Chapter 2

Performance at the TIMSS 2007 International Benchmarks for Science Achievement

The TIMSS science achievement scale summarizes student performance on test items designed to measure breadth of content in the life, physical, and earth sciences as well as a range of cognitive processes within the knowing, applying, and reasoning domains. To interpret the achievement results in meaningful ways, it is important to understand the content of the assessment. As a way of interpreting the scaled results, TIMSS uses four points on the scale as international benchmarks and describes achievement at those benchmarks in relation to students' performance on the test questions. The benchmarks represent the range of performance shown by students internationally (and, at the fourth grade, complement the PIRLS International Benchmarks). The Advanced International Benchmark is 625, the High International Benchmark is 550, the Intermediate International Benchmark is 475, and the Low International Benchmark is 400.

The TIMSS & PIRLS International Study Center worked with the TIMSS 2007 Science and Mathematics Item Review Committee (SMIRC)[1] to conduct a detailed scale anchoring analysis to describe science achievement at these benchmarks. Scale anchoring is a way of describing TIMSS 2007 performance at different points on the TIMSS science scale in terms of the types of items students answered correctly. In addition to a data analysis component to identify items that discriminated between successive points

1 The members of the Science and Mathematics Item Review Committee (SMIRC) are listed in Appendix F.

on the scale,[2] the analysis also involved a judgmental component in which the SMIRC members examined the science content and cognitive processing dimensions assessed by each item and generalized to describe students' knowledge and understandings.

This chapter presents the TIMSS 2007 science achievement results for the International Benchmarks for the countries and benchmarking participants. Then, benchmark by benchmark for each grade, there is a detailed description of the understanding of science content and the cognitive processing skills and strategies demonstrated by students at each of the international benchmarks, together with illustrative items. For each example item, the percent correct for each of the TIMSS 2007 participants is given as well as the international average across countries. The correct answer is circled for multiple-choice items. For open-ended items, the answers exemplify the types of student responses that were given full credit.[3] Of course, the items published herein were selected from the items released for public use.[4] Beyond illustrating the benchmark and being released, an effort was made across the benchmarks to include examples of different item formats and content area domains.

How Do Countries Compare with the TIMSS 2007 International Benchmarks of Science Achievement?

Exhibit 2.1 summarizes what fourth- and eighth-grade students scoring at the TIMSS International Benchmarks typically know and can do in science. At each grade, there was a substantial variation in performance between students achieving at the high end of the scale and the low end of the scale. At the fourth grade, students at the Advanced International Benchmark applied knowledge and understanding of scientific processes and relationships in beginning scientific inquiry whereas those at the Low International Benchmark displayed some elementary knowledge of life science and physical science. At the eighth grade, students at the Advanced International Benchmark demonstrated a grasp of some complex and abstract concepts in biology, chemistry, physics, and Earth science. In comparison, those at the

2 For example, in brief, a multiple-choice item anchored at the Advanced International Benchmark if at least 65 percent of students scoring at 625 answered the item correctly and fewer than 50 percent of students scoring at the High International Benchmark (550) answered correctly, and so on, for each successively lower benchmark. Since constructed-response questions nearly eliminate guessing, the criterion for the constructed-response items was simply 50 percent at the particular benchmark. For more information, see the "Scale Anchoring Analysis" section of Appendix A as well as the *TIMSS 2007 Technical Report*.

3 All of the constructed-response items were scored according to detailed scoring guides containing descriptions and examples of the types of responses that should receive credit. Although most constructed-response items were worth 1 point, some were worth 2 points (with 1 point awarded for partial credit). If the example item was worth 2 points, the data are for responses receiving 2 points (full credit).

4 After each TIMSS assessment, approximately one-third of the items are released into the public domain and the rest of the items are kept secure for use in measuring trends over time in subsequent assessments.

Low International Benchmark simply recognized some basic facts from the life and physical sciences.

Exhibit 2.2 displays the percentage of students in each country and benchmarking entity that reached each international benchmark. At each grade, the results are presented in descending order according to the percentage of students reaching the Advanced International Benchmark (indicated by the green dots, and shown in the column labeled "Advanced").

Generally, the TIMSS 2007 participants with the highest average achievement had greater percentages of students reaching each benchmark, and lower achieving countries had smaller percentages. Thus, consistent with the results in Exhibit 1.1, Singapore and Chinese Taipei had the highest percentages of students reaching the advanced benchmark and appear at the top in Exhibit 2.2. Keeping in mind that the Advanced International Benchmark represents fluency on items involving the most complex topics and reasoning skills in the *TIMSS 2007 Science Framework*, Singapore in particular had high percentages of students reaching the advanced benchmark—36 percent at fourth grade and 32 percent at eighth grade.

As a point of reference, Exhibit 2.2 provides the median percentage in TIMSS 2007 for each of the international benchmarks. By definition, half the countries (not including the benchmarking participants) will have a percentage above the median and half below. The median percentage of students reaching the Advanced International Benchmark was 7 percent at the fourth grade and 3 percent at the eighth grade. Following Singapore at the fourth grade, Chinese Taipei had 19 percent and the Russian Federation 16 percent of their students reaching the advanced benchmark. Other countries with at least 10 percent of fourth grade students reaching the advanced benchmark included the United States (15%), England and Hong Kong SAR (14%), Hungary and Italy (13%), Japan and Armenia (12%), the Slovak Republic (11%), and Australia, Latvia, Germany, and Kazakhstan (10%). Among the benchmarking participants, about one-fifth of fourth-grade students in the U.S. states of Massachusetts and Minnesota reached the

Exhibit 2.1 **TIMSS 2007 International Benchmarks of Science Achievement**

TIMSS2007 Science 4th Grade

Advanced International Benchmark – 625

Students can apply knowledge and understanding of scientific processes and relationships in beginning scientific inquiry. Students communicate their understanding of characteristics and life processes of organisms as well as of factors relating to human health. They demonstrate understanding of relationships among various physical properties of common materials and have some practical knowledge of electricity. Students demonstrate some understanding of the solar system and Earth's physical features and processes. They show a developing ability to interpret the results of investigations and draw conclusions as well as a beginning ability to evaluate and support an argument.

High International Benchmark – 550

Students can apply knowledge and understanding to explain everyday phenomena. Students demonstrate some understanding of plant and animal structure, life processes, and the environment and some knowledge of properties of matter and physical phenomena. They show some knowledge of the solar system, and of Earth's structure, processes, and resources. Students demonstrate beginning scientific inquiry knowledge and skills, and provide brief descriptive responses combining knowledge of science concepts with information from everyday experience of physical and life processes.

Intermediate International Benchmark – 475

Students can apply basic knowledge and understanding to practical situations in the sciences. Students recognize some basic information related to characteristics of living things and their interaction with the environment, and show some understanding of human biology and health. They also show some understanding of familiar physical phenomena. Students know some basic facts about the solar system and have a developing understanding of Earth's resources. They demonstrate some ability to interpret information in pictorial diagrams and apply factual knowledge to practical situations.

Low International Benchmark – 400

Students have some elementary knowledge of life science and physical science. Students can demonstrate knowledge of some simple facts related to human health and the behavioral and physical characteristics of animals. They recognize some properties of matter, and demonstrate a beginning understanding of forces. Students interpret labeled pictures and simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.1 **TIMSS 2007 International Benchmarks of Science Achievement (Continued)**

TIMSS2007 Science 8th Grade

Advanced International Benchmark – 625

Students can demonstrate a grasp of some complex and abstract concepts in biology, chemistry, physics, and Earth science. They have an understanding of the complexity of living organisms and how they relate to their environment. They show understanding of the properties of magnets, sound, and light, as well as demonstrating understanding of structure of matter and physical and chemical properties and changes. Students apply knowledge of the solar system and of Earth's features and processes, and apply understanding of major environmental issues. They understand some fundamentals of scientific investigation and can apply basic physical principles to solve some quantitative problems. They can provide written explanations to communicate scientific knowledge.

High International Benchmark – 550

Students can demonstrate conceptual understanding of some science cycles, systems, and principles. They have some understanding of biological concepts including cell processes, human biology and health, and the interrelationship of plants and animals in ecosystems. They apply knowledge to situations related to light and sound, demonstrate elementary knowledge of heat and forces, and show some evidence of understanding the structure of matter, and chemical and physical properties and changes. They demonstrate some understanding of the solar system, Earth's processes and resources, and some basic understanding of major environmental issues. Students demonstrate some scientific inquiry skills. They combine information to draw conclusions, interpret tabular and graphical information, and provide short explanations conveying scientific knowledge.

Intermediate International Benchmark – 475

Students can recognize and communicate basic scientific knowledge across a range of topics. They demonstrate some understanding of characteristics of animals, food webs, and the effect of population changes in ecosystems. They are acquainted with some aspects of sound and force and have elementary knowledge of chemical change. They demonstrate elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students extract information from tables and interpret pictorial diagrams. They can apply knowledge to practical situations and communicate their knowledge through brief descriptive responses.

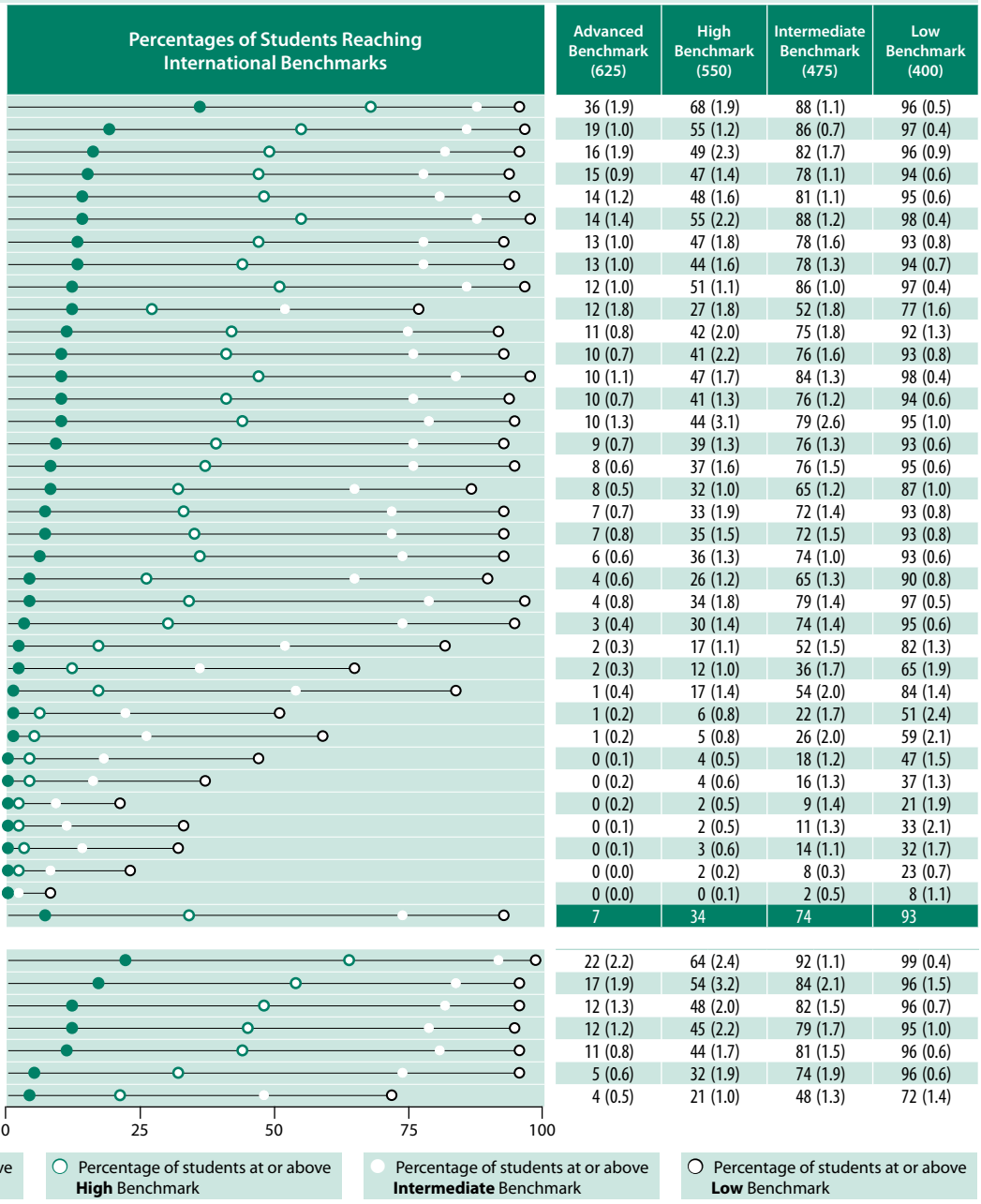
Low International Benchmark – 400

Students can recognize some basic facts from the life and physical sciences. They have some knowledge of the human body, and demonstrate some familiarity with everyday physical phenomena. Students can interpret pictorial diagrams and apply knowledge of simple physical concepts to practical situations.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.2 Percentages of Students Reaching the TIMSS 2007 International Benchmarks of Science Achievement

TIMSS2007 Science 4th Grade



Country	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Singapore	36 (1.9)	68 (1.9)	88 (1.1)	96 (0.5)
Chinese Taipei	19 (1.0)	55 (1.2)	86 (0.7)	97 (0.4)
Russian Federation	16 (1.9)	49 (2.3)	82 (1.7)	96 (0.9)
[2] † United States	15 (0.9)	47 (1.4)	78 (1.1)	94 (0.6)
England	14 (1.2)	48 (1.6)	81 (1.1)	95 (0.6)
Hong Kong SAR	14 (1.4)	55 (2.2)	88 (1.2)	98 (0.4)
Hungary	13 (1.0)	47 (1.8)	78 (1.6)	93 (0.8)
Italy	13 (1.0)	44 (1.6)	78 (1.3)	94 (0.7)
Japan	12 (1.0)	51 (1.1)	86 (1.0)	97 (0.4)
Armenia	12 (1.8)	27 (1.8)	52 (1.8)	77 (1.6)
Slovak Republic	11 (0.8)	42 (2.0)	75 (1.8)	92 (1.3)
Australia	10 (0.7)	41 (2.2)	76 (1.6)	93 (0.8)
[1] Latvia	10 (1.1)	47 (1.7)	84 (1.3)	98 (0.4)
Germany	10 (0.7)	41 (1.3)	76 (1.2)	94 (0.6)
[1] Kazakhstan	10 (1.3)	44 (3.1)	79 (2.6)	95 (1.0)
Austria	9 (0.7)	39 (1.3)	76 (1.3)	93 (0.6)
Sweden	8 (0.6)	37 (1.6)	76 (1.5)	95 (0.6)
New Zealand	8 (0.5)	32 (1.0)	65 (1.2)	87 (1.0)
Czech Republic	7 (0.7)	33 (1.9)	72 (1.4)	93 (0.8)
† Denmark	7 (0.8)	35 (1.5)	72 (1.5)	93 (0.8)
Slovenia	6 (0.6)	36 (1.3)	74 (1.0)	93 (0.6)
† Scotland	4 (0.6)	26 (1.2)	65 (1.3)	90 (0.8)
‡ Netherlands	4 (0.8)	34 (1.8)	79 (1.4)	97 (0.5)
[1] Lithuania	3 (0.4)	30 (1.4)	74 (1.4)	95 (0.6)
Ukraine	2 (0.3)	17 (1.1)	52 (1.5)	82 (1.3)
Iran, Islamic Rep. of	2 (0.3)	12 (1.0)	36 (1.7)	65 (1.9)
Norway	1 (0.4)	17 (1.4)	54 (2.0)	84 (1.4)
Colombia	1 (0.2)	6 (0.8)	22 (1.7)	51 (2.4)
[1] Georgia	1 (0.2)	5 (0.8)	26 (2.0)	59 (2.1)
El Salvador	0 (0.1)	4 (0.5)	18 (1.2)	47 (1.5)
◆◆ Kuwait	0 (0.2)	4 (0.6)	16 (1.3)	37 (1.3)
Morocco	0 (0.2)	2 (0.5)	9 (1.4)	21 (1.9)
Algeria	0 (0.1)	2 (0.5)	11 (1.3)	33 (2.1)
Tunisia	0 (0.1)	3 (0.6)	14 (1.1)	32 (1.7)
Qatar	0 (0.0)	2 (0.2)	8 (0.3)	23 (0.7)
Yemen	0 (0.0)	0 (0.1)	2 (0.5)	8 (1.1)
International Median	7	34	74	93
Benchmarking Participants				
[2] Massachusetts, US	22 (2.2)	64 (2.4)	92 (1.1)	99 (0.4)
Minnesota, US	17 (1.9)	54 (3.2)	84 (2.1)	96 (1.5)
[2] Alberta, Canada	12 (1.3)	48 (2.0)	82 (1.5)	96 (0.7)
[2] Ontario, Canada	12 (1.2)	45 (2.2)	79 (1.7)	95 (1.0)
[2] British Columbia, Canada	11 (0.8)	44 (1.7)	81 (1.5)	96 (0.6)
[2] Quebec, Canada	5 (0.6)	32 (1.9)	74 (1.9)	96 (0.6)
◆◆ ‡ Dubai, UAE	4 (0.5)	21 (1.0)	48 (1.3)	72 (1.4)

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

[1] National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

[2] National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

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Exhibit 2.2 Percentages of Students Reaching the TIMSS 2007 International Benchmarks of Science Achievement (Continued)

