)	50 (2.5)	11 (1.3)	11 (1.2)
† United States	55 (3.2)	64 (2.2)	36 (3.2)	48 (2.6)	21 (2.0)	27 (2.5)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	55 (2.9)	57 (2.0)	36 (2.5)	51 (2.1)	25 (2.1)	28 (1.6)
Austria	51 (3.3)	61 (2.9)	54 (3.1)	62 (3.2)	9 (1.9)	11 (2.3)
Bulgaria	37 (3.6)	41 (5.0)	25 (3.9)	19 (3.3)	38 (3.6)	29 (3.6)
Netherlands	41 (2.8)	58 (2.9)	50 (4.0)	58 (4.2)	22 (3.0)	30 (3.8)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	43 (3.2)	48 (3.6)	10 (1.7)	10 (2.1)	4 (1.2)	6 (1.2)
†1 Germany	46 (3.1)	55 (3.2)	37 (2.9)	42 (3.2)	16 (2.1)	22 (2.9)
Romania	46 (2.7)	50 (2.6)	16 (1.9)	19 (2.4)	14 (2.0)	15 (2.3)
Slovenia	53 (3.4)	57 (2.9)	41 (2.7)	52 (2.7)	18 (2.1)	27 (2.7)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	47 (3.8)	51 (3.3)	23 (2.6)	36 (3.3)	19 (2.3)	26 (2.7)
Greece	28 (2.1)	30 (2.2)	17 (1.8)	24 (2.2)	17 (1.7)	28 (2.7)
† South Africa	34 (2.4)	36 (2.5)	5 (1.5)	8 (1.8)	6 (1.1)	4 (1.2)
Thailand	59 (2.4)	57 (2.3)	3 (0.8)	5 (1.0)	4 (1.0)	5 (1.1)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	61 (2.9)	–	53 (3.9)	–	43 (5.2)
Kuwait	–	50 (4.1)	–	19 (4.0)	–	24 (3.0)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
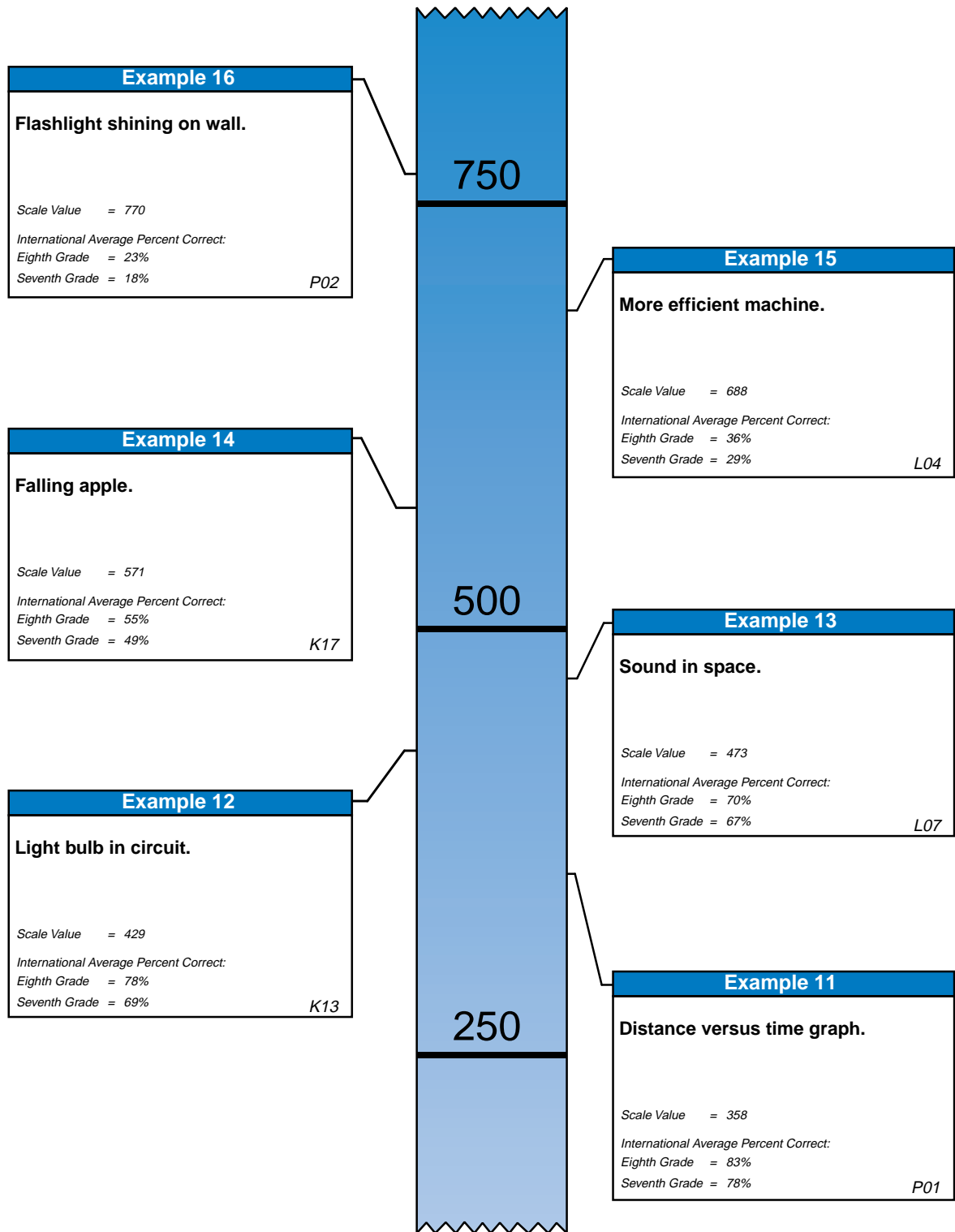
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.3

International Difficulty Map for Physics Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Example 16

Flashlight shining on wall.

Scale Value   = 770

International Average Percent Correct:
Eighth Grade = 23%
Seventh Grade = 18%

P02

Example 15

More efficient machine.

Scale Value   = 688

International Average Percent Correct:
Eighth Grade = 36%
Seventh Grade = 29%

L04

Example 14

Falling apple.

Scale Value   = 571

International Average Percent Correct:
Eighth Grade = 55%
Seventh Grade = 49%

K17

Example 13

Sound in space.

