Chapter 2

Performance at International Benchmarks

How Do Countries Compare with International Benchmarks of Science Achievement?

The TIMSS science achievement scale summarizes student performance on test items designed to measure a wide range of student knowledge and proficiency. In order to provide meaningful descriptions of what performance on the scale could mean in terms of the science that students know and can do, TIMSS identified four points on the scale for use as international benchmarks. Selected to represent the range of performance shown by students internationally, the advanced benchmark is 625, the high benchmark is 550, the intermediate benchmark is 475, and the low benchmark is 400. TIMSS worked with the Science and Mathematics Item Review Committee to conduct an ambitious scale-anchoring exercise to describe performance at these benchmarks.

Exhibit 2.1 summarizes what eighth- and fourth-grade students scoring at these benchmarks typically know and can do. At the eighth grade, performance ranged from demonstrating a grasp of some complex and abstract science concepts at the advanced benchmark to

recognizing some facts from the life and physical sciences at the low benchmark. At the fourth grade, students at the advanced benchmark can apply knowledge and understanding in beginning scientific inquiry whereas those at the low benchmark demonstrated just some elementary knowledge of the earth, life, and physical sciences. More detailed descriptions appear in the remaining sections of the chapter, together with example test items illustrating performance at each benchmark.

Exhibit 2.2 displays the percentage of students in each participating country that reached each international benchmark. Both the eighth- and fourth-grade results are presented in decreasing order by percentage reaching the advanced benchmark. In general, the high-performing countries had greater percentages of students reaching each benchmark, and the low-performing countries had lower percentages. Among the high performers at the eighth grade, for example, Singapore and Chinese Taipei had one-fourth or more of their students reaching the advanced benchmark, about two-thirds reaching the high benchmark, around 85 percent or more reaching the intermediate benchmark, and almost all (95 percent or more) reaching the low benchmark. In contrast, low-performing countries had almost no students reaching the advanced benchmark, no more than 8 percent reaching the high benchmark, about one-third reaching the intermediate benchmark, and about two-thirds reaching the low benchmark. At the fourth grade, 25 percent of the Singaporean students performed at or above the advanced benchmark, followed by about 15 percent of the students from England and Chinese Taipei. In all three of these top-performing countries, nearly all fourth-grade students, from 94 to 98 percent, reached the low benchmark. For the lowest-performing countries, Tunisia and Morocco, very few, if any, fourth-grade students reached the advanced benchmark, 1 or 2 percent reached the high benchmark, 9 to 10 percent the intermediate benchmark, and 24 to 27 percent the low benchmark.

Although Exhibit 2.2 is organized to draw particular attention to the percentage of high-achieving students in each country, it

conveys information about the distribution of middle and low performers also. For example, even though the Netherlands does not have the highest percentages at the advanced benchmark (6 percent at eighth grade and 3 percent at fourth grade), it appears to do an excellent job of educating all of its students, since 98 percent of the eighth-grade students and 99 percent of the fourth-grade students reached the low benchmarks at their respective grades. It should be noted that at the eighth grade, 13 countries as well as three of the benchmarking participants have less than 10 percent of their eighth-grade students reaching the advanced benchmark but have 90 percent or more reaching the low benchmark.

Exhibits 2.3 and 2.4, for the eighth and fourth grades, respectively, provide information on the changes in student performance between the previous assessments and TIMSS 2003. The exhibits show the percentage of students reaching each international benchmark (advanced-625, high-550, intermediate-475, and low-400) in each of the years. In general, the patterns in overall achievement are reflected in the benchmarks. For example, at the eighth grade the decrease in performance in the Slovak Republic, Bulgaria, Belgium (Flemish), and Cyprus is also apparent at all four benchmarks, implying a decrease at most levels of the proficiency distribution. In the Russian Federation, however, the decrease is reflected at the three top benchmarks but not at the low benchmark. Although Hong Kong SAR and Lithuania had an increase in performance over earlier assessments at all four benchmarks, and participants such as Korea, Latvia, Jordan, and Ontario had increases at all but the advanced benchmarks, for many countries increased performance was reflected at the intermediate and low international benchmarks. The United States, Australia, New Zealand, Scotland, Slovenia, Israel, Malaysia, Moldova, England, and Quebec all showed improved performance in the lower half of the proficiency distribution.

At the fourth grade, the general improvements between 1995 and 2003 also are reflected generally at the benchmarks. Singapore,

Hungary, Iran, and Ontario showed improvement at all four international benchmarks, while England, Latvia (LSS), Hong Kong SAR, Slovenia, and Cyprus improved at all but the advanced benchmark. Japan and Norway had a decrease in performance at all four benchmarks, while Quebec showed declines at all but the low international benchmark. The United States, Scotland, and the Netherlands had decreased performance at the advanced and high international benchmarks but not at the two lower ones, and Australia had a decrease at the advanced benchmark only.

To help interpret the achievement results, the remaining sections of the chapter first describe eighth-grade science achievement at each of the international benchmarks together with examples of the types of items typically answered correctly by students performing at the benchmark and then describes fourth-grade achievement at each of the international benchmarks together with examples of the types of items typically answered correctly by students performing at the benchmark.

At both the eighth and fourth grades, the analysis of performance at these benchmarks in science suggests that five primary factors appeared to differentiate performance among the four levels:

- The depth and breadth of content knowledge;
- The context of the problem (progressing from practical to more abstract);
- The level of scientific investigation skills;
- The complexity of diagrams, graphs, and tables;
- The completeness of written responses.

At both grade levels, student performance at the lower benchmarks is characterized by elementary knowledge of basic science facts, whereas at the advanced benchmarks students can, in addition, draw on more abstract conceptual knowledge and engage in scientific inquiry.

How Were the Benchmark Descriptions Developed?

To develop descriptions of achievement at the TIMSS 2003 international benchmarks, the TIMSS International Study Center used the scale anchoring method. Scale anchoring is a way of describing students' performance at different points on the TIMSS 2003 achievement scales at eighth and fourth grades in terms of the types of items students at those grades, respectively, answered correctly. It involves an empirical component in which items that discriminate between successive points on the scale are identified, and a judgmental component in which subject matter experts examine the content of the items and generalize to students' knowledge and understandings.

For the scale anchoring analysis, the results of students from all the TIMSS 2003 countries were pooled, so that the benchmark descriptions refer to all students achieving at that level. (That is, it does not matter which country the students are from, only how they performed on the test.) Criteria were applied to the TIMSS 2003 achievement scale results at the eighth grade to identify the sets of items that eighth-grade students reaching each international benchmark were likely to answer correctly and that those at the next lower benchmark were unlikely to answer correctly.[1] Similarly, criteria were applied to the TIMSS 2003 achievement scale results at the fourth grade to identify the sets of items that fourth-grade students reaching each international benchmark were likely to answer correctly and that those at the next lower benchmark were unlikely to answer correctly.

The sets of items produced by the analysis represented the accomplishments of students reaching each successively higher benchmark, and were used by a panel of subject-matter experts from the TIMSS countries to develop the benchmark descriptions.[2] The work of the panel involved developing a short description for each item of the mathematical understandings demonstrated by students answering it correctly, summarizing students' knowledge and understanding across the set of items for each benchmark to provide more general statements of achievement, and selecting example items illustrating the descriptions.

1 For example, for the advanced benchmark, an item was included if at least 65 percent of students scoring at the scale point corresponding to this benchmark answered the item correctly and less than 50 percent of students scoring at the high benchmark answered it correctly. Similarly, for the high benchmark, an item was included if at least 65 percent of students scoring at that point answered the item correctly and less than 50 percent of students at the intermediate benchmark answered it correctly.

2 The participants in the scale anchoring process are listed in Appendix G.

How Should the Descriptions Be Interpreted?

In general, the parts of the descriptions that relate to the scientific concepts or procedures are relatively straightforward. It needs to be acknowledged, however, that the cognitive behavior necessary to answer some items correctly may vary according to students' experience. An item may require only simple recall for a student familiar with the item's content and context, but necessitate problem-solving strategies from a student unfamiliar with the material. Nevertheless, the descriptions are based on what the panel believed to be the way the great majority of eighth- or fourth-grade students could be expected to perform when responding to the item.

It also needs to be emphasized that the descriptions of achievement characteristic of students at the international benchmarks are based solely on student performance on the TIMSS 2003 items. Since those items were developed in particular to sample the science domains prescribed for this study, neither the set of items nor the descriptions based on them purport to be comprehensive. There are undoubtedly other science curriculum elements on which students at the various benchmarks would have been successful if they had been included in the assessment.

Please note that at both grades students reaching a particular benchmark demonstrated the knowledge and understandings characterizing that benchmark as well as the competencies of students at the lower benchmarks. The description of achievement at each higher benchmark is cumulative, building on the description of achievement demonstrated by students at the next lower benchmark.

Finally, it must be emphasized that the descriptions of the international benchmarks are provided as one possible way of beginning to examine student performance. Some students scoring below a benchmark may indeed know or understand some of the concepts that characterize a higher level. Thus, it is important to consider performance on the individual items and clusters of items in developing a profile of student achievement in each country.

Several example items are included for each benchmark to complement the descriptions by giving a more concrete notion of the abilities students were able to demonstrate. Each example item is accompanied by the percentage of correct responses for each country as well as the international average. In general, at each grade, the five or six countries scoring highest on the overall test also scored highest on each of the items used to illustrate benchmarks. Likewise, the five or six countries with the lowest mean achievement also tended to have consistently low percentages of correct responses on the illustrative items. Not surprisingly, this was true for items assessing a range of cognitive skills – recall of information, using conceptual knowledge, and applying reasoning and analytic skills. The TIMSS 2003 results support the premise that successful problem solving and inquiry is grounded in mastery of more fundamental knowledge and skills.

Item Examples and Student Performance

Beginning with the eighth grade and then for the fourth grade, the remainder of this chapter describes each benchmark and presents two example items illustrating what students know and can do at that level. For each example item, the percent correct for each of the TIMSS 2003 countries is displayed, as well as the international average. The correct answer is circled for multiple-choice items. For open-ended items, the answers shown exemplify the types of student responses that were given full credit. The example items are ones that students reaching each benchmark were likely to answer correctly, and they represent the types of items used to develop the description of achievement at that benchmark.[3]

3 Some of the items used to develop the benchmark descriptions are being kept secure to measure achievement trends in future TIMSS assessments and are not available for publication.

Exhibit 2.1: **TIMSS 2003 International Benchmarks of Science Achievement**

SCIENCE Grade 8

Advanced International Benchmark – 625

Students demonstrate a grasp of some complex and abstract science concepts. They can apply knowledge of the solar system and of Earth features, processes, and conditions, and apply understanding of the complexity of living organisms and how they relate to their environment. They show understanding of electricity, thermal expansion, and sound, as well as the structure of matter and physical and chemical properties and changes. They show understanding of environmental and resource issues. Students 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 demonstrate conceptual understanding of some science cycles, systems, and principles. They have some understanding of Earth's processes and the solar system, biological systems, populations, reproduction and heredity, and structure and function of organisms.They show some understanding of physical and chemical changes, and the structure of matter. They solve some basic physics problems related to light, heat, electricity, and magnetism, and they demonstrate basic knowledge of major environmental issues. They demonstrate some scientific inquiry skills. They can combine information to draw conclusions; interpret information in diagrams, graphs and tables to solve problems; and provide short explanations conveying scientific knowledge and cause/effect relationships.

Intermediate International Benchmark – 475

Students can recognize and communicate basic scientific knowledge across a range of topics. They recognize some characteristics of the solar system, water cycle, animals, and human health. They are acquainted with some aspects of energy, force and motion, light reflection, and sound. Students demonstrate elementary knowledge of human impact on and changes in the environment. They can apply and briefly communicate knowledge, extract tabular information, extrapolate from data presented in a simple linear graph, and interpret pictorial diagrams.

Low International Benchmark – 400

Students recognize some basic facts from the life and physical sciences. They have some knowledge of the human body and heredity, and demonstrate familiarity with some everyday physical phenomena. Students can 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) 2003

Exhibit 2.1: **TIMSS 2003 International Benchmarks of Science Achievement**

Advanced International Benchmark – 625

Students can apply knowledge and understanding in beginning scientific inquiry. Students demonstrate some understanding of Earth's features and processes and the solar system. They can communicate their understanding of structure, function, and life processes in organisms and classify organisms according to major physical and behavioral features. They demonstrate some understanding of physical phenomena and properties of common materials. Students demonstrate beginning scientific inquiry knowledge and skills.

High International Benchmark – 550

Students can apply knowledge and understanding to explain everyday phenomena. Students demonstrate some knowledge of Earth structure and processes and the solar system and some understanding of plant structure, life processes, and human biology. They demonstrate some knowledge of physical states, common physical phenomena, and chemical changes. They provide brief descriptions and explanations of some everyday phenomena and compare, contrast, and draw conclusions.

Intermediate International Benchmark – 475

Students can apply basic knowledge and understanding to practical situations in the sciences. Students demonstrate knowledge of some basic facts about Earth's features and processes and the solar system. They recognize some basic information about human biology and health and show some understanding of development and life cycles of organisms. They know some basic facts about familiar physical phenomena, states, and changes. They apply factual knowledge to practical situations, interpret pictorial diagrams, and combine information to draw conclusions.

Low International Benchmark – 400

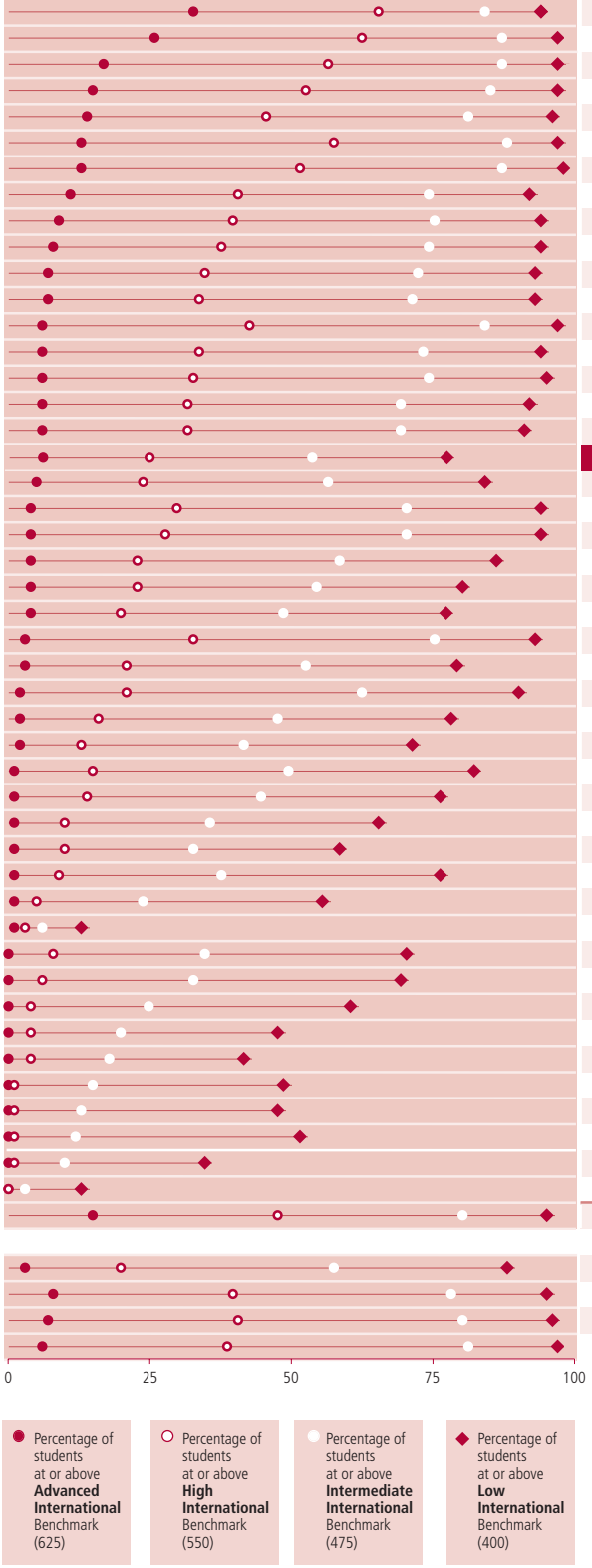
Students have some elementary knowledge of the earth, life, and physical sciences. Students recognize simple facts presented in everyday language and context about Earth's physical features, the seasons, the solar system, human biology, and the development and characteristics of animals and plants. They recognize facts about a range of familiar physical phenomena — rainbows, magnets, electricity, boiling, floating, and dissolving. They interpret labeled pictures and simple pictorial diagrams and provide short written responses to questions requiring factual information.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

