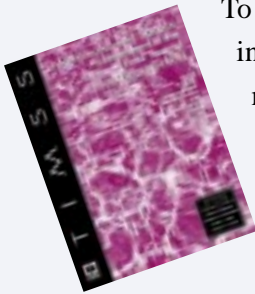


Now Available

International comparative results in mathematics and science achievement for students around the world in their final year of secondary school can be found in the recently released report:

MATHEMATICS AND SCIENCE ACHIEVEMENT IN THE FINAL YEAR OF SECONDARY SCHOOL



To provide comprehensive information about what mathematics and science understandings students have as they embark on the challenges beyond secondary school, this

report contains the results from three different tests. It describes the mathematics and science literacy of all final-year students in 21 countries, regardless of their school curriculum. This test was designed to be reported separately for mathematics and science. For 16 countries, the report also describes the advanced mathematics and physics achievement of school-leaving students with special preparation in these subjects. For the tests in advanced mathematics and physics, results are presented for major content areas.

For each of the three tests, achievement is presented by gender, and country-by-country results are displayed for example items to illustrate the range of performance and topics covered. Results are included for selected background and attitudinal factors. For advanced mathematics and physics, information also is provided about instructional practices.



Table 1 Achievement in Mathematics and Science Literacy

Mathematics and Science Literacy

Country	Mean Achievement
<i>Netherlands</i>	559
Sweden	555
<i>Iceland</i>	541
<i>Norway</i>	536
Switzerland	531
<i>Denmark</i>	528
<i>Canada</i>	526
New Zealand	525
<i>Austria</i>	519
<i>Australia</i>	525
<i>Slovenia</i>	514
<i>France</i>	505
<i>Germany</i>	496
Czech Republic	476
Hungary	477
Russian Federation	476
<i>Italy</i>	475
<i>United States</i>	471
Lithuania	465
Cyprus	447
<i>South Africa</i>	352
International Average	500

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96



- Significantly Higher than International Average
- Not Significantly Different than International Average
- Significantly Lower than International Average

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or classroom sampling procedures.




- ▶ **The Netherlands and Sweden were the top-performing countries in mathematics and science literacy. Iceland, Norway, Switzerland, Denmark, Canada, New Zealand, and Austria also performed above the international average of the 21 countries.**
- ▶ **Countries performing below the international average were: Hungary, the Russian Federation, Italy, the United States, Lithuania, Cyprus, and South Africa.**

Table 2

Achievement in
Mathematics Literacy and Science Literacy

Mathematics Literacy		Science Literacy	
Country	Mean Achievement	Country	Mean Achievement
Netherlands	560	Sweden	559
Sweden	552	Netherlands	558
Denmark	547	Iceland	549
Switzerland	540	Norway	544
Iceland	534	Canada	532
Norway	528	New Zealand	529
France	523	Switzerland	523
New Zealand	522	Austria	520
Canada	519	Australia	527
Austria	518	Slovenia	517
Australia	522	Denmark	509
Slovenia	512	Germany	497
Germany	495	Czech Republic	487
Czech Republic	466	France	487
Hungary	483	Russian Federation	481
Italy	476	United States	480
Russian Federation	471	Italy	475
Lithuania	469	Hungary	471
United States	461	Lithuania	461
Cyprus	446	Cyprus	448
South Africa	356	South Africa	349
International Average	500	International Average	500

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96

	Significantly Higher than International Average
	Not Significantly Different than International Average
	Significantly Lower than International Average

key findings

- ▶ When the results were looked at separately for mathematics and science, the top-performers in mathematics literacy were the Netherlands, Sweden, Denmark, and Switzerland. The top-performers in science literacy were Sweden, the Netherlands, Iceland, and Norway.
- ▶ Countries that had higher achievement in mathematics literacy than in science literacy were Denmark, France, Hungary, Lithuania, and Switzerland. Those with higher achievement in science literacy were Canada, the Czech Republic, Iceland, Norway, the Russian Federation, Sweden, and the United States.
- ▶ Males had significantly higher average achievement than females in mathematics and science literacy in all countries except South Africa. This also was true for science literacy. In mathematics literacy, there were no significant gender differences in performance in Hungary, the United States, and South Africa.