Scale Value   = 473

International Average Percent Correct:
Eighth Grade = 70%
Seventh Grade = 67%

L07

Example 12

Light bulb in circuit.

Scale Value   = 429

International Average Percent Correct:
Eighth Grade = 78%
Seventh Grade = 69%

K13

Example 11

Distance versus time graph.

Scale Value   = 358

International Average Percent Correct:
Eighth Grade = 83%
Seventh Grade = 78%

P01

750

500

250

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown
at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

Distance versus time graph

The graph shows the progress made by an ant moving along a straight line.
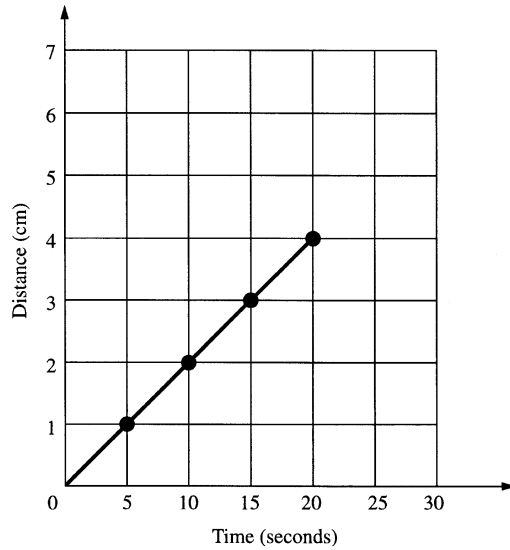
If the ant keeps moving at the same speed, how far will it have traveled at the end of 30 seconds?
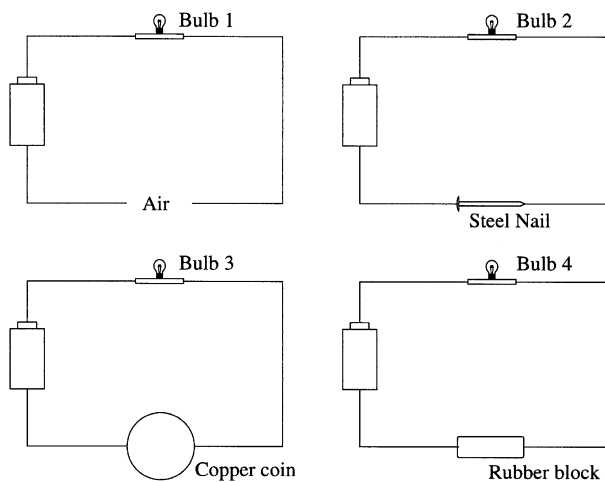
A.   5 cm

B.   6 cm

C.   20 cm

D.   30 cm

Performance Category: Using Tools, Routine Procedures, and Science Processes

EXAMPLE ITEM 12
PHYSICS

Light bulb in circuit

The following diagrams show a flashlight battery and a bulb connected by wires to various substances.

Which of the bulbs will light?

A.   1 and 2 only

B.   2 and 3 only

C.   3 and 4 only

D.   1, 2, and 3 only

E.   2, 3, and 4 only

Performance Category: Understanding Complex Information

EXAMPLE ITEM 13
PHYSICS

Sound in space

The crews of two boats at sea can communicate with each other by shouting. Why is it impossible for the crews of two spaceships a similar distance apart in space to do this?

A.   The sound is reflected more in space.

B.   The pressure is too high inside the spaceships.

C.   The spaceships are traveling faster than sound.

D.   There is no air in space for the sound to travel through.

Performance Category: Understanding Complex Information

EXAMPLE ITEM 14
PHYSICS

Falling apple

The drawing shows an apple falling to the ground. In which of the three positions does gravity act on the apple?

A.   2 only

B.   1 and 2 only

C.   1 and 3 only

D.   1, 2, and 3

Position 1

Position 2

Position 3
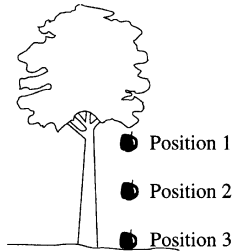
Performance Category: Understanding Simple Information

EXAMPLE ITEM 15
PHYSICS

More efficient machine

Machine A and Machine B are each used to clear a field. The table shows how large an area each cleared in 1 hour and how much gasoline each used.

	Area of field cleared in 1 hour	Gasoline used in 1 hour
Machine A	2 hectares	3/4 liter
Machine B	1 hectare	1/2 liter

Which machine is more efficient in converting the energy in gasoline to work? Explain your answer.

Machine A because it did double the amount of work but didn't use dob double the amount of gasoline.

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 16
PHYSICS

Flashlight shining on wall

A flashlight close to a wall produces a small circle of light compared to the circle it makes when the flashlight is far from the wall. Does more light reach the wall when the flashlight is further away?

___ Yes

✓ No   (Check one)

Explain your answer.

The same amount of light reaches the wall except when it is close it is all on a smaller area.

Performance Category: Theorizing, Analyzing, and Solving Problems

WHAT HAVE STUDENTS LEARNED ABOUT CHEMISTRY?

The chemistry items measured students' knowledge of topics related to chemical transformations as well as the chemical properties and classification of matter. The country-by-country results for the five example items (Examples 17 - 21) are shown in Table 3.4. The item difficulty map for the chemistry example items is portrayed in Figure 3.4. As discussed in Chapter 2, the items covering chemistry were the most difficult for students compared to the other science content areas (international averages correct across all chemistry items of 51% for eighth grade and 43% for seventh grade).

Both Example Items 17 and 18 required students to supply explanations that demonstrated knowledge of the necessity of oxygen for combustion, but performance was very different on the two items. On average, nearly 90% of both seventh- and eighth-grade students (86% and 89%) explained the loss of oxygen or air (using either scientific or non-scientific language) in Example Item 17, which directly indicates the isolation of the flame from the air in the provided diagram. In most countries, seventh- and eighth-grade students performed comparably, with all except Colombia and South Africa having more than 70% correct responses at both grades.