Exhibit 2.2: Percentages of Students Reaching TIMSS 2003 International Benchmarks of Science Achievement

SCIENCE Grade 8

Countries	Percentages of Students Reaching International Benchmarks	Advanced International Benchmark (625)	High International Benchmark (550)	Intermediate International Benchmark (475)	Low International Benchmark (400)
Singapore		33 (1.6)	66 (2.3)	85 (1.7)	95 (0.8)
Chinese Taipei		26 (1.5)	63 (1.9)	88 (1.1)	98 (0.4)
◆◆ Korea, Rep. of		17 (0.9)	57 (1.1)	88 (0.7)	98 (0.4)
Japan		15 (0.7)	53 (1.1)	86 (0.8)	98 (0.3)
Hungary		14 (1.1)	46 (1.7)	82 (1.1)	97 (0.6)
† Hong Kong, SAR		13 (1.2)	58 (1.9)	89 (1.4)	98 (0.7)
Estonia		13 (1.0)	52 (1.6)	88 (1.2)	99 (0.3)
‡ United States		11 (0.8)	41 (1.7)	75 (1.4)	93 (0.8)
Australia		9 (1.1)	40 (2.0)	76 (1.9)	95 (0.8)
Sweden		8 (0.8)	38 (1.6)	75 (1.4)	95 (0.7)
New Zealand		7 (1.5)	35 (3.0)	73 (2.2)	94 (1.3)
Slovak Republic		7 (0.8)	34 (1.8)	72 (1.5)	94 (0.7)
† Netherlands		6 (0.8)	43 (2.4)	85 (1.7)	98 (0.7)
1 Lithuania		6 (0.6)	34 (1.2)	74 (1.3)	95 (0.6)
Slovenia		6 (0.5)	33 (1.3)	75 (1.3)	96 (0.6)
Russian Federation		6 (0.8)	32 (1.8)	70 (1.8)	93 (0.9)
† Scotland		6 (0.7)	32 (1.9)	70 (1.7)	92 (0.9)
International Avg.		6 (0.1)	25 (0.2)	54 (0.2)	78 (0.2)
2 Israel		5 (0.5)	24 (1.3)	57 (1.6)	85 (1.1)
Latvia		4 (0.4)	30 (1.5)	71 (1.6)	95 (0.6)
Malaysia		4 (0.8)	28 (2.2)	71 (2.0)	95 (0.7)
Italy		4 (0.6)	23 (1.5)	59 (1.5)	87 (1.1)
Bulgaria		4 (0.7)	23 (1.7)	55 (2.1)	81 (2.0)
Romania		4 (0.8)	20 (1.8)	49 (2.2)	78 (1.9)
Belgium (Flemish)		3 (0.3)	33 (1.6)	76 (1.4)	94 (0.9)
Jordan		3 (0.5)	21 (1.4)	53 (1.8)	80 (1.3)
Norway		2 (0.3)	21 (1.1)	63 (1.3)	91 (0.8)
1 Serbia		2 (0.3)	16 (1.0)	48 (1.3)	79 (1.0)
2 Macedonia, Rep. of		2 (0.3)	13 (1.2)	42 (1.8)	72 (1.5)
Moldova, Rep. of		1 (0.3)	15 (1.2)	50 (1.9)	83 (1.5)
Armenia		1 (0.3)	14 (1.3)	45 (1.9)	77 (1.4)
Palestinian Nat'l Auth.		1 (0.2)	10 (0.8)	36 (1.4)	66 (1.5)
Egypt		1 (0.2)	10 (0.7)	33 (1.4)	59 (1.6)
Iran, Islamic Rep. of		1 (0.2)	9 (0.6)	38 (1.3)	77 (1.3)
Chile		1 (0.1)	5 (0.6)	24 (1.3)	56 (1.5)
South Africa		1 (0.2)	3 (0.7)	6 (1.4)	13 (1.9)
Cyprus		0 (0.2)	8 (0.6)	35 (1.0)	71 (1.2)
Bahrain		0 (0.1)	6 (0.6)	33 (1.1)	70 (1.2)
1 Indonesia		0 (0.1)	4 (0.5)	25 (1.8)	61 (2.1)
Lebanon		0 (0.1)	4 (0.7)	20 (1.5)	48 (2.0)
Philippines		0 (0.1)	4 (0.6)	18 (1.7)	42 (2.5)
Saudi Arabia		0 (0.0)	1 (0.4)	15 (1.5)	49 (2.3)
1 ‡ Morocco		0 (0.0)	1 (0.3)	13 (1.1)	48 (1.9)
Tunisia		0 (0.0)	1 (0.2)	12 (1.0)	52 (1.5)
Botswana		0 (0.1)	1 (0.5)	10 (0.9)	35 (1.3)
Ghana		0 (0.0)	0 (0.1)	3 (0.4)	13 (1.3)
‡ England		15 (1.7)	48 (2.7)	81 (1.8)	96 (0.6)
Benchmarking Participants					
Basque Country, Spain		3 (0.6)	20 (1.5)	58 (1.9)	89 (0.9)
Indiana State, US		8 (1.5)	40 (2.8)	79 (2.1)	96 (0.8)
Ontario Province, Can.		7 (0.7)	41 (1.8)	81 (1.2)	97 (0.5)
Quebec Province, Can.		6 (1.0)	39 (2.0)	82 (1.5)	98 (0.4)



SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).

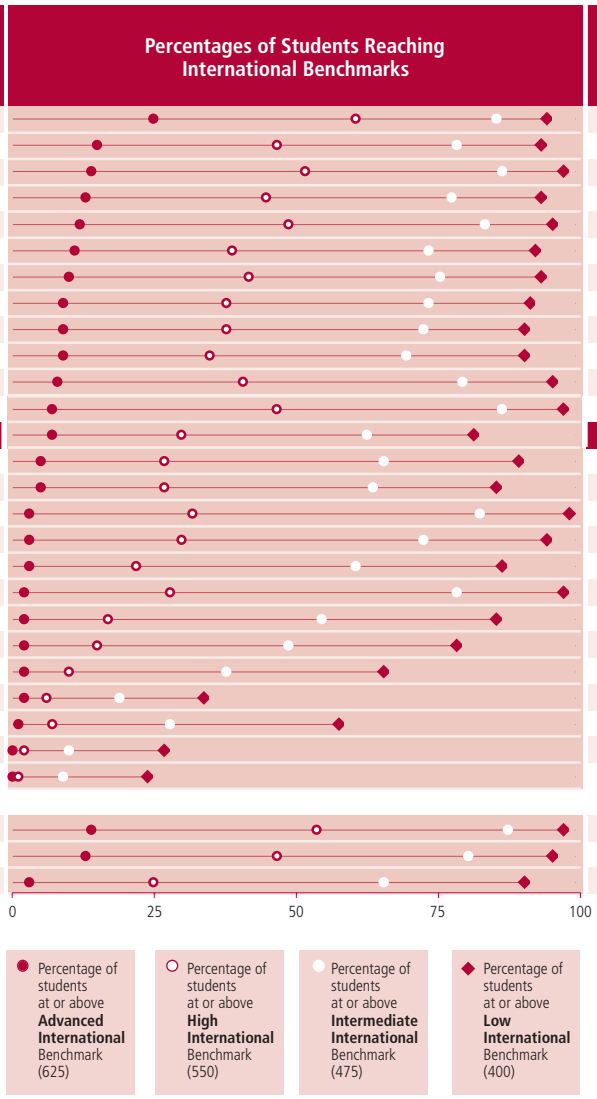
◆◆ Korea tested the same cohort of students as other countries, but later in 2003, at the beginning of the next school year.

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

Exhibit 2.2: Percentages of Students Reaching TIMSS 2003 International Benchmarks of Science Achievement

SCIENCE Grade 4

Countries	Advanced International Benchmark (625)	High International Benchmark (550)	Intermediate International Benchmark (475)	Low International Benchmark (400)
Singapore	25 (2.4)	61 (2.6)	86 (1.6)	95 (0.9)
† England	15 (1.4)	47 (1.8)	79 (1.3)	94 (0.7)
Chinese Taipei	14 (1.0)	52 (1.1)	87 (0.7)	98 (0.3)
† United States	13 (0.8)	45 (1.4)	78 (1.0)	94 (0.5)
Japan	12 (0.6)	49 (1.1)	84 (0.7)	96 (0.4)
Russian Federation	11 (1.4)	39 (2.7)	74 (2.4)	93 (1.1)
Hungary	10 (0.9)	42 (1.6)	76 (1.4)	94 (0.7)
† Australia	9 (1.0)	38 (1.7)	74 (2.0)	92 (1.1)
New Zealand	9 (0.7)	38 (1.3)	73 (1.2)	91 (0.8)
Italy	9 (1.1)	35 (1.9)	70 (1.6)	91 (0.9)
Latvia	8 (0.6)	41 (1.6)	80 (1.3)	96 (0.6)
† Hong Kong, SAR	7 (0.8)	47 (2.2)	87 (1.2)	98 (0.3)
International Avg.	7 (0.2)	30 (0.3)	63 (0.3)	82 (0.2)
† Scotland	5 (0.5)	27 (1.5)	66 (1.5)	90 (0.9)
Moldova, Rep. of	5 (0.9)	27 (1.9)	64 (2.1)	86 (1.3)
† Netherlands	3 (0.5)	32 (1.5)	83 (1.2)	99 (0.4)
1 Lithuania	3 (0.5)	30 (1.3)	73 (1.6)	95 (0.7)
Slovenia	3 (0.4)	22 (1.3)	61 (1.4)	87 (0.9)
Belgium (Flemish)	2 (0.3)	28 (1.1)	79 (1.3)	98 (0.4)
Cyprus	2 (0.3)	17 (1.0)	55 (1.4)	86 (0.8)
Norway	2 (0.3)	15 (0.9)	49 (1.4)	79 (1.5)
Armenia	2 (0.4)	10 (1.0)	38 (1.7)	66 (1.8)
Philippines	2 (1.0)	6 (1.9)	19 (2.5)	34 (2.5)
Iran, Islamic Rep. of	1 (0.2)	7 (0.7)	28 (1.5)	58 (1.7)
Tunisia	0 (0.1)	2 (0.3)	10 (1.0)	27 (1.7)
Morocco	0 (0.0)	1 (0.3)	9 (0.8)	24 (1.6)
Benchmarking Participants				
Indiana State, US	14 (2.2)	54 (2.2)	88 (1.5)	98 (0.4)
Ontario Province, Can.	13 (1.6)	47 (1.9)	81 (1.4)	96 (0.6)
Quebec Province, Can.	3 (0.4)	25 (1.3)	66 (1.4)	91 (0.8)



SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

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

Exhibit 2.3: Trends in Percentages of Students Reaching TIMSS 2003 International Benchmarks of Science Achievement in 1995, 1999, and 2003

SCIENCE Grade 8

Countries	Advanced International Benchmark (625)			High International Benchmark (550)		
	2003 (Percent of Students)	1999 (Percent of Students)	1995 (Percent of Students)	2003 (Percent of Students)	1999 (Percent of Students)	1995 (Percent of Students)
Singapore	33 (1.6)	29 (3.2)	29 (3.2)	66 (2.3)	60 (3.5)	64 (2.8)
Chinese Taipei	26 (1.5)	27 (1.8)	✧ ✧	63 (1.9)	61 (2.1)	✧ ✧
Korea, Rep. of	17 (0.9)	19 (1.1)	17 (1.0)	57 (1.1)	50 (1.2) ▲	50 (1.2) ▲
Japan	15 (0.7)	16 (1.0)	18 (0.9) ▼	53 (1.1)	52 (1.3)	54 (1.1)
Hungary	14 (1.1)	19 (1.3) ▼	12 (1.1)	46 (1.7)	53 (1.8) ▼	44 (1.7)
Hong Kong, SAR	13 (1.2)	7 (0.9) ▲	7 (1.0) ▲	58 (1.9)	40 (2.1) ▲	33 (2.7) ▲
United States	11 (0.8)	12 (1.0)	11 (1.1)	41 (1.7)	37 (1.9)	38 (2.0)
Australia	9 (1.1)	– –	10 (1.1)	40 (2.0)	– –	36 (1.7)
Sweden	8 (0.8)	✧ ✧	19 (1.6) ▼	38 (1.6)	✧ ✧	52 (2.4) ▼
Slovak Republic	7 (0.8)	12 (1.1) ▼	12 (1.3) ▼	34 (1.8)	43 (1.7) ▼	42 (1.7) ▼
New Zealand	7 (1.5)	10 (1.3)	9 (1.2)	35 (3.0)	35 (2.2)	34 (2.1)
Netherlands	6 (0.8)	14 (2.1) ▼	12 (1.8) ▼	43 (2.4)	50 (3.6)	48 (2.8)
Russian Federation	6 (0.8)	15 (2.3) ▼	11 (1.1) ▼	32 (1.8)	41 (2.8) ▼	38 (2.3) ▼
Lithuania	6 (0.6)	5 (0.9)	2 (0.5) ▲	34 (1.2)	22 (1.8) ▲	14 (1.5) ▲
Scotland	6 (0.7)	✧ ✧	9 (1.4)	32 (1.9)	✧ ✧	30 (2.5)
Slovenia	6 (0.5)	– –	8 (0.8) ▼	33 (1.3)	– –	32 (1.5)
Israel	5 (0.5)	5 (0.5)	– –	24 (1.3)	23 (1.4)	– –
Latvia (LSS)	4 (0.6)	5 (1.1)	3 (0.6)	30 (1.8)	27 (2.5)	18 (1.1) ▲
Bulgaria	4 (0.7)	12 (2.0) ▼	22 (1.7) ▼	23 (1.7)	38 (2.6) ▼	46 (2.3) ▼
Italy	4 (0.6)	6 (0.9) ▼	– –	23 (1.5)	26 (1.8)	– –
Romania	4 (0.8)	5 (0.8)	5 (0.8)	20 (1.8)	21 (2.1)	22 (1.8)
Malaysia	4 (0.8)	5 (0.8)	✧ ✧	28 (2.2)	24 (2.0)	✧ ✧
Jordan	3 (0.5)	4 (0.5)	✧ ✧	21 (1.4)	17 (1.0) ▲	✧ ✧
Belgium (Flemish)	3 (0.3)	9 (1.3) ▼	9 (1.0) ▼	33 (1.6)	44 (1.5) ▼	45 (2.5) ▼
Norway	2 (0.3)	✧ ✧	6 (0.6) ▼	21 (1.1)	✧ ✧	32 (1.5) ▼
Macedonia, Rep. of	2 (0.3)	3 (0.4) ▼	✧ ✧	13 (1.2)	17 (1.9) ▼	✧ ✧
Moldova, Rep. of	1 (0.3)	4 (0.4) ▼	✧ ✧	15 (1.2)	17 (1.3)	✧ ✧
Iran, Islamic Rep. of	1 (0.2)	1 (0.3)	1 (0.4)	9 (0.6)	11 (1.3)	11 (1.3)
South Africa	1 (0.2)	0 (0.2)	– –	3 (0.7)	2 (0.7)	– –
Chile	1 (0.1)	1 (0.3)	✧ ✧	5 (0.6)	7 (1.1)	✧ ✧
Cyprus	0 (0.2)	2 (0.4) ▼	2 (0.4) ▼	8 (0.6)	14 (0.8) ▼	15 (1.0) ▼
Philippines	0 (0.1)	1 (0.2)	✧ ✧	4 (0.6)	4 (0.7)	✧ ✧
Indonesia	0 (0.1)	1 (0.3) ▼	✧ ✧	4 (0.5)	8 (1.0) ▼	✧ ✧
Tunisia	0 (0.0)	0 (0.1)	✧ ✧	1 (0.2)	3 (0.5) ▼	✧ ✧
‡ England	15 (1.7)	17 (1.7)	15 (1.7)	48 (2.7)	45 (2.4)	43 (1.8)
International Avg.	7 (0.2)	9 (0.2) ▼	11 (0.3) ▼	30 (0.3)	30 (0.3)	37 (0.4) ▼
Benchmarking Participants						
Indiana State, US	8 (1.5)	14 (2.1) ▼	✧ ✧	40 (2.8)	44 (3.5)	✧ ✧
Ontario Province, Can.	7 (0.7)	7 (0.9)	5 (0.6)	41 (1.8)	34 (1.6) ▲	26 (1.6) ▲
Quebec Province, Can.	6 (1.0)	10 (2.2)	7 (1.5)	39 (2.0)	43 (3.7)	30 (2.8) ▲

▲ 2003 significantly higher

▼ 2003 significantly lower

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

Trend notes: Because of differences in population coverage, 1999 data are not shown for Australia and Slovenia, and 1995 data are not shown for Israel, Italy, and South Africa. Korea tested later in 2003 than in 1999 and 1995, at the beginning of the next school year. Similarly, Lithuania tested later in 1999 than in 2003 and 1995. Data for Latvia in this exhibit include Latvian-speaking schools only.