TIMSS2007 Science 8th Grade

Country	Advanced Benchmark (625)	High Benchmark (550)	Intermediate Benchmark (475)	Low Benchmark (400)
Singapore	32 (1.6)	61 (2.2)	80 (1.8)	93 (1.1)
Chinese Taipei	25 (1.5)	60 (1.9)	83 (1.2)	95 (0.6)
Japan	17 (0.9)	55 (1.1)	85 (0.8)	96 (0.4)
† England	17 (1.6)	48 (2.3)	79 (1.9)	94 (0.9)
Korea, Rep. of	17 (0.9)	54 (1.1)	85 (0.8)	97 (0.4)
Hungary	13 (1.1)	46 (1.6)	80 (1.3)	96 (0.7)
Czech Republic	11 (0.9)	44 (1.4)	82 (0.8)	97 (0.4)
Slovenia	11 (0.7)	45 (1.2)	81 (1.1)	97 (0.5)
Russian Federation	11 (1.0)	41 (2.1)	76 (1.6)	95 (0.7)
† Hong Kong SAR	10 (1.0)	45 (2.6)	77 (2.2)	92 (1.3)
2 † United States	10 (0.7)	38 (1.4)	71 (1.3)	92 (0.7)
Armenia	8 (1.7)	23 (2.0)	55 (2.4)	83 (1.3)
Australia	8 (1.4)	33 (1.8)	70 (1.7)	92 (0.8)
1 Lithuania	8 (0.6)	36 (1.4)	72 (1.4)	93 (0.8)
Sweden	6 (0.6)	32 (1.2)	69 (1.4)	91 (0.8)
Jordan	5 (0.6)	26 (1.5)	56 (1.8)	79 (1.4)
Malta	5 (0.3)	21 (0.6)	48 (0.7)	71 (0.6)
3 Bulgaria	5 (0.9)	22 (1.8)	51 (2.4)	76 (2.1)
† Scotland	5 (0.6)	26 (1.5)	61 (1.8)	87 (1.1)
3 Israel	5 (0.6)	21 (1.4)	51 (1.9)	75 (1.8)
Italy	4 (0.7)	24 (1.3)	62 (1.4)	88 (1.0)
Turkey	3 (0.5)	16 (1.2)	40 (1.7)	71 (1.5)
Ukraine	3 (0.4)	22 (1.4)	58 (1.8)	85 (1.3)
Thailand	3 (0.8)	17 (1.9)	48 (2.2)	80 (1.5)
Malaysia	3 (0.7)	18 (2.2)	50 (2.7)	80 (2.2)
Iran, Islamic Rep. of	2 (0.5)	14 (1.2)	41 (1.8)	76 (1.7)
Bahrain	2 (0.4)	17 (0.8)	49 (0.9)	78 (0.7)
1 2 Serbia	2 (0.3)	16 (1.1)	51 (1.6)	81 (1.1)
Romania	2 (0.3)	16 (1.2)	46 (1.9)	77 (1.6)
Norway	2 (0.2)	20 (1.0)	58 (1.4)	87 (0.9)
Bosnia and Herzegovina	2 (0.3)	14 (1.0)	47 (1.7)	80 (1.2)
Cyprus	1 (0.3)	12 (0.8)	42 (1.1)	74 (1.0)
Palestinian Nat'l Auth.	1 (0.2)	9 (0.6)	28 (1.2)	54 (1.5)
Lebanon	1 (0.4)	8 (1.2)	28 (2.1)	55 (2.9)
Syrian Arab Republic	1 (0.2)	9 (0.8)	39 (1.6)	76 (1.5)
Egypt	1 (0.1)	7 (0.6)	27 (1.4)	55 (1.6)
Oman	1 (0.2)	8 (0.6)	32 (1.2)	61 (1.4)
Colombia	1 (0.1)	4 (0.5)	22 (1.5)	59 (2.1)
👀 Kuwait	0 (0.1)	6 (0.7)	28 (1.2)	60 (1.4)
1 Georgia	0 (0.1)	5 (0.7)	27 (1.9)	61 (2.4)
Indonesia	0 (0.1)	4 (0.6)	27 (1.8)	65 (2.0)
Tunisia	0 (0.1)	4 (0.5)	31 (1.3)	77 (1.2)
Saudi Arabia	0 (0.0)	2 (0.5)	18 (1.0)	52 (1.4)
Qatar	0 (0.0)	2 (0.2)	11 (0.5)	29 (0.6)
Ghana	0 (0.0)	1 (0.3)	6 (0.9)	19 (1.6)
El Salvador	0 (0.1)	1 (0.3)	11 (1.0)	42 (1.7)
Botswana	0 (0.0)	2 (0.3)	11 (0.7)	35 (1.3)
Algeria	0 (0.0)	1 (0.2)	14 (0.8)	55 (1.2)
‡ Morocco	0 (0.1)	3 (0.5)	18 (1.4)	51 (2.1)
International Median	3	17	49	78
Benchmarking Participants				
2 Massachusetts, US	20 (1.8)	56 (2.5)	84 (2.0)	96 (0.9)
2 † Minnesota, US	11 (1.7)	45 (2.6)	82 (2.3)	96 (1.0)
2 Ontario, Canada	7 (1.1)	37 (2.0)	77 (1.7)	96 (1.0)
3 British Columbia, Canada	7 (0.9)	38 (1.6)	77 (1.2)	95 (0.6)
👀 ‡ Dubai, UAE	6 (0.8)	27 (1.8)	58 (1.6)	82 (1.1)
3 Quebec, Canada	4 (0.8)	27 (1.5)	68 (1.7)	94 (0.9)
Basque Country, Spain	3 (0.6)	24 (1.6)	64 (1.7)	91 (1.0)

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

● Percentage of students at or above **Advanced** Benchmark

○ Percentage of students at or above **High** Benchmark

○ Percentage of students at or above **Intermediate** Benchmark

○ Percentage of students at or above **Low** Benchmark

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

‡ Did not satisfy guidelines for sample participation rates (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

3 National Defined Population covers less than 90% of National Target Population (but at least 77%, see Appendix A).

👀 Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

advanced benchmark (22 and 17 percent, respectively), and three Canadian provinces had more than 10 percent of students reaching this benchmark—Alberta and Ontario (12%) and British Columbia (11%). At the eighth grade, following Singapore, one-fourth (25%) of students in Chinese Taipei reached the advanced benchmark. Other countries with at least 10 percent of students reaching this benchmark included Japan, England, and Korea (17%), Hungary (13%), the Czech Republic, Slovenia, and the Russian Federation (11%), and Hong Kong SAR and the United States (10%).

Although Exhibit 2.2 is organized to draw particular attention to the percentage of high-achieving students in each country and benchmarking participant, it also conveys information about the distribution of middle and low performers. Since students reaching a particular benchmark also reached lower benchmarks, the percentages illustrated graphically and shown in the table are cumulative. At the fourth grade, the median for the Low International Benchmark was an impressive 93 percent, indicating that in at least half the countries almost all of the fourth grade students had elementary knowledge and skills in science. A number of countries had 95 percent or more of fourth grade students reaching this benchmark, including Singapore, Chinese Taipei, the Russian Federation, England, Hong Kong SAR, Japan, Latvia, Kazakhstan, Sweden, the Netherlands, and Lithuania. The two U.S. states and four Canadian provinces also had 95 percent of more of their students reaching the low benchmark. At the other end of the achievement distribution, however, less than half the students reached the low benchmark in El Salvador (47%), Kuwait (37%), Algeria (33%), Tunisia (32%), Qatar (23%), Morocco (21%), and Yemen (8%).

At the fourth grade, the median for the Intermediate International Benchmark was 74 percent and the High Benchmark median was 34 percent, indicating that in half the countries, three-quarters or more of students could apply basic science knowledge and understanding in practical situations and one-third or more could apply knowledge and understanding to explain everyday phenomena. Many countries have patterns consistent with the median results, although there are some exceptions. For example, the results

for Armenia are above the median for the advanced benchmark (12%), but well below the median at the high (27%), intermediate (52%), and low (77%) benchmarks.

At the eighth grade, the substantial variation in achievement at the Advanced International Benchmark was mirrored at each of the other benchmarks. For example, the High International Benchmark was reached by more than 50 percent of students in Singapore, Chinese Taipei, Japan, and Korea, but by only 1 percent in Ghana, El Salvador, and Algeria. The range at the Intermediate International Benchmark was from 85 percent in Japan and Korea to 6 percent in Ghana. The Low International Benchmark was reached by 95 percent or more in seven countries (Chinese Taipei, Japan, Korea, Hungary, the Czech Republic, Slovenia, and the Russian Federation), the two U.S. states, and the Canadian provinces of Ontario and British Columbia. However, several countries had fewer than half of students reaching the low benchmark, El Salvador (42%), Botswana (35%), Qatar (29%), and Ghana (19%).

Exhibit 2.3 presents changes in the percentages of students reaching the benchmarks. Trends across the four benchmarks generally were consistent with the patterns of overall changes across the previous assessments. A number of countries have shown steady improvement at the fourth grade at all benchmarks. For example, Slovenia and Iran had increased percentages of students at each of the benchmarks in each assessment, and Singapore, Hong Kong SAR, Italy, Armenia, and Latvia at each benchmark in at least one cycle of the assessment. Among those with lower average achievement in 2007 compared to 1995, Norway had decreased percentages at all four benchmarks, and the Czech Republic and Austria had decreased percentages at the three top benchmarks.

Exhibit 2.3 Trends in Percentages of Students Reaching the TIMSS 2007 International Benchmarks of Science Achievement

TIMSS2007 Science 4th Grade

Country	Advanced International Benchmark (625)			High International Benchmark (550)		
	2007 Percent of Students	2003 Percent of Students	1995 Percent of Students	2007 Percent of Students	2003 Percent of Students	1995 Percent of Students
Singapore	36 (1.9)	25 (2.4) ▲	14 (1.6) ▲	68 (1.9)	61 (2.6) ▲	42 (2.2) ▲
Chinese Taipei	19 (1.0)	14 (1.0) ▲	◊ ◊	55 (1.2)	52 (1.1)	◊ ◊
Russian Federation	16 (1.9)	11 (1.4)	◊ ◊	49 (2.3)	39 (2.7) ▲	◊ ◊
United States	15 (0.9)	13 (0.8)	19 (1.2) ▼	47 (1.4)	45 (1.4)	50 (1.6)
England	14 (1.2)	15 (1.4)	15 (1.1)	48 (1.6)	47 (1.8)	42 (1.7) ▲
Hong Kong SAR	14 (1.4)	7 (0.8) ▲	5 (0.6) ▲	55 (2.2)	47 (2.2) ▲	30 (1.6) ▲
Hungary	13 (1.0)	10 (0.9) ▲	7 (0.7) ▲	47 (1.8)	42 (1.6)	32 (1.7) ▲
Italy	13 (1.0)	9 (1.1) ▲	– –	44 (1.6)	35 (1.9) ▲	– –
Japan	12 (1.0)	12 (0.6)	15 (0.8) ▼	51 (1.1)	49 (1.1)	54 (1.3)
Armenia	12 (1.8)	2 (0.4) ▲	◊ ◊	27 (1.8)	10 (1.0) ▲	◊ ◊
Australia	10 (0.7)	9 (1.0)	13 (1.1)	41 (2.2)	38 (1.7)	40 (1.3)
Latvia	10 (1.1)	7 (0.7) ▲	5 (1.4) ▲	47 (1.7)	39 (1.9) ▲	21 (2.1) ▲
Austria	9 (0.7)	◊ ◊	13 (1.4) ▼	39 (1.3)	◊ ◊	45 (1.8) ▼
New Zealand	8 (0.5)	9 (0.7)	11 (1.2) ▼	32 (1.0)	39 (1.3) ▼	35 (1.8)
Czech Republic	7 (0.7)	◊ ◊	12 (1.1) ▼	33 (1.9)	◊ ◊	42 (1.5) ▼
Slovenia	6 (0.6)	3 (0.4) ▲	2 (0.4) ▲	36 (1.3)	22 (1.3) ▲	14 (1.1) ▲
Scotland	4 (0.6)	5 (0.5)	12 (1.1) ▼	26 (1.2)	27 (1.5)	37 (1.8) ▼
Netherlands	4 (0.8)	3 (0.5)	6 (0.7) ▼	34 (1.8)	32 (1.5)	38 (2.1)
Lithuania	3 (0.4)	3 (0.5)	◊ ◊	30 (1.4)	30 (1.3)	◊ ◊
Iran, Islamic Rep. of	2 (0.3)	1 (0.2) ▲	0 (0.1) ▲	12 (1.0)	7 (0.7) ▲	3 (0.7) ▲
Norway	1 (0.4)	2 (0.3)	8 (0.9) ▼	17 (1.4)	15 (0.9)	32 (1.6) ▼
Morocco	0 (0.2)	0 (0.0)	◊ ◊	2 (0.5)	1 (0.3)	◊ ◊
Tunisia	0 (0.1)	0 (0.1)	◊ ◊	3 (0.5)	2 (0.3) ▲	◊ ◊
Benchmarking Participants						
Minnesota, US	17 (1.9)	◊ ◊	21 (2.8)	54 (3.2)	◊ ◊	54 (3.9)
Alberta, Canada	12 (1.3)	◊ ◊	21 (2.2) ▼	48 (2.0)	◊ ◊	57 (3.5) ▼
Ontario, Canada	12 (1.2)	13 (1.6)	10 (0.7)	45 (2.2)	47 (1.9)	37 (1.7) ▲
Quebec, Canada	5 (0.6)	3 (0.4) ▲	9 (1.3) ▼	32 (1.9)	25 (1.3) ▲	40 (3.7) ▼

▲ 2007 percent significantly higher
▼ 2007 percent significantly lower

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Trend notes: Data are not shown for Kuwait, because comparable data from previous cycles are not available. Data for Tunisia do not include private schools.

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

A dash (–) indicates comparable data are not available.

A diamond (◊) indicates the country did not participate in the assessment.

Exhibit 2.3 **Trends in Percentages of Students Reaching the TIMSS 2007 International Benchmarks of Science Achievement (Continued)**

TIMSS2007 Science 4th Grade

Country	Intermediate International Benchmark (475)						Low International Benchmark (400)					
	2007 Percent of Students		2003 Percent of Students		1995 Percent of Students		2007 Percent of Students		2003 Percent of Students		1995 Percent of Students	
Singapore	88 (1.1)		86 (1.6)		71 (1.7)	▲	96 (0.5)		95 (0.9)		89 (0.9)	▲
Chinese Taipei	86 (0.7)		87 (0.7)		◊ ◊		97 (0.4)		98 (0.3)	▼	◊ ◊	
Russian Federation	82 (1.7)		74 (2.4)	▲	◊ ◊		96 (0.9)		93 (1.1)		◊ ◊	
United States	78 (1.1)		78 (1.0)		78 (1.1)		94 (0.6)		94 (0.5)		92 (0.7)	
England	81 (1.1)		79 (1.3)		72 (1.3)	▲	95 (0.6)		94 (0.7)		90 (0.8)	▲
Hong Kong SAR	88 (1.2)		87 (1.2)		69 (1.7)	▲	98 (0.4)		98 (0.3)		91 (1.1)	▲
Hungary	78 (1.6)		76 (1.4)		67 (1.8)	▲	93 (0.8)		94 (0.7)		90 (1.0)	▲
Italy	78 (1.3)		70 (1.6)	▲	– –		94 (0.7)		91 (0.9)	▲	– –	
Japan	86 (1.0)		84 (0.7)	▲	87 (0.7)		97 (0.4)		96 (0.4)		97 (0.4)	
Armenia	52 (1.8)		38 (1.7)	▲	◊ ◊		77 (1.6)		66 (1.8)	▲	◊ ◊	
Australia	76 (1.6)		74 (2.0)		72 (1.7)	▲	93 (0.8)		92 (1.1)		89 (1.1)	▲
Latvia	84 (1.3)		80 (1.5)	▲	55 (2.1)	▲	98 (0.4)		96 (0.6)		85 (1.4)	▲
Austria	76 (1.3)		◊ ◊		79 (1.5)	▼	93 (0.6)		◊ ◊		94 (0.7)	
New Zealand	65 (1.2)		74 (1.2)	▼	66 (1.8)		87 (1.0)		92 (0.7)	▼	85 (1.7)	
Czech Republic	72 (1.4)		◊ ◊		77 (1.2)	▼	93 (0.8)		◊ ◊		95 (0.6)	
Slovenia	74 (1.0)		61 (1.4)	▲	45 (1.5)	▲	93 (0.6)		87 (0.9)	▲	79 (1.4)	▲
Scotland	65 (1.3)		66 (1.5)		68 (1.9)		90 (0.8)		90 (0.9)		88 (1.3)	
Netherlands	79 (1.4)		83 (1.2)	▼	82 (1.6)		97 (0.5)		99 (0.4)		98 (0.7)	
Lithuania	74 (1.4)		73 (1.6)		◊ ◊		95 (0.6)		95 (0.7)		◊ ◊	
Iran, Islamic Rep. of	36 (1.7)		28 (1.5)	▲	15 (1.5)	▲	65 (1.9)		58 (1.7)	▲	42 (2.1)	▲
Norway	54 (2.0)		49 (1.4)	▲	65 (1.7)	▼	84 (1.4)		79 (1.5)	▲	88 (1.1)	▼
Morocco	9 (1.4)		9 (0.8)		◊ ◊		21 (1.9)		24 (1.6)		◊ ◊	
Tunisia	14 (1.1)		10 (1.0)	▲	◊ ◊		31 (1.7)		27 (1.7)	▲	◊ ◊	
Benchmarking Participants												
Minnesota, US	84 (2.1)		◊ ◊		82 (2.6)		96 (1.5)		◊ ◊		95 (2.1)	
Alberta, Canada	82 (1.5)		◊ ◊		84 (3.2)		96 (0.7)		◊ ◊		94 (2.5)	
Ontario, Canada	79 (1.7)		81 (1.4)		71 (1.7)	▲	95 (1.0)		96 (0.6)		90 (1.0)	▲
Quebec, Canada	74 (1.9)		66 (1.4)	▲	77 (2.5)		96 (0.6)		91 (0.8)	▲	94 (1.3)	

▲ 2007 percent significantly higher
▼ 2007 percent significantly lower

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.3 Trends in Percentages of Students Reaching the TIMSS 2007 International Benchmarks of Science Achievement (Continued)