Compared to Example Item 17, Example Item 18 was more complicated, requiring students to explain that carbon dioxide in fire extinguishers displaces oxygen and prevents it from reaching the fire. As might be expected, this item was much more difficult for students, which is reflected in the international averages of 42% and 50%

correct responses for seventh and eighth grades. Across countries, correct responses on 70% or more of the items were achieved on average by eighth-grade students in England (71%), Singapore (70%), Sweden (70%), and Austria (74%). In general, the eighth-grade students performed better than the seventh-grade students, with the most notable increase observed in Scotland (40% to 59%).

Across countries, especially at the seventh-grade, students found Example Item 19 to be rather difficult. On average, 43% of the eighth-grade students across countries, but only 28% of the seventh-grade students, identified ion formation as the correct response. At both grades, about one-third of the students, on average, incorrectly identified the formation of molecules as the result of electron loss. Dramatic across-country variations in performance point to differences in the stage at which atomic structure is first introduced into the curriculum.[3] Many countries had relatively low performance in both seventh and eighth grades, indicating that this topic had not been taught by the eighth grade (Iceland, Norway, and Denmark, for example). For other countries, such as Lithuania and Greece, the substantial increases between seventh and eighth grades indicate curriculum coverage of this topic in the eighth grade. Topic coverage by the seventh grade is indicated by relatively high performances in both grades for several countries, including the eastern European countries of the Czech Republic, Hungary, the Slovak Republic, Bulgaria, Romania, and Slovenia.

In Example Item 20, students were required to use knowledge of the difference between chemical and physical transformations. International averages were low (26% and 31%), and only three countries had more than 50% correct responses at the eighth grade (Iran, Japan, and Singapore). The largest between-grade increase was seen for Japan, from 19% to 54%. As was observed with Example Item 19, Lithuania also had a substantial increase for Example Item 20, from 10% to 37%. Large between-grade differences for Lithuania are also reflected in their achievement on the overall science scale (Table 1.3) and on chemistry, in particular (Table 2.3).

Example Item 21 measured knowledge about the chemical make-up of cells. Internationally, students found this short-answer-format item to be quite difficult, with about one-third (32%) of the eighth-grade and only 21% of seventh-grade students providing the correct response, on average. The highest performance on this item was achieved in Bulgaria, with 50% of seventh- and 68% of eighth-grade students responding correctly. In a few countries, there were large increases in performance between the seventh and eighth grades. This was most pronounced for Singapore, with an increase from 21% to 66%.

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[3] These results are supported, in most cases, by review of the reports provided by NRCs for the Test-Curriculum Matching Analysis (Appendix B), identifying whether the topic covered by this item was in the intended curriculum at the seventh or eighth grade.

Table 3.4

Percent Correct for Chemistry Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Country	Example 17 Glass over candle flame.		Example 18 Carbon dioxide fire extinguisher.		Example 19 Atom loses electron.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	92 (1.7)	97 (1.3)	44 (2.8)	58 (4.1)	23 (2.2)	20 (2.7)
† Belgium (Fr)	87 (2.2)	84 (2.5)	30 (3.3)	33 (3.5)	19 (2.8)	25 (4.6)
Canada	91 (1.4)	93 (1.2)	52 (2.9)	61 (2.0)	19 (1.6)	25 (2.1)
Cyprus	78 (1.8)	82 (1.8)	29 (2.4)	41 (3.3)	19 (3.0)	22 (2.8)
Czech Republic	97 (0.9)	98 (1.0)	47 (3.3)	57 (2.8)	72 (2.4)	73 (3.0)
†2 England	92 (1.7)	97 (1.1)	59 (3.3)	71 (3.1)	14 (2.1)	28 (2.9)
France	85 (1.9)	86 (2.0)	34 (2.7)	50 (3.6)	18 (2.1)	40 (3.6)
Hong Kong	90 (1.7)	91 (1.9)	32 (2.6)	37 (2.6)	56 (2.6)	58 (2.2)
Hungary	94 (1.4)	98 (0.6)	60 (3.1)	62 (2.4)	67 (2.5)	73 (2.7)
Iceland	94 (1.7)	91 (2.6)	45 (4.0)	57 (4.5)	8 (2.0)	9 (2.5)
Iran, Islamic Rep.	93 (1.6)	94 (1.2)	63 (3.9)	63 (2.7)	19 (2.9)	40 (3.8)
Ireland	89 (1.8)	93 (1.5)	54 (2.7)	66 (3.2)	20 (2.4)	46 (2.9)
Japan	86 (1.6)	90 (1.2)	36 (1.9)	45 (2.0)	27 (2.0)	33 (2.0)
Korea	90 (1.8)	93 (1.3)	52 (2.4)	54 (2.5)	20 (2.1)	45 (3.0)
1 Latvia (LSS)	81 (2.4)	86 (2.8)	28 (3.0)	42 (3.0)	15 (2.1)	39 (3.0)
1 Lithuania	85 (2.2)	95 (1.7)	17 (2.7)	29 (3.2)	8 (1.9)	65 (3.4)
New Zealand	89 (1.9)	93 (1.3)	48 (3.1)	65 (2.4)	12 (1.9)	18 (2.2)
Norway	93 (1.8)	95 (1.1)	52 (4.3)	63 (2.2)	9 (1.7)	19 (1.9)
Portugal	77 (2.0)	89 (1.5)	24 (2.4)	35 (2.7)	19 (2.2)	68 (2.5)
Russian Federation	92 (1.4)	93 (1.5)	43 (2.5)	54 (3.2)	36 (3.0)	75 (2.4)
† Scotland	79 (2.1)	93 (1.4)	40 (2.6)	59 (3.5)	15 (1.9)	21 (2.1)
Singapore	92 (1.6)	96 (0.7)	56 (3.3)	70 (2.3)	23 (2.5)	51 (2.9)
Slovak Republic	96 (1.0)	95 (1.4)	48 (2.6)	46 (2.8)	69 (2.6)	77 (2.6)
Spain	85 (1.9)	89 (1.7)	36 (2.6)	43 (2.9)	51 (3.5)	70 (2.3)
Sweden	94 (1.2)	97 (0.9)	70 (2.7)	70 (2.3)	10 (1.8)	44 (3.1)
1 Switzerland	95 (1.0)	96 (1.0)	48 (2.6)	57 (2.5)	15 (1.7)	22 (2.2)
† United States	86 (2.0)	90 (1.3)	53 (3.0)	62 (2.7)	30 (2.8)	47 (2.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):						
Australia	89 (1.8)	91 (1.2)	57 (2.4)	61 (1.9)	13 (1.4)	31 (2.2)
Austria	95 (1.3)	95 (1.5)	63 (3.1)	74 (2.9)	64 (3.2)	64 (3.1)
Bulgaria	92 (2.7)	92 (2.5)	44 (4.5)	46 (4.0)	64 (3.5)	70 (4.4)
Netherlands	93 (1.7)	96 (1.3)	41 (3.4)	56 (3.3)	12 (2.1)	21 (3.2)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):						
Colombia	54 (3.1)	58 (3.1)	13 (2.4)	23 (4.1)	31 (3.6)	40 (4.1)
†1 Germany	92 (1.6)	92 (2.0)	62 (3.3)	69 (3.0)	24 (3.0)	38 (4.0)
Romania	84 (1.9)	87 (1.7)	34 (2.9)	33 (2.5)	60 (3.0)	74 (2.6)
Slovenia	97 (1.0)	99 (0.4)	49 (3.2)	52 (3.2)	81 (2.5)	80 (2.1)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):						
Denmark	90 (2.0)	97 (1.0)	21 (2.4)	33 (3.0)	8 (2.4)	17 (2.2)
Greece	79 (2.0)	86 (1.8)	31 (2.3)	37 (2.3)	15 (1.8)	53 (2.6)
† South Africa	35 (3.5)	35 (3.3)	12 (2.2)	15 (2.9)	14 (1.4)	13 (1.7)
Thailand	78 (2.0)	81 (1.8)	27 (2.7)	34 (2.4)	10 (1.2)	15 (1.6)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):						
1 Israel	–	82 (2.9)	–	63 (4.5)	–	72 (4.9)
Kuwait	–	71 (4.8)	–	49 (4.6)	–	31 (3.0)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