( ) 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 TIMSS 2003 International Benchmarks of Science Achievement in 1995, 1999, and 2003

SCIENCE Grade 8

Countries	Intermediate International Benchmark (475)			Low International Benchmark (400)		
	2003 (Percent of Students)	1999 (Percent of Students)	1995 (Percent of Students)	2003 (Percent of Students)	1999 (Percent of Students)	1995 (Percent of Students)
Singapore	85 (1.7)	84 (2.4)	91 (1.3) ▼	95 (0.8)	95 (1.2)	99 (0.2) ▼
Chinese Taipei	88 (1.1)	86 (1.3)	✧ ✧	98 (0.4)	96 (0.6) ▲	✧ ✧
Korea, Rep. of	88 (0.7)	81 (1.0) ▲	81 (0.9) ▲	98 (0.4)	96 (0.4) ▲	95 (0.5) ▲
Japan	86 (0.8)	84 (0.9)	85 (0.7)	98 (0.3)	97 (0.4)	97 (0.3)
Hungary	82 (1.1)	83 (1.3)	80 (1.5)	97 (0.6)	96 (0.8)	95 (0.7)
Hong Kong, SAR	89 (1.4)	80 (1.9) ▲	70 (2.7) ▲	98 (0.7)	96 (0.9)	90 (1.7) ▲
United States	75 (1.4)	67 (1.9) ▲	68 (2.2) ▲	93 (0.8)	87 (1.3) ▲	87 (1.6) ▲
Australia	76 (1.9)	– –	69 (1.6) ▲	95 (0.8)	– –	89 (1.0) ▲
Sweden	75 (1.4)	✧ ✧	83 (1.7) ▼	95 (0.7)	✧ ✧	97 (0.7) ▼
Slovak Republic	72 (1.5)	79 (1.4) ▼	77 (1.5) ▼	94 (0.7)	96 (0.6) ▼	95 (0.6)
New Zealand	73 (2.2)	66 (2.0) ▲	67 (2.2) ▲	94 (1.3)	88 (1.4) ▲	89 (1.2) ▲
Netherlands	85 (1.7)	83 (3.3)	82 (2.7)	98 (0.7)	96 (1.2)	96 (2.0)
Russian Federation	70 (1.8)	73 (2.3)	71 (2.2)	93 (0.9)	92 (1.0)	92 (1.1)
Lithuania	74 (1.3)	57 (2.0) ▲	45 (2.2) ▲	95 (0.6)	86 (1.7) ▲	79 (1.6) ▲
Scotland	70 (1.7)	✧ ✧	61 (2.2) ▲	92 (0.9)	✧ ✧	86 (1.4) ▲
Slovenia	75 (1.3)	– –	69 (1.6) ▲	96 (0.6)	– –	93 (0.7) ▲
Israel	57 (1.6)	50 (2.1) ▲	– –	85 (1.1)	75 (2.0) ▲	– –
Latvia (LSS)	72 (1.8)	65 (1.9) ▲	51 (1.8) ▲	95 (0.9)	91 (1.2) ▲	83 (1.4) ▲
Bulgaria	55 (2.1)	70 (2.0) ▼	75 (1.9) ▼	81 (2.0)	89 (1.4) ▼	93 (1.1) ▼
Italy	59 (1.5)	59 (2.0)	– –	87 (1.1)	86 (1.2)	– –
Romania	49 (2.2)	50 (2.6)	51 (2.2)	78 (1.9)	78 (2.0)	77 (1.7)
Malaysia	71 (2.0)	59 (2.2) ▲	✧ ✧	95 (0.7)	87 (1.4) ▲	✧ ✧
Jordan	53 (1.8)	42 (1.4) ▲	✧ ✧	80 (1.3)	69 (1.6) ▲	✧ ✧
Belgium (Flemish)	76 (1.4)	81 (1.5) ▼	80 (3.0)	94 (0.9)	97 (1.0) ▼	94 (2.0)
Norway	63 (1.3)	✧ ✧	72 (1.3) ▼	91 (0.8)	✧ ✧	94 (0.9) ▼
Macedonia, Rep. of	42 (1.8)	46 (2.0)	✧ ✧	72 (1.5)	73 (2.2)	✧ ✧
Moldova, Rep. of	50 (1.9)	44 (1.8) ▲	✧ ✧	83 (1.5)	74 (1.6) ▲	✧ ✧
Iran, Islamic Rep. of	38 (1.3)	38 (1.8)	43 (2.2) ▼	77 (1.3)	72 (1.8) ▲	81 (1.8) ▼
South Africa	6 (1.4)	7 (1.5)	– –	13 (1.9)	14 (2.1)	– –
Chile	24 (1.3)	27 (1.7)	✧ ✧	56 (1.5)	60 (1.5) ▼	✧ ✧
Cyprus	35 (1.0)	45 (1.5) ▼	43 (1.3) ▼	71 (1.2)	77 (1.1) ▼	72 (1.1)
Philippines	18 (1.7)	15 (1.9)	✧ ✧	42 (2.5)	34 (2.7) ▲	✧ ✧
Indonesia	25 (1.8)	33 (1.7) ▼	✧ ✧	61 (2.1)	68 (2.5) ▼	✧ ✧
Tunisia	12 (1.0)	25 (1.6) ▼	✧ ✧	52 (1.5)	68 (2.1) ▼	✧ ✧
‡ England	81 (1.8)	76 (1.9)	75 (1.4) ▲	96 (0.6)	94 (0.7) ▲	93 (0.7) ▲
International Avg.	61 (0.3)	58 (0.3) ▲	69 (0.4) ▼	84 (0.3)	81 (0.3) ▲	90 (0.2) ▼
Benchmarking Participants						
Indiana State, US	79 (2.1)	76 (2.6)	✧ ✧	96 (0.8)	93 (1.3) ▲	✧ ✧
Ontario Province, Can.	81 (1.2)	72 (1.6) ▲	61 (1.9) ▲	97 (0.5)	95 (0.5) ▲	88 (1.1) ▲
Quebec Province, Can.	82 (1.5)	83 (2.4)	69 (3.5) ▲	98 (0.4)	98 (0.5)	92 (2.6) ▲

▲ 2003 significantly higher

▼ 2003 significantly lower

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

Trend notes: Because of differences in population coverage, 1999 data are not shown for Australia and Slovenia, and 1995 data are not shown for Israel, Italy, and South Africa. Korea tested later in 2003 than in 1999 and 1995, at the beginning of the next school year. Similarly, Lithuania tested later in 1999 than in 2003 and 1995. Data for Latvia in this exhibit include Latvian-speaking schools only.

( ) 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 2.4: Trends in Percentages of Students Reaching TIMSS 2003 International Benchmarks of Science Achievement in 1995 and 2003

Countries	Advanced International Benchmark (625)		High International Benchmark (550)		Intermediate International Benchmark (475)		Low International Benchmark (400)	
	2003 (Percent of Students)	1995 (Percent of Students)	2003 (Percent of Students)	1995 (Percent of Students)	2003 (Percent of Students)	1995 (Percent of Students)	2003 (Percent of Students)	1995 (Percent of Students)
Singapore	25 (2.4)	14 (1.6) ▲	61 (2.6)	42 (2.2) ▲	86 (1.6)	71 (1.7) ▲	95 (0.9)	89 (0.9) ▲
England	15 (1.4)	15 (1.1)	47 (1.8)	42 (1.7) ▲	79 (1.3)	72 (1.3) ▲	94 (0.7)	90 (0.8) ▲
United States	13 (0.8)	19 (1.2) ▼	45 (1.4)	50 (1.6) ▼	78 (1.0)	78 (1.1)	94 (0.5)	92 (0.7)
Japan	12 (0.6)	15 (0.8) ▼	49 (1.1)	54 (1.3) ▼	84 (0.7)	87 (0.7) ▼	96 (0.4)	97 (0.4) ▼
Hungary	10 (0.9)	7 (0.7) ▲	42 (1.6)	32 (1.7) ▲	76 (1.4)	67 (1.8) ▲	94 (0.7)	90 (1.0) ▲
New Zealand	9 (0.7)	11 (1.2)	39 (1.3)	35 (1.8)	74 (1.2)	66 (1.8) ▲	92 (0.7)	85 (1.7) ▲
Australia	9 (1.0)	13 (1.1) ▼	38 (1.7)	40 (1.3)	74 (2.0)	72 (1.7)	92 (1.1)	89 (1.1)
Latvia (LSS)	7 (0.8)	5 (1.4)	39 (1.9)	21 (2.1) ▲	80 (1.5)	55 (2.1) ▲	96 (0.6)	85 (1.4) ▲
Hong Kong, SAR	7 (0.8)	5 (0.6)	47 (2.2)	30 (1.6) ▲	87 (1.2)	69 (1.7) ▲	98 (0.3)	91 (1.1) ▲
Scotland	5 (0.5)	12 (1.1) ▼	27 (1.5)	37 (1.8) ▼	66 (1.5)	68 (1.9)	90 (0.9)	88 (1.3)
Slovenia	3 (0.4)	2 (0.4)	22 (1.3)	14 (1.1) ▲	61 (1.4)	45 (1.5) ▲	87 (0.9)	79 (1.4) ▲
Netherlands	3 (0.5)	6 (0.7) ▼	32 (1.5)	38 (2.1) ▼	83 (1.2)	82 (1.6)	99 (0.4)	98 (0.7)
Norway	2 (0.3)	8 (0.9) ▼	15 (0.9)	32 (1.6) ▼	49 (1.4)	65 (1.7) ▼	79 (1.5)	88 (1.1) ▼
Cyprus	2 (0.3)	1 (0.4)	17 (1.0)	11 (1.0) ▲	55 (1.4)	39 (1.8) ▲	86 (0.8)	74 (1.3) ▲
Iran, Islamic Rep. of	1 (0.2)	0 (0.1) ▲	7 (0.7)	3 (0.7) ▲	28 (1.5)	15 (1.5) ▲	58 (1.7)	42 (2.1) ▲
International Avg.	8 (0.3)	9 (0.2) ▼	35 (0.5)	32 (0.4) ▲	71 (0.4)	63 (0.4) ▲	90 (0.3)	85 (0.3) ▲
Benchmarking Participants								
Ontario Province, Can.	13 (1.6)	10 (0.7) ▲	47 (1.9)	37 (1.7) ▲	81 (1.4)	71 (1.7) ▲	96 (0.6)	90 (1.0) ▲
Quebec Province, Can.	3 (0.4)	9 (1.3) ▼	25 (1.3)	40 (3.7) ▼	66 (1.4)	77 (2.5) ▼	91 (0.8)	94 (1.3)

▲ 2003 significantly higher

▼ 2003 significantly lower

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

Trend notes: Because of differences between 1995 and 2003 in population coverage, 1995 data are not shown for Italy. Data for Latvia in this exhibit include Latvian-speaking schools only. To be comparable with 1995, 2003 data for New Zealand in this exhibit include students in English medium instruction only (98% of the estimated population).

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

Grade 8: Achievement at the Advanced International Benchmark

Exhibit 2.5 describes performance at the advanced international benchmark. Eighth-grade students reaching this benchmark demonstrated a grasp of some complex and abstract science concepts and could apply knowledge of earth, life, physical, and environmental science. They understand some fundamentals of scientific investigation and could apply basic physical principles to solve quantitative problems. They also could provide written explanations to communicate scientific knowledge. 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.

Example Item 1 in Exhibit 2.6 illustrates the type of physics question an eighth-grade student performing at the advanced benchmark generally answered correctly. Students were shown a diagram depicting a ray of sunlight entering a glass prism and a screen on the other side, and were asked to describe what would be seen on the screen, drawing on the diagram if necessary. To receive full credit, students had to explicitly indicate that different colors are seen on the screen, either through a written explanation or by drawing on the diagram. Partial credit was awarded to students who mentioned refraction or bending of the light beam but made no reference to color. This question was difficult for most students, with on average just 23 percent receiving full credit for their responses. However, more than half the students in Korea, Singapore, Malaysia, and Ontario gained full credit.

Students reaching the advanced benchmark typically could interpret information in diagrams, maps, graphs, and tables to solve problems or draw conclusions. Illustrating this, Example Item 2 from earth science shown in Exhibit 2.7 provides students with information in tabular form about the planets Venus and Mercury – surface temperature, atmospheric composition, distance from the Sun, and time to revolve around the Sun. To answer this item correctly, students had to recognize that the best explanation for the higher surface temperature

on Venus was that the high proportion of carbon dioxide in its atmosphere causes a greenhouse effect. This item was answered correctly by 36 percent of students on average, with more than half of the students in Korea, Hong Kong SAR, Chinese Taipei, and Singapore choosing the correct answer.

Exhibit 2.5: **Description of TIMSS 2003 Advanced International Benchmark (625) of Science Achievement**

SCIENCE Grade 8

Advanced International Benchmark – 625

Summary

Students demonstrate a grasp of some complex and abstract science concepts. They can apply knowledge of the solar system and of Earth features, processes, and conditions, and apply understanding of the complexity of living organisms and how they relate to their environment. They show understanding of electricity, thermal expansion, and sound, as well as the structure of matter and physical and chemical properties and changes. They show understanding of environmental and resource issues. Students 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.

Students can apply knowledge of the solar system and of Earth features, processes, and conditions. 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. They recognize the gravitational pull of the moon as the major cause of tides. They recognize that surface temperature of a planet is amplified by atmospheric composition and can relate latitude to average yearly temperature. Students identify a physical process that causes weathering of rocks and, from a list of rock types, identify limestone as the type involved in the formation of underground caves. Students recognize the low percentage of water on Earth that is fresh.