TIMSS2007 Science 8th Grade

Country	Advanced International Benchmark (625)				High International Benchmark (550)			
	2007 Percent of Students	2003 Percent of Students	1999 Percent of Students	1995 Percent of Students	2007 Percent of Students	2003 Percent of Students	1999 Percent of Students	1995 Percent of Students
Singapore	32 (1.6)	33 (1.6)	29 (3.2)	29 (3.2)	61 (2.2)	66 (2.3)	60 (3.5)	64 (2.8)
Chinese Taipei	25 (1.5)	26 (1.5)	27 (1.8)	◊ ◊	60 (1.9)	63 (1.9)	61 (2.1)	◊ ◊
Japan	17 (0.9)	15 (0.7)	16 (1.0)	18 (0.9)	55 (1.1)	53 (1.1)	52 (1.3)	54 (1.1)
England	17 (1.6)	15 (1.7)	17 (1.7)	15 (1.7)	48 (2.3)	48 (2.7)	45 (2.4)	43 (1.8)
Korea, Rep. of	17 (0.9)	17 (0.9)	19 (1.1)	17 (1.0)	54 (1.1)	57 (1.1)	50 (1.2) ▲	50 (1.2) ▲
Hungary	13 (1.1)	14 (1.1)	19 (1.3) ▼	12 (1.1)	46 (1.6)	46 (1.7)	53 (1.8) ▼	44 (1.7)
Czech Republic	11 (0.9)	◊ ◊	14 (1.4)	17 (1.8) ▼	44 (1.4)	◊ ◊	45 (2.2)	52 (2.5) ▼
Slovenia	11 (0.7)	6 (0.5) ▲	– –	8 (0.8) ▲	45 (1.2)	33 (1.3) ▲	– –	32 (1.5) ▲
Russian Federation	11 (1.0)	6 (0.8) ▲	15 (2.3)	11 (1.1)	41 (2.1)	32 (1.8) ▲	41 (2.8)	38 (2.3)
Hong Kong SAR	10 (1.0)	13 (1.2) ▼	7 (0.9)	7 (1.0) ▲	45 (2.6)	58 (1.9) ▼	40 (2.1)	33 (2.7) ▲
United States	10 (0.7)	11 (0.8)	12 (1.0) ▼	11 (1.1)	38 (1.4)	41 (1.7)	37 (1.9)	38 (2.0)
Armenia	8 (1.7)	1 (0.3) ▲	◊ ◊	◊ ◊	23 (2.0)	14 (1.3) ▲	◊ ◊	◊ ◊
Australia	8 (1.4)	9 (1.1)	– –	10 (1.1)	33 (1.8)	40 (2.0) ▼	– –	36 (1.7)
Lithuania	8 (0.6)	6 (0.6) ▲	5 (0.9) ▲	2 (0.5) ▲	36 (1.4)	34 (1.2)	22 (1.8) ▲	14 (1.5) ▲
Sweden	6 (0.6)	8 (0.8)	◊ ◊	19 (1.6) ▼	32 (1.2)	38 (1.6) ▼	◊ ◊	52 (2.4) ▼
Jordan	5 (0.6)	3 (0.5) ▲	4 (0.5) ▲	◊ ◊	26 (1.5)	21 (1.4) ▲	17 (1.0) ▲	◊ ◊
Scotland	5 (0.6)	6 (0.7)	◊ ◊	9 (1.4) ▼	26 (1.5)	32 (1.9) ▼	◊ ◊	30 (2.5)
Israel	5 (0.6)	5 (0.5)	5 (0.5)	– –	21 (1.4)	24 (1.3)	23 (1.4)	– –
Italy	4 (0.7)	4 (0.6)	6 (0.9) ▼	– –	24 (1.3)	23 (1.5)	26 (1.8)	– –
Thailand	3 (0.8)	◊ ◊	2 (0.5)	– –	17 (1.9)	◊ ◊	18 (2.1)	– –
Malaysia	3 (0.7)	4 (0.8)	5 (0.8)	◊ ◊	18 (2.2)	28 (2.2) ▼	24 (2.0)	◊ ◊
Iran, Islamic Rep. of	2 (0.5)	1 (0.2) ▲	1 (0.3)	1 (0.4)	14 (1.2)	9 (0.6) ▲	11 (1.3)	11 (1.3)
Bahrain	2 (0.4)	0 (0.1) ▲	◊ ◊	◊ ◊	17 (0.8)	6 (0.6) ▲	◊ ◊	◊ ◊
Serbia	2 (0.3)	2 (0.3)	◊ ◊	◊ ◊	16 (1.1)	16 (1.0)	◊ ◊	◊ ◊
Romania	2 (0.3)	4 (0.8)	5 (0.8) ▼	5 (0.8) ▼	16 (1.2)	20 (1.8)	21 (2.1) ▼	22 (1.8) ▼
Norway	2 (0.2)	2 (0.3)	◊ ◊	6 (0.6) ▼	20 (1.0)	21 (1.1)	◊ ◊	32 (1.5) ▼
Cyprus	1 (0.3)	0 (0.2) ▲	2 (0.4)	2 (0.4)	12 (0.8)	8 (0.6) ▲	14 (0.8)	15 (1.0) ▼
Palestinian Nat'l Auth.	1 (0.2)	1 (0.2)	◊ ◊	◊ ◊	9 (0.6)	10 (0.8)	◊ ◊	◊ ◊
Lebanon	1 (0.4)	0 (0.1)	◊ ◊	◊ ◊	8 (1.2)	4 (0.7) ▲	◊ ◊	◊ ◊
Egypt	1 (0.1)	1 (0.2) ▼	◊ ◊	◊ ◊	7 (0.6)	10 (0.7) ▼	◊ ◊	◊ ◊
Colombia	1 (0.1)	◊ ◊	◊ ◊	0 (0.2)	4 (0.5)	◊ ◊	◊ ◊	2 (0.4) ▲
Indonesia	0 (0.2)	0 (0.1)	1 (0.3) ▼	◊ ◊	5 (0.7)	4 (0.5)	8 (1.0)	◊ ◊
Tunisia	0 (0.1)	0 (0.0)	0 (0.1)	◊ ◊	4 (0.5)	1 (0.2) ▲	3 (0.5)	◊ ◊
Ghana	0 (0.0)	0 (0.0)	◊ ◊	◊ ◊	1 (0.3)	0 (0.1) ▲	◊ ◊	◊ ◊
Botswana	0 (0.0)	0 (0.1)	◊ ◊	◊ ◊	2 (0.3)	1 (0.5)	◊ ◊	◊ ◊
Benchmarking Participants								
Massachusetts, US	20 (1.8)	◊ ◊	15 (2.4)	◊ ◊	56 (2.5)	◊ ◊	43 (3.1) ▲	◊ ◊
Minnesota, US	11 (1.7)	◊ ◊	◊ ◊	17 (2.4) ▼	45 (2.6)	◊ ◊	◊ ◊	50 (3.8)
Ontario, Canada	7 (1.1)	7 (0.7)	7 (0.9)	5 (0.6)	37 (2.0)	41 (1.8)	34 (1.6)	26 (1.6) ▲
British Columbia, Canada	7 (0.9)	◊ ◊	14 (2.2) ▼	◊ ◊	38 (1.6)	◊ ◊	47 (3.0) ▼	◊ ◊
Quebec, Canada	4 (0.8)	6 (1.0)	10 (2.2) ▼	7 (1.5)	27 (1.5)	39 (2.0) ▼	43 (3.7) ▼	30 (2.8)
Basque Country, Spain	3 (0.6)	3 (0.6)	◊ ◊	◊ ◊	24 (1.6)	20 (1.5)	◊ ◊	◊ ◊

▲ 2007 percent significantly higher
▼ 2007 percent significantly lower

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Trend notes: Data are not shown for Bulgaria, Kuwait, Morocco, Saudi Arabia, and Turkey, because comparable data from previous cycles are not available. Data for Indonesia do not include Islamic schools.

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

A dash (–) indicates comparable data are not available.

A diamond (◊) indicates the country did not participate in the assessment.

Exhibit 2.3 Trends in Percentages of Students Reaching the TIMSS 2007 International Benchmarks of Science Achievement (Continued)

TIMSS2007 Science 8th Grade

Country	Intermediate International Benchmark (475)				Low International Benchmark (400)			
	2007 Percent of Students	2003 Percent of Students	1999 Percent of Students	1995 Percent of Students	2007 Percent of Students	2003 Percent of Students	1999 Percent of Students	1995 Percent of Students
Singapore	80 (1.8)	85 (1.7) ▼	84 (2.4)	91 (1.3) ▼	93 (1.1)	95 (0.8) ▼	95 (1.2)	99 (0.2) ▼
Chinese Taipei	83 (1.2)	88 (1.1) ▼	86 (1.3)	◊ ◊	95 (0.6)	98 (0.4) ▼	96 (0.6)	◊ ◊
Japan	85 (0.8)	86 (0.8)	84 (0.9)	85 (0.7)	96 (0.4)	98 (0.3) ▼	97 (0.4)	97 (0.3)
England	79 (1.9)	81 (1.8)	76 (1.9)	75 (1.4)	94 (0.9)	96 (0.6)	94 (0.7)	93 (0.7)
Korea, Rep. of	85 (0.8)	88 (0.7) ▼	81 (1.0) ▲	81 (0.9) ▲	97 (0.4)	98 (0.4) ▼	96 (0.4) ▲	95 (0.5) ▲
Hungary	80 (1.3)	82 (1.1)	83 (1.3)	80 (1.5)	96 (0.7)	97 (0.6)	96 (0.8)	95 (0.7)
Czech Republic	82 (0.8)	◊ ◊	79 (1.7)	86 (1.3) ▼	97 (0.4)	◊ ◊	96 (0.8)	98 (0.5)
Slovenia	81 (1.1)	75 (1.3) ▲	– –	69 (1.6) ▲	97 (0.5)	96 (0.6)	– –	93 (0.7) ▲
Russian Federation	76 (1.6)	70 (1.8) ▲	73 (2.3)	71 (2.2)	95 (0.7)	93 (0.9)	92 (1.0) ▲	92 (1.1)
Hong Kong SAR	77 (2.2)	89 (1.4) ▼	80 (1.9)	70 (2.7) ▲	92 (1.3)	98 (0.7) ▼	96 (0.9) ▼	90 (1.7)
United States	71 (1.3)	75 (1.4)	67 (1.9)	68 (2.2)	92 (0.7)	93 (0.8)	87 (1.3) ▲	87 (1.6) ▲
Armenia	55 (2.4)	45 (1.9) ▲	◊ ◊	◊ ◊	83 (1.3)	77 (1.4) ▲	◊ ◊	◊ ◊
Australia	70 (1.7)	76 (1.9) ▼	– –	69 (1.6)	92 (0.8)	95 (0.8) ▼	– –	89 (1.0) ▲
Lithuania	72 (1.4)	74 (1.3)	57 (2.0) ▲	45 (2.2) ▲	93 (0.8)	95 (0.6) ▼	86 (1.7) ▲	79 (1.6) ▲
Sweden	69 (1.4)	75 (1.4) ▼	◊ ◊	83 (1.7) ▼	91 (0.8)	95 (0.7) ▼	◊ ◊	97 (0.7) ▼
Jordan	56 (1.8)	53 (1.8)	42 (1.4) ▲	◊ ◊	79 (1.4)	80 (1.3)	69 (1.6) ▲	◊ ◊
Scotland	61 (1.8)	70 (1.7) ▼	◊ ◊	61 (2.2)	87 (1.1)	92 (0.9) ▼	◊ ◊	86 (1.4)
Israel	51 (1.9)	57 (1.6) ▼	50 (2.1)	– –	75 (1.8)	85 (1.1) ▼	75 (2.0)	– –
Italy	62 (1.4)	59 (1.5)	59 (2.0)	– –	88 (1.0)	87 (1.1)	86 (1.2)	– –
Thailand	48 (2.2)	◊ ◊	54 (2.3) ▼	– –	80 (1.5)	◊ ◊	87 (1.2) ▼	– –
Malaysia	50 (2.7)	71 (2.0) ▼	59 (2.2) ▼	◊ ◊	80 (2.2)	95 (0.7) ▼	87 (1.4) ▼	◊ ◊
Iran, Islamic Rep. of	41 (1.8)	38 (1.3)	38 (1.8)	43 (2.2)	76 (1.7)	77 (1.3)	72 (1.8)	81 (1.8) ▼
Bahrain	49 (0.9)	33 (1.1) ▲	◊ ◊	◊ ◊	78 (0.7)	70 (1.2) ▲	◊ ◊	◊ ◊
Serbia	51 (1.6)	48 (1.3)	◊ ◊	◊ ◊	81 (1.1)	79 (1.0)	◊ ◊	◊ ◊
Romania	46 (1.9)	49 (2.2)	50 (2.6)	51 (2.2)	77 (1.6)	78 (1.9)	78 (2.0)	77 (1.7)
Norway	58 (1.4)	63 (1.3) ▼	◊ ◊	72 (1.3) ▼	87 (0.9)	91 (0.8) ▼	◊ ◊	94 (0.9) ▼
Cyprus	42 (1.1)	35 (1.0) ▲	45 (1.5)	43 (1.3)	74 (1.0)	71 (1.2) ▲	77 (1.1) ▼	72 (1.1)
Palestinian Nat'l Auth.	28 (1.2)	36 (1.4) ▼	◊ ◊	◊ ◊	54 (1.5)	66 (1.5) ▼	◊ ◊	◊ ◊
Lebanon	28 (2.1)	20 (1.5) ▲	◊ ◊	◊ ◊	55 (2.9)	48 (2.0) ▲	◊ ◊	◊ ◊
Egypt	27 (1.4)	33 (1.4) ▼	◊ ◊	◊ ◊	55 (1.6)	59 (1.6) ▼	◊ ◊	◊ ◊
Colombia	22 (1.5)	◊ ◊	◊ ◊	9 (1.3) ▲	59 (2.1)	◊ ◊	◊ ◊	35 (2.4) ▲
Indonesia	30 (2.1)	25 (1.8)	33 (1.7)	◊ ◊	68 (2.4)	61 (2.1) ▲	68 (2.5)	◊ ◊
Tunisia	31 (1.3)	12 (1.0) ▲	25 (1.6) ▲	◊ ◊	77 (1.2)	52 (1.5) ▲	68 (2.1) ▲	◊ ◊
Ghana	6 (0.9)	3 (0.4) ▲	◊ ◊	◊ ◊	19 (1.6)	13 (1.3) ▲	◊ ◊	◊ ◊
Botswana	11 (0.7)	10 (0.9)	◊ ◊	◊ ◊	35 (1.3)	35 (1.3)	◊ ◊	◊ ◊
Benchmarking Participants								
Massachusetts, US	84 (2.0)	◊ ◊	75 (3.2) ▲	◊ ◊	96 (0.9)	◊ ◊	93 (1.4)	◊ ◊
Minnesota, US	82 (2.3)	◊ ◊	◊ ◊	79 (3.1)	96 (1.0)	◊ ◊	◊ ◊	94 (1.4)
Ontario, Canada	77 (1.7)	81 (1.2)	72 (1.6) ▲	61 (1.9) ▲	96 (1.0)	97 (0.5)	95 (0.5)	88 (1.1) ▲
British Columbia, Canada	77 (1.2)	◊ ◊	81 (2.6)	◊ ◊	95 (0.6)	◊ ◊	96 (1.1)	◊ ◊
Quebec, Canada	68 (1.7)	82 (1.5) ▼	83 (2.4) ▼	69 (3.5)	94 (0.9)	98 (0.4) ▼	98 (0.5) ▼	92 (2.6)
Basque Country, Spain	64 (1.7)	58 (1.9) ▲	◊ ◊	◊ ◊	91 (1.0)	89 (0.9)	◊ ◊	◊ ◊

▲ 2007 percent significantly higher
▼ 2007 percent significantly lower

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

At the eighth grade, countries showing consistent improvement at each benchmark across assessments since 1995 included Slovenia and Lithuania. Armenia, Bahrain, and Cyprus had increased percentages from 2003 reaching all four benchmarks, and the Russian Federation for the top three benchmarks. Lebanon, Tunisia, and Ghana showed improvement at the high, intermediate, and low benchmarks, but not at the advanced benchmark.

Fourth Grade: Achievement at the Advanced International Benchmark

At the fourth grade, almost half the assessment items (45%) were devoted to assessing the *life science* content domain. According to the *TIMSS 2007 Science Framework*, students should demonstrate knowledge of the characteristics and life processes of living things, know and compare the life cycles of common organisms such as the butterfly and frog, describe relationships between plants and animals in common ecosystems, and have a rudimentary knowledge of human health, nutrition, and disease. Within the *physical science* domain (35% of the assessment), students should compare or classify objects and materials on the basis of physical properties, identify common energy sources and have some understanding of heat flow, relate familiar physical phenomena to the behavior of light and sound, have some notion of a complete electrical circuit and some practical knowledge of magnets and their uses, and have some grasp of the idea of forces as they relate to movement. In the *earth science* content domain (20% of the assessment), fourth grade students were expected to demonstrate some general knowledge about the structure and physical characteristics of Earth; Earth's processes, cycles, and history; and some understandings about Earth's place in the solar system. Within each of the content domains, students were expected to demonstrate knowledge as well as application and reasoning skills.

Exhibit 2.4 describes fourth-grade performance at the Advanced International Benchmark. Students achieving at or above this benchmark demonstrated fluency with many framework topics. They communicated their understanding of characteristics and life processes of organisms and of relationships among physical properties of materials. They demonstrated

some understanding of the solar system and of Earth's physical features and processes, and a developing ability to interpret the results of investigations and draw conclusions. They typically demonstrated success on the knowledge and skills represented by this benchmark, as well as those demonstrated at the high, intermediate, and low benchmarks.