A dash (–) indicates data are not available. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.4 (Continued)

Percent Correct for Chemistry Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

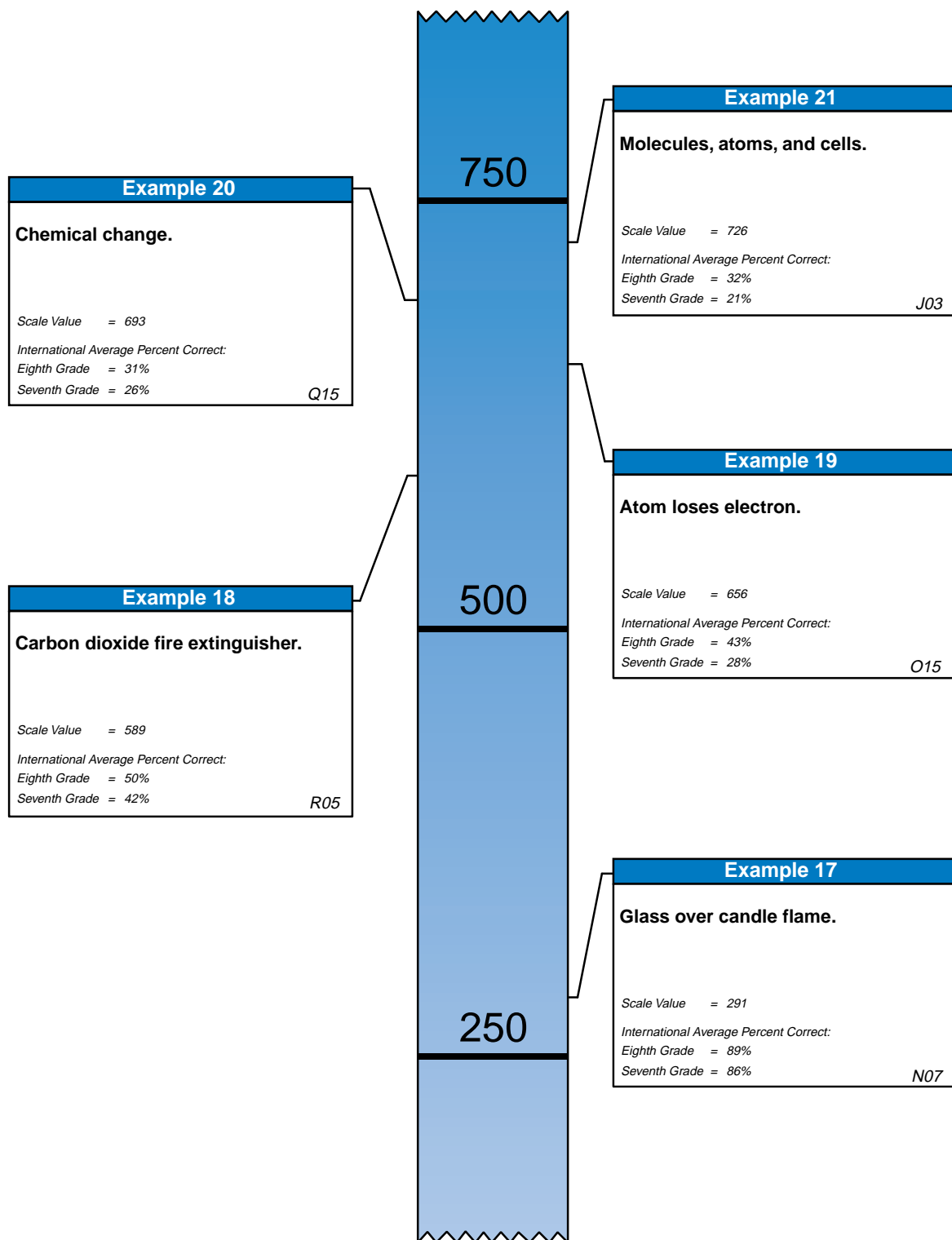| Country	Example 20 Chemical change.		Example 21 Molecules, atoms, and cells.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	25 (2.4)	31 (3.0)	17 (1.8)	19 (2.3)
† Belgium (Fr)	11 (2.2)	13 (1.9)	9 (1.7)	20 (2.8)
Canada	37 (2.1)	38 (2.6)	23 (2.3)	24 (1.6)
Cyprus	–	–	11 (1.6)	35 (2.9)
Czech Republic	31 (3.2)	34 (4.0)	32 (3.0)	43 (3.9)
†2 England	37 (3.4)	41 (3.5)	25 (2.9)	34 (3.0)
France	21 (2.1)	19 (2.8)	17 (2.0)	25 (2.6)
Hong Kong	24 (2.6)	30 (2.5)	26 (2.5)	32 (2.5)
Hungary	17 (2.1)	18 (2.2)	32 (2.2)	42 (3.1)
Iceland	21 (2.6)	20 (2.9)	9 (1.8)	12 (2.8)
Iran, Islamic Rep.	46 (2.8)	52 (2.5)	14 (2.2)	23 (2.4)
Ireland	35 (2.3)	39 (2.9)	25 (2.3)	25 (2.4)
Japan	19 (1.8)	54 (1.9)	32 (2.0)	47 (2.2)
Korea	24 (2.8)	48 (3.0)	17 (1.9)	30 (2.3)
1 Latvia (LSS)	15 (2.4)	26 (3.0)	12 (1.8)	38 (2.9)
1 Lithuania	10 (2.1)	37 (3.4)	14 (2.1)	39 (2.9)
New Zealand	33 (2.6)	42 (2.4)	16 (2.0)	27 (2.5)
Norway	6 (1.5)	12 (1.7)	12 (1.8)	29 (1.9)
Portugal	20 (2.1)	40 (2.7)	18 (1.7)	37 (2.4)
Russian Federation	15 (1.8)	31 (4.6)	41 (3.4)	53 (3.6)
† Scotland	24 (2.3)	33 (2.9)	21 (2.1)	27 (2.8)
Singapore	62 (3.0)	62 (2.1)	21 (2.2)	66 (2.6)
Slovak Republic	31 (2.1)	31 (2.4)	28 (2.3)	42 (2.6)
Spain	13 (1.9)	17 (2.2)	30 (2.4)	41 (2.2)
Sweden	16 (2.0)	22 (1.9)	21 (2.7)	39 (2.6)
1 Switzerland	19 (1.8)	25 (2.4)	9 (1.3)	20 (1.6)
† United States	40 (2.7)	43 (2.7)	27 (2.7)	29 (1.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):				
Australia	37 (2.4)	47 (2.3)	18 (1.4)	27 (2.0)
Austria	28 (2.4)	34 (3.5)	17 (2.2)	28 (3.6)
Bulgaria	33 (3.2)	33 (4.1)	50 (4.9)	68 (4.7)
Netherlands	31 (4.1)	35 (3.7)	15 (2.8)	24 (3.1)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):				
Colombia	17 (2.0)	18 (3.9)	17 (2.6)	21 (2.5)
†1 Germany	21 (2.4)	25 (2.7)	16 (2.1)	21 (2.5)
Romania	25 (2.2)	21 (2.4)	29 (2.5)	31 (3.2)
Slovenia	28 (2.6)	22 (2.6)	24 (2.1)	28 (2.9)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):				
Denmark	31 (3.2)	32 (3.1)	14 (2.3)	29 (2.8)
Greece	21 (2.0)	27 (2.0)	32 (2.2)	44 (2.5)
† South Africa	21 (1.5)	26 (2.1)	7 (1.3)	7 (1.6)
Thailand	23 (1.6)	16 (1.9)	21 (2.0)	31 (2.8)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):				
1 Israel	–	23 (3.5)	–	26 (3.6)
Kuwait	–	31 (3.3)	–	20 (3.3)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
Israel and Kuwait did not test at the seventh grade. Internationally comparable data are unavailable for Cyprus on Example 20.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.4