Students show understanding of the complexity of living organisms and how they relate to their environment. They recognize the hierarchy of organization in living organisms, and can state one structure that is found in plant but not animal cells. They state two factors in addition to chlorophyll that are needed for photosynthesis, can explain that photosynthesis takes place when light is shone on a plant, and recognize that the gas given off is oxygen. They can justify their choice of plants or animals as the likely first inhabitants of an island, and state one effect of introducing a new predator. They recognize that producers use energy from the sun to make food chemical elements and that recycle back into the environment when animals and plants die. Students also know some animal adaptations needed for survival including physical and behavioral characteristics. In addition, they can list some conditions that are found at the bottom of oceans that make it difficult for most organisms to live there, and recognize that fossils found in sedimentary rock are formed from organisms that lived in the sea. In the area of human health, students recognize that leafy vegetables are a good source of minerals and that vaccines provide the body with long-term immunity.

Students show understanding of physics principles and phenomena, including electricity, thermal expansion, and sound. They interpret a circuit diagram and recognizes that the current flows through two bulbs is the same and recognize that an iron nail becomes magnetized when current flows through a wire coiled around the nail. They recognize that mass is conserved during thermal expansion and that railway tracks have gaps to allow for thermal expansion. They recognize that the motion and arrangement of particles of a liquid are slower and closer together than those of gas particles. Students also recognize that force of gravity acts on a person regardless of position and movement. They can describe what is seen when sunlight passes through a glass prism. They recognize that plucking a guitar string harder affects the volume rather than the pitch of sound produced, and they can predict the effect of removing air on the propagation of sound.

Students demonstrate an understanding of the structure of matter as well as of physical and chemical properties and changes. They recognize that the nucleus of most atoms is composed of protons and neutrons, that an ion is formed when a neutral atom gains an electron, and that the diagram that best represents the structure of water molecules. They identify which of oxygen, hydrogen, and water are elements and distinguish between mixtures and a pure substance (sugar). Students recognize that sugar molecules continue to exist when sugar is dissolved in water. They recognize that water should be added to a saline solution to make it half as concentrated, and determine the amount of water necessary. Based on an incomplete table comparing pure water and salt water, students can explain that the addition of salt to water produces a solution of greater density. They can distinguish between chemical and physical changes, identify oxygen as the gas that causes rust formation, and recognize that both burning coal and exploding fireworks release energy. Students explain why litmus paper does not change color in a mixture of the right proportions of an acid and a base. Students can identify a property of metals and describe how this property may be used to determine whether a substance is a metal or nonmetal. They recognize that electrical conductivity has been used to classify materials into two groups. Students can calculate the density of a metal in a block given the block's mass and length of its sides. They can compare the previously computed density of a metal block to the densities of different metals presented in a table, infer what metal the block is made of, and explain their answers.

Students show understanding of environmental and resource issues. They can state one renewable energy source and describe one way it can be used, and recognize coal as a non-renewable resource. Students recognize that increased algal growth in a lake is likely due to fertilizer runoff, can explain how acid rain is formed from the burning of fossil fuels, and can describe how science and technology may be used to address oil spills in the oceans. Based on demographic and other information, students can predict population change and explain how this will affect land use and pollution. They can state one reason why the human population increased rapidly over the last 200 years.

Students demonstrate understanding of some fundamentals of scientific investigation. In an experimental situation, they recognize which variables to control, what questions can be addressed by an investigation, why scientists make repeated measurements and how an estimate may be improved by averaging repeated measurements. Given a set of equipment, they can design a procedure to measure the volume of an irregularly-shaped object. 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 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) 2003

Exhibit 2.6: TIMSS 2003 Advanced International Benchmark (625) of Science Achievement – Example Item 1

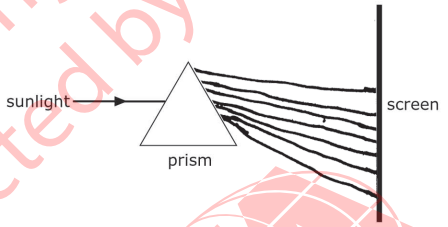
An ItemThat Students Reaching the Advanced International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 8

Content Area: Physics

Description: Describes that a spectrum can be seen when sunlight passes through by a glass prism.

The diagram shows a ray of sunlight entering a glass prism.



Describe what will be seen on the screen.
(You may draw on the diagram to help explain your answer.)

On the screen, you will see the 7 colors of the rainbow.

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

Country	Percent Full Credit
◆◆ Korea, Rep. of	74 (2.1) ▲
Singapore	65 (2.5) ▲
Malaysia	53 (3.0) ▲
† Hong Kong, SAR	49 (2.5) ▲
‡ United States	49 (2.2) ▲
† Netherlands	45 (3.5) ▲
New Zealand	43 (3.3) ▲
Chinese Taipei	38 (2.5) ▲
Jordan	36 (2.8) ▲
Bahrain	34 (2.8) ▲
Armenia	33 (3.6) ▲
Palestinian Nat'l Auth.	33 (2.6) ▲
1 Lithuania	32 (3.0) ▲
Iran, Islamic Rep. of	31 (2.6) ▲
† Scotland	28 (2.9)
Sweden	25 (2.7)
Egypt	24 (2.0)
Hungary	24 (2.6)
Italy	24 (2.7)
International Avg.	23 (0.3)
Australia	22 (2.8)
Estonia	20 (2.5)
Romania	18 (2.3) ▼
2 Israel	17 (2.3) ▼
Latvia	17 (2.5) ▼
Belgium (Flemish)	15 (1.9) ▼
Norway	15 (2.0) ▼
Slovenia	15 (2.3) ▼
Saudi Arabia	14 (2.6) ▼
Chile	11 (1.5) ▼
Russian Federation	11 (2.0) ▼
Philippines	10 (1.2) ▼
Japan	10 (1.6) ▼
1 Indonesia	9 (1.4) ▼
Lebanon	7 (1.6) ▼
Bulgaria	7 (1.7) ▼
2 Macedonia, Rep. of	7 (1.6) ▼
Slovak Republic	6 (1.4) ▼
Botswana	5 (1.0) ▼
Cyprus	4 (1.3) ▼
South Africa	3 (0.9) ▼
Moldova, Rep. of	2 (0.8) ▼
1 Serbia	2 (0.8) ▼
Ghana	1 (0.4) ▼
1 ‡ Morocco	1 (0.7) ▼
Tunisia	0 (0.3) ▼
‡ England	47 (4.7) ▲
Benchmarking Participants	
Basque Country, Spain	16 (3.0) ▼
Indiana State, US	44 (3.4) ▲
Ontario Province, Can.	66 (3.9) ▲
Quebec Province, Can.	45 (3.0) ▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered fully correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).

◆◆ Korea tested the same cohort of students as other countries, but later in 2003, 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 2.7: TIMSS 2003 Advanced International Benchmark (625) of Science Achievement – Example Item 2

An Item That Students Reaching the Advanced International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 8

Content Area: Earth Science

Description: Given a table showing information about Venus and Mercury, recognizes that the higher average surface temperature on Venus is due to the greenhouse effect.

The table shows some information about the planets Venus and Mercury.

	Average Surface Temperature (°C)	Atmospheric Composition	Mean Distance from the Sun (millions of km)	Time to Revolve Around the Sun (Number of Days)
Venus	470	Mostly Carbon Dioxide	108	225
Mercury	300	Trace amounts of gases	58	88

Which of the following best explains why the surface temperature of Venus is higher than that of Mercury?

Ⓐ There is less absorption of sunlight on Mercury because of the lack of atmospheric gases.

● The high percentage of carbon dioxide in the atmosphere of Venus causes a greenhouse effect.

Ⓒ The longer time for Venus to revolve around the Sun allows it to absorb more heat from the Sun.

Ⓓ The Sun's rays are less direct on Mercury because it is closer to the Sun.

Country	Percent Full Credit	
◗◖ Korea, Rep. of	70 (1.9)	▲
† Hong Kong, SAR	69 (1.7)	▲
Chinese Taipei	69 (1.6)	▲
Singapore	60 (1.8)	▲
‡ United States	49 (1.5)	▲
Australia	48 (2.6)	▲
Japan	47 (1.9)	▲
Egypt	46 (1.8)	▲
Sweden	46 (2.6)	▲
New Zealand	45 (2.4)	▲
1 Lithuania	44 (2.1)	▲
Estonia	43 (2.6)	▲
2 Israel	41 (2.3)	▲
Hungary	41 (2.4)	▲
† Scotland	40 (2.5)	
Slovenia	39 (2.4)	
Latvia	38 (2.3)	
Italy	38 (2.2)	
† Netherlands	38 (2.4)	
Slovak Republic	38 (2.0)	
Belgium (Flemish)	38 (1.6)	
Russian Federation	37 (3.0)	
International Avg.	36 (0.3)	
1 Serbia	34 (2.1)	
Norway	34 (2.0)	
Iran, Islamic Rep. of	33 (1.9)	
Bulgaria	33 (2.2)	
Malaysia	31 (1.8)	▼
Chile	30 (1.6)	▼
Cyprus	30 (1.6)	▼
Palestinian Nat'l Auth.	28 (1.6)	▼
Bahrain	28 (1.8)	▼
Romania	28 (2.2)	▼
Philippines	28 (1.4)	▼
Jordan	28 (1.9)	▼
Botswana	24 (1.7)	▼
Moldova, Rep. of	24 (2.1)	▼
Lebanon	24 (1.6)	▼
South Africa	23 (1.3)	▼
Ghana	22 (1.7)	▼
Tunisia	19 (1.3)	▼
Saudi Arabia	18 (2.0)	▼
1 Indonesia	16 (1.4)	▼
1 ‡ Morocco	16 (1.8)	▼
2 Macedonia, Rep. of	15 (1.7)	▼
Armenia	15 (1.7)	▼
‡ England	44 (3.0)	▲
Benchmarking Participants		
Basque Country, Spain	34 (2.6)	
Indiana State, US	45 (2.9)	▲
Ontario Province, Can.	40 (2.3)	
Quebec Province, Can.	47 (2.4)	▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).

◗◖ Korea tested the same cohort of students as other countries, but later in 2003, 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.

Grade 8: Achievement at the High International Benchmark

Exhibit 2.8 describes performance at the high international benchmark. Eighth-grade students performing at this level demonstrated conceptual understanding of some science cycles, systems, and principles. For example, they were able to interpret a four-step decision diagram showing how to separate a mixture of sand, salt, iron filings, and small pieces of cork into its components, as depicted in Example Item 3 in Exhibit 2.9. To obtain full credit, students had to identify the component of the mixture extracted at each of the four steps. Partial credit was awarded to students identifying two or three components correctly. Internationally, 34 percent of the students, on average, achieved full credit. Countries where the majority of students were awarded full credit included Singapore, Chinese Taipei, Japan, Hong Kong SAR, Estonia, Korea, Hungary, the Slovak Republic, and province of Quebec.

Eighth-grade students reaching the high benchmark generally showed some understanding of ecosystems and food chains. In Example Item 4 in Exhibit 2.10, students were asked to predict what would happen to a community consisting of mice, snakes, and wheat plants if the snakes were all killed. To obtain full credit, students had to mention explicitly the effect on both the mouse population and the wheat plants. Partial credit was awarded to students who referred to one or other effect, but not both. The majority of students in Singapore, Malaysia, Chinese Taipei, Estonia, Australia, and Ontario achieved full credit, although internationally, just about one-third of the eighth-grade students did so.

Exhibit 2.8: **Description of TIMSS 2003 High International Benchmark (550) of Science Achievement**

SCIENCE Grade 8

High International Benchmark – 550

Summary

Students demonstrate conceptual understanding of some science cycles, systems, and principles. They have some understanding of Earth's processes and the solar system, biological systems, populations, reproduction and heredity, and structure and function of organisms. They show some understanding of physical and chemical changes, and the structure of matter. They solve some basic physics problems related to light, heat, electricity, and magnetism, and they demonstrate basic knowledge of major environmental issues. They demonstrate some scientific inquiry skills. They can combine information to draw conclusions; interpret information in diagrams, graphs and tables to solve problems; and provide short explanations conveying scientific knowledge and cause/effect relationships.

Students have some understanding of Earth's processes and the solar system. They can recognize a definition of sedimentary rock and know that fossil fuels are formed from the remains of living things. They recognize that Earthquakes and volcanoes occur along the boundaries of tectonic plates. Students recognize how a river changes as it flows from a mountain to a plain, can describe how atmospheric conditions on Earth change with increasing elevation, and can predict the likely location of a jungle relative to a mountain. Students recognize some features of the solar system, including the main differences between planets and moons, the definition of an Earth year and the relative distances of the Sun and Moon from Earth.

Students show some understanding of ecosystems, population, and structure and function. They interpret a diagram depicting the exchange of gases in a forest ecosystem, demonstrate an understanding of interrelations of plants and animals in ecosystems, and recognize that the loss of a food supply is likely the cause of a drop in population size. They also can explain that camouflage helps animals survive. They recognize that the main function of chlorophyll in plants is to absorb light energy. Students demonstrate some understanding of reproduction and heredity by recognizing that sperm and egg join during fertilization, and explaining that acquired characteristics such as the loss of a kidney cannot be passed onto the next generation. Students can state the importance of exercise for good health, and recognize which food source contains fat. They can identify some functions of blood, and know one function of the uterus. They can describe how body temperature in humans is controlled. In addition, students can determine characteristics used to sort animals into classification groups.

Students can analyze situations and solve some basic problems related to light, heat, magnetism, and electricity. For example, they can relate shadow size to distance from a light source. They can recognize a ray diagram showing the path of light reflected from a mirror. They can also explain why lightning is seen before thunder is heard. Students also 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, that the thermal expansion of alcohol is greater than that of glass, and that gas molecules move faster when temperature increases. They can demonstrate knowledge of magnetism by drawing and explaining the orientation of a compass needle under the influence of a magnet and by labeling the poles of magnets cut into pieces. Students also can complete a table showing a proportional relation between voltage and current. They also demonstrate understanding of some physical properties of matter. For example, they can compare the densities of helium and air by recognizing that helium balloons rise in air. They also recognize that the surface of a liquid remains horizontal in a tilted container. They can explain that the temperature of boiling water does not increase as heat is added.

Students show some evidence of understanding chemical and physical changes and the structure of matter. They can identify vinegar as acidic solution and explain what causes a balloon to inflate when sodium bicarbonate in the balloon is mixed with vinegar. They can explain that candles burning in closed containers will extinguish due to lack of oxygen. They use a four step decision diagram that describes how to separate iron filings, cork, sand and salt from a mixture to identify which component is separated by magnetism, floating/sinking, filtering, and evaporation. Students interpret data in a table of physical properties to identify iron, water, and oxygen, and recognize that a graph that shows the effect of temperature on the solubility of sugar in water. They recognize that objects are made up of atoms.

Students demonstrate basic knowledge of major environmental issues. They can explain why the depletion of the ozone layer may be harmful to people, and recognize that increased carbon dioxide in the atmosphere may lead to global warming and that using public transportation can reduce air pollution. They can distinguish renewable from nonrenewable energy sources, describe the effects of a dam on wildlife, state two reasons why some people do not have enough water to drink, and recognize that overgrazing can lead to soil erosion. Students can also distinguish between soil change caused by natural causes and by human activity.

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

Exhibit 2.9: TIMSS 2003 High International Benchmark (550) of Science Achievement – Example Item 3

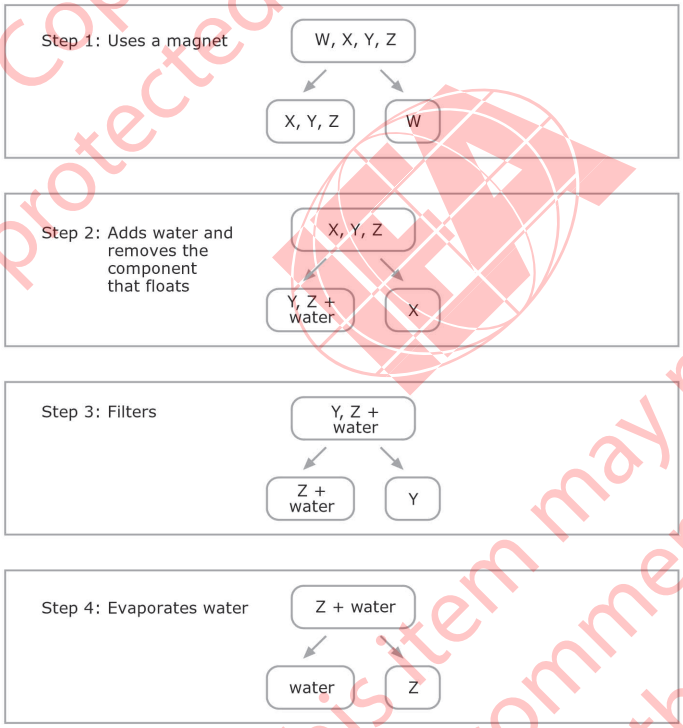
An Item That Students Reaching the High International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 8

Content Area: Chemistry

Description: Using a four-step decision diagram showing the steps used to separate iron filings, cork, sand, and salt from a mixture, identifies which component is separated by magnetism, floating/sinking, filtering, and evaporation.