The emphasis in the science literacy items was on an attempt to measure how well final-year students can use their knowledge in addressing real-world problems having a science component. On Example Item 1, requiring an understanding of how influenza is transmitted, about two-thirds of the final-year students, on average, responded correctly. Correct responses included specific mention of the transmission of germs; reference to transmission by sneezing, coughing, or close contact; or simply the statement that José got influenza from someone who had it. Approximately 11% of the students, on average, across countries responded incorrectly that José got influenza from getting too cold.

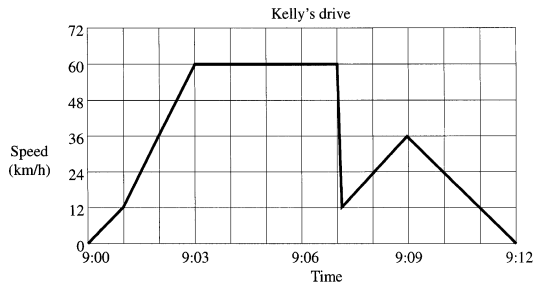
1

José caught influenza. Write down one way he could have caught it.

*if a friend in school has the flu
and if he is sneezing on him
and coughing on him.*

Kelly went for a drive in her car. During the drive, a cat ran in front of the car. Kelly slammed on the brakes and missed the cat.

Slightly shaken, Kelly decided to return home by a shorter route. The graph below is a record of the car's speed during the drive.



- a) What was the maximum speed of the car during the drive?
60
- b) What time was it when Kelly slammed on the brakes to avoid the cat?
9:07

Several items in the mathematics literacy test required students to interpret the information in graphs. In Part A of Example Item 2, which was relatively straightforward, students had to be able to read the line graph and use the labeled information on the vertical axis to provide the answer of 60 km per hour as the car's maximum speed. Students were somewhat less successful with Part B, which required interpretation of the information in the graph based on events, and the ability to read a marked but unlabeled point on the horizontal axis. Whereas the international average was 74% correct responses on Part A, only 59% of the final-year students, on average, provided the correct answer of 9:07 for the time that Kelly slammed on her brakes (Part B). About 7% of the students, on average, responded that Kelly slammed on her brakes at 9:06, the closest labeled point on the horizontal axis.

Table 3

Percent Correct on Selected Mathematics and Science Literacy Items

Country	Example 1	Example 2A	Example 2B
<i>Australia</i>	61	88	68
<i>Austria</i>	81	84	65
<i>Canada</i>	64	80	67
Cyprus	20	54	33
Czech Republic	67	66	47
<i>Denmark</i>	86	78	67
<i>France</i>	68	71	65
<i>Germany</i>	66	74	62
Hungary	68	56	-
<i>Iceland</i>	91	74	63
<i>Italy</i>	52	62	47
Lithuania	55	61	47
<i>Netherlands</i>	76	91	83
New Zealand	74	91	74
<i>Norway</i>	88	78	65
Russian Federation	76	62	46
<i>Slovenia</i>	78	80	62
<i>South Africa</i>	24	60	19
Sweden	88	85	69
Switzerland	78	75	62
<i>United States</i>	59	85	67
International Average	68	74	59

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.




Countries shown in italics did not satisfy one or more guidelines for sample participation rates or classroom sampling procedures.

The report presents standard errors for all survey estimates.

Table 4 Achievement in Advanced Mathematics

Advanced Mathematics	
Country	Mean Achievement
France	557
Russian Federation	542
Switzerland	533
<i>Denmark</i>	<i>522</i>
Cyprus	518
Lithuania	516
<i>Australia</i>	<i>525</i>
Greece	513
Sweden	512
Canada	509
<i>Slovenia</i>	<i>475</i>
<i>Italy</i>	<i>474</i>
Czech Republic	469
Germany	465
<i>United States</i>	<i>442</i>
<i>Austria</i>	<i>436</i>
International Average	501

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96

-  Significantly Higher than International Average
-  Not Significantly Different than International Average
-  Significantly Lower than International Average

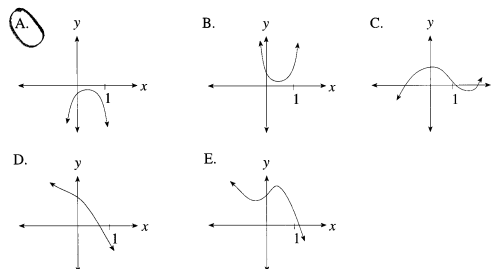
key findings

- ▶ Led by France, the countries performing above the international average in advanced mathematics also included the Russian Federation, Switzerland, Denmark, Cyprus, and Lithuania.
- ▶ The countries performing below the international average were the Czech Republic, Germany, the United States, and Austria.
- ▶ Significant gender differences favoring males were found in all countries except Greece, Cyprus, Australia, Italy, and Slovenia. In some countries, many more males than females have taken advanced mathematics courses, but this varied across countries.
- ▶ Classroom indicators associated with high achievement included frequently solving equations, doing reasoning tasks, and using calculators.