International Difficulty Map for Chemistry Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Example 21

Molecules, atoms, and cells.

Scale Value = 726

International Average Percent Correct:
Eighth Grade = 32%
Seventh Grade = 21%

J03

Example 20

Chemical change.

Scale Value = 693

International Average Percent Correct:
Eighth Grade = 31%
Seventh Grade = 26%

Q15

Example 19

Atom loses electron.

Scale Value = 656

International Average Percent Correct:
Eighth Grade = 43%
Seventh Grade = 28%

O15

Example 18

Carbon dioxide fire extinguisher.

Scale Value = 589

International Average Percent Correct:
Eighth Grade = 50%
Seventh Grade = 42%

R05

Example 17

Glass over candle flame.

Scale Value = 291

International Average Percent Correct:
Eighth Grade = 89%
Seventh Grade = 86%

N07

750

500

250

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown
at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

EXAMPLE ITEM 17
CHEMISTRY

Glass over candle flame

When a glass jar is placed over a lighted candle, the flame goes out.

← Glass jar
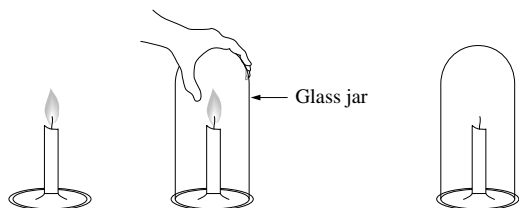
Why does this happen? *The flame needs a supply of oxygen to stay alive. The jar cuts off the supply and when it is all burnt by the candle the candle cannot burn anymore so it goes out.*

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 18
CHEMISTRY

Carbon dioxide fire extinguisher

Carbon dioxide is the active material in some fire extinguishers. How does carbon dioxide extinguish a fire?

A fire needs oxygen to burn so a fire extinguisher sprays out the carbon dioxide to replace the presence of oxygen. Without oxygen, a fire can't burn.

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 19
CHEMISTRY

Atom loses electron

If a neutral atom loses an electron, what is formed?

A.   A gas

B.   An ion

C.   An acid

D.   A molecule

Performance Category: Understanding Simple Information

EXAMPLE ITEM 20
CHEMISTRY

Chemical change

Which is NOT an example of a chemical change?

A. Boiling water

B. Rusting iron

C. Burning wood

D. Baking bread

Performance Category: Understanding simple Information

EXAMPLE ITEM 21
CHEMISTRY

Molecules, atoms, and cells

The words *cloth, thread*, and *fiber* can be used in the following sentence: *cloth* consists of *threads* which are made of *fiber.*

Use the words *molecules, atoms,* and *cells* to complete the following sentence:

_____cells_____ consist of ___molecules___ which are made of ___atoms___ .

Performance Category: Understanding Simple Information

WHAT HAVE STUDENTS LEARNED ABOUT ENVIRONMENTAL ISSUES AND THE NATURE OF SCIENCE?