Teresa is given a mixture of salt, sand, iron filings, and small pieces of cork. She separates the mixture using a 4-step procedure as shown in the diagram. The letters W, X, Y, and Z are used to stand for the four components but do not indicate which letter stands for which component.



Identify what each component is by writing *salt, sand, iron, or cork* in the correct spaces below.

Component W is: iron

Component X is: cork

Component Y is: sand

Component Z is: salt

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

Country	Percent Full Credit	
Singapore	68 (2.2)	▲
Chinese Taipei	67 (2.5)	▲
Japan	58 (2.5)	▲
† Hong Kong, SAR	58 (2.3)	▲
Estonia	56 (2.8)	▲
◆◆ Korea, Rep. of	54 (2.5)	▲
Hungary	51 (3.2)	▲
Slovak Republic	51 (3.0)	▲
Latvia	49 (3.4)	▲
† Scotland	48 (2.9)	▲
† Netherlands	47 (3.3)	▲
Sweden	47 (2.3)	▲
1 Lithuania	47 (2.8)	▲
New Zealand	46 (4.1)	▲
Malaysia	46 (3.0)	▲
Russian Federation	45 (2.8)	▲
Australia	44 (3.5)	▲
Belgium (Flemish)	44 (2.4)	▲
Armenia	42 (3.5)	▲
Slovenia	41 (4.1)	
Italy	39 (3.0)	
‡ United States	35 (2.0)	
Jordan	35 (3.1)	
Romania	35 (3.0)	
International Avg.	34 (0.4)	
Moldova, Rep. of	34 (3.7)	
2 Israel	33 (2.6)	
Norway	26 (2.8)	▼
Lebanon	26 (2.5)	▼
Chile	26 (2.2)	▼
Iran, Islamic Rep. of	25 (2.1)	▼
Bahrain	23 (2.6)	▼
Egypt	22 (2.2)	▼
Bulgaria	21 (3.1)	▼
Palestinian Nat'l Auth.	20 (1.9)	▼
1 Serbia	20 (2.6)	▼
Cyprus	19 (2.3)	▼
Tunisia	15 (1.8)	▼
Saudi Arabia	14 (2.5)	▼
2 Macedonia, Rep. of	14 (2.3)	▼
1 Indonesia	12 (1.6)	▼
Philippines	11 (1.5)	▼
South Africa	8 (1.3)	▼
Botswana	7 (1.6)	▼
1 ‡ Morocco	6 (1.9)	▼
Ghana	6 (1.2)	▼
‡ England	48 (3.8)	▲
Benchmarking Participants		
Basque Country, Spain	44 (3.8)	▲
Indiana State, US	42 (3.8)	▲
Ontario Province, Can.	37 (3.5)	
Quebec Province, Can.	50 (3.5)	▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered fully correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).

◆◆ Korea tested the same cohort of students as other countries, but later in 2003, 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.

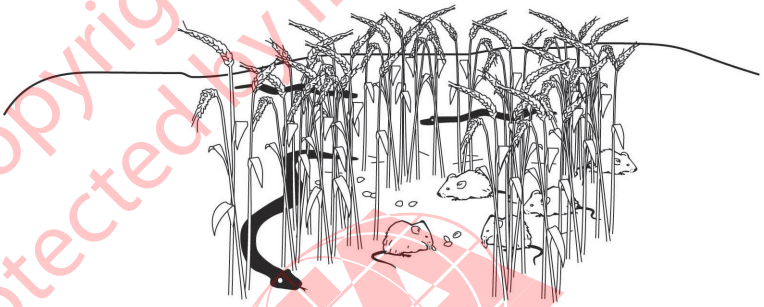
Exhibit 2.10: TIMSS 2003 High International Benchmark (550) of Science Achievement – Example Item 4

An Item That Students Reaching the High International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 8

Content Area: Life Science

Description: Given that a community consists of mice, snakes, and wheat plants, explains what will happen to the mice and wheat plants if the snakes are killed.



The diagram above shows a community consisting of mice, snakes and wheat plants.

What would happen to this community if people killed the snakes?

Because there are no snakes, we would get more mice. This would cause less wheat plants.

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

Country	Percent Full Credit	
Singapore	78 (1.8)	▲
Malaysia	68 (2.1)	▲
Chinese Taipei	55 (2.0)	▲
Estonia	52 (2.3)	▲
Australia	50 (2.3)	▲
Sweden	48 (2.1)	▲
Hungary	48 (1.9)	▲
Belgium (Flemish)	46 (1.9)	▲
† Netherlands	45 (2.6)	▲
‡ United States	44 (1.7)	▲
† Scotland	42 (2.5)	▲
Slovak Republic	41 (2.4)	▲
1 Lithuania	41 (2.2)	▲
Iran, Islamic Rep. of	40 (2.1)	▲
Jordan	39 (2.4)	▲
Russian Federation	38 (1.6)	▲
◆◆ Korea, Rep. of	38 (1.9)	▲
† Hong Kong, SAR	37 (2.0)	
Romania	37 (2.7)	
New Zealand	35 (3.2)	
Egypt	34 (1.9)	
Armenia	34 (2.1)	
International Avg.	33 (0.3)	
Slovenia	33 (2.0)	
Latvia	32 (2.3)	
1 Serbia	32 (2.1)	
2 Macedonia, Rep. of	32 (2.5)	
Japan	31 (1.6)	
Norway	31 (2.4)	
1 Indonesia	30 (1.7)	
2 Israel	30 (2.0)	▼
Italy	27 (2.1)	▼
Moldova, Rep. of	26 (2.2)	▼
Tunisia	26 (1.8)	▼
Saudi Arabia	24 (2.1)	▼
Bulgaria	22 (2.2)	▼
Cyprus	18 (1.5)	▼
Chile	16 (1.8)	▼
Bahrain	16 (1.3)	▼
Palestinian Nat'l Auth.	16 (1.3)	▼
1 ‡ Morocco	16 (1.8)	▼
Philippines	16 (1.5)	▼
Lebanon	9 (1.6)	▼
Botswana	6 (1.1)	▼
South Africa	6 (1.1)	▼
Ghana	3 (0.6)	▼
‡ England	57 (2.4)	▲
Benchmarking Participants		
Basque Country, Spain	28 (2.4)	▼
Indiana State, US	40 (3.7)	
Ontario Province, Can.	55 (2.6)	▲
Quebec Province, Can.	41 (2.4)	▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered fully correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).

◆◆ Korea tested the same cohort of students as other countries, but later in 2003, 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.

Grade 8: Achievement at the Intermediate International Benchmark

Eighth-grade students at the intermediate benchmark could recognize and communicate basic scientific knowledge across a range of topics (see Exhibit 2.11). Example Item 5 in Exhibit 2.12 shows an example from physics. When presented with a diagram showing a ball on the end of a string being whirled in a circle, students could apply their knowledge of circular motion to identify the diagram showing that the ball will fly in a straight line when the string is released. The international average percent correct for this item was 60 percent. In Korea, the Netherlands, and Estonia, 80 percent or more of the students answered correctly.

Example Item 6 from earth science, shown in Exhibit 2.13, addresses students' understanding of gravity. Students were presented with a diagram showing a person holding a ball while standing at three very different places on Earth. To answer correctly, students had to select the diagram showing that the dropped ball will always fall towards the center of the Earth. Internationally, on average, 70 percent of the eighth-grade students chose the correct option. About three-fourths or more of the students answered correctly in 21 countries and 3 benchmarking participants, with 90 percent or more in Japan, Estonia, and Korea.

Exhibit 2.11: **Description of TIMSS 2003 Intermediate International Benchmark (475) of Science Achievement**

Intermediate International Benchmark – 475

Summary

Students can recognize and communicate basic scientific knowledge across a range of topics. They recognize some characteristics of the solar system, water cycle, animals, and human health. They are acquainted with some aspects of energy, force and motion, light reflection, and sound. Students demonstrate elementary knowledge of human impact on and changes in the environment. They can apply and briefly communicate knowledge, extract tabular information, extrapolate from data presented in a simple linear graph, and interpret pictorial diagrams.

Students demonstrate some familiarity with the solar system. They recognize the Sun as a star, and can draw the position of the moon relative to the Sun and Earth during a solar eclipse. Students demonstrate some understanding of the water cycle by ordering the processes involved in Earth's water cycle and by recognizing the Sun as the source of energy for the water cycle. They can recognize that gravity draws objects toward the center of Earth. They recognize examples of fossil fuels.

Students have some knowledge of the characteristics of animals and human health. They recognize that mammals feed milk to their young and demonstrate some understanding of the immune system by recognizing that bacteria can be destroyed by white blood cells and by explaining why some people catch colds and others do not. Students also recognize that gills have the same function as lungs.

In physics, students are acquainted with some aspects of energy, force, and motion. They recognize that a compressed spring has stored energy and that an object will move in a straight line when released from a circular path. They can explain why a nail becomes warmer when pulled out of a wooden board. Students can demonstrate some knowledge of light by recognizing the necessity of reflected light for visibility of an object and by identifying the apparent position of a reflected image in a mirror. They can recognize that sound needs a medium through which to travel.

Students have some chemistry knowledge related to everyday life. For example, they recognize that fanning a fire makes it burn faster by supplying more oxygen.

Students demonstrate elementary knowledge of human impact on and changes in the environment. They can describe both a positive and a negative effect on farming of a dam located upriver. From a list of common waste materials, they recognize that paper will break down most quickly. They can state how volcanic eruptions impact the environment.

Students can extract information from a table to draw conclusions and interpret pictorial diagrams. They also can extrapolate from data presented in a simple linear graph. 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) 2003

Exhibit 2.12: TIMSS 2003 Intermediate International Benchmark (475) of Science Achievement – Example Item 5

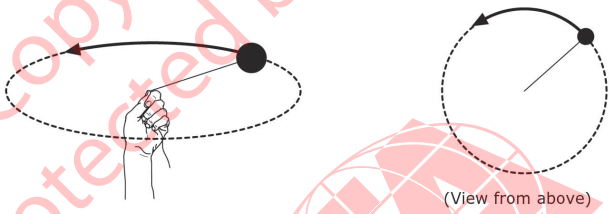
An Item That Students Reaching the Intermediate International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 8

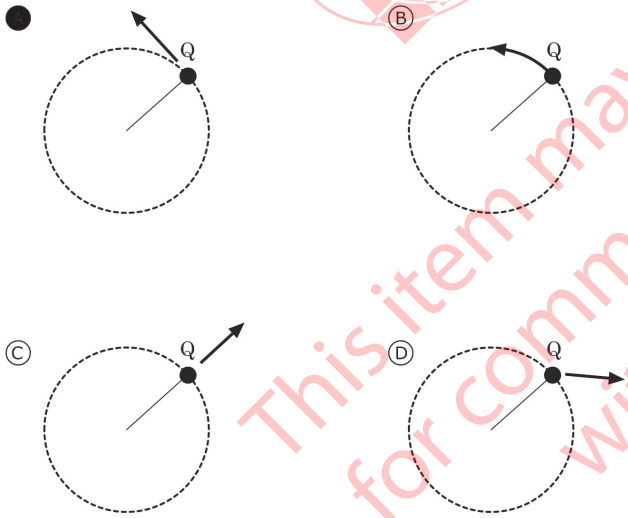
Content Area: Physics

Description: Applies knowledge of circular motion to identify the diagram that shows that an object will move in a straight line when released from a circular path.

The diagram on the left shows a ball on the end of a string being whirled in a circle. The diagram on the right shows the whirling ball as viewed from above.



After several whirls, the string is released when the ball is at Q. Which of these diagrams shows the direction in which the ball will fly the instant the string is released?



Country	Percent Full Credit
◆◆ Korea, Rep. of	87 (1.2) ▲
† Netherlands	82 (1.8) ▲
Estonia	80 (1.6) ▲
Singapore	79 (1.3) ▲
Australia	77 (1.9) ▲
Japan	77 (1.5) ▲
Hungary	77 (1.8) ▲
† Scotland	77 (1.4) ▲
New Zealand	77 (2.4) ▲
Belgium (Flemish)	76 (1.5) ▲
‡ United States	76 (1.4) ▲
1 Lithuania	75 (1.6) ▲
Malaysia	75 (1.8) ▲
Sweden	74 (1.8) ▲
Russian Federation	74 (1.7) ▲
Slovak Republic	72 (2.2) ▲
Norway	72 (1.8) ▲
Latvia	71 (2.1) ▲
Slovenia	70 (2.0) ▲
† Hong Kong, SAR	69 (1.6) ▲
Chinese Taipei	68 (1.5) ▲
Italy	61 (2.1)
Bulgaria	60 (2.6)
1 Serbia	60 (2.2)
International Avg.	60 (0.3)
Cyprus	59 (1.8)
2 Israel	58 (2.0)
Romania	58 (2.8)
Chile	58 (1.6)
Armenia	58 (2.5)
2 Macedonia, Rep. of	54 (2.4) ▼
Moldova, Rep. of	52 (3.0) ▼
Iran, Islamic Rep. of	48 (1.9) ▼
Jordan	47 (2.2) ▼
1 Indonesia	47 (1.9) ▼
Bahrain	44 (2.0) ▼
Philippines	42 (1.9) ▼
Saudi Arabia	38 (2.5) ▼
Palestinian Nat'l Auth.	36 (1.9) ▼
1 ‡ Morocco	33 (2.2) ▼
Tunisia	31 (1.9) ▼
Egypt	30 (1.9) ▼
Lebanon	30 (2.1) ▼
Botswana	30 (1.7) ▼
South Africa	22 (1.8) ▼
Ghana	22 (1.6) ▼
‡ England	74 (2.0) ▲
Benchmarking Participants	
Basque Country, Spain	72 (2.3) ▲
Indiana State, US	77 (2.7) ▲
Ontario Province, Can.	78 (1.8) ▲
Quebec Province, Can.	79 (1.5) ▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).

◆◆ Korea tested the same cohort of students as other countries, but later in 2003, 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.

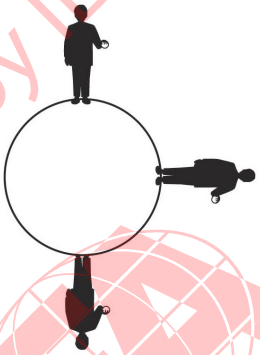
Exhibit 2.13: TIMSS 2003 Intermediate International Benchmark (475) of Science Achievement – Example Item 6

An Item That Students Reaching the Intermediate International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 8

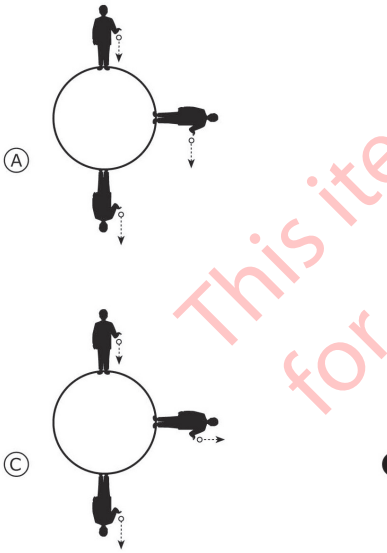
Content Area: Earth Science

Description: Uses knowledge of gravity to recognize that objects fall towards the center of Earth.