Although not expected to have mastered the concept of density as yet, students at the fourth grade are expected to appreciate that an object's capacity to float or sink is not determined by its size. Example Item 1 (Exhibit 2.5) presents a physical science item likely to be answered correctly by students performing at the advanced benchmark. In this example, students were shown a diagram depicting three beakers of the same size and containing the same amount of water, and three ice cubes of varying size. On average internationally across countries, 39 percent of students recognized that all three ice-cubes would float, regardless of their size. In Chinese Taipei, 60 percent of the fourth grade students chose the correct option, followed closely by Japan (58%), Singapore (57%), and Austria and Australia (both 56%).

In the life science domain at the fourth grade, students are expected to understand some basic principles of heredity and reproduction, including that animals produce offspring by reproducing with their own kind. One such item likely to be answered by students reaching the advanced level is shown in Exhibit 2.6. Example Item 2 is a constructed-response item that asks students to explain whether the last remaining member of a species (a giant turtle) can reproduce so that the species does not die out. To gain credit on this item, students explained that turtles cannot reproduce by themselves, and that a male turtle would need a female. On average internationally, just 30 percent of the students answered this item correctly. More than half the students in Lithuania (58%) and Latvia (55%) gained credit on this item.

Exhibit 2.4 **Description of the TIMSS 2007 Advanced International Benchmark (625) of Science Achievement**

TIMSS2007 Science 4th Grade

Advanced International Benchmark – 625

Summary

Students can apply knowledge and understanding of scientific processes and relationships in beginning scientific inquiry. Students communicate their understanding of characteristics and life processes of organisms as well as of factors relating to human health. They demonstrate understanding of relationships among various physical properties of common materials and have some practical knowledge of electricity. Students demonstrate some understanding of the solar system and Earth's physical features and processes. They show a developing ability to interpret the results of investigations and draw conclusions as well as a beginning ability to evaluate and support an argument.

In life science, students communicate their understanding of characteristics and life processes of organisms as well as of factors relating to human health. From a diagram, they recognize an animal that has a skeleton on the outside of its body, identify the body covering that protects a reptile, and recognize a group of mammals. They state one physical feature or behavior of sea mammals that distinguishes them from fish and, from a diagram of an animal's skull, describe a function of particular types of teeth. Students show some knowledge of reproduction and recognize examples of animals that take care of their young. They describe one physical change that can take place in a mammal as the weather gets cold, state how migration increases the survival of birds, and recognize an advantage to monarch butterflies of being poisonous to birds. They also describe human activities that can lead to the extinction of animals. Students evaluate and support an argument for the need for a balanced diet, select the best source of calcium from a list of common foods, and explain why people should drink liquids frequently. They suggest one way to avoid catching flu and one cause for higher than normal human body temperature, and recognize that food provides the energy needed to heal a cut.

In physical science, students demonstrate understanding of relationships among various physical properties of common materials. They recognize that ice cubes float in water regardless of their size, and identify the diagram that best shows how ice floats in water. Using information about physical properties of familiar items, students identify another item with matching properties and, from partial diagrammatic information, draw a conclusion about the relative weight of one of four cubes. Students name a property that can be used to separate balls of the same volume but made of different metals. They recognize the best conductor of heat from a list of familiar materials, and can label the freezing point of water on a diagram of a thermometer. Students name one thing that shows that sunlight is made up of different colors and distinguish objects that produce their own light from those that do not. From a description of a multi-step investigation, students can describe the results and conclude that the color of an object looks different under different colored light. Students demonstrate some practical knowledge of electricity. Given two electric circuit diagrams showing different battery configurations, students explain which circuit will allow a bulb to light. They also name a source of energy other than coal, oil, or natural gas that is used to produce electricity.

In Earth science, students demonstrate some understanding of the solar system and Earth's physical features and processes. They recognize how long it takes for Earth to rotate on its axis and to orbit the Sun, and that the Moon is visible because it reflects light from the Sun. They recognize the relative proportions of land and water on Earth and have some understanding of the composition of Earth's crust. Students recognize that decaying plants and animals enrich the soil and make plants grow. They describe the use of a natural resource and identify a change in soil from natural causes. They can interpret a map indicating that a river flows from mountains to the ocean and describe one disadvantage of farming near a river.

Students demonstrate a developing ability to interpret the results of investigations and drawing conclusions as well as a beginning ability to evaluate and support an argument.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

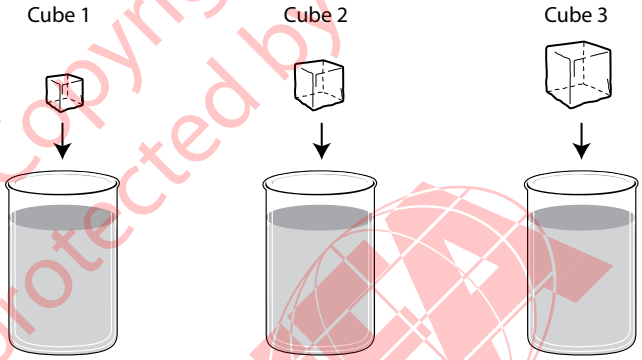
Exhibit 2.5 TIMSS 2007 Advanced International Benchmark (625) of Science Achievement – Example Item 1

TIMSS2007 Science 4th Grade

Content Domain: Physical Science

Description: Recognizes that, regardless of their size, ice cubes float in water.

Susie has three ice cubes of different sizes. She places each ice cube into an identical beaker containing the same volume of water, as shown in the diagram.



What happens to the ice cubes when they are placed in the water?

Ⓐ Cubes 1, 2, and 3 will sink.

● Cubes 1, 2, and 3 will float.

Ⓒ Cube 1 will float, and cubes 2 and 3 will sink.

Ⓓ Cubes 1 and 2 will float, and cube 3 will sink.

Country	Percent Correct	
Chinese Taipei	60 (2.1)	▲
Japan	58 (2.3)	▲
Singapore	57 (1.8)	▲
Austria	56 (2.4)	▲
Australia	56 (2.4)	▲
Sweden	51 (2.1)	▲
† Denmark	50 (2.5)	▲
Germany	49 (1.7)	▲
Norway	49 (2.3)	▲
Hong Kong SAR	48 (2.1)	▲
Russian Federation	46 (2.1)	▲
2 † United States	44 (1.6)	▲
New Zealand	44 (2.5)	
1 Latvia	43 (2.7)	
Czech Republic	41 (2.7)	
Slovenia	40 (2.0)	
1 Kazakhstan	40 (2.4)	
Italy	39 (2.1)	
International Avg.	39 (0.4)	
El Salvador	38 (1.9)	
Colombia	37 (2.3)	
England	37 (2.2)	
Slovak Republic	36 (2.2)	
† Scotland	36 (2.4)	
1 Lithuania	36 (2.7)	
‡ Netherlands	35 (2.5)	
Hungary	34 (2.4)	▼
Armenia	33 (3.2)	
◆◆ Kuwait	31 (2.0)	▼
Qatar	28 (1.5)	▼
Ukraine	27 (2.3)	▼
1 Georgia	26 (2.3)	▼
Yemen	25 (1.8)	▼
Morocco	24 (2.7)	▼
Iran, Islamic Rep. of	21 (2.1)	▼
Tunisia	20 (1.9)	▼
Algeria	20 (1.8)	▼
Benchmarking Participants		
2 Massachusetts, US	55 (2.7)	▲
2 † Minnesota, US	52 (4.3)	▲
2 Quebec, Canada	48 (2.7)	▲
2 British Columbia, Canada	47 (2.6)	▲
2 Alberta, Canada	46 (2.4)	▲
2 Ontario, Canada	42 (3.0)	
◆◆ ‡ Dubai, UAE	29 (2.1)	▼

Percent significantly higher than international average ▲
Percent significantly lower than international average ▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

Exhibit 2.6 TIMSS 2007 Advanced International Benchmark (625) of Science Achievement – Example Item 2

TIMSS2007 Science 4th Grade

Content Domain: Life Science

Description: Explains that the last surviving member of a species of a turtle cannot reproduce and gives a reason.

There is a giant turtle that lives on an island. He is the only turtle left of a special type of giant turtle.

Can he reproduce so that this type of turtle does not die out?

(Check one box.)

☐ Yes

☑ No

Give a reason for your answer.

Turtles cannot reproduce all by themselves. It is a male turtle so he needs a female.

The answer shown illustrates the type of student response that was given full credit

Country	Percent Full Credit	
[1] Lithuania	58 (2.4)	▲
[1] Latvia	55 (2.4)	▲
Germany	49 (2.1)	▲
Australia	48 (2.5)	▲
Czech Republic	47 (2.2)	▲
England	47 (2.4)	▲
Hungary	45 (2.6)	▲
Japan	45 (2.1)	▲
Slovak Republic	45 (2.5)	▲
Chinese Taipei	43 (2.4)	▲
‡ Netherlands	43 (2.2)	▲
[2] † United States	42 (1.6)	▲
† Denmark	42 (2.5)	▲
Russian Federation	41 (2.4)	▲
Singapore	38 (2.4)	▲
Italy	38 (2.3)	▲
Hong Kong SAR	36 (2.2)	▲
† Scotland	36 (2.1)	▲
New Zealand	35 (2.0)	▲
Sweden	34 (2.7)	
Slovenia	32 (2.0)	
International Avg.	30 (0.3)	
Armenia	25 (2.4)	▼
[1] Kazakhstan	25 (2.4)	▼
Ukraine	23 (1.9)	▼
Norway	18 (2.1)	▼
Algeria	12 (1.6)	▼
Colombia	12 (1.7)	▼
El Salvador	12 (1.3)	▼
◆◆ Kuwait	9 (1.4)	▼
[1] Georgia	9 (2.0)	▼
Morocco	8 (1.4)	▼
Tunisia	5 (0.9)	▼
Iran, Islamic Rep. of	4 (1.0)	▼
Qatar	2 (0.5)	▼
Yemen	1 (0.4)	▼
Austria	– –	
Benchmarking Participants		
[2] Massachusetts, US	49 (3.3)	▲
[2] † Minnesota, US	42 (3.1)	▲
[2] Ontario, Canada	35 (2.8)	
[2] Alberta, Canada	33 (2.5)	
[2] British Columbia, Canada	33 (2.4)	
[2] Quebec, Canada	29 (2.6)	
◆◆ ‡ Dubai, UAE	12 (1.7)	▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Percent significantly higher than international average ▲
Percent significantly lower than international average ▼

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

[1] National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

[2] National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

A dash (–) indicates comparable data are not available.

Fourth Grade: Achievement at the High International Benchmark

Exhibit 2.7 describes performance at the high benchmark. Students reaching this level demonstrated some competency with many of the topics in the framework. For example, in the life science domain they demonstrated some understanding of plant and animal structure, life processes, and the environment; and in the physical science domain, some knowledge of properties of matter and physical phenomena. Students at this level also demonstrate some knowledge of the solar system, and of Earth's structure, processes, and resources, as well as beginning scientific inquiry knowledge and skills.

Exhibit 2.8 presents a multiple-choice item involving heat transfer that illustrates one type of physical science item typically answered correctly by students reaching the high benchmark. Example Item 3 requires students to recognize that, when heat is applied to one end of a metal ruler, the heat will be conducted from the heated end to the other end. Internationally, 57 percent of students, on average, were able to provide a correct response. More than 80 percent of students provided the correct answer in Japan (92%) and Singapore (88%).

Example Item 4 shown in Exhibit 2.9 is an example of a life science task likely to be completed by students reaching the high benchmark. In this constructed-response item, students were given a diagram of the life cycle of a moth and asked to label three of the four stages. Internationally on average, 33 percent of students correctly labeled the egg, caterpillar, and pupa stages of the cycle. More than 60 percent of students in the Slovak Republic (66%), Singapore (64%), and Chinese Taipei (61%) answered this item correctly, and more than 90 percent did so in Japan (93%).

Exhibit 2.7 **Description of the TIMSS 2007 High International Benchmark (550) of Science Achievement**

TIMSS2007 Science 4th Grade

High International Benchmark – 550

Summary

Students can apply knowledge and understanding to explain everyday phenomena. Students demonstrate some understanding of plant and animal structure, life processes, and the environment and some knowledge of properties of matter and physical phenomena. They show some knowledge of the solar system, and of Earth's structure, processes, and resources. Students demonstrate beginning scientific inquiry knowledge and skills, and provide brief descriptive responses combining knowledge of science concepts with information from everyday experience of physical and life processes.

In life science, students demonstrate some understanding of plant and animal structure and life processes. They recognize from a diagram the part of a flowering plant that produces seeds and that plants make food using energy from the sun. They identify fish and sea mammals by their physical features and behaviors, and distinguish between plant eaters and meat eaters by their teeth. Students demonstrate some understanding of life cycles and reproduction. For example, they can complete a diagram showing the life cycle of a moth and recognize that if the only remaining members of a species of mammal are female, they will not be able to reproduce. Students demonstrate some understanding of ecosystems and the environment. They complete a food chain and identify a predator-prey relationship, and from a picture of a pond ecosystem, identify living and non-living things. They identify human activities with positive or negative effects on the environment.

In physical science, students demonstrate some understanding of properties of matter and common physical phenomena. They explain that objects with more volume than others do not necessarily weigh more and identify examples of matter that exist as solid, liquid, or gas at room temperature. Students describe changes in matter, such as how a liquid can be turned into a solid or gas, and demonstrate a basic understanding of mixtures and solutions. For example, they identify the steps in separating a mixture of iron filings and sand, and recognize that salt water is a mixture. Students recognize that a material dissolves faster in hot water than in cold and that more of it will dissolve in hot water. In addition, they explain that small pieces of material dissolve faster than larger pieces. Students demonstrate a basic understanding of heat and conductivity, recognizing, for example, that metal conducts heat better than wood, and that ice in a closed container melts more slowly than ice exposed to the open air. Students demonstrate awareness of magnetic and gravitational forces, and of electricity. From a diagram, students complete the labeling of the poles on magnets, and predict the movement of two magnets with labeled poles. They recognize an example of an object moving because of the force of gravity and that gravity causes objects to fall to the ground. From a diagram of an electric circuit, students state why an unbroken bulb does not light up. Students demonstrate a basic understanding of the properties of light. They recognize from a diagram the direction of a shadow and what causes a shadow to be formed.

In Earth science, students demonstrate some knowledge of the solar system, and Earth's structure, processes, and resources. They identify Earth, the Moon, and the Sun from a diagram, and, from a table showing planetary distance, identify the planet closest to the Sun and the planet most likely to have the lowest surface temperature. Students recognize that most of Earth's surface is covered by water and can describe one advantage of farming near a river. They explain that when moist air becomes very cold, water in the air may condense or freeze and early-morning moisture can be due to condensation. From tabular information about weather conditions, students identify a place where it is likely to snow. Students recognize that a mountain-side rock layer containing shellfish fossils was once part of a sea floor, and that animal fossils are the best evidence that there once were many kinds of animals on Earth that no longer exist today.

Students demonstrate beginning scientific inquiry knowledge and skills. They compare, contrast, and draw conclusions, and provide brief descriptive responses combining knowledge of science concepts with information from everyday experience of physical and life processes.

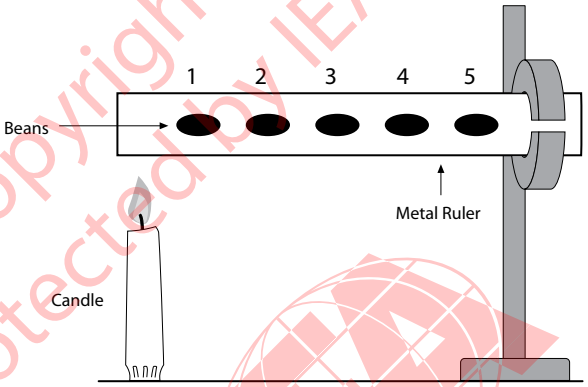
SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.8 TIMSS 2007 High International Benchmark (550) of Science Achievement – Example Item 3

TIMSS2007 Science 4th Grade

Content Domain: Physical Science

Description: From a diagram showing a metal ruler heated at one end, recognizes the direction of heat transfer starting from the heated end.



Beans are fixed on a metal ruler with butter as shown in the figure above. The ruler is heated at one end. In which order will the beans fall off?

- ● 1, 2, 3, 4, 5
- Ⓑ 5, 4, 3, 2, 1
- Ⓒ 1, 3, 5, 4, 2
- Ⓓ All at the same time

Country	Percent Correct	
Japan	92 (1.2)	▲
Singapore	88 (1.4)	▲
Hong Kong SAR	75 (2.1)	▲
Russian Federation	70 (2.4)	▲
Slovenia	70 (2.1)	▲
Czech Republic	69 (2.4)	▲
1 Latvia	69 (2.3)	▲
Hungary	67 (2.0)	▲
1 Kazakhstan	67 (2.6)	▲
England	67 (2.3)	▲
2 † United States	66 (1.7)	▲
‡ Netherlands	65 (2.5)	▲
Chinese Taipei	65 (2.0)	▲
Italy	65 (2.2)	▲
Ukraine	65 (2.0)	▲
Germany	64 (1.8)	▲
Austria	63 (2.2)	▲
1 Lithuania	63 (2.8)	▲
Slovak Republic	63 (2.4)	▲
† Denmark	62 (2.4)	▲
Australia	59 (2.8)	
† Scotland	58 (2.6)	
New Zealand	58 (2.2)	
International Avg.	57 (0.4)	
Armenia	56 (3.2)	
Sweden	55 (2.2)	
Norway	53 (2.5)	
1 Georgia	41 (2.7)	▼
Qatar	40 (1.5)	▼
Colombia	39 (2.3)	▼
El Salvador	36 (2.2)	▼
Algeria	35 (2.3)	▼
◆◆ Kuwait	35 (2.3)	▼
Tunisia	31 (2.2)	▼
Morocco	24 (3.2)	▼
Iran, Islamic Rep. of	24 (2.2)	▼
Yemen	20 (1.6)	▼
Benchmarking Participants		
2 † Minnesota, US	65 (3.8)	▲
2 Alberta, Canada	63 (2.4)	▲
2 Massachusetts, US	63 (3.6)	
2 Quebec, Canada	61 (2.4)	▲
2 British Columbia, Canada	61 (2.6)	
2 Ontario, Canada	60 (3.1)	
◆◆ ‡ Dubai, UAE	52 (2.3)	

Percent significantly higher than international average ▲
Percent significantly lower than international average ▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

Exhibit 2.9 TIMSS 2007 High International Benchmark (550) of Science Achievement – Example Item 4

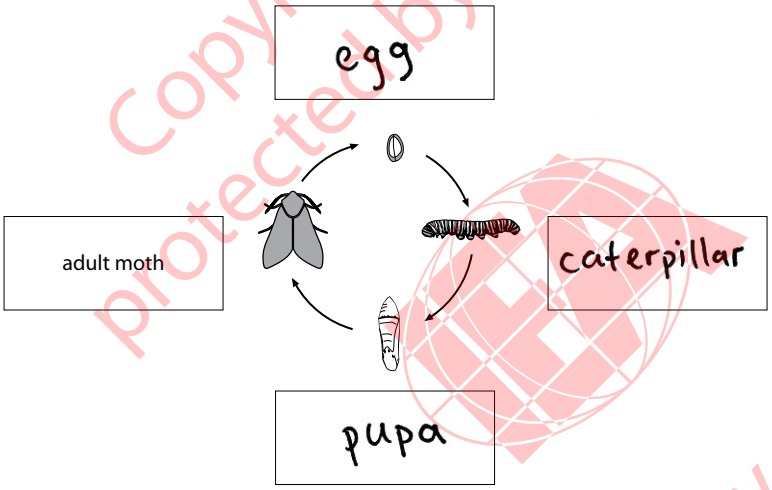
TIMSS2007 Science 4th Grade

Content Domain: Life Science

Description: Complete a diagram showing the life cycle of a moth.