The fifth science category includes six items about environmental and resource issues, six items covering the nature of scientific knowledge, and two items involving the interaction of science and technology. Table 3.5 shows the percent correct and Figure 3.5 the international difficulty map for four example items (Example Items 22 - 25), illustrating the types of items and student performance expectations covered in these science areas.

Example Items 22, 23, and 24 are all related to the nature of scientific knowledge. Item 22, requiring deductive reasoning to draw conclusions based on experimental observations, was the easiest of the three internationally. On average, nearly two-thirds of the eighth-grade and more than half of the seventh-grade students answered this item correctly (62% and 55%). Performances for individual countries ranged from a low of 23% to 30% correct at both grades in Japan, South Africa, and Kuwait, to more than 75% correct at both grades in Bulgaria. In comparison to Example Item 22, Example Item 23, requiring knowledge of the precision of replicated scientific measurements, was slightly more difficult. On average, it was answered correctly by about half of the students at both the seventh and eighth grades (49% and 53%). Even a little more difficult for students was Example Item 24, which involved the design of experiments and required choosing the experimental procedure required to test a hypothesis. Internationally, at both grades, fewer than half of the students, on average, chose the correct response (40% at seventh grade and 45% at eighth grade). There was little between-grade improvement in most of the individual countries.

Example Item 25, measuring knowledge of the principal cause of acid rain, was related to environmental issues. Across countries, about one-third or fewer students in both grades selected the correct response related to the burning of fossil fuels (on average, 31% at seventh grade and 35% at eighth grade). There was little variation across countries, and in only two countries (Slovenia and Thailand) did 50% or more of the students respond correctly at both grades.

Table 3.5

Percent Correct for Environmental Issues and the Nature of Science Example Items - Lower and Upper Grade (Seventh and Eighth Grades*)

Country	Example 22 Liquid evaporation experiment.		Example 23 Replication of measurements.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	71 (2.5)	76 (3.4)	47 (2.5)	42 (3.4)
† Belgium (Fr)	68 (2.6)	77 (3.2)	42 (3.1)	45 (2.9)
Canada	70 (2.1)	78 (1.8)	61 (2.4)	58 (2.0)
Cyprus	49 (2.6)	65 (2.5)	46 (2.8)	51 (3.3)
Czech Republic	46 (3.2)	59 (2.9)	61 (2.9)	64 (2.7)
†2 England	59 (3.3)	72 (3.4)	62 (2.7)	64 (3.5)
France	65 (2.6)	75 (2.3)	42 (2.6)	51 (2.6)
Hong Kong	63 (2.7)	68 (2.6)	70 (3.5)	70 (2.5)
Hungary	68 (2.5)	68 (2.7)	29 (2.4)	39 (2.9)
Iceland	48 (4.2)	56 (2.8)	52 (3.6)	59 (3.5)
Iran, Islamic Rep.	63 (4.8)	67 (2.7)	32 (3.9)	39 (3.0)
Ireland	62 (2.2)	74 (2.3)	55 (2.3)	54 (2.7)
Japan	27 (1.7)	30 (2.1)	30 (2.1)	39 (2.0)
Korea	76 (2.6)	79 (2.4)	78 (2.7)	85 (1.8)
1 Latvia (LSS)	54 (2.8)	69 (3.0)	45 (3.0)	49 (3.4)
1 Lithuania	39 (3.1)	58 (3.4)	48 (3.1)	50 (3.1)
New Zealand	63 (2.7)	68 (2.5)	49 (2.9)	63 (2.8)
Norway	53 (3.3)	57 (2.8)	54 (3.6)	53 (2.7)
Portugal	34 (2.6)	54 (2.9)	35 (2.7)	35 (1.9)
Russian Federation	48 (2.3)	59 (2.7)	60 (3.0)	61 (2.0)
† Scotland	67 (3.0)	72 (2.8)	53 (2.6)	63 (2.8)
Singapore	68 (2.4)	80 (1.8)	58 (2.9)	65 (2.2)
Slovak Republic	33 (2.6)	50 (3.3)	65 (2.5)	70 (2.6)
Spain	53 (2.7)	60 (2.8)	24 (2.1)	28 (2.3)
Sweden	51 (2.9)	61 (2.3)	62 (2.7)	68 (2.1)
1 Switzerland	43 (2.7)	52 (2.7)	26 (2.2)	25 (1.9)
† United States	69 (2.4)	75 (2.0)	58 (3.0)	61 (1.9)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):				
Australia	66 (2.3)	70 (2.5)	62 (2.5)	63 (1.9)
Austria	57 (2.9)	58 (2.8)	29 (2.5)	36 (2.7)
Bulgaria	77 (3.2)	84 (2.8)	50 (4.1)	56 (4.4)
Netherlands	72 (3.7)	77 (3.0)	55 (3.3)	58 (4.2)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):				
Colombia	44 (4.2)	42 (3.7)	32 (3.1)	39 (4.0)
†1 Germany	42 (3.0)	60 (3.1)	32 (2.9)	33 (2.9)
Romania	48 (2.6)	53 (2.9)	46 (2.8)	54 (2.7)
Slovenia	73 (2.4)	77 (2.7)	77 (2.2)	73 (2.7)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):				
Denmark	48 (2.9)	61 (3.4)	48 (3.7)	58 (3.1)
Greece	44 (2.4)	57 (2.5)	56 (2.0)	63 (3.3)
† South Africa	23 (2.8)	25 (3.1)	26 (2.0)	23 (2.1)
Thailand	47 (2.4)	45 (2.1)	70 (2.5)	77 (2.1)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):				
1 Israel	–	64 (3.9)	–	28 (3.8)
Kuwait	–	28 (3.0)	–	60 (3.5)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).