The diagram above shows a person holding a ball standing at three different places on Earth. If the person drops the ball, gravity will make it fall.

Which of the following diagrams best shows the direction the dropped ball will fall at the three different positions?



Country	Percent Full Credit	
Japan	92 (1.2)	▲
Estonia	91 (1.7)	▲
◆◆ Korea, Rep. of	90 (1.5)	▲
Hungary	88 (2.1)	▲
Sweden	87 (1.8)	▲
† Netherlands	87 (2.2)	▲
Malaysia	86 (1.5)	▲
Chinese Taipei	86 (1.7)	▲
Norway	84 (2.0)	▲
Slovenia	83 (2.4)	▲
Russian Federation	82 (1.8)	▲
1 Lithuania	81 (2.2)	▲
New Zealand	81 (2.9)	▲
† Hong Kong, SAR	81 (2.2)	▲
Latvia	80 (2.5)	▲
Singapore	80 (1.7)	▲
Slovak Republic	80 (2.2)	▲
Australia	79 (2.5)	▲
1 Serbia	78 (2.6)	▲
Belgium (Flemish)	77 (2.2)	▲
‡ United States	75 (1.8)	▲
† Scotland	73 (2.9)	
Armenia	72 (2.4)	
Lebanon	72 (2.5)	
Italy	71 (2.6)	
International Avg.	70 (0.4)	
Romania	70 (3.3)	
Iran, Islamic Rep. of	67 (2.7)	
Bahrain	67 (2.3)	
Jordan	66 (2.6)	
Moldova, Rep. of	66 (3.7)	
2 Israel	65 (3.2)	
Philippines	65 (2.4)	▼
1 Indonesia	62 (2.2)	▼
Bulgaria	61 (4.0)	▼
Botswana	61 (2.7)	▼
Saudi Arabia	61 (3.1)	▼
Palestinian Nat'l Auth.	58 (2.3)	▼
Chile	58 (2.4)	▼
Cyprus	58 (3.3)	▼
2 Macedonia, Rep. of	54 (3.4)	▼
Egypt	51 (2.3)	▼
Tunisia	47 (2.5)	▼
Ghana	43 (2.9)	▼
South Africa	40 (2.1)	▼
1 ‡ Morocco	6 (1.3)	▼
‡ England	78 (3.0)	▲
Benchmarking Participants		
Basque Country, Spain	67 (3.4)	
Indiana State, US	80 (3.3)	▲
Ontario Province, Can.	80 (2.5)	▲
Quebec Province, Can.	86 (1.8)	▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).

◆◆ Korea tested the same cohort of students as other countries, but later in 2003, 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.

Grade 8: Achievement at the Low International Benchmark

As shown in Exhibit 2.14, students performing at the low international benchmark recognized basic facts from the life and physical sciences. They had some knowledge of the human body and heredity, and demonstrated familiarity with some everyday physical phenomena. Example Item 7, presented in Exhibit 2.15, is from life science, and addresses students' knowledge of heredity. To answer correctly, students had to recognize that traits are transferred from parents to offspring through both the sperm and the egg. The international average was 74 percent correct, and three countries – Chinese Taipei, Hong Kong SAR, and Korea – had 90 percent or more of their students choosing the correct answer.

As an example from everyday physical phenomena, Example Item 8 shown in Exhibit 2.16 required students to identify the diagram depicting the correct arrangement of batteries in a flashlight. This was a relatively easy item, with at least half the eighth-grade students in every country and benchmarking entity choosing the correct option. On average across participants, 85 percent of students answered correctly.

Exhibit 2.14: **Description of TIMSS 2003 Low International Benchmark (400) of Science Achievement**

Low International Benchmark – 400

Summary

Students recognize some basic facts from the life and physical sciences. They have some knowledge of the human body and heredity, and demonstrate familiarity with some everyday physical phenomena. Students can interpret some 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. They demonstrate some knowledge of inheritance by recognizing that traits are transferred through sperm and egg, and that traits are inherited from both parents.

Students recognize some facts about familiar physical phenomena. They can identify a situation where work is being done and the correct arrangement of batteries in a flashlight. They recognize evaporation as a process that takes place when clothes dry. Students are also able to identify a heterogeneous powder as a mixture.

Students can 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) 2003

Exhibit 2.15: TIMSS 2003 Low International Benchmark (400) of Science Achievement – Example Item 7

An Item That Students Reaching the Low International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 8

Content Area: Life Science

Description: Recognizes that traits are transferred to offspring through the sperm and egg.

Traits are transferred from generation to generation through the

Ⓐ sperm only

Ⓑ egg only

● sperm and the egg

Ⓓ testes

Country	Percent Full Credit	
Chinese Taipei	97 (0.7)	▲
† Hong Kong, SAR	97 (0.6)	▲
◆◆ Korea, Rep. of	91 (0.9)	▲
Hungary	88 (1.6)	▲
Sweden	87 (1.5)	▲
† Netherlands	86 (1.6)	▲
Singapore	86 (1.0)	▲
‡ United States	86 (1.2)	▲
2 Israel	85 (1.4)	▲
† Scotland	83 (1.8)	▲
Estonia	83 (1.6)	▲
Belgium (Flemish)	83 (1.5)	▲
Chile	83 (1.1)	▲
Romania	80 (2.3)	▲
Slovak Republic	79 (2.0)	▲
Italy	79 (1.9)	▲
Malaysia	79 (1.4)	▲
Norway	78 (1.9)	▲
Latvia	77 (1.8)	▲
Bulgaria	76 (2.3)	
Philippines	76 (1.6)	
Japan	76 (1.8)	
Slovenia	76 (2.2)	
Bahrain	75 (1.7)	
Russian Federation	74 (2.0)	
International Avg.	**74 (0.3)**	
Australia	73 (2.2)	
1 Lithuania	72 (1.9)	
Egypt	71 (1.8)	
Armenia	71 (1.9)	
New Zealand	70 (2.6)	
Moldova, Rep. of	68 (2.2)	▼
2 Macedonia, Rep. of	68 (2.4)	▼
1 Serbia	67 (1.9)	▼
1 Indonesia	67 (1.9)	▼
1 ‡ Morocco	66 (2.6)	▼
Tunisia	64 (2.0)	▼
Cyprus	63 (2.0)	▼
Palestinian Nat'l Auth.	62 (2.0)	▼
Jordan	57 (2.1)	▼
Botswana	57 (1.8)	▼
Saudi Arabia	52 (2.8)	▼
South Africa	52 (1.5)	▼
Iran, Islamic Rep. of	50 (1.9)	▼
Ghana	50 (2.1)	▼
Lebanon	37 (2.6)	▼
‡ England	88 (1.5)	▲
Benchmarking Participants		
Basque Country, Spain	81 (2.6)	▲
Indiana State, US	87 (1.7)	▲
Ontario Province, Can.	79 (2.1)	▲
Quebec Province, Can.	89 (1.4)	▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).

◆◆ Korea tested the same cohort of students as other countries, but later in 2003, 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.

Exhibit 2.16: TIMSS 2003 Low International Benchmark (400) of Science Achievement – Example Item 8

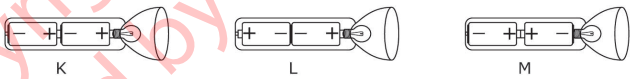
An Item That Students Reaching the Low International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 8

Content Area: Physics

Description: Identifies the diagram depicting the correct arrangement of batteries in a flashlight.

The diagrams show a flashlight and three ways to put batteries in it.



In order to make the flashlight work, which way must the batteries be placed?

- ● Only as in K
- Ⓑ Only as in L
- Ⓒ Only as in M
- Ⓓ None of these ways would work.

Country	Percent Full Credit	
Singapore	97 (0.5)	▲
◆◆ Korea, Rep. of	93 (0.8)	▲
Japan	93 (0.9)	▲
† Hong Kong, SAR	93 (0.9)	▲
Russian Federation	93 (1.0)	▲
Slovak Republic	93 (1.1)	▲
Estonia	93 (1.1)	▲
Chinese Taipei	92 (0.8)	▲
Malaysia	91 (1.0)	▲
Romania	91 (1.2)	▲
Latvia	91 (1.5)	▲
Hungary	91 (1.2)	▲
Bulgaria	91 (1.6)	▲
Bahrain	90 (1.2)	▲
1 Lithuania	90 (1.1)	▲
Moldova, Rep. of	90 (1.6)	▲
Sweden	89 (1.0)	▲
‡ United States	89 (0.8)	▲
Armenia	88 (1.5)	▲
New Zealand	88 (2.0)	
Slovenia	87 (1.3)	▲
Lebanon	86 (1.4)	
† Netherlands	86 (1.7)	
Australia	85 (1.8)	
Belgium (Flemish)	85 (1.4)	
Cyprus	85 (1.5)	
International Avg.	**85 (0.2)**	
† Scotland	84 (1.6)	
1 Indonesia	84 (1.2)	
1 Serbia	84 (1.5)	
2 Macedonia, Rep. of	84 (1.7)	
Italy	83 (1.4)	
Iran, Islamic Rep. of	83 (1.3)	
Chile	82 (1.2)	
2 Israel	82 (1.6)	
Norway	81 (1.5)	▼
Botswana	81 (1.3)	▼
1 ‡ Morocco	81 (2.2)	
Jordan	78 (1.9)	▼
Saudi Arabia	78 (2.3)	▼
Palestinian Nat'l Auth.	78 (1.8)	▼
Philippines	77 (1.6)	▼
Egypt	67 (2.1)	▼
Tunisia	59 (1.9)	▼
Ghana	55 (1.8)	▼
South Africa	52 (1.7)	▼
‡ England	95 (1.0)	▲
Benchmarking Participants		
Basque Country, Spain	84 (2.1)	
Indiana State, US	90 (1.5)	▲
Ontario Province, Can.	86 (1.6)	
Quebec Province, Can.	87 (1.5)	

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Nearly satisfied guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

‡ Did not satisfy guidelines for sample participation rates (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

2 National Defined Population covers less than 90% of National Desired Population (see Exhibit A.6).

◆◆ Korea tested the same cohort of students as other countries, but later in 2003, 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.

Grade 4: Achievement at the Advanced International Benchmark

At the fourth grade, students reaching the advanced benchmark demonstrated that they could apply their knowledge and understanding of science in beginning scientific inquiry. (see Exhibit 2.17). Example Item 1 in Exhibit 2.18 is part of an extended problem solving and inquiry task in the earth science content area, in which students were provided with a plan of a house and garden and were required to answer a series of questions about planting a new garden. In the question shown in this example, students were given a plan of the house and garden showing the points of the compass, and asked to explain which side of the house would receive most sun in the morning. To be awarded credit, students had to choose the East side, and explain their answer in terms of the sun rising in the East. Internationally, on average, just 26 percent of the fourth-grade students answered this item correctly. The best performance was in Chinese Taipei and Hong Kong SAR, where more than half of the students answered correctly.

In physical science, fourth-grade students reaching the advanced level were able to use their knowledge of physical properties to identify common materials. In Example Item 2 (Exhibit 2.19), students were required to interpret tabular information about the physical properties of three materials to identify which of them were wood, rock, and iron. To obtain full credit, students had to identify all three. Students correctly identifying one or two of the materials were awarded partial credit. On average, internationally, 38 percent of students achieved full credit. Performance was highest in Singapore and Japan, where 74 and 69 percent, respectively, obtained full credit.

Exhibit 2.17: **Description of TIMSS 2003 Advanced International Benchmark (625) of Science Achievement**

Advanced International Benchmark – 625

Summary

Students can apply knowledge and understanding in beginning scientific inquiry. Students demonstrate some understanding of Earth's features and processes and the solar system. They can communicate their understanding of structure, function, and life processes in organisms and classify organisms according to major physical and behavioral features. They demonstrate some understanding of physical phenomena and properties of common materials. Students demonstrate beginning scientific inquiry knowledge and skills.

Students demonstrate some understanding of Earth's features and processes and of the Moon in the solar system. They recognize that the Moon can be seen because it reflects the light from the Sun. They recognize that metals are found in rocks and can relate fossils to evidence of the past. From a plan of a house and garden, students can explain which side of the house receives most morning sun. They identify changes in soil from natural causes and recognize that decaying plants and animals enrich the soil and make plants grow. They can interpret a table of temperature and cloud cover data to predict a location where it snowed and interpret a map indicating that a river flows from mountains to the ocean.

Students can communicate their understanding of structure, function, and life processes in organisms by stating why humans need a skeleton, what the human body does to cool down during exercise, and how colds can be transmitted. They also can describe a physical change that takes place in children's bodies as they become adults. Students show some knowledge of reproduction by explaining why the last surviving member of an animal species cannot reproduce, that the color of a flower is determined by the flower color of the parent plant, and why some insects are important for flowering. They can recognize a group of animals that are all mammals, that the energy needed to heal a cut comes from food, and can select cheese from a list of common foods as the best source of calcium. They can combine information from a plan of a garden and a diagram showing plants and their light requirements to complete a table listing plants that would grow well in different areas of the garden. They can describe human activities that can lead to the extinction of animals.

Students demonstrate some understanding of physical properties of common materials and physical phenomena. They recognize that heat is required for melting and boiling but not for freezing. They also recognize that magnets with like poles repel and that magnetism, not gravity, makes objects repel each other. From a diagram, they recognize the direction of motion of two carts carrying magnets. They can identify two things wrong with a diagram showing a person's shadow and location of the sun. They can name one thing that shows that sunlight is made up of different colors. From investigations of the effects of different colored lights on the apparent color of a red shirt, students can describe the results and conclude that the color looks different under different colored light. They can also distinguish between renewable and non-renewable energy sources. In addition, they can recognize and explain that fine salt dissolves faster in water than coarse salt, and recognize the diagram that best shows how ice floats in water. They can interpret information from a table of physical properties to identify wood, rock and iron.

Students demonstrate beginning scientific inquiry knowledge and skills. They can describe the results of an investigation, draw conclusion from the results, and infer the purpose of an experiment from a table of data.

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

Exhibit 2.18: TIMSS 2003 Advanced International Benchmark (625) of Science Achievement – Example Item 1

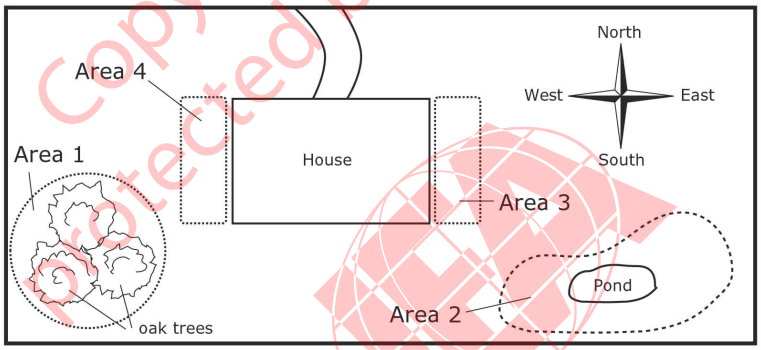
An Item That Students Reaching the Advanced International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 4

Content Area: Earth Science

Description: From a plan of a house and garden showing North, South, East, and West, identifies the side of the house that receives the most sun in the morning and explains why.

A plan of Rebecca's house and garden is shown below. There are four areas in the garden where she would like to grow some plants (Areas 1, 2, 3, and 4).



Which side of Rebecca's house will receive the most sun in the morning?

(Check one box.)

- [x] East side (Area 3)
- [ ] West side (Area 4)

Explain your answer.

Because the sun comes up on the East side.