The diagram below shows the life cycle of a moth.

Write the name of each stage in the boxes provided.
One stage has been completed for you.



The answer shown illustrates the type of student response that was given full credit

Country	Percent Full Credit	
Japan	93 (1.3)	▲
Slovak Republic	66 (2.3)	▲
Singapore	64 (2.0)	▲
Chinese Taipei	61 (2.4)	▲
Hungary	56 (2.5)	▲
Australia	56 (2.5)	▲
Sweden	53 (2.6)	▲
New Zealand	52 (1.9)	▲
2 † United States	48 (1.8)	▲
† Denmark	45 (2.6)	▲
1 Lithuania	43 (2.8)	▲
Czech Republic	40 (2.7)	▲
1 Latvia	39 (3.0)	▲
Germany	38 (1.8)	▲
‡ Netherlands	37 (2.6)	
Austria	36 (1.8)	▲
England	36 (2.2)	
† Scotland	33 (2.5)	
International Avg.	33 (0.4)	
👀 Kuwait	32 (2.5)	
Italy	32 (2.3)	
1 Kazakhstan	26 (4.4)	
Slovenia	25 (2.0)	▼
Iran, Islamic Rep. of	23 (2.4)	▼
Russian Federation	23 (1.7)	▼
Hong Kong SAR	22 (2.1)	▼
Armenia	21 (2.4)	▼
Norway	20 (2.0)	▼
Ukraine	18 (2.0)	▼
1 Georgia	16 (2.4)	▼
Qatar	7 (0.8)	▼
El Salvador	5 (0.9)	▼
Colombia	4 (1.1)	▼
Algeria	1 (0.4)	▼
Tunisia	1 (0.3)	▼
Yemen	0 (0.0)	▼
Morocco	0 (0.0)	▼
Benchmarking Participants		
2 Massachusetts, US	59 (4.1)	▲
2 Alberta, Canada	55 (2.2)	▲
2 † Minnesota, US	54 (3.6)	▲
2 British Columbia, Canada	49 (2.4)	▲
2 Ontario, Canada	48 (3.1)	▲
2 Quebec, Canada	27 (2.7)	▼
👀 ‡ Dubai, UAE	17 (2.1)	▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

▲ Percent significantly higher than international average
▼ Percent significantly lower than international average

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix A).
‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).
1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).
2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).
👀 Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Fourth Grade: Achievement at the Intermediate International Benchmark

Exhibit 2.10 shows the description of performance at the intermediate benchmark. Students reaching this benchmark applied basic knowledge and understanding to practical situations in the sciences. For example, they recognize some basic information about characteristics of living things and about human biology and health. They show some understanding of familiar physical phenomena, as well as some basic facts about the solar system and Earth's resources. They demonstrate some ability to interpret information in pictorial diagrams and apply factual knowledge to practical situations.

Example Item 5 at the intermediate benchmark addresses scientific investigation in a life science context. As displayed in Exhibit 2.11, students were shown a picture of two sunflower plants grown in similar pots of soil from seeds from the same plant. One plant was larger and healthier-looking than the other. To earn credit on this item, students had to describe one way that the larger plant may have been treated differently from the smaller one. On average across countries, almost two-thirds of students (63%) explained correctly that, for example, it might have been given more light or water. Eighty percent or more of students answered correctly in Singapore, Lithuania, the Netherlands, Sweden, Australia, England, Slovenia, Hong Kong SAR, and Austria. For the benchmarking participants, the two U.S. states and four Canadian provinces also achieved at this level.

Example Item 6 presented in Exhibit 2.12 is a physical science problem set in an everyday context likely to be answered correctly by students reaching the intermediate benchmark. Illustrated by a diagram, the item asked students to explain why, when a person blows through a straw into a glass of water, bubbles form and rise to the surface. Students earned credit on this constructed-response item by explaining that the bubbles are formed from air, and rise to the surface of the water because air is lighter than water. Approximately half the students (51%), internationally on average, were able to provide an acceptable explanation, with the highest performance in the Russian Federation (79%), Chinese Taipei (77%), Denmark (74%), Singapore (72%), Kazakhstan (71%), and the Czech Republic (70%).

Exhibit 2.10 **Description of the TIMSS 2007 Intermediate International Benchmark (475) of Science Achievement**

TIMSS2007 Science 4th Grade

Intermediate International Benchmark – 475

Summary

Students can apply basic knowledge and understanding to practical situations in the sciences. Students recognize some basic information related to characteristics of living things and their interaction with the environment, and show some understanding of human biology and health. They also show some understanding of familiar physical phenomena. Students know some basic facts about the solar system and have a developing understanding of Earth's resources. They demonstrate some ability to interpret information in pictorial diagrams and apply factual knowledge to practical situations.

In life science, students demonstrate knowledge of some basic facts related to human biology and health. For example, they recognize the stomach as an organ where digestion takes place, and that the body needs more oxygen during exercise. Students recognize that fruits and vegetables are the best source of vitamins and minerals, describe one way people can protect their teeth from decay in addition to brushing, and how influenza can be passed from person to person. Students demonstrate some knowledge of the characteristics of living things and their interaction with the environment. For example, from pictures of animals, students pair each animal with its distinguishing biological characteristics (skeleton, milk production, number of legs). They recognize the foot structure that belongs to a pond-dwelling bird and that fat layers help keep a walrus warm. Students interpret a simple food chain diagram and, from pictorial diagrams, recognize a bird likely to eat mammals. They recognize that trees make food using sunlight, and in the context of an investigation of plant growth, describe a treatment that can cause one plant to grow better than another. Students show some understanding of life cycles of organisms, recognizing that tadpoles hatch from frogs' eggs and that snakes shed their outer covering as they grow. They also recognize that the function of seeds is to produce new plants.

In physical science, students show some understanding of familiar physical phenomena. They recognize that an iron nail can complete an electrical circuit and allow a light bulb to glow. From a diagram showing a person blowing into water using a straw, students explain why bubbles rise to the top, and they recognize that a floating body is lighter than bodies of the same shape and size that sink. They can infer the color of a white shirt under a blue light. Students apply factual knowledge to some practical situations. For example, they identify electricity as the energy source for three household objects shown in a diagram and can state two uses of electricity in daily life. Students can state one way that water in either ice or liquid form is used by humans and can identify materials that burn.

In Earth science, students know some basic facts about the solar system. For example, they name two planets other than Earth that orbit the Sun and state one difference between the Sun and the Moon. Also, they can state one difference in weather between two seasons and recognize the effect of wind strength on a ribbon attached to a pole. Students are developing understanding of Earth's resources. For example, they can state two different uses humans have for wood and explain why people should not drink water directly from oceans and seas.

Students demonstrate some ability to interpret information in pictorial diagrams, apply factual knowledge to everyday situations, and provide simple explanations for physical phenomena.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.11 TIMSS 2007 Intermediate International Benchmark (475) of Science Achievement – Example Item 5

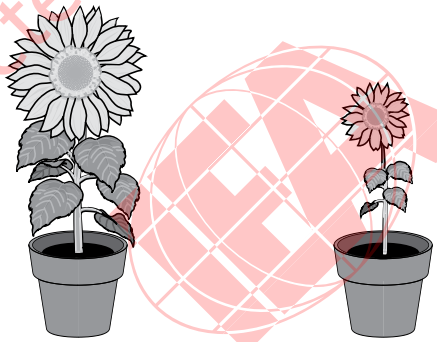
TIMSS2007 Science 4th Grade

Content Domain: Life Science

Description: In the context of an investigation of plant growth, describes a treatment that can cause one plant to grow better than another.

Carl and Jan each had a sunflower seed taken from the same plant. They took two identical pots and put potting soil in each. They then planted one seed in each pot. Carl looked after one pot in his home, and Jan looked after the other pot in her home.

After some time, they compared the plants and saw that there was a large difference in their growth, as shown in the pictures below.



Carl's plant Jan's plant

Describe one way in which Carl may have treated his plant differently from the way Jan treated hers.

Carl might have given it more light and water.

The answer shown illustrates the type of student response that was given full credit

Country	Percent Full Credit
Singapore	85 (1.8) ▲
1 Lithuania	85 (1.7) ▲
‡ Netherlands	84 (2.0) ▲
Sweden	84 (1.9) ▲
Australia	83 (2.3) ▲
England	81 (1.8) ▲
Slovenia	81 (1.6) ▲
Hong Kong SAR	81 (2.0) ▲
Austria	80 (1.9) ▲
1 Latvia	79 (2.4) ▲
Germany	79 (1.6) ▲
† Denmark	79 (2.3) ▲
Italy	79 (1.7) ▲
Norway	78 (2.0) ▲
2 † United States	78 (1.2) ▲
New Zealand	77 (1.6) ▲
† Scotland	74 (2.0) ▲
Chinese Taipei	73 (2.1) ▲
Hungary	71 (2.9) ▲
Czech Republic	71 (2.3) ▲
Russian Federation	69 (2.4) ▲
Ukraine	66 (2.3)
International Avg.	63 (0.4)
1 Kazakhstan	62 (3.0)
Colombia	60 (3.1)
Iran, Islamic Rep. of	59 (2.3) ▼
Armenia	59 (2.6)
Slovak Republic	58 (2.4) ▼
Japan	49 (2.3) ▼
El Salvador	47 (2.3) ▼
1 Georgia	40 (2.5) ▼
Algeria	37 (2.8) ▼
Tunisia	30 (2.2) ▼
Morocco	23 (3.4) ▼
◆◆ Kuwait	22 (1.8) ▼
Qatar	16 (1.0) ▼
Yemen	7 (1.2) ▼
Benchmarking Participants	
2 Massachusetts, US	88 (1.7) ▲
2 Quebec, Canada	84 (2.0) ▲
2 Ontario, Canada	84 (2.3) ▲
2 Alberta, Canada	83 (2.1) ▲
2 † Minnesota, US	83 (3.1) ▲
2 British Columbia, Canada	81 (1.8) ▲
◆◆ ‡ Dubai, UAE	56 (3.2) ▼

Percent significantly higher than international average ▲
Percent significantly lower than international average ▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

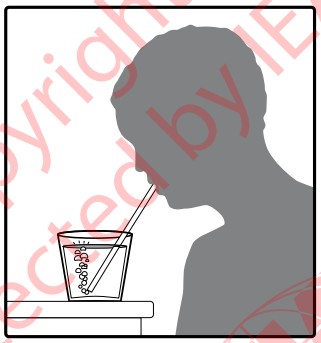
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Exhibit 2.12 TIMSS 2007 Intermediate International Benchmark (475) of Science Achievement – Example Item 6

TIMSS2007 Science 4th Grade

Content Domain: Physical Science

Description: From a diagram showing a person blowing into water using a straw, explains why bubbles rise to the top.



When you blow into water using a straw, bubbles are formed and rise to the top. Why do the bubbles rise in water?

They rise because they are made from air which is lighter than water.

The answer shown illustrates the type of student response that was given full credit

Country	Percent Full Credit	
Russian Federation	79 (2.3)	▲
Chinese Taipei	77 (1.7)	▲
† Denmark	74 (2.3)	▲
Singapore	72 (1.9)	▲
1 Kazakhstan	71 (3.1)	▲
Czech Republic	70 (2.2)	▲
Australia	67 (2.8)	▲
Slovenia	67 (2.3)	▲
England	66 (2.3)	▲
Austria	66 (2.0)	▲
Ukraine	65 (2.0)	▲
Japan	65 (2.0)	▲
New Zealand	64 (1.8)	▲
Slovak Republic	64 (2.5)	▲
Norway	63 (2.7)	▲
2 † United States	61 (1.7)	▲
1 Lithuania	61 (2.4)	▲
‡ Netherlands	59 (2.6)	▲
Hungary	59 (2.2)	▲
† Scotland	54 (2.4)	
Germany	52 (2.0)	
International Avg.	51 (0.4)	
Sweden	50 (2.3)	
Armenia	49 (3.2)	
Hong Kong SAR	48 (2.4)	
Italy	47 (2.2)	▼
Iran, Islamic Rep. of	31 (2.4)	▼
Algeria	29 (2.1)	▼
Colombia	28 (2.6)	▼
El Salvador	27 (1.7)	▼
1 Georgia	25 (2.1)	▼
Morocco	23 (2.5)	▼
👀 Kuwait	23 (2.0)	▼
Qatar	21 (1.2)	▼
Yemen	15 (1.5)	▼
Tunisia	11 (1.5)	▼
1 Latvia	– –	
Benchmarking Participants		
2 Ontario, Canada	65 (3.0)	▲
2 British Columbia, Canada	65 (2.5)	▲
2 Alberta, Canada	65 (2.7)	▲
2 † Minnesota, US	59 (3.7)	▲
2 Massachusetts, US	59 (3.8)	▲
2 Quebec, Canada	58 (2.5)	▲
👀 ‡ Dubai, UAE	43 (2.1)	▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

▲ Percent significantly higher than international average
▼ Percent significantly lower than international average

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

👀 Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

A dash (–) indicates comparable data are not available.

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Fourth Grade: Achievement at the Low International Benchmark

Exhibit 2.13 presents the description of student achievement at the low benchmark. At this benchmark students demonstrated some elementary knowledge of the life and physical sciences, including simple facts related to human health and the behavioral and physical characteristics of animals. They recognized some properties of matter and demonstrated a beginning understanding of forces. They could interpret labeled pictures and simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information about the sciences.

Example Item 7 (Exhibit 2.14) is a multiple-choice item from the life science domain that characterizes student performance at the low international benchmark. Given a pictorial representation of four animals, students were required to identify the animal most likely to live in a desert. On average internationally, 68% of fourth grade students correctly recognized the lizard as the most likely desert dweller. More than 90 percent of students in the United States recognized the correct answer.

Example Item 8 presented in Exhibit 2.15 assesses a topic within the physical science domain that measures students' ability to compare and classify objects and materials on the basis of physical properties (e.g., weight/mass, shape, volume, color, hardness, texture, odor, taste, magnetic attraction). This multiple-choice item presents three objects of the same size and shape and requires students to recognize that the object made of iron is the heaviest. With an international average of 80 percent, this item was relatively easy for students in many countries. In 25 countries, the two U.S. states, and the Canadian province of Quebec, 80 percent or more of the students answered correctly.

Exhibit 2.13 **Description of the TIMSS 2007 Low International Benchmark (400) of Science Achievement**

TIMSS2007 Science 4th Grade

Low International Benchmark – 400

Summary

Students have some elementary knowledge of life science and physical science. Students can demonstrate knowledge of some simple facts related to human health and the behavioral and physical characteristics of animals. They recognize some properties of matter, and demonstrate a beginning understanding of forces. Students interpret labeled pictures and simple diagrams, complete simple tables, and provide short written responses to questions requiring factual information.

In life science, students demonstrate knowledge of some simple facts related to human health. They state one effect the Sun can have on unprotected skin and recognize that the lung is the body organ most harmed by smoking. They also demonstrate some knowledge of behavioral and physical characteristics of animals. They recognize that birds sit on their eggs to keep them warm and recognize wings as being common to birds, bats, and butterflies. Students exhibit a rudimentary understanding of ecosystems. For example, they identify an animal that lives in the desert, recognize a wolf as a predator, and match animals to their ecosystems.

In physical science, students are familiar with some properties of matter. For example, they recognize that ice is the solid form of water, that iron nails rust, and that iron objects are likely to be heavier than wood or Styrofoam objects of the same size and shape. Students have a beginning understanding of forces. From a diagram, they identify the direction of the force of Earth's gravity and identify wind as the cause of movement in a sail boat. Students recognize that the vibrations that produce sound in a guitar start with the strings and, from a diagram, recognize the thermometer reading showing the hottest water.

Students interpret labeled pictures and simple diagrams (e.g., forces on a block, thermometer readings), complete simple tables (match animals to ecosystems), and provide short written responses to questions requiring factual information (e.g., state an effect the Sun can have on unprotected skin).