1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent. Israel and Kuwait did not test at the seventh grade.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Table 3.5 (Continued)

Percent Correct for Environmental Issues and the Nature of Science Example Items - Lower and Upper Grade (Seventh and Eighth Grades*)

Country	Example 24 Plant/mineral experiment.		Example 25 Acid rain.	
	Seventh Grade	Eighth Grade	Seventh Grade	Eighth Grade
† Belgium (Fl)	42 (2.7)	47 (4.1)	30 (2.6)	30 (3.1)
† Belgium (Fr)	40 (3.2)	40 (2.9)	–	–
Canada	46 (2.5)	50 (2.1)	27 (2.3)	31 (2.3)
Cyprus	30 (2.7)	31 (2.9)	25 (2.5)	23 (2.2)
Czech Republic	39 (3.1)	42 (2.5)	38 (3.3)	45 (3.0)
†2 England	40 (2.7)	44 (3.2)	29 (3.3)	44 (3.5)
France	43 (2.4)	43 (2.6)	–	–
Hong Kong	52 (2.4)	57 (2.7)	34 (2.3)	38 (2.6)
Hungary	25 (2.4)	30 (2.6)	40 (2.6)	41 (2.7)
Iceland	33 (4.0)	47 (4.1)	36 (2.9)	35 (4.5)
Iran, Islamic Rep.	22 (2.3)	31 (3.5)	24 (5.3)	23 (2.7)
Ireland	38 (2.3)	36 (2.4)	36 (2.6)	43 (2.6)
Japan	58 (2.2)	57 (1.9)	37 (1.8)	46 (2.0)
Korea	30 (2.5)	36 (2.8)	48 (2.9)	50 (3.0)
1 Latvia (LSS)	37 (2.9)	45 (3.3)	21 (2.5)	25 (2.8)
1 Lithuania	29 (2.8)	26 (3.1)	23 (2.7)	24 (2.8)
New Zealand	44 (2.7)	47 (2.6)	26 (2.4)	31 (2.0)
Norway	47 (3.0)	50 (2.7)	24 (2.4)	31 (2.3)
Portugal	36 (2.4)	49 (2.2)	25 (2.3)	32 (2.2)
Russian Federation	26 (2.3)	35 (4.0)	19 (2.1)	21 (2.5)
† Scotland	39 (2.4)	40 (2.8)	28 (2.2)	32 (3.0)
Singapore	64 (2.6)	71 (1.8)	31 (2.2)	31 (2.3)
Slovak Republic	44 (2.8)	43 (3.0)	21 (2.7)	14 (1.9)
Spain	45 (2.5)	49 (2.7)	37 (2.4)	34 (2.5)
Sweden	59 (2.8)	63 (2.1)	26 (2.5)	31 (1.9)
1 Switzerland	46 (2.8)	51 (3.0)	35 (2.4)	39 (2.6)
† United States	41 (2.6)	47 (2.5)	32 (2.5)	32 (1.7)
Countries Not Satisfying Guidelines for Sample Participation Rates (see Appendix A for Details):				
Australia	42 (2.1)	48 (1.5)	32 (2.0)	42 (2.0)
Austria	43 (2.8)	52 (3.1)	40 (2.2)	55 (3.1)
Bulgaria	42 (4.2)	71 (3.7)	20 (2.8)	47 (4.5)
Netherlands	62 (3.4)	71 (2.9)	38 (3.6)	44 (3.0)
Countries Not Meeting Age/Grade Specifications (High Percentage of Older Students; See Appendix A for Details):				
Colombia	44 (3.5)	44 (4.4)	25 (2.6)	31 (3.9)
†1 Germany	40 (3.1)	42 (2.8)	38 (2.8)	40 (2.8)
Romania	30 (2.7)	35 (2.7)	25 (2.5)	26 (2.4)
Slovenia	35 (2.8)	41 (2.9)	59 (2.6)	55 (3.4)
Countries With Unapproved Sampling Procedures at Classroom Level (See Appendix A for Details):				
Denmark	39 (2.8)	36 (3.6)	22 (2.5)	27 (2.6)
Greece	42 (2.1)	44 (2.3)	21 (1.8)	21 (1.9)
† South Africa	35 (2.2)	33 (2.2)	23 (1.9)	22 (2.1)
Thailand	28 (2.3)	29 (2.6)	51 (2.5)	62 (2.2)
Unapproved Sampling Procedures at Classroom Level and Not Meeting Other Guidelines (See Appendix A for Details):				
1 Israel	–	52 (4.6)	–	30 (3.4)
Kuwait	–	36 (3.7)	–	46 (4.0)

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.

†Met guidelines for sample participation rates only after replacement schools were included (see Appendix A for details).
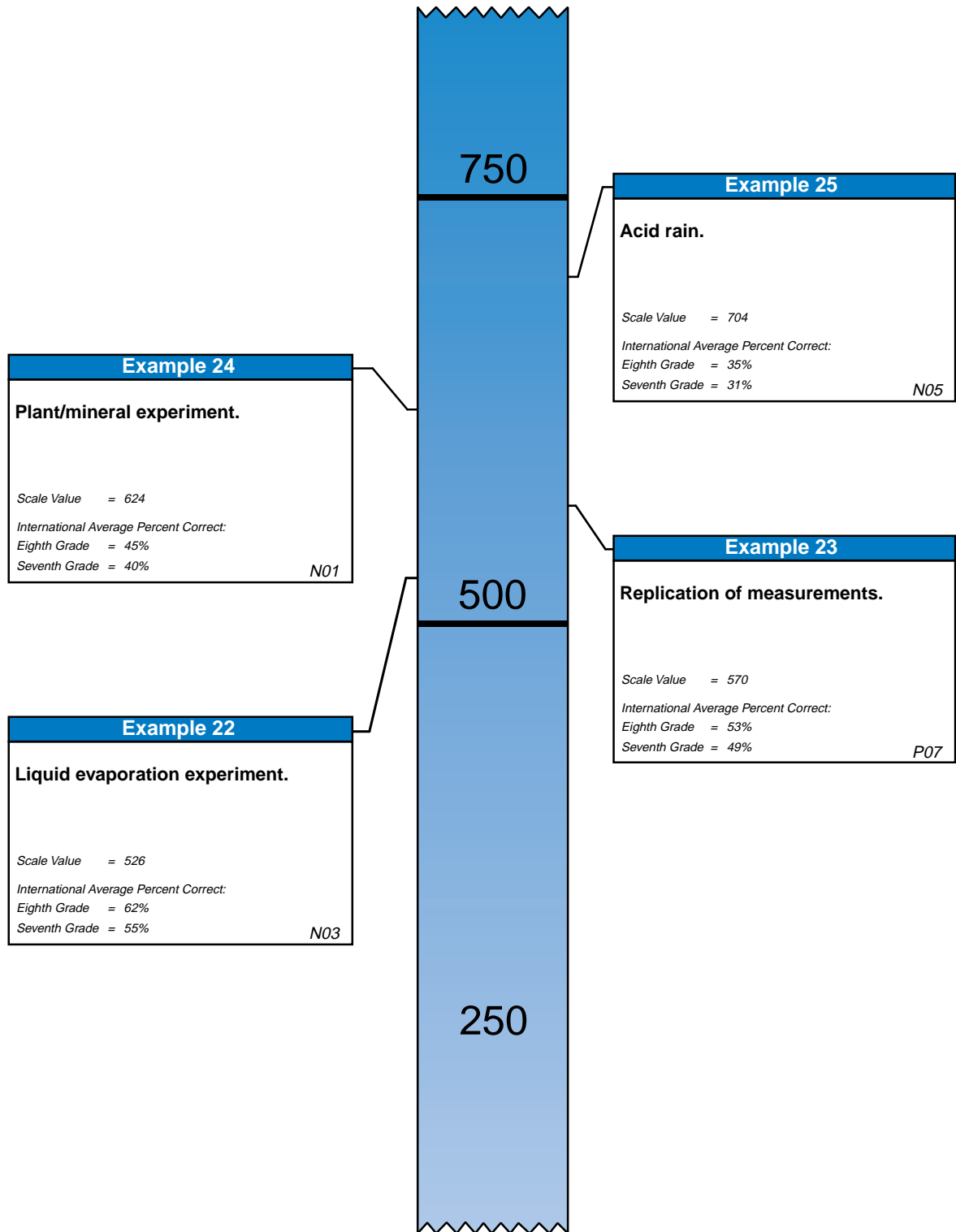
1National Desired Population does not cover all of International Desired Population (see Table A.2). Because coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2National Defined Population covers less than 90 percent of National Desired Population (see Table A.2).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent. Israel and Kuwait did not test at the seventh grade. Internationally comparable data are unavailable for Belgium (Fr), France, and Japan on Example 25.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