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

Country	Percent Full Credit	
Chinese Taipei	55 (2.3)	▲
† Hong Kong, SAR	51 (3.2)	▲
Japan	45 (2.6)	▲
Singapore	42 (2.7)	▲
Hungary	41 (2.5)	▲
Latvia	34 (3.3)	▲
† Netherlands	33 (3.0)	▲
Slovenia	30 (3.6)	
Italy	30 (2.5)	
† United States	29 (1.8)	
Cyprus	28 (2.2)	
† Australia	28 (3.4)	
New Zealand	27 (2.7)	
International Avg.	**26 (0.5)**	
1 Lithuania	23 (2.8)	
Belgium (Flemish)	22 (2.6)	
† England	21 (2.9)	
Russian Federation	21 (2.3)	▼
Moldova, Rep. of	16 (2.8)	▼
Norway	14 (1.9)	▼
Iran, Islamic Rep. of	13 (1.9)	▼
† Scotland	11 (1.8)	▼
Morocco	10 (2.1)	▼
Philippines	7 (1.7)	▼
Tunisia	7 (1.5)	▼
Armenia	4 (0.9)	▼
Benchmarking Participants		
Indiana State, US	31 (4.2)	
Ontario Province, Can.	28 (3.2)	
Quebec Province, Can.	22 (2.7)	

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered fully correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

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

Exhibit 2.19 TIMSS 2003 Advanced International Benchmark (625) of Science Achievement – Example Item 2

An Item That Students Reaching the Advanced International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 4

Content Area: Physical Science

Description: Interprets information from a table of physical properties of three materials to identify wood, rock, and iron).

The properties of three materials are compared in the table below. One of the materials is wood, one is rock and one is iron.

Property	Material 1	Material 2	Material 3
Sinks in water?	Yes	No	Yes
Burns easily?	No	Yes	No
Attracted by a magnet?	Yes	No	No

Identify the three materials by filling in the spaces below.

Wood is material number: 2

Rock is material number: 3

Iron is material number: 1

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

Country	Percent Full Credit	
Singapore	74 (2.3)	▲
Japan	69 (1.6)	▲
† Netherlands	59 (2.7)	▲
† Hong Kong, SAR	58 (2.7)	▲
† England	53 (2.5)	▲
Belgium (Flemish)	52 (2.4)	▲
Chinese Taipei	48 (1.7)	▲
1 Lithuania	45 (2.5)	▲
Cyprus	44 (1.9)	▲
Russian Federation	42 (2.8)	
Latvia	42 (2.6)	
Italy	41 (2.2)	
† Australia	39 (2.8)	
† United States	39 (1.7)	
International Avg.	**38 (0.4)**	
† Scotland	38 (2.6)	
New Zealand	37 (1.9)	
Hungary	35 (2.1)	
Slovenia	35 (2.4)	
Norway	25 (2.0)	▼
Tunisia	15 (1.7)	▼
Armenia	14 (1.6)	▼
Philippines	12 (1.7)	▼
Moldova, Rep. of	9 (1.3)	▼
Iran, Islamic Rep. of	9 (1.4)	▼
Morocco	7 (1.4)	▼
Benchmarking Participants		
Indiana State, US	47 (3.1)	▲
Ontario Province, Can.	43 (2.9)	
Quebec Province, Can.	41 (2.5)	

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered fully correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

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

Grade 4: Achievement at the High International Benchmark

As detailed in Exhibit 2.20, fourth-grade students reaching the high benchmark were able to apply their knowledge and understanding to explain everyday phenomena. For example, Exhibit 2.21 containing Example Item 3 from earth science shows that when given a diagram showing a variety of landscape features, including mountains, a forest, a desert, a meadow, a river, and the ocean, these fourth-grade students were able to recognize the best location for growing crops. The international average was 57 percent, with students from Japan having the highest achievement (75%) followed by Latvia, the United States, and Hong Kong SAR (70% each).

In the physical sciences, students demonstrated some understanding of physical states. Example Item 4 presented in Exhibit 2.22 shows that students can describe one difference between solids and liquids. Students were given credit if they referred to differences in the arrangement or speed of particles or molecules, to solids having a fixed shape and liquids taking the shape of their container, or to solids being hard and liquids being wet, flowing, runny, or similar. Forty-four percent of the fourth-grade students, on average, internationally, performed this task correctly. England and Singapore had the highest performance, with 74 and 73 percent of students answering correctly.

Exhibit 2.20: **Description of TIMSS 2003 High International Benchmark (550) of Science Achievement**

High International Benchmark – 550

Summary

Students can apply knowledge and understanding to explain everyday phenomena. Students demonstrate some knowledge of Earth structure and processes and the solar system and some understanding of plant structure, life processes, and human biology. They demonstrate some knowledge of physical states, common physical phenomena, and chemical changes. They provide brief descriptions and explanations of some everyday phenomena and compare, contrast, and draw conclusions.

Students demonstrate some knowledge of Earth structure and processes and the solar system. They identify the Earth, Moon, and Sun from a diagram and can interpret a pictorial diagram of the angle/length of shadows cast by sunlight at different times of day. 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 a diagram showing a variety of landscape features, they recognize the best location for growing crops.

Students demonstrate some understanding of plant structure and life processes. They can explain why plants are living things and can state one thing apart from light and water that plants need to grow well. They can infer from a picture how a plant's seeds are spread. They also compare and contrast different animals, including distinguishing plant eaters and meat eaters by their teeth and fish and sea mammals by their physical features and behaviors. Students demonstrate some understanding of human biology. For example, they can state one thing that can cause the temperature of the human body to be higher than normal, and can recognize that sensory messages are interpreted in the brain and that exercise causes an increase in breathing and pulse rates.

In the physical sciences, students demonstrate some understanding of physical states, common physical phenomena, and chemical changes. They describe changes in matter, such as how a liquid can be turned into a solid or gas, and can state one difference between solids and liquids. From a diagram, they recognize the direction of heat transfer along a metal ruler and that ice melts most slowly in a closed container. They recognize that more sugar will dissolve in hot water and that metal conducts heat better than wood. They can infer the color of a light bulb from the apparent color of a red shirt. They recognize that gravity causes objects to fall to the ground, and from a diagram showing a person blowing into water using straw, can explain why bubbles rise to the top. From a diagram showing powders, students recognize those likely to be mixtures.

Students provide brief descriptive responses combining knowledge of science concepts with information from everyday experience of physical and life processes (e.g., early morning moisture can be due to condensation, liquid can be converted to a gas by heating, and seeds can be spread by wind). Students can compare, contrast, and draw conclusions (e.g., the structure of teeth from plant eaters and meat eaters, the physical features or behaviors distinguishing fish from sea mammals).

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

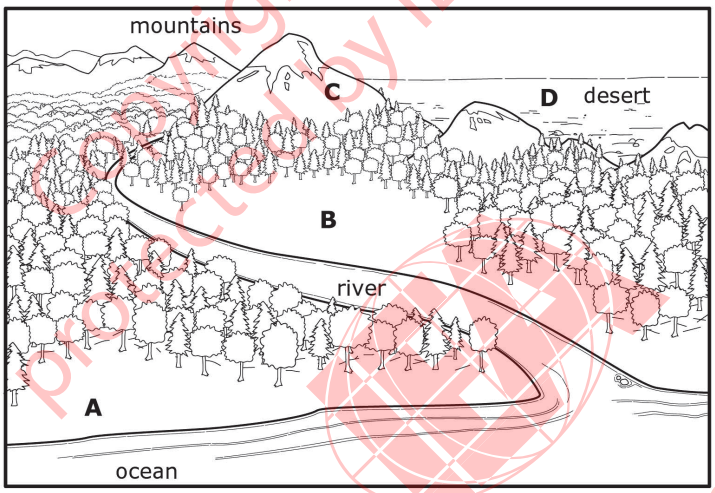
Exhibit 2.21: TIMSS 2003 High International Benchmark (550) of Science Achievement – Example Item 3

An Item That Students Reaching the High International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 4

Content Area: Earth Science

Description: From a diagram showing a variety of landscape features, recognizes the best location for growing crops.



Look at the picture above. Where is the best location to grow crops?

Ⓐ Location A

● Location B

Ⓒ Location C

Ⓓ Location D

Country	Percent Full Credit	
Japan	75 (1.6)	▲
Latvia	70 (1.9)	▲
† United States	70 (1.1)	▲
† Hong Kong, SAR	70 (2.0)	▲
1 Lithuania	69 (1.8)	▲
† Netherlands	69 (2.2)	▲
Hungary	69 (2.2)	▲
† England	69 (2.0)	▲
† Scotland	68 (2.0)	▲
Italy	68 (2.0)	▲
Chinese Taipei	67 (1.9)	▲
† Australia	66 (2.5)	▲
Norway	63 (2.3)	▲
New Zealand	63 (2.3)	▲
Russian Federation	63 (2.5)	▲
Singapore	62 (2.0)	▲
Cyprus	59 (2.2)	
International Avg.	57 (0.4)	
Slovenia	56 (2.5)	
Moldova, Rep. of	54 (3.0)	
Belgium (Flemish)	44 (2.2)	▼
Armenia	34 (2.3)	▼
Iran, Islamic Rep. of	32 (2.4)	▼
Morocco	27 (2.0)	▼
Philippines	24 (2.2)	▼
Tunisia	22 (1.6)	▼
Benchmarking Participants		
Indiana State, US	75 (2.3)	▲
Ontario Province, Can.	71 (2.4)	▲
Quebec Province, Can.	66 (2.4)	▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

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

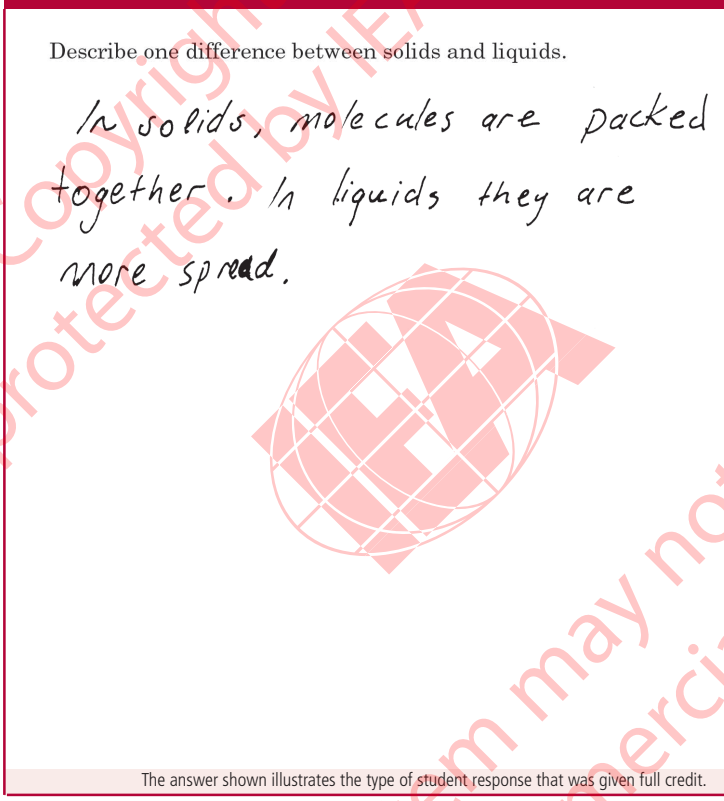
Exhibit 2.22: TIMSS 2003 High International Benchmark (550) of Science Achievement – Example Item 4

An Item That Students Reaching the High International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 4

Content Area: Physical Science

Description: Describes one difference between solids and liquids.



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

Country	Percent Full Credit	
† England	74 (2.2)	▲
Singapore	73 (2.0)	▲
† United States	67 (1.6)	▲
Chinese Taipei	66 (1.8)	▲
† Australia	64 (2.1)	▲
Hungary	64 (2.0)	▲
New Zealand	62 (2.2)	▲
Japan	59 (1.8)	▲
† Scotland	57 (2.1)	▲
† Hong Kong, SAR	56 (2.3)	▲
Italy	55 (2.1)	▲
Slovenia	51 (2.6)	▲
Russian Federation	49 (2.5)	▲
International Avg.	44 (0.4)	
Latvia	44 (2.5)	
Cyprus	41 (2.1)	
Moldova, Rep. of	37 (2.2)	▼
Belgium (Flemish)	32 (1.8)	▼
† Lithuania	30 (1.6)	▼
Iran, Islamic Rep. of	29 (2.5)	▼
Philippines	22 (3.2)	▼
† Netherlands	21 (2.2)	▼
Armenia	21 (1.7)	▼
Norway	16 (2.0)	▼
Tunisia	11 (1.5)	▼
Morocco	8 (1.4)	▼
Benchmarking Participants		
Indiana State, US	71 (2.7)	▲
Ontario Province, Can.	70 (1.9)	▲
Quebec Province, Can.	51 (1.9)	▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered fully correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

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

Grade 4: Achievement at the Intermediate International Benchmark

Exhibit 2.23 presents the description of student achievement at the intermediate benchmark. At this benchmark, fourth-grade students could apply basic knowledge and understanding to practical situations in the sciences. In physical science, students showed some understanding of familiar physical phenomena, states, and changes. For example, as illustrated by Example Item 5 in Exhibit 2.24, when presented with a diagram depicting four identical burning candles each covered by a glass container of different size, students recognized that the candle in the largest container will be the last to go out. Sixty-six percent of the fourth-grade students, on average, internationally, answered the question correctly. Eighty percent or more answered correctly in Cyprus, Singapore, the Netherlands, and Hong Kong SAR.

In life science, the fourth-grade students demonstrated knowledge of some basic facts related to human biology and health. For example, as shown in Example Item 6 in Exhibit 2.25, when shown a diagram depicting six different organisms (a human, a frog, a dog, a whale, a butterfly, and a bird) students could classify them according to how they produce their young - those that give birth and those that lay eggs. Students correctly classifying all six organisms achieved full credit on this item, while those misclassifying no more than two earned partial credit. On average, internationally, 58 percent of fourth-grade students received full credit, with highest performance in Singapore (84%), the United States (76%), New Zealand (74%), the Netherlands (73%), and Australia (72%).

Exhibit 2.23: **Description of TIMSS 2003 Intermediate International Benchmark (475) of Science Achievement**

Intermediate International Benchmark – 475

Summary

Students can apply basic knowledge and understanding to practical situations in the sciences. Students demonstrate knowledge of some basic facts about Earth's features and processes and the solar system. They recognize some basic information about human biology and health and show some understanding of development and life cycles of organisms. They know some basic facts about familiar physical phenomena, states, and changes. They apply factual knowledge to practical situations, interpret pictorial diagrams, and combine information to draw conclusions.

Students know some basic facts about Earth's features and processes and the solar system. They can state one difference between the Sun and the Moon and one difference between two previously named seasons. They recognize the effect of rock hardness on abrasion and can recognize from its shape and size which rock has been carried furthest down a river. They also recognize that most of Earth's surface is covered by water, and that the water in the ocean is salty. They know that fossils are found in rocks, and that minerals come from rocks. Students recognize the effect of wind strength on a ribbon attached to a pole and can state two different uses humans have for wood.

In life science, students demonstrate knowledge of some basic facts related to human biology and health. For example, they recognize that a person's hair type can be predicted by parental hair type, and that excess food is stored as fat. They can state one thing that may happen to the body if not protected from the Sun. Students demonstrate some knowledge of the diversity, structure and habitats of animal life. For example, they recognize from pictorial diagrams the bird most likely to eat mammals, and the type of plants usually found in a tropical rain forest. They show some understanding of development and life cycles of organisms, including knowing that snakes shed their outer covering as they grow larger and classifying common organisms into those that give birth and those that lay eggs. From a list of common items, students can distinguish between living and non-living things. They can interpret from a food chain diagram that snakes eat voles and that tadpoles eat plants. They know that trees make their own food using sunlight, and can recognize from pictures of two types of seeds that they are scattered by the wind. They combine information from a plan of a garden and a diagram showing plants and their light requirements to explain why roses do not grow well under an oak tree.