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

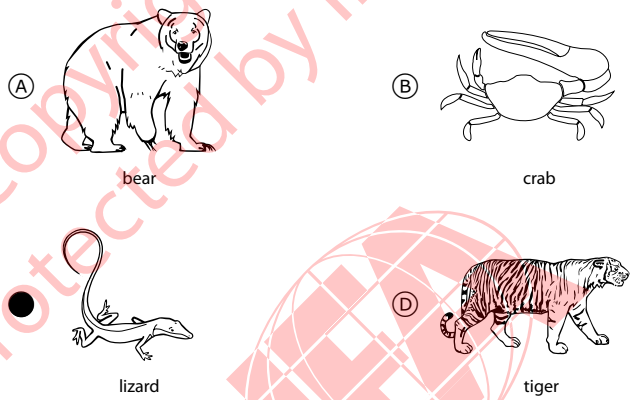
Exhibit 2.14 TIMSS 2007 Low International Benchmark (400) of Science Achievement – Example Item 7

TIMSS2007 Science 4th Grade

Content Domain: Life Science

Description: Recognizes from diagrams of animals which is most likely to live in a desert.

Which of these animals is most likely to live in the desert?



Country	Percent Correct	
2 † United States	92 (0.8)	▲
Russian Federation	89 (2.2)	▲
Australia	88 (1.8)	▲
1 Kazakhstan	86 (2.3)	▲
England	84 (1.9)	▲
† Denmark	84 (2.1)	▲
‡ Netherlands	83 (1.9)	▲
New Zealand	81 (1.4)	▲
◆◆ Kuwait	80 (1.8)	▲
Sweden	80 (1.7)	▲
Germany	78 (1.4)	▲
Austria	78 (1.7)	▲
Norway	77 (2.3)	▲
† Scotland	77 (1.9)	▲
Armenia	76 (2.4)	▲
Hong Kong SAR	74 (1.8)	▲
Singapore	71 (1.8)	
Ukraine	71 (2.2)	
1 Lithuania	70 (2.2)	
Hungary	69 (2.4)	
Chinese Taipei	69 (2.1)	
International Avg.	68 (0.4)	
1 Latvia	68 (2.8)	
Iran, Islamic Rep. of	67 (2.3)	
Japan	66 (2.1)	
Qatar	64 (1.5)	▼
1 Georgia	62 (3.1)	▼
Slovenia	61 (2.0)	▼
Italy	61 (2.4)	▼
El Salvador	53 (2.4)	▼
Czech Republic	53 (2.8)	▼
Algeria	49 (3.2)	▼
Slovak Republic	46 (2.4)	▼
Morocco	43 (2.7)	▼
Tunisia	42 (2.5)	▼
Colombia	38 (2.4)	▼
Yemen	28 (2.1)	▼
Benchmarking Participants		
2 † Minnesota, US	89 (2.6)	▲
2 Massachusetts, US	88 (1.4)	▲
2 Alberta, Canada	84 (1.7)	▲
2 Quebec, Canada	84 (2.0)	▲
2 British Columbia, Canada	82 (1.4)	▲
2 Ontario, Canada	82 (2.3)	▲
◆◆ ‡ Dubai, UAE	74 (2.4)	▲

Percent significantly higher than international average ▲
Percent significantly lower than international average ▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

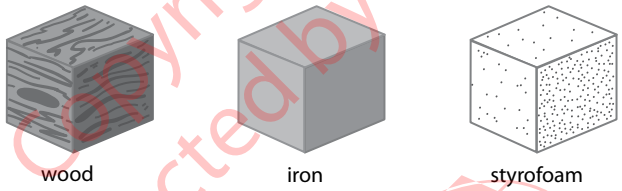
Exhibit 2.15 TIMSS 2007 Low International Benchmark (400) of Science Achievement – Example Item 8

TIMSS2007 Science 4th Grade

Content Domain: Physical Science

Description: Recognizes that an iron object is most likely to be heavier than a wood or styrofoam object of the same shape and size.

The three objects below are the same shape and size.



Which statement about the weight of the objects is most likely to be correct?

Ⓐ The wood object is the heaviest.

● The iron object is the heaviest.

Ⓒ The styrofoam object is the heaviest.

Ⓓ All three objects weigh the same.

Country	Percent Correct	
Japan	94 (1.2)	▲
Russian Federation	92 (1.3)	▲
Chinese Taipei	91 (1.4)	▲
Hong Kong SAR	90 (1.4)	▲
Germany	90 (1.2)	▲
Slovenia	89 (1.2)	▲
England	89 (1.6)	▲
Hungary	89 (1.4)	▲
1 Kazakhstan	89 (2.5)	▲
Italy	88 (1.4)	▲
Austria	88 (1.5)	▲
Singapore	88 (1.4)	▲
Czech Republic	87 (1.7)	▲
‡ Netherlands	86 (1.8)	▲
1 Latvia	86 (2.2)	▲
Slovak Republic	85 (1.4)	▲
Sweden	84 (1.8)	▲
1 Georgia	84 (2.0)	▲
† Denmark	84 (1.9)	▲
1 Lithuania	83 (2.1)	
Ukraine	82 (2.2)	
† Scotland	82 (1.8)	
Norway	81 (1.7)	
2 † United States	80 (1.1)	
El Salvador	80 (1.9)	
International Avg.	80 (0.3)	
Colombia	77 (2.4)	
Armenia	69 (2.0)	▼
◆◆ Kuwait	69 (2.3)	▼
Morocco	69 (2.4)	▼
Iran, Islamic Rep. of	68 (2.5)	▼
Australia	68 (3.1)	▼
New Zealand	67 (2.3)	▼
Algeria	66 (3.3)	▼
Tunisia	60 (2.5)	▼
Yemen	48 (2.6)	▼
Qatar	47 (1.6)	▼
Benchmarking Participants		
2 Massachusetts, US	86 (2.2)	▲
2 † Minnesota, US	85 (3.3)	
2 Quebec, Canada	84 (1.8)	▲
2 Ontario, Canada	79 (2.8)	
2 Alberta, Canada	79 (2.0)	
2 British Columbia, Canada	78 (2.3)	
◆◆ ‡ Dubai, UAE	68 (1.9)	▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

▲ Percent significantly higher than international average

▼ Percent significantly lower than international average

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

Eighth Grade: Achievement at the Advanced International Benchmark

At the eighth grade, TIMSS 2007 assessed four content domains with each given similar weight—biology (35%), chemistry (20%), physics (25%), and earth science (20%). According to the TIMSS 2007 Science Framework, in biology, students should be able to classify organisms into the major taxonomic groups, identify cell structures and their function, distinguish between growth and development in different organisms, and show some understanding of diversity, adaptation, and natural selection among organisms. By the eighth grade, students are expected to have an understanding of the interdependence of living organisms and their relationship to the physical environment, and demonstrate knowledge of human health, nutrition, and disease. In chemistry, students should be able to classify substances on the basis of characteristic physical properties and have a clear understanding of the properties of matter. Students should recognize the differences between physical and chemical changes and recognize the conservation of matter during these changes. In physics, students are expected to be able to describe processes involved in changes of state and apply knowledge of energy transformations, heat, and temperature. They should know basic properties of light and sound, understand the relationship between current and voltage in electrical circuits, and describe properties and forces of permanent magnets and electromagnets. Students are expected to have a quantitative knowledge of mechanics, as well as a commonsense understanding of density and pressure as they relate to familiar physical phenomena. In the earth science domain, eighth grade students are expected to demonstrate knowledge of the structure and physical characteristics of Earth's crust, mantle, and core, and apply the concept of cycles and patterns to describe Earth's processes, including the rock and water cycles. Students should have an understanding of Earth's resources and their use and conservation, and demonstrate knowledge of the solar system in terms of the relative distances, sizes, and motions of the sun, the planets, and their moons, and of how phenomena on Earth relate to the motion of bodies in the solar system. Within each content domain, students needed to draw on a range of

cognitive skills and go beyond the solution of routine problems to encompass unfamiliar situations, complex contexts, and multi-step problems.

Exhibit 2.16 describes performance at the Advanced International Benchmark. Students achieving at or above the advanced benchmark demonstrated a grasp of some complex and abstract science concepts. For example, they have an understanding of the complexity of living organisms and how they relate to their environment, and show knowledge of the structure of matter and of physical and chemical properties and changes. They show understanding of the properties of magnets, sound, and light. Students apply knowledge and understanding of the solar system and Earth's features and processes, and of major environmental issues. They understand some fundamentals of scientific investigation, can apply basic physical principles to solve quantitative problems, and can provide written explanations to communicate scientific knowledge.

Exhibit 2.17 shows the type of chemistry item likely to be answered correctly by students reaching the Advanced International Benchmark. In Example Item 1, students were told that two substances together had a mass of 110 grams, and asked to predict the mass of a new substance formed by combining the two original substances and explain their reasoning. On average, 23 percent of the students across countries received full credit by applying knowledge of conservation of mass in a chemical reaction to explain that the mass of the new substance also will be 100 grams. More than half the students in Japan (65%), Korea (51%), and Chinese Taipei (51%) earned full credit on this item.

Example Item 2 (Exhibit 2.18) from the physics domain assesses students understanding of the properties of magnets and, in particular, magnetic polarity. Given a diagram depicting three magnets, two of which are touching and a third which is separated from the touching pair, students were asked to provide two explanations: firstly, why the touching magnets touch, and secondly, why the separated pair remain separated. To earn full credit, students had to apply knowledge of the polarity of magnets (i.e., that opposite poles attract and like poles repel) to explain that the touching magnets had

facing north and south poles, while the separated magnets either had facing south poles or facing north poles. Internationally on average, 23 percent of the eighth grade students earned full credit, while more than half the students did so in Japan (71%), Singapore (61%), and Korea (52%).

Exhibit 2.16 **Description of the TIMSS 2007 Advanced International Benchmark (625) of Science Achievement**

TIMSS2007 Science 8th Grade

Advanced International Benchmark – 625

Summary

Students can demonstrate a grasp of some complex and abstract concepts in biology, chemistry, physics, and Earth science. They have an understanding of the complexity of living organisms and how they relate to their environment. They show understanding of the properties of magnets, sound, and light, as well as demonstrating understanding of structure of matter and physical and chemical properties and changes. Students apply knowledge of the solar system and of Earth's features and processes, and apply understanding of major environmental issues. They understand some fundamentals of scientific investigation and can apply basic physical principles to solve some quantitative problems. They can provide written explanations to communicate scientific knowledge.

In biology, students demonstrate understanding of the complexity of living organisms and how they relate to their environment. They recognize a function of the cell membrane and know the purpose of cellular respiration. Students recognize an organism in which oxygen and carbon dioxide are exchanged between air and blood through the skin, and recognize an organ in a frog that has a function similar to that of lungs. They also identify a function shared by lungs, skin, and kidneys. Students identify a developing stage and a growth stage in the life cycle of an organism and describe what takes place during each stage. They recognize that organisms in an ecosystem that are producers use energy from the sun to make food, and complete a diagram to show the direction of energy flow in a food web. Students demonstrate some appreciation of the impact of human population growth on the environment and know some animal adaptations needed for survival, including physical and behavioral characteristics.

In chemistry, students demonstrate an understanding of the structure of matter as well as of physical and chemical properties and changes. They recognize the particulate structure of matter (molecules, atoms, subatomic particles), and identify a model of subatomic particles in an atom and a representation of the structure of water molecules. Students apply knowledge of density to explain why oil floats on water and to explain that the addition of salt to water produces a solution of greater density. They apply knowledge of expansion of water during freezing and recognize that electrical conductivity may be used to classify materials. Students show some understanding of chemical change. For example, they describe what might be observed as a chemical reaction takes place, identify oxygen as the gas that causes rust, and state that litmus paper changing from blue to pink is a sign that a chemical change took place. They apply knowledge of conservation of mass during neutralization and other chemical reactions.

In physics, students demonstrate a sound understanding of states of matter and phase change. For example, they explain that the temperature of water does not exceed its boiling point despite the addition of heat and explain why the mass of water remains unchanged after freezing. Students demonstrate a good understanding of the properties of magnets. For example, they describe how to use a magnet to determine if a metal bar is also a magnet, and apply knowledge of magnetic poles to explain why some magnets will touch while others remain separated. Students apply scientific knowledge of gravity, sound and light in everyday situations. They recognize that gravity acts on a person regardless of position and movement, predict the effect of removing air on the propagation of sound, and recognize that color comes from light waves reflected by an object.

In Earth science, students apply knowledge of the solar system and of Earth's features and processes. They relate the changing seasons to the tilt in Earth's axis as it orbits the Sun and the phases of the Moon to its motion around Earth. Students interpret contour maps and diagrams showing weather conditions and describe changes in atmospheric conditions that occur with increasing elevation. Students demonstrate understanding of major environmental issues such as causes of acid rain and global warming.

Students have some understanding of fundamentals of scientific investigation. In an experimental situation, they recognize which variables to control and can design an investigation to determine, for example, the effect of fertilizer on plant growth. They apply basic physical principles to solve some quantitative problems and develop explanations involving abstract concepts. They can compare information from several sources, combine information to predict and draw conclusions, and interpret information in diagrams, maps, graphs, and tables to solve problems. They can provide written explanations to communicate scientific knowledge.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.17 TIMSS 2007 Advanced International Benchmark (625) of Science Achievement – Example Item 1

TIMSS2007 Science 8th Grade

Content Domain: Chemistry

Description: Applies knowledge of conservation of mass during a chemical reaction to explain what happens to mass when a new substance is formed.

The mass of substances A and B are measured on a balance, as shown in Figure 1. Substance B is put into the beaker and substance C is formed. The empty beaker is put back on the balance, as shown in Figure 2.

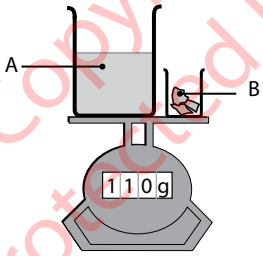


Figure 1

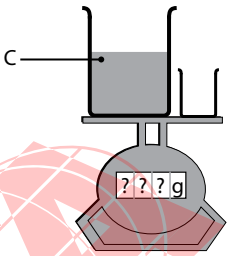


Figure 2

The scale in Figure 1 shows a mass of 110 grams.

What will it show in Figure 2?

(Check one box.)

- ☐ More than 110 grams
- ☑ 110 grams
- ☐ Less than 110 grams

Explain your answer.

The mass will be the same because the mass of reactants equals the mass of products.

The answer shown illustrates the type of student response that was given full credit

Country	Percent Full Credit	
Japan	65 (2.1)	▲
Korea, Rep. of	51 (2.0)	▲
Chinese Taipei	51 (2.3)	▲
Italy	46 (2.4)	▲
Czech Republic	43 (2.1)	▲
Slovenia	39 (2.4)	▲
Hungary	39 (2.4)	▲
Russian Federation	39 (2.5)	▲
Sweden	38 (2.0)	▲
Singapore	37 (1.9)	▲
1 Lithuania	37 (2.1)	▲
3 Israel	33 (2.1)	▲
† Hong Kong SAR	30 (2.3)	▲
Ukraine	29 (2.4)	▲
† England	28 (2.1)	▲
Armenia	28 (2.5)	
Malta	27 (1.5)	▲
Australia	25 (2.4)	
Norway	25 (1.9)	
Thailand	25 (1.7)	
2 † United States	24 (1.6)	
Cyprus	24 (1.6)	
International Avg.	23 (0.3)	
† Scotland	22 (1.9)	
Tunisia	22 (1.9)	
Romania	22 (2.4)	
1 2 Serbia	20 (2.1)	
Jordan	19 (2.0)	
3 Bulgaria	19 (2.4)	
Bahrain	18 (1.6)	▼
Lebanon	18 (2.3)	▼
Bosnia and Herzegovina	17 (2.1)	▼
Colombia	16 (1.6)	▼
Turkey	16 (1.6)	▼
Malaysia	14 (1.7)	▼
Iran, Islamic Rep. of	13 (1.5)	▼
Syrian Arab Republic	13 (1.5)	▼
Palestinian Nat'l Auth.	11 (1.5)	▼
El Salvador	9 (1.3)	▼
Oman	9 (1.4)	▼
Egypt	8 (1.2)	▼
Algeria	7 (1.0)	▼
◆◆ Kuwait	7 (1.2)	▼
Indonesia	6 (1.0)	▼
Saudi Arabia	5 (1.0)	▼
1 Georgia	4 (0.8)	▼
Qatar	3 (0.6)	▼
Ghana	3 (0.7)	▼
Botswana	1 (0.4)	▼
‡ Morocco	15 (2.0)	▼
Benchmarking Participants		
2 Massachusetts, US	44 (3.3)	▲
2 Ontario, Canada	39 (3.5)	▲
3 Quebec, Canada	36 (2.8)	▲
2 † Minnesota, US	33 (2.9)	▲
3 British Columbia, Canada	32 (2.3)	▲
Basque Country, Spain	22 (2.3)	
◆◆ ‡ Dubai, UAE	19 (2.3)	

Percent significantly higher than international average ▲
Percent significantly lower than international average ▼

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

‡ Did not satisfy guidelines for sample participation rates (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

3 National Defined Population covers less than 90% of National Target Population (but at least 77%, see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

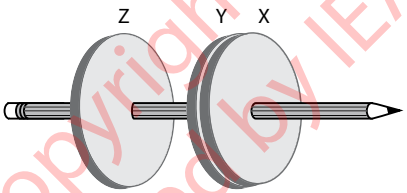
SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.18 TIMSS 2007 Advanced International Benchmark (625) of Science Achievement – Example Item 2

TIMSS2007 Science 8th Grade

Content Domain: Physics

Description: From a diagram showing three magnets, explain why two of them are touching and why the third remains separated.



The diagram shows what happens to three magnets when they are placed close together on a pencil.

Magnets X and Y move until they touch each other, but magnets Y and Z remain separated.

1. Explain why magnets X and Y touch each other.

Because north and south poles were facing each other.

2. Explain why magnets Y and Z remain separated.

Because they may have had south and south or north and north facing each other.