3

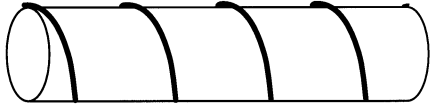
The advanced mathematics test for students having taken advanced mathematics included questions about numbers, equations, and functions; calculus; and geometry. For example, in calculus, students needed to understand the derivatives of a function. Example Item 3 indicates that 45% of the students, on average, understood that the first derivative is used to tell whether a function is increasing or decreasing, and the second derivative is used to indicate the concavity of a function. Students in Sweden had the best performance (61% correct).

Which of the following graphs has these features:
 $f'(0) > 0$, $f'(1) < 0$, and $f''(x)$ is always negative?



4

A string is wound symmetrically around a circular rod. The string goes exactly 4 times around the rod. The circumference of the rod is 4 cm and its length is 12 cm.



Find the length of the string. Show all your work.

Handwritten student work for Example Item 4:

$x = \frac{d}{4}$
 $x = \frac{12\text{cm}}{4} = 3\text{cm}$

$\sigma = 4\text{cm}$
 $12\text{cm} = d$

$y^2 = \sigma^2 + x^2$
 $y^2 = 16 + 9 = 25\text{cm}^2$
 $y = 5\text{cm}$
 $y \cdot n = 5\text{cm} \cdot 4 = 20\text{cm}$

To solve Example Item 4, students had to use their visualization skills to recognize an application of the Pythagorean Theorem. Essentially, students needed to represent the surface of the rod as a rectangle, draw the congruent segments indicating the string, calculate the length of one string segment using the Pythagorean Theorem, and multiply that result by the number of segments. Students in all participating countries found this problem very difficult. Only 10%, on average, provided a fully-correct response, with another 2%, on average, receiving partial credit.

The TIMSS Item Set for the Final Year of Secondary School: Mathematics and Science Literacy, Advanced Mathematics, and Physics is now available. Item Sets for the Primary and Middle Schools are also available.

Table 5

Advanced Mathematics

Percent Correct on Selected Advanced Mathematics Items

Country	Example	Example	
	3	4	4
		Partially Correct	Fully Correct
<i>Australia</i>	52	1	14
<i>Austria</i>	42	2	9
Canada	47	1	12
Cyprus	36	2	0
Czech Republic	39	4	8
<i>Denmark</i>	49	2	11
France	52	2	4
Germany	38	1	8
Greece	37	1	5
<i>Italy</i>	42	3	6
Lithuania	43	1	18
Russian Federation	48	2	12
<i>Slovenia</i>	39	1	5
Sweden	61	1	24
Switzerland	45	1	17
<i>United States</i>	47	0	4
International Average	45	2	10

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or classroom sampling procedures.

The report presents standard errors for all survey estimates.

Table 6

Achievement in
Physics

Physics	
Country	Mean Achievement
Norway	581
Sweden	573
Russian Federation	545
Denmark	534
Slovenia	523
Germany	522
Australia	518
Cyprus	494
Latvia (LSS)	488
Greece	486
Switzerland	488
Canada	485
France	466
Czech Republic	451
Austria	435
United States	423
International Average	501

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96

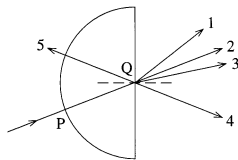
- Significantly Higher than International Average
- Not Significantly Different than International Average
- Significantly Lower than International Average

key findings

- ▶ Norway and Sweden had average physics achievement similar to each other, and significantly higher than other participating countries. The Russian Federation and Denmark also performed above the international average.
- ▶ Six countries performed below the international average. The United States had significantly lower achievement than every country except Austria.
- ▶ Males had significantly higher achievement than females in physics. Although the proportions of males and females having taken physics were about equal in Canada, Latvia (LSS), the Russian Federation, Switzerland, and the United States, in several countries, males outnumbered females by two or three to one.
- ▶ Most final-year students having taken advanced mathematics or physics plan to attend university. Popular choices for future study include engineering, business, and health sciences.