Figure 3.5

International Difficulty Map for Environmental Issues and the Nature of Science Example Items - Lower and Upper Grades (Seventh and Eighth Grades*)

Example 25

Acid rain.

Scale Value   = 704

International Average Percent Correct:
Eighth Grade   = 35%
Seventh Grade = 31%

N05

Example 24

Plant/mineral experiment.

Scale Value   = 624

International Average Percent Correct:
Eighth Grade   = 45%
Seventh Grade = 40%

N01

Example 23

Replication of measurements.

Scale Value   = 570

International Average Percent Correct:
Eighth Grade   = 53%
Seventh Grade = 49%

P07

Example 22

Liquid evaporation experiment.

Scale Value   = 526

International Average Percent Correct:
Eighth Grade   = 62%
Seventh Grade = 55%

N03

750

500

250

*Seventh and eighth grades in most countries; see Table 2 for information about the grades tested in each country.
NOTE: Each item was placed onto the TIMSS international science scale based on students' performance in both grades. Items are shown
at the point on the scale where students with that level of proficiency had a 65 percent probability of providing a correct response.

EXAMPLE ITEM 22
ENVIRONMENTAL ISSUES AND THE NATURE OF SCIENCE

Liquid evaporation experiment

A cupful of water and a similar cupful of gasoline were placed on a table near a window on a hot sunny day. A few hours later it was observed that both the cups had less liquid in them but that there was less gasoline left than water. What does this experiment show?

A. All liquids evaporate.

B. Gasoline gets hotter than water.

C. Some liquids evaporate faster than others.

D. Liquids will only evaporate in sunshine.

Performance Category: Theorizing, Analyzing, and Solving Problems

EXAMPLE ITEM 23
ENVIRONMENTAL ISSUES AND THE NATURE OF SCIENCE

Replication of measurements

Whenever scientists carefully measure any quantity many times, they expect that

A. all of the measurements will be exactly the same

B. only two of the measurements will be exactly the same

C. all but one of the measurements will be exactly the same

D. most of the measurements will be close but not exactly the same

Performance Category: Understanding Simple Information

EXAMPLE ITEM 24
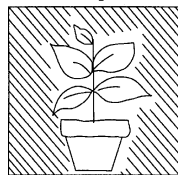### ENVIRONMENTAL ISSUES AND THE NATURE OF SCIENCE

Plant/mineral experiment

A girl had an idea that plants needed minerals from the soil for healthy growth. She placed a plant in the Sun, as shown in the diagram below.
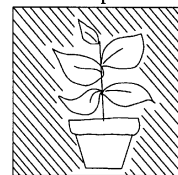
Sunlight

Sand, minerals and water
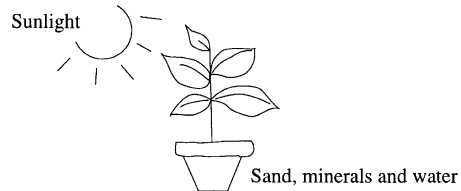
In order to check her idea she also needed to use another plant. Which of the following should she use?
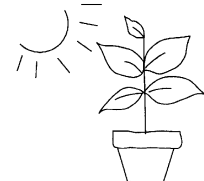
A. Dark cupboard

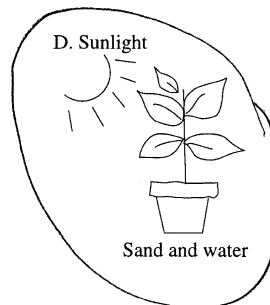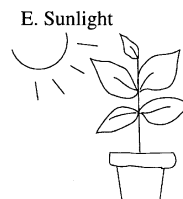Sand, minerals and water

B. Dark cupboard

Sand and water

C. Sunlight

Sand only

D. Sunlight

Sand and water

E. Sunlight

Sand and minerals

Performance Category: Investigating the Natural World

EXAMPLE ITEM 25
ENVIRONMENTAL ISSUES AND THE NATURE OF SCIENCE

Acid rain

One of the principal causes of acid rain is

A.   waste acid from chemical factories being pumped into rivers

B.   acid from chemical laboratories evaporating into the air

C.   gases from burning coal and oil dissolving in water in the atmosphere

D.   gases from air conditioners and refrigerators escaping into the atmosphere

Performance Category: Understanding Simple Information