The answer shown illustrates the type of student response that was given full credit

Country	Percent Full Credit	
Japan	71 (2.0)	▲
Singapore	61 (1.8)	▲
Korea, Rep. of	52 (2.3)	▲
Hungary	47 (2.6)	▲
† England	46 (2.5)	▲
Malaysia	46 (2.5)	▲
Czech Republic	45 (2.7)	▲
Romania	43 (2.7)	▲
1 2 Serbia	43 (3.0)	▲
Iran, Islamic Rep. of	40 (2.8)	▲
Italy	36 (2.3)	▲
Russian Federation	34 (2.7)	▲
Bosnia and Herzegovina	28 (2.3)	▲
Egypt	27 (2.0)	▲
Bahrain	26 (2.1)	
3 Bulgaria	24 (2.5)	
Tunisia	24 (1.7)	
Australia	23 (2.2)	
Sweden	23 (2.1)	
Thailand	23 (1.9)	
International Avg.	23 (0.3)	
Indonesia	23 (1.9)	
Ukraine	21 (2.0)	
Jordan	20 (2.3)	
† Hong Kong SAR	20 (2.1)	
◆◆ Kuwait	19 (1.8)	▼
Turkey	17 (1.9)	▼
2 † United States	16 (1.6)	▼
Oman	16 (1.7)	▼
Botswana	15 (1.7)	▼
Armenia	15 (1.5)	▼
Malta	14 (1.0)	▼
Norway	14 (1.8)	▼
Palestinian Nat'l Auth.	13 (1.9)	▼
† Scotland	11 (1.8)	▼
3 Israel	10 (1.5)	▼
Slovenia	10 (1.3)	▼
Qatar	9 (0.9)	▼
Ghana	9 (1.2)	▼
1 Lithuania	8 (1.2)	▼
Saudi Arabia	8 (1.0)	▼
Syrian Arab Republic	7 (1.1)	▼
Lebanon	6 (1.4)	▼
Colombia	6 (1.1)	▼
1 Georgia	5 (1.4)	▼
El Salvador	3 (0.6)	▼
Cyprus	2 (0.6)	▼
Algeria	2 (0.6)	▼
Chinese Taipei	– –	
‡ Morocco	15 (2.3)	▼
Benchmarking Participants		
2 Massachusetts, US	28 (2.9)	
2 Ontario, Canada	27 (2.7)	
◆◆ ‡ Dubai, UAE	26 (2.5)	
Basque Country, Spain	21 (2.3)	
3 British Columbia, Canada	16 (1.8)	▼
2 † Minnesota, US	13 (2.3)	▼
3 Quebec, Canada	11 (1.1)	▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

▲ Percent significantly higher than international average
▼ Percent significantly lower than international average

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

‡ Did not satisfy guidelines for sample participation rates (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

3 National Defined Population covers less than 90% of National Target Population (but at least 77%, see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

A dash (–) indicates comparable data are not available.

TIMSS & PIRLS International Study Center
Lynch School of Education, Boston College

Eighth Grade: Achievement at the High International Benchmark

Exhibit 2.19 describes performance at the High International Benchmark. Students reaching the high benchmark demonstrated conceptual understanding of some science cycles, systems, and principles, and were able to show understanding of some cell processes, human biology and health, and the interrelationship of plants and animals in ecosystems. They demonstrated elementary knowledge of light, sound, heat, and forces, and showed some evidence of understanding the structure of matter, and chemical and physical properties and changes. Students performing at this level showed some understanding of the solar system and Earth's processes and resources, and some basic understanding of major environmental issues. Students demonstrated some scientific inquiry skills, and could combine information to draw conclusions, interpret tabular and graphical information, and provide short explanations conveying scientific knowledge.

Example Item 3 in Exhibit 2.20 shows the type of physics item likely to be answered correctly by students reaching the high benchmark. In the context of an investigation into thermal conductivity, this multiple-choice question asks students to choose among glass, wood, metal, and plastic as the best conductor of heat. On average, internationally, 47 percent of students correctly chose metal as the best conductor. More than 70 percent of students answered correctly in Singapore (79%) and in Chinese Taipei (75%).

Exhibit 2.21 presents an item from the biology domain exemplifying the high benchmark. Example Item 4 asks students to name two factors that are needed for photosynthesis in addition to chlorophyll. Students needed to mention carbon dioxide and sunlight to receive full credit, which was achieved by 40 percent of students, on average internationally. The highest percentages of students answering correctly were in Hong Kong SAR (81%), Singapore (76%), and Japan (75%).

Exhibit 2.19: Description of the TIMSS 2007 High International Benchmark (550) of Science Achievement

High International Benchmark – 550

Summary

Students can demonstrate conceptual understanding of some science cycles, systems, and principles. They have some understanding of biological concepts including cell processes, human biology and health, and the interrelationship of plants and animals in ecosystems. They apply knowledge to situations related to light and sound, demonstrate elementary knowledge of heat and forces, and show some evidence of understanding the structure of matter, and chemical and physical properties and changes. They demonstrate some understanding of the solar system, Earth's processes and resources, and some basic understanding of major environmental issues. Students demonstrate some scientific inquiry skills. They combine information to draw conclusions, interpret tabular and graphical information, and provide short explanations conveying scientific knowledge.

In biology, students demonstrate some understanding of cells and cell processes. They recognize the hierarchy of organization in living organisms and can state one structure that is found in plant cells but not in animal cells. They have an understanding of photosynthesis, and can recognize the main function of chlorophyll and indicate which gas is released into the air during photosynthesis and which gas is removed. Students demonstrate some understanding of human biology and health. For example, they recognize a description of digestion, and identify which food source contains the highest percentage of protein. Students also have some understanding of reproduction and heredity. For example, they state one function of the uterus and recognize that one can determine whether two people are related by comparing genes. Students show an understanding of interrelations of plants and animals in ecosystems. They explain why birds of prey cannot survive in an environment without plants, and that camouflage helps animals survive. They recognize that the loss of a food supply is a likely cause of a drop in population size and can complete the food web of an ocean ecosystem based on information in a table. They apply knowledge of competition to explain why weeds should be removed from crop fields.

In chemistry, students show some evidence of understanding the structure of matter, and chemical and physical properties and changes. Given the chemical formula for sulfuric acid, students complete a table to show the number of atoms of each element in a molecule of the acid. They interpret data in a table of physical properties to identify iron, water, and oxygen, and recognize a graph that shows the effect of temperature on the solubility of sugar in water. In the context of an investigation, students identify which of two solutions is more dilute and justify the selection. Students recognize that oxygen is necessary for burning, and explain what causes a balloon to inflate when sodium bicarbonate in the balloon is mixed with vinegar. Students work through multi-step investigations of density to interpret the results of various methods of measuring mass and explain the differences, select information from a table, and use this information to calculate mass and draw a conclusion.

In physics, students apply knowledge to situations related to light and sound. For example, they recognize the pathway of light for an object to be seen and explain why lightning is seen before thunder is heard. They recognize how sound waves with large amplitude differ in energy and loudness from sound waves with smaller amplitude. Students demonstrate elementary knowledge of heat and forces. They recognize that conduction is a process by which heat is transferred along a metal rod; that metal conducts heat faster than glass, wood, or plastic; and that the thermal expansion of alcohol is greater than that of glass. They state the forces acting on students sitting on a wall and recognize an object likely to be used as a lever.

In Earth science, students demonstrate some understanding of the solar system and Earth's processes. Students recognize the main difference between planets and moons, and the definition of an Earth year. They explain why light from the Moon reaches Earth in less time than light from the Sun, and recognize the gravitational pull of the moon on Earth as the major cause of tides. Students recognize the Sun as the source of energy for the water cycle, and explain how water evaporated from the sea ends up as rain on land. They describe what causes earthquakes. Students demonstrate some understanding of Earth's resources and major environmental issues. They describe how soil is formed and describe how trees can reduce soil erosion. They recognize that increased carbon dioxide in the atmosphere may lead to global warming.

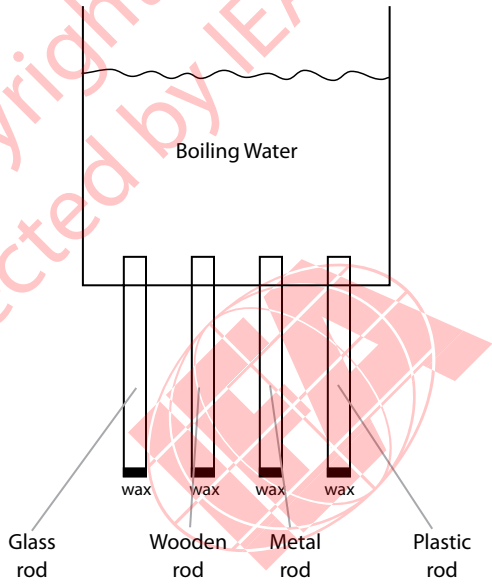
Students demonstrate some scientific inquiry skills. They combine information to draw conclusions; interpret information in various types of diagrams, contour maps, graphs, and tables; and provide short explanations conveying scientific knowledge and cause/effect relationships.

Exhibit 2.20 TIMSS 2007 High International Benchmark (550) of Science Achievement – Example Item 3

TIMSS2007 Science 8th Grade

Content Domain: Physics

Description: Based on a diagram demonstrating an investigation of thermal conductivity, recognizes that metal conducts heat faster than glass, wood, or plastic.



The diagram shows four identical size rods each of a different material sealed into the bottom of a container. The same amount of wax is placed on the end of each rod and then the container is filled with boiling water. On which rod will the wax melt first?

Ⓐ Glass rod
Ⓑ Wooden rod
● Metal rod
Ⓓ Plastic rod

Country	Percent Correct	
Singapore	79 (1.7)	▲
Chinese Taipei	75 (1.8)	▲
Japan	68 (1.9)	▲
† England	66 (2.3)	▲
Russian Federation	63 (2.4)	▲
Sweden	61 (2.1)	▲
† Scotland	61 (2.4)	▲
Australia	60 (2.5)	▲
Korea, Rep. of	60 (2.3)	▲
3 Israel	60 (2.4)	▲
2 † United States	57 (1.8)	▲
Cyprus	57 (2.0)	▲
Hungary	57 (2.6)	▲
Czech Republic	57 (2.0)	▲
† Hong Kong SAR	55 (2.8)	▲
Malaysia	55 (2.4)	▲
Slovenia	53 (2.4)	▲
Thailand	53 (2.1)	▲
Ukraine	51 (2.3)	
Armenia	50 (3.1)	
Bosnia and Herzegovina	48 (2.7)	
International Avg.	47 (0.3)	
Romania	47 (2.2)	
Bahrain	47 (2.0)	
3 Bulgaria	47 (2.9)	
Malta	46 (1.7)	
Iran, Islamic Rep. of	45 (2.5)	
Italy	45 (2.2)	
Jordan	45 (2.2)	
Norway	44 (2.3)	
1 2 Serbia	44 (3.1)	
◆◆ Kuwait	43 (2.4)	
Algeria	42 (1.9)	▼
Palestinian Nat'l Auth.	41 (2.4)	▼
1 Lithuania	40 (2.2)	▼
Oman	40 (2.2)	▼
Egypt	38 (1.9)	▼
Turkey	37 (2.1)	▼
Qatar	36 (1.4)	▼
Syrian Arab Republic	36 (2.0)	▼
Botswana	35 (2.2)	▼
Tunisia	34 (2.4)	▼
Lebanon	34 (3.0)	▼
El Salvador	33 (2.1)	▼
Colombia	31 (1.9)	▼
Saudi Arabia	31 (2.7)	▼
1 Georgia	29 (2.6)	▼
Ghana	28 (2.1)	▼
Indonesia	21 (2.1)	▼
‡ Morocco	38 (3.4)	▼
Benchmarking Participants		
2 Massachusetts, US	67 (2.9)	▲
◆◆ ‡ Dubai, UAE	61 (2.0)	▲
2 Ontario, Canada	61 (2.7)	▲
2 † Minnesota, US	58 (3.3)	▲
3 British Columbia, Canada	53 (2.4)	▲
3 Quebec, Canada	52 (2.5)	▲
Basque Country, Spain	48 (3.0)	

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Percent significantly higher than international average ▲
Percent significantly lower than international average ▼

† Met guidelines for sample participation rates only after replacement schools were included (see Appendix A).
‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).
‡ Did not satisfy guidelines for sample participation rates (see Appendix A).
1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).
2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).
3 National Defined Population covers less than 90% of National Target Population (but at least 77%, see Appendix A).
◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.
( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Exhibit 2.21 TIMSS 2007 High International Benchmark (550) of Science Achievement – Example Item 4

TIMSS2007 Science 8th Grade

Content Domain: Biology

Description: Given that chlorophyll is needed for photosynthesis, states two other factors that are needed.

Food and oxygen are produced during photosynthesis in green plants. Chlorophyll is one thing that is needed for photosynthesis.

Name two more factors that are needed for photosynthesis.

1. Sunlight

2. Carbon dioxide

The answer shown illustrates the type of student response that was given full credit

Country	Percent Full Credit	
† Hong Kong SAR	81 (2.4)	▲
Singapore	76 (1.6)	▲
Japan	75 (2.0)	▲
Chinese Taipei	66 (2.3)	▲
Korea, Rep. of	65 (2.1)	▲
† England	57 (2.4)	▲
Slovenia	55 (2.3)	▲
Jordan	54 (2.3)	▲
2 † United States	49 (1.5)	▲
Malaysia	48 (2.6)	▲
Bahrain	46 (2.2)	▲
Bosnia and Herzegovina	46 (2.7)	▲
Palestinian Nat'l Auth.	45 (2.6)	▲
1 2 Serbia	45 (3.0)	
Indonesia	43 (2.6)	
◆◆ Kuwait	43 (2.1)	
Cyprus	43 (2.1)	
Russian Federation	43 (3.2)	
Egypt	42 (2.1)	
Armenia	41 (2.8)	
International Avg.	40 (0.3)	
Sweden	39 (2.2)	
Turkey	39 (2.2)	
Italy	39 (2.4)	
Ghana	37 (2.2)	
Oman	37 (2.2)	
Hungary	36 (2.4)	
1 Lithuania	36 (2.3)	
Lebanon	35 (3.0)	
Colombia	35 (2.2)	▼
Tunisia	35 (2.6)	▼
Ukraine	34 (2.1)	▼
Czech Republic	34 (2.1)	▼
Australia	33 (2.0)	▼
† Scotland	33 (2.2)	▼
Qatar	32 (1.3)	▼
Romania	31 (1.9)	▼
Saudi Arabia	31 (2.3)	▼
Botswana	30 (2.1)	▼
1 Georgia	30 (3.5)	▼
Norway	30 (2.2)	▼
3 Bulgaria	30 (2.9)	▼
Thailand	29 (2.2)	▼
Syrian Arab Republic	29 (2.2)	▼
El Salvador	27 (2.1)	▼
Malta	25 (1.4)	▼
3 Israel	24 (2.1)	▼
Algeria	23 (1.7)	▼
Iran, Islamic Rep. of	14 (1.8)	▼
‡ Morocco	8 (1.4)	▼
Benchmarking Participants		
◆◆ ‡ Dubai, UAE	61 (2.3)	▲
2 Massachusetts, US	54 (2.9)	▲
2 † Minnesota, US	54 (2.8)	▲
2 Ontario, Canada	46 (3.0)	▲
Basque Country, Spain	43 (3.5)	
3 British Columbia, Canada	43 (2.5)	
3 Quebec, Canada	38 (2.6)	

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

▲ Percent significantly higher than international average
▼ Percent significantly lower than international average

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

‡ Did not satisfy guidelines for sample participation rates (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

3 National Defined Population covers less than 90% of National Target Population (but at least 77%, see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

Eighth Grade: Achievement at the Intermediate International Benchmark

Exhibit 2.22 describes students' performance at the Intermediate International Benchmark. Students reaching this benchmark were able to recognize and communicate basic scientific knowledge across a range of topics. They demonstrated some understanding of characteristics of animals, and are acquainted with some aspects of sound, force, and chemical change. They demonstrated elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students reaching this benchmark showed that they could extract information from tables and diagrams, apply knowledge to practical situations, and communicate their knowledge through brief descriptive responses.

Exhibit 2.23 presents Example Item 5 from the biology domain. This multiple-choice item requires students to identify an animal characteristic found only in mammals. On average internationally, 63 percent of the eighth grade students recognized *glands that make milk* as the correct answer. More than 80 percent of students in Chinese Taipei (91%), Hong Kong SAR (86%), Thailand (84%), and Turkey (82%) answered correctly.

Example Item 6 presented in Exhibit 2.24 also illustrates a type of item from the physics domain likely to be answered correctly by students reaching the intermediate benchmark. Students were required to recognize the reason that a sound can cause an echo on Earth but not on the Moon. Almost two-thirds (65%) of students, on average internationally, recognized that there would be no echo on the Moon because there is no air for the sound to travel through. Korea (90%), Chinese Taipei (89%), Hong Kong SAR (84%), Lithuania (83%), Japan (82%), Sweden (81%), and Hungary (80%) had at least 80 percent of students answer correctly.

Exhibit 2.22 **Description of the TIMSS 2007 Intermediate International Benchmark (475) of Science Achievement**

TIMSS2007 Science 8th Grade

Intermediate International Benchmark – 475

Summary

Students can recognize and communicate basic scientific knowledge across a range of topics. They demonstrate some understanding of characteristics of animals, food webs, and the effect of population changes in ecosystems. They are acquainted with some aspects of sound and force and have elementary knowledge of chemical change. They demonstrate elementary knowledge of the solar system, Earth's processes, and resources and the environment. Students extract information from tables and interpret pictorial diagrams. They can apply knowledge to practical situations and communicate their knowledge through brief descriptive responses.

In biology, students demonstrate some understanding of the characteristics of animals and human health. For example, they recognize a characteristic that is found only in mammals and identify an organ of the digestive system. They recognize a disease caused by a virus and demonstrate some understanding of the immune system by recognizing that bacteria can be destroyed by white blood cells. Students understand how vaccination helps prevent illness, and can explain why exposure of a person to influenza does not necessarily lead to infection. They also state why exercise is important for good health. Students demonstrate some understanding of food webs and the effect of population changes in ecosystems. They recognize an organism that is an energy producer and use a completed food web to predict and explain what is most likely to happen to a predator population when its prey population is reduced.