5

This item refers to the following diagram.



A ray of light passes from P to Q through a semicircular glass block in air.

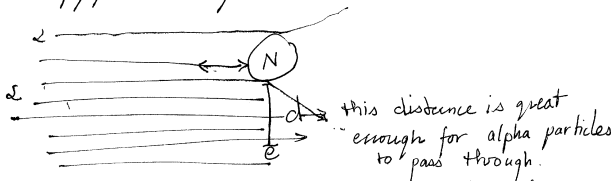
Which arrow shows the direction in which the refracted ray of light would travel after leaving Q?

- A. 1
- B. 2
- C. 3
- D. 4
- E. 5

The physics test for final-year students having taken physics covered mechanics; electricity and magnetism; heat; wave phenomena; and modern physics – particle, quantum and astrophysics, and relativity. One item in wave phenomena required an understanding of the refraction of light as it passes through a semicircular glass block into air (Example Item 5). The high performers included Norway, the Russian Federation, and Sweden, where slightly more than half of the students chose the correct answer.

A stream of alpha particles is directed at a thin sheet of gold 80 atoms thick.
 Explain why most of the alpha particles pass through the sheet.

most alpha particles pass through the sheet because, of the size of the alpha particle, compared to the nucleus is very small. Because there is a vast amount of space between the nucleus and the electrons orbiting it, there is lots of room for alpha particles to simply pass through.



Even if some of the alpha particles hit the edge of the nucleus, they would deflect off with an angle, but still pass through.

Example Item 6, from modern physics, related to the Rutherford scattering experiment. A fully-correct response required the student to explain that alpha particles may be scattered or deflected only by interacting with the nuclei in the gold atoms, and that the distance between the nuclei is very large compared to the diameter of the nucleus or of an alpha particle. Although, on average, only 10% of students internationally provided fully correct answers, a further 14% provided at least a partially-correct response, referencing the general idea of relative size or empty space within the gold atom.

Table 7

Percent Correct on Selected Physics Items

Country	Example	Example	
	5	6	6
		Partially Correct	Fully Correct
<i>Australia</i>	42	29	8
<i>Austria</i>	29	17	5
<i>Canada</i>	42	19	12
<i>Cyprus</i>	47	18	7
<i>Czech Republic</i>	34	7	1
<i>Denmark</i>	32	8	7
<i>France</i>	24	11	5
<i>Germany</i>	40	11	24
<i>Greece</i>	18	4	2
<i>Latvia (LSS)</i>	41	11	8
<i>Norway</i>	52	23	17
<i>Russian Federation</i>	51	8	17
<i>Slovenia</i>	30	4	21
<i>Sweden</i>	53	23	7
<i>Switzerland</i>	34	15	13
<i>United States</i>	27	11	2
International Average	37	14	10

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

The database for the Final Year of Secondary School will be available in June of 1998

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or classroom sampling procedures.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

The report presents standard errors for all survey estimates.

About TIMSS

Since its inception in 1959, the International Association for the Evaluation of Educational Achievement (IEA) has conducted a series of international comparative studies designed to provide information to policy-makers, educators, researchers, and practitioners about educational achievement and learning contexts.

TIMSS is the largest and most ambitious of these studies ever undertaken. The successful collaboration of research centers around the world in implementing TIMSS is a tribute to the dedication and professionalism of all involved. All told, TIMSS achievement testing in mathematics and science included:

- 45 countries
- 5 grade levels (3rd, 4th, 7th, 8th, and final year of secondary school)
- more than half a million students
- testing in more than 30 different languages
- more than 15,000 participating schools
- performance assessment

- questionnaires from students, teachers, and school principals containing about 1,500 questions
- many thousands of individuals to give the tests and process the data

TIMSS was conducted with attention to quality at every step of the way. Rigorous procedures were designed specifically to translate the tests, and numerous regional training sessions were held in data collection and scoring procedures. Quality control observers monitored testing sessions. The samples of students selected for testing were scrutinized according to rigorous standards designed to prevent bias and ensure comparability.

The international direction of TIMSS is funded by the National Center for Education Statistics of the U.S. Department of Education, the U.S. National Science Foundation, and the Canadian Government. Each country provides its own funding for the national implementation of TIMSS.

TIMSS Publications are available on the World Wide Web:

www.csteep.bc.edu/timss

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