Students show some understanding of familiar physical phenomena, states, and changes. They recognize that all objects have mass and that copper is a good heat conductor. They can state two uses of electricity in daily life. They recognize the state of a material from the shape it takes when transferred from a smaller to a larger container. Students can state one way that water in ice and liquid forms is used by humans. They recognize that salt water is a mixture, and can identify an object that is made of metal. They recognize that soap bubbles contain air. They can infer the color of a white shirt under a blue light. They recall that plant matter (apple core) will decay faster than other given substances. They can identify materials that burn, and from diagrams of candles in sealed containers, can identify the candle in the largest container as the last to go out.

Students apply factual knowledge to practical situations (e.g., recognize that excess food is stored as fat) and demonstrate some ability to interpret information in pictorial diagrams to reason to a conclusion (e.g., interpreting diagrams showing rocks of different shapes and sizes to identify the rock carried furthest down a river). They can also combine information from two sources to draw a conclusion (e.g., planning a garden).

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

Exhibit 2.24: TIMSS 2003 Intermediate International Benchmark (475) of Science Achievement – Example Item 5

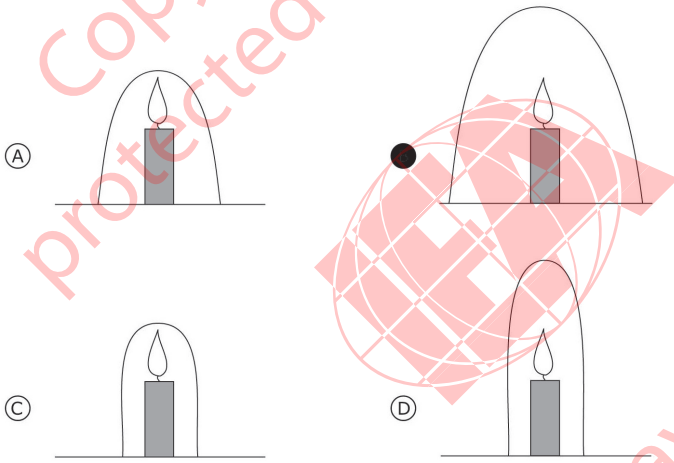
An Item That Students Reaching the Intermediate International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 4

Content Area: Physical Science

Description: Recognizes that a candle in the largest sealed container will be the last to go out.

The pictures below show four identical burning candles. Each is covered by a glass container of a different size. Which candle flame will be the last to go out?



Country	Percent Full Credit
Cyprus	81 (2.0) ▲
Singapore	81 (2.4) ▲
† Netherlands	81 (2.8) ▲
† Hong Kong, SAR	80 (2.0) ▲
Hungary	79 (2.6) ▲
Latvia	78 (2.4) ▲
Belgium (Flemish)	78 (2.3) ▲
Chinese Taipei	75 (2.1) ▲
Italy	74 (2.7) ▲
Slovenia	73 (3.9)
† United States	72 (1.8) ▲
1 Lithuania	71 (2.7)
† England	69 (3.4)
Norway	68 (2.7)
International Avg.	66 (0.6)
Russian Federation	66 (2.6)
† Australia	66 (3.1)
† Scotland	65 (2.6)
New Zealand	63 (2.9)
Moldova, Rep. of	61 (3.0)
Armenia	55 (3.0) ▼
Iran, Islamic Rep. of	52 (3.8) ▼
Japan	51 (3.0) ▼
Philippines	47 (2.9) ▼
Morocco	34 (3.5) ▼
Tunisia	30 (2.8) ▼
Benchmarking Participants	
Indiana State, US	75 (3.1) ▲
Ontario Province, Can.	72 (3.3)
Quebec Province, Can.	67 (2.7)

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

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

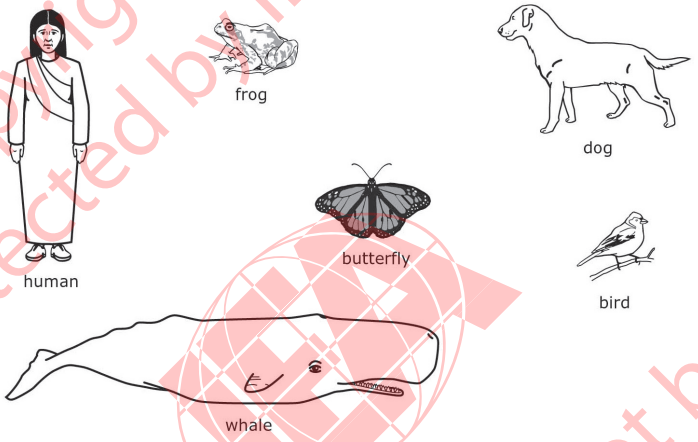
Exhibit 2.25: TIMSS 2003 Intermediate International Benchmark (475) of Science Achievement – Example Item 6

An Item That Students Reaching the Intermediate International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 4

Content Area: Life Science

Description: Given a diagram of six organisms, classifies them into those that give birth and those that lay eggs.



Some of the organisms shown above give birth to young that develop inside the mother. Some of the organisms have young that hatch from eggs that are laid outside the mother.

In the table below, write down the names of the organisms that belong to each group.

Organisms that give birth	Organisms that lay eggs
Human Dog Whale	Frog Butterfly Bird

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

Country	Percent Full Credit
Singapore	84 (1.3) ▲
† United States	76 (1.1) ▲
New Zealand	74 (1.9) ▲
† Netherlands	73 (2.5) ▲
† Australia	72 (2.6) ▲
† England	67 (2.0) ▲
Japan	67 (1.8) ▲
Italy	64 (2.5) ▲
Belgium (Flemish)	63 (2.2) ▲
Russian Federation	63 (2.7) ▲
Latvia	62 (2.1) ▲
Hungary	62 (2.0) ▲
1 Lithuania	60 (1.9)
† Scotland	59 (2.1)
Norway	58 (1.7)
† Hong Kong, SAR	58 (2.3)
International Avg.	58 (0.4)
Cyprus	54 (2.1)
Chinese Taipei	53 (1.9) ▼
Slovenia	52 (2.4) ▼
Moldova, Rep. of	51 (2.3) ▼
Armenia	46 (2.8) ▼
Philippines	41 (2.4) ▼
Iran, Islamic Rep. of	35 (2.5) ▼
Morocco	23 (2.3) ▼
Tunisia	19 (1.5) ▼
Benchmarking Participants	
Indiana State, US	80 (1.7) ▲
Ontario Province, Can.	70 (2.6) ▲
Quebec Province, Can.	67 (2.2) ▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered fully correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

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

Grade 4: Achievement at the Low International Benchmark

As can be seen from the description presented in Exhibit 2.26, fourth-grade students reaching the low international benchmark have some elementary knowledge of the earth, life, and physical sciences. As an example from life science (Example Item 7 in Exhibit 2.27), students could identify insects from a diagram by the presence of six legs. This item was answered correctly by most students (81 percent on average, internationally) and by more than 90 percent in Lithuania, Singapore, Japan, Italy, the Russian Federation, the United States, and Norway.

Students reaching the low benchmark showed familiarity with everyday physical phenomena. For example, as shown in Example Item 8 in Exhibit 2.28, students recognized that the weight of an object is independent of its orientation on a weighing scale. Almost three-fourths (72%), on average, internationally, recognized that an object would weigh the same regardless of how it was placed on the scale. More than 80 percent of the fourth-grade students in Lithuania, Moldova, the Russian Federation, Slovenia, Chinese Taipei, and Latvia answered this question correctly.

Exhibit 2.26: **Description of TIMSS 2003 Low International Benchmark (400) of Science Achievement**

Low International Benchmark – 400

Summary

Students have some elementary knowledge of the earth, life, and physical sciences. Students recognize simple facts presented in everyday language and context about Earth's physical features, the seasons, the solar system, human biology, and the development and characteristics of animals and plants. They recognize facts about a range of familiar physical phenomena – rainbows, magnets, electricity, boiling, floating, and dissolving. They interpret labeled pictures and simple pictorial diagrams and provide short written responses to questions requiring factual information.

Students know some elementary facts about Earth's physical features, seasons, and the solar system. They identify oxygen as the gas in the air needed for breathing, can explain why people should not drink water directly from the oceans, and recognize the hottest of Earth's layers. They know that the Sun is hotter than the Earth, the Moon, or Mars, that the Earth moves around the Sun, and can state the names of two seasons.

In life science, students demonstrate knowledge of some simple facts related to human biology. They recognize that air enters the lungs, that washing hands prevents illness by removing germs, which teeth are used for grinding, and that rice is edible and cotton is not. They also demonstrate some knowledge of animal development and structure. For example, they recognize that tadpoles hatch from frogs' eggs, that the larval form of a butterfly, that fat layers help keep animals warm, and that birds sit on their eggs to keep them warm. They recognize wings as being common to birds, bats, and butterflies, which foot structure belongs to a bird that lives on water, and can identify insects by the presence of six legs. Given lists of familiar animals, students can identify those that exhibit specified characteristics, such as eating only plants, eating only animals, and not laying eggs. From pictorial diagrams, students identify an animal that lives in the desert and the root as the plant part that takes in water. They can communicate an effect of environmental change (temperature) on aquatic life.

Students are familiar with some everyday physical phenomena, for example, sunlight and rain are required to produce rainbows, water changes into vapor during boiling, and sugar dissolves in water. From a diagram, they can identify the heaviest floating object, and recognize that the weight of an object does not depend on how it is placed on a scale. They recognize that magnets attract iron and that iron nails rust. In addition, students recognize that an iron nail can complete an electrical circuit to allow a bulb to light, and given diagrams showing a light bulb connected to a battery, recognize in which one the bulb will light.

Students interpret labeled pictures and simple diagrams (e.g., plant parts, stages of development of animals, simple electrical circuit) and provide short written responses to questions requiring factual information (e.g., an example of temperature change on aquatic life).

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

Exhibit 2.27: TIMSS 2003 Low International Benchmark (400) of Science Achievement – Example Item 7

An Item That Students Reaching the Low International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 4

Content Area: Life Science

Description: Given a diagram, recognizes insects by presence of six legs.

Which of these are insects?

● 1 and 3 only

Ⓑ 1 and 4 only

Ⓒ 2 and 4 only

Ⓓ 3 and 4 only

Country	Percent Full Credit	
[1] Lithuania	94 (1.1)	▲
Singapore	92 (1.0)	▲
Japan	91 (1.1)	▲
Italy	91 (1.1)	▲
Russian Federation	91 (1.2)	▲
† United States	91 (0.8)	▲
Norway	90 (1.3)	▲
Chinese Taipei	89 (1.2)	▲
Belgium (Flemish)	89 (1.4)	▲
† Netherlands	89 (1.6)	▲
† Australia	88 (1.6)	▲
Hungary	86 (1.5)	▲
† England	86 (1.6)	▲
Cyprus	85 (1.7)	▲
New Zealand	85 (1.5)	▲
Moldova, Rep. of	85 (1.5)	▲
Latvia	84 (1.6)	▲
† Scotland	83 (1.5)	
International Avg.	81 (0.3)	
† Hong Kong, SAR	81 (1.5)	
Slovenia	79 (1.7)	
Iran, Islamic Rep. of	76 (2.0)	▼
Philippines	64 (2.0)	▼
Armenia	59 (2.7)	▼
Tunisia	49 (2.1)	▼
Morocco	35 (2.4)	▼
Benchmarking Participants		
Indiana State, US	92 (1.6)	▲
Ontario Province, Can.	89 (1.4)	▲
Quebec Province, Can.	88 (1.3)	▲

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

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

Exhibit 2.28: TIMSS 2003 Low International Benchmark (400) of Science Achievement – Example Item 8

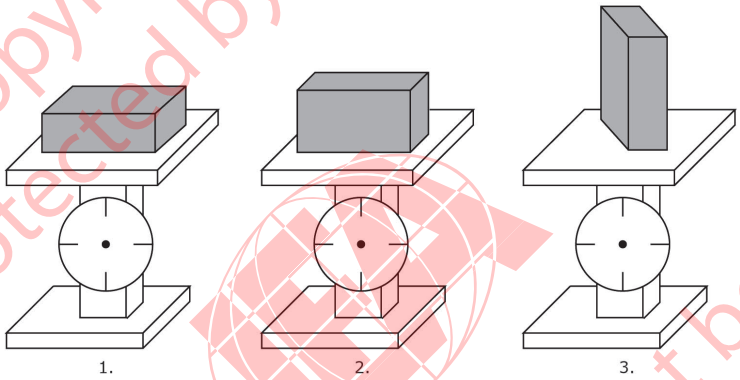
An Item That Students Reaching the Low International Benchmark Are Likely to Answer Correctly*

SCIENCE Grade 4

Content Area: Physical Science

Description: Recognizes that the weight of an object does not change depending on its orientation on a scale.

The same brick is put on a scale in three different ways.



What will the scale show?

Ⓐ 1 will show the greatest weight.

Ⓑ 2 will show the greatest weight.

Ⓒ 3 will show the greatest weight.

● All will show the same weight.

Country	Percent Full Credit	
[1] Lithuania	88 (1.4)	▲
Moldova, Rep. of	87 (1.7)	▲
Russian Federation	86 (1.5)	▲
Slovenia	85 (1.8)	▲
Chinese Taipei	85 (1.4)	▲
Latvia	84 (2.0)	▲
Singapore	79 (1.3)	▲
Hungary	79 (1.8)	▲
Italy	78 (2.0)	▲
† England	76 (1.7)	▲
Armenia	74 (2.6)	
† Netherlands	74 (2.3)	
† Australia	74 (2.3)	
Belgium (Flemish)	73 (1.7)	
† United States	73 (1.2)	
International Avg.	72 (0.4)	
Iran, Islamic Rep. of	72 (2.2)	
† Hong Kong, SAR	69 (2.1)	
† Scotland	68 (2.0)	▼
Japan	66 (2.0)	▼
New Zealand	66 (1.6)	▼
Cyprus	63 (2.3)	▼
Norway	54 (2.2)	▼
Morocco	54 (2.8)	▼
Philippines	52 (2.3)	▼
Tunisia	45 (2.3)	▼
Benchmarking Participants		
Indiana State, US	78 (2.5)	▲
Ontario Province, Can.	68 (2.3)	
Quebec Province, Can.	65 (2.1)	▼

▲ Country average significantly higher than international average

▼ Country average significantly lower than international average

SOURCE: IEA's Trends in International Mathematics and Science Study (TIMSS) 2003

* The item was answered correctly by a majority of students reaching this benchmark.

† Met guidelines for sample participation rates only after replacement schools were included (see Exhibit A.9).

1 National Desired Population does not cover all of International Desired Population (see Exhibit A.6).

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

What Issues Emerge from the Benchmark Descriptions?

At both grades, the benchmark descriptions and example items strongly suggest a gradation in achievement, from the top-performing students' ability to grasp complex and abstract science concepts, apply knowledge to solve problems, and understand the fundamentals of scientific investigation to the lower-performing students' recognition of basic facts and familiarity with everyday physical phenomena. Basic scientific inquiry skills were not demonstrated until the upper benchmarks, indicating that science curricula in many countries may not be placing much emphasis on scientific investigation at fourth or eighth grades.

In looking across the item-level results, it also is important to note the variation in performance across the topics covered. For example, on just the few items (16) presented in this chapter, there was a substantial range in performance for many countries. While some countries consistently registered high or low performance, and others had results consistently near the international average, a number of countries performed significantly above the international average on at least one item, and significantly below the international average on at least one item. Such results may reflect intended differences in emphasis in national curricula. It is likely, however, that such results may be unintended, and the findings will provide important information about strengths and weaknesses in intended or implemented curricula. At the very least, an in-depth examination of the TIMSS 2003 results may reveal aspects of curricula that merit further investigation.