Students have some knowledge of chemistry in everyday life. For example, they identify vinegar as an acidic solution and, in the context of an investigation, the condition under which nails would rust. Students also have elementary knowledge of chemical change. For example, they recognize from a description of indicator color changes that neutralization has occurred, and identify photosynthesis as a chemical process involving energy absorption.

In physics, students are acquainted with some aspects of sound and force. They recognize that sound needs a medium through which to travel. Given a diagram showing a ball being thrown upward, they state the force that causes the ball to fall.

In Earth science, students demonstrate some familiarity with the solar system and Earth's processes. They recognize that gravity draws objects toward the center of Earth and that night and day are caused by Earth rotating on its axis. Students demonstrate some understanding of the water cycle by ordering the processes involved and matching each process with its description. Students demonstrate elementary knowledge of Earth's resources and the environment. They recognize examples of fossil fuels, state how volcanic eruptions impact the environment, and predict a long-term effect of cutting down trees. From a list of common waste materials, students recognize that paper will break down most quickly.

Students extract information from a table to draw conclusions and interpret pictorial diagrams. Students can apply knowledge to practical situations and communicate their knowledge through brief descriptive responses.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.23 TIMSS 2007 Intermediate International Benchmark (475) of Science Achievement – Example Item 5

TIMSS2007 Science 8th Grade

Content Domain: Biology

Description: Recognizes a characteristic that is found only in mammals.

Which characteristic is found ONLY in mammals?

Ⓐ eyes that detect color

● glands that make milk

Ⓒ skin that absorbs oxygen

Ⓓ bodies that are protected by scales

Country	Percent Correct	
Chinese Taipei	91 (1.3)	▲
† Hong Kong SAR	86 (1.8)	▲
Thailand	84 (1.5)	▲
Turkey	82 (1.6)	▲
Syrian Arab Republic	79 (1.9)	▲
Hungary	78 (1.9)	▲
1 Lithuania	76 (1.9)	▲
Slovenia	76 (1.9)	▲
Japan	75 (1.8)	▲
Czech Republic	74 (1.7)	▲
Armenia	73 (2.0)	▲
Cyprus	72 (1.8)	▲
Jordan	72 (2.0)	▲
Saudi Arabia	72 (1.8)	▲
◆◆ Kuwait	70 (2.1)	▲
3 Bulgaria	70 (2.7)	▲
Korea, Rep. of	70 (1.8)	▲
1 Georgia	69 (2.6)	▲
3 Israel	68 (2.4)	▲
1 2 Serbia	67 (2.5)	
Bosnia and Herzegovina	67 (2.5)	
Bahrain	66 (2.1)	
Romania	66 (2.4)	
Italy	65 (2.2)	
Russian Federation	63 (2.0)	
International Avg.	**63 (0.3)**	
Iran, Islamic Rep. of	60 (2.4)	
Singapore	60 (1.9)	
Lebanon	60 (3.0)	
Algeria	58 (1.9)	▼
Australia	56 (2.7)	▼
Palestinian Nat'l Auth.	55 (1.9)	▼
Indonesia	55 (2.5)	▼
Malaysia	55 (2.6)	▼
Colombia	54 (1.9)	▼
Ukraine	54 (2.3)	▼
Botswana	53 (2.4)	▼
2 † United States	53 (1.8)	▼
El Salvador	53 (2.2)	▼
Sweden	53 (1.9)	▼
† England	53 (2.4)	▼
Norway	51 (2.3)	▼
Qatar	49 (1.5)	▼
Oman	49 (2.0)	▼
Tunisia	48 (2.3)	▼
Malta	44 (1.7)	▼
† Scotland	41 (2.2)	▼
Egypt	40 (1.9)	▼
Ghana	31 (2.1)	▼
‡ Morocco	66 (2.8)	
Benchmarking Participants		
2 Massachusetts, US	62 (3.4)	
2 † Minnesota, US	61 (3.0)	
Basque Country, Spain	60 (3.7)	
◆◆ ‡ Dubai, UAE	57 (2.5)	▼
3 Quebec, Canada	56 (2.5)	▼
3 British Columbia, Canada	50 (2.5)	▼
2 Ontario, Canada	42 (2.6)	▼

▲ Percent significantly higher than international average

▼ Percent significantly lower than international average

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

‡ Did not satisfy guidelines for sample participation rates (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

2 National Defined Population covers 90% to 95% of National Target Population (see Appendix A).

3 National Defined Population covers less than 90% of National Target Population (but at least 77%, see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.24 TIMSS 2007 Intermediate International Benchmark (475) of Science Achievement – Example Item 6

TIMSS2007 Science 8th Grade

Content Domain: Physics

Description: Applies knowledge that sound requires a medium to travel through by contrasting a situation on Earth to a situation on the Moon.

In a deep valley on Earth, a person shouting will hear an echo as the sound is reflected back off the surrounding mountains. In a similar valley on the Moon, no echo will be heard. This is because

Ⓐ the gravitational pull on the Moon is too low

Ⓑ the temperature on the Moon is too low

● there is no air on the Moon for the sound to travel through

Ⓓ the mountains on the Moon cannot reflect sound

Country	Percent Correct	
Korea, Rep. of	90 (1.3)	▲
Chinese Taipei	89 (1.3)	▲
† Hong Kong SAR	84 (1.9)	▲
1 Lithuania	83 (1.8)	▲
Japan	82 (1.7)	▲
Sweden	81 (1.7)	▲
Hungary	80 (2.0)	▲
Slovenia	78 (2.1)	▲
Singapore	77 (2.0)	▲
† England	77 (2.3)	▲
Czech Republic	74 (1.9)	▲
Jordan	73 (2.1)	▲
Australia	73 (2.4)	▲
Russian Federation	73 (2.0)	▲
Bahrain	72 (2.2)	▲
Bosnia and Herzegovina	71 (2.4)	▲
2 † United States	71 (1.7)	▲
1 2 Serbia	71 (2.6)	▲
Malta	71 (1.5)	▲
† Scotland	71 (1.9)	▲
Armenia	69 (2.5)	
◆◆ Kuwait	69 (2.1)	▲
Romania	68 (2.6)	
Italy	67 (2.3)	
Indonesia	67 (2.2)	
International Avg.	65 (0.3)	
Oman	64 (2.5)	
Malaysia	63 (2.0)	
3 Israel	63 (2.3)	
Syrian Arab Republic	62 (2.1)	
Norway	62 (2.1)	
Egypt	60 (2.3)	▼
Palestinian Nat'l Auth.	60 (2.4)	▼
Ukraine	59 (2.5)	▼
Saudi Arabia	58 (2.5)	▼
3 Bulgaria	57 (3.1)	▼
Turkey	57 (2.4)	▼
Iran, Islamic Rep. of	55 (2.4)	▼
Thailand	54 (2.3)	▼
Lebanon	52 (2.8)	▼
Tunisia	52 (2.1)	▼
Botswana	50 (2.6)	▼
El Salvador	50 (2.4)	▼
1 Georgia	49 (2.8)	▼
Cyprus	48 (2.1)	▼
Colombia	46 (2.0)	▼
Algeria	46 (1.9)	▼
Qatar	44 (1.5)	▼
Ghana	34 (1.9)	▼
‡ Morocco	44 (3.3)	▼
Benchmarking Participants		
◆◆ ‡ Dubai, UAE	78 (2.4)	▲
2 Ontario, Canada	75 (2.7)	▲
3 Quebec, Canada	73 (2.1)	▲
2 Massachusetts, US	71 (3.3)	
3 British Columbia, Canada	70 (2.1)	▲
Basque Country, Spain	65 (2.9)	
2 † Minnesota, US	64 (3.6)	

Percent significantly higher than international average ▲

Percent significantly lower than international average ▼

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

‡ Did not satisfy guidelines for sample participation rates (see Appendix A).

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3 National Defined Population covers less than 90% of National Target Population (but at least 77%, see Appendix A).

◆◆ Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Eighth Grade: Achievement at the Low International Benchmark

Exhibit 2.25 describes performance at the Low International Benchmark. Students performing at this level recognized some basic facts from the life and physical sciences. They have some knowledge of the human body and demonstrate some familiarity with everyday physical phenomena. They can interpret diagrams and apply knowledge of simple physical concepts to practical situations.

Example Items 7 and 8 are presented in Exhibits 2.26 and 2.27, respectively. These multiple-choice items illustrate the types of items likely to be answered correctly by students reaching the low benchmark. In Example Item 7 from the physics domain, students were given a definition of work (work is done when an object is moved in the direction of an applied force) and asked to identify a diagram depicting a person doing work. On average internationally, this item was answered correctly by 78 percent of the students, who recognized that a person pushing a cart up a ramp was doing work. Every country except Tunisia had more than half their students answer correctly.

Example Item 8 in the biology domain required students to recognize that the cells that conduct messages are known as nerve cells. Seventy-five percent answered correctly, on average internationally. Nine countries, including Chinese Taipei, Korea, Hong Kong SAR, the Russian Federation, the Ukraine, the United States, Hungary, Thailand, and England, had 90 percent or more of students answer correctly, as well as four benchmarking participants—the U.S. states of Massachusetts and Minnesota and the Canadian provinces of Ontario and British Columbia.

Exhibit 2.25 **Description of the TIMSS 2007 Low International Benchmark (400) of Science Achievement**

TIMSS2007 Science 8th Grade

Low International Benchmark – 400

Summary

Students can recognize some basic facts from the life and physical sciences. They have some knowledge of the human body, and demonstrate some familiarity with everyday physical phenomena. Students can interpret pictorial diagrams and apply knowledge of simple physical concepts to practical situations.

Students demonstrate some basic knowledge of human biology. They identify the circulatory system from a list of its parts, and recognize that nerves carry sensory messages to the brain.

Students recognize some basic information about the physical properties of materials and phenomena. They recognize the material that best conducts heat and electricity, the form of energy in a compressed spring, and identify a situation where work is being done. Also, they can recognize the chemical formula for carbon dioxide.

Students interpret some pictorial diagrams and apply knowledge of simple physical concepts to practical situations.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

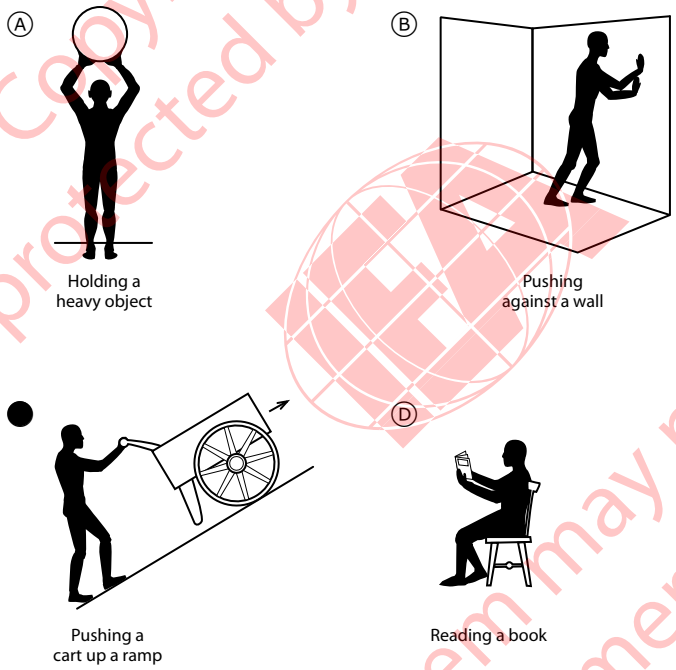
Exhibit 2.26 TIMSS 2007 Low International Benchmark (400) of Science Achievement – Example Item 7

TIMSS2007 Science 8th Grade

Content Domain: Physics

Description: Given the definition of work, identifies a diagram that shows that work is being done.

Work is done when an object is moved in the direction of an applied force. A person performed different tasks as shown in the diagrams below. In which diagram is the person doing work?



Country	Percent Correct	
Singapore	96 (0.9)	▲
2 † United States	91 (1.0)	▲
3 Bulgaria	91 (2.1)	▲
Russian Federation	91 (1.3)	▲
Korea, Rep. of	91 (1.1)	▲
Hungary	90 (1.6)	▲
Ukraine	90 (1.4)	▲
1 Lithuania	89 (1.2)	▲
Slovenia	88 (1.6)	▲
Turkey	88 (1.8)	▲
1 2 Serbia	87 (1.8)	▲
Italy	87 (1.5)	▲
Indonesia	86 (1.3)	▲
Iran, Islamic Rep. of	86 (2.0)	▲
Czech Republic	86 (1.4)	▲
Australia	86 (1.6)	▲
Lebanon	86 (1.9)	▲
Malta	86 (1.2)	▲
† England	85 (1.7)	▲
Malaysia	84 (1.6)	▲
† Scotland	83 (1.7)	▲
1 Georgia	82 (1.8)	▲
Sweden	82 (1.6)	▲
Japan	82 (1.6)	▲
Chinese Taipei	81 (1.9)	
Armenia	80 (1.9)	
Romania	79 (2.4)	
Syrian Arab Republic	79 (1.8)	
Jordan	79 (1.7)	
International Avg.	78 (0.3)	
Bosnia and Herzegovina	78 (2.0)	
Norway	76 (1.8)	
† Hong Kong SAR	75 (1.7)	
Thailand	74 (1.7)	▼
Cyprus	72 (1.7)	▼
Algeria	71 (1.9)	▼
3 Israel	71 (2.2)	▼
Bahrain	70 (1.8)	▼
Egypt	70 (1.9)	▼
Colombia	70 (2.7)	▼
El Salvador	68 (2.3)	▼
👀 Kuwait	67 (2.1)	▼
Palestinian Nat'l Auth.	65 (2.2)	▼
Botswana	64 (1.9)	▼
Ghana	63 (2.1)	▼
Saudi Arabia	61 (2.8)	▼
Oman	58 (2.1)	▼
Qatar	55 (1.7)	▼
Tunisia	49 (2.1)	▼
‡ Morocco	60 (3.5)	▼
Benchmarking Participants		
2 † Minnesota, US	93 (1.3)	▲
3 Quebec, Canada	89 (1.8)	▲
2 Ontario, Canada	87 (1.6)	▲
2 Massachusetts, US	87 (2.2)	▲
3 British Columbia, Canada	86 (1.4)	▲
👀 ‡ Dubai, UAE	84 (2.0)	▲
Basque Country, Spain	78 (2.4)	

Percent significantly higher than international average ▲
Percent significantly lower than international average ▼

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

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Appendix A).

‡ Did not satisfy guidelines for sample participation rates (see Appendix A).

1 National Target Population does not include all of the International Target Population defined by TIMSS (see Appendix A).

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3 National Defined Population covers less than 90% of National Target Population (but at least 77%, see Appendix A).

👀 Kuwait and Dubai, UAE tested the same cohort of students as other countries, but later in 2007, at the beginning of the next school year.

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SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

Exhibit 2.27 TIMSS 2007 Low International Benchmark (400) of Science Achievement – Example Item 8

TIMSS2007 Science 8th Grade

Content Domain: Biology

Description: Recognizes the cells that conduct messages.

Cells that conduct messages are known as

Ⓐ skin cells

● nerve cells

Ⓒ blood cells

Ⓓ kidney cells

Country	Percent Correct	
Chinese Taipei	97 (0.9)	▲
Korea, Rep. of	95 (0.8)	▲
† Hong Kong SAR	94 (1.4)	▲
Russian Federation	94 (1.3)	▲
Ukraine	92 (1.4)	▲
2 † United States	92 (1.0)	▲
Hungary	92 (1.3)	▲
Thailand	91 (1.0)	▲
† England	91 (1.5)	▲
Japan	89 (1.2)	▲
Sweden	89 (1.3)	▲
Singapore	88 (1.4)	▲
1 Lithuania	88 (1.7)	▲
Iran, Islamic Rep. of	86 (1.7)	▲
Australia	86 (2.0)	▲
Jordan	85 (1.8)	▲
3 Bulgaria	82 (2.9)	▲
† Scotland	81 (2.0)	▲
Italy	80 (1.7)	▲
Bahrain	78 (1.9)	
Czech Republic	78 (1.8)	
Norway	78 (2.1)	
Egypt	77 (2.0)	
Armenia	77 (2.0)	
Syrian Arab Republic	77 (1.9)	
Colombia	77 (2.0)	
Malaysia	75 (1.8)	
International Avg.	75 (0.3)	
1 Georgia	74 (2.7)	
1 2 Serbia	74 (2.3)	
Saudi Arabia	73 (2.0)	
Slovenia	72 (2.0)	
Palestinian Nat'l Auth.	71 (2.2)	
Tunisia	69 (2.1)	▼
Romania	68 (2.5)	▼
Turkey	67 (2.4)	▼
Malta	67 (1.5)	▼
Algeria	67 (1.9)	▼
3 Israel	65 (2.5)	▼
Oman	64 (2.0)	▼
Lebanon	63 (2.4)	▼
Bosnia and Herzegovina	63 (2.5)	▼
◆◆ Kuwait	62 (2.3)	▼
El Salvador	61 (2.2)	▼
Cyprus	60 (2.2)	▼
Indonesia	59 (2.4)	▼
Botswana	59 (2.0)	▼
Qatar	40 (1.4)	▼
Ghana	24 (1.9)	▼
‡ Morocco	51 (2.5)	▼
Benchmarking Participants		
2 Ontario, Canada	94 (1.4)	▲
2 † Minnesota, US	93 (1.7)	▲
2 Massachusetts, US	93 (1.3)	▲
3 British Columbia, Canada	91 (1.4)	▲
◆◆ ‡ Dubai, UAE	84 (1.9)	▲
3 Quebec, Canada	79 (1.8)	▲
Basque Country, Spain	79 (2.6)	

Percent significantly higher than international average ▲

Percent significantly lower than international average ▼

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2007

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