


Exhibit 4.12: Description of the TIMSS 2019 High International Benchmark (550) of Science Achievement


 High International Benchmark

550 Summary

Students apply understanding of concepts from biology, chemistry, physics, and Earth science. Students can apply knowledge of the characteristics of groups of animals, life processes in humans, cells and their functions, genetic inheritance, ecosystems, and nutrition. Students show some knowledge and understanding of the composition and properties of matter and chemical reactions. They can apply basic knowledge of energy transformation and transfer, electrical circuits, properties of magnets, light, sound, and forces. They can apply knowledge of Earth's physical features, processes, cycles, and history, and show some understanding of Earth's resources and their use.

Students apply knowledge of the characteristics of groups of animals and life processes in humans. They apply knowledge of cells and their functions, recognizing, for example, what happens to an animal's cells as it grows, and distinguishing between plant and animal cells. Students have a basic understanding of genetic inheritance in plants and animals. They can communicate understanding of ecosystems and the interaction of organisms with their environment. Students can apply some knowledge of human health related to nutrition.

Students show some knowledge and understanding of the composition and properties of matter, including identifying structural models of simple substances. Students show some knowledge of chemical reactions.

Students apply basic knowledge of energy transformation and transfer. They demonstrate understanding of parallel electrical circuits as well as properties of magnets. Students demonstrate understanding of light and sound in practical situations. They can identify the forces acting on objects at rest, predict whether an object will float or sink, and analyze force diagrams.

Students apply knowledge of Earth's physical features, processes, cycles, and history. They can interpret weather pattern data to identify climate types and have some understanding of Earth's resources and their use. They can recognize that the planets are visible because they reflect the Sun's light.

Students can combine and interpret information from various types of diagrams, graphs, and tables to draw conclusions.

Exhibit 4.12.1: High International Benchmark of Science Achievement – Example Item 1

Content Domain: Biology

Cognitive Domain: Reasoning

Description: Explains how roof gardens in cities help reduce the amount of carbon dioxide in the air

In some large cities, owners of large buildings and houses have installed gardens on the roofs. Having more gardens helps reduce the amount of carbon dioxide in the air.

How does increasing the number of gardens help reduce the amount of carbon dioxide in the air?

The trees and plants in the gardens take carbon dioxide out of the air during photosynthesis and give off oxygen.

The answer shown illustrates the type of response that would receive full credit (1 point).

Country	Percent Full Credit	
² Singapore	85 (1.5)	▲
Chinese Taipei	69 (2.0)	▲
² Kazakhstan	68 (2.3)	▲
Turkey	67 (2.4)	▲
² Russian Federation	65 (2.5)	▲
² Sweden	63 (2.6)	▲
† Hong Kong SAR	60 (2.9)	▲
Korea, Rep. of	58 (2.5)	▲
Australia	57 (2.0)	▲
Qatar	57 (2.0)	▲
³ Israel	57 (2.2)	▲
Ireland	56 (2.3)	▲
Lithuania	53 (2.7)	
Cyprus	52 (2.3)	
† United States	51 (2.5)	
Bahrain	50 (2.1)	
Romania	49 (2.5)	
United Arab Emirates	49 (1.2)	
Finland	49 (1.8)	
Kuwait	49 (2.8)	
International Average	48 (0.4)	
Jordan	48 (2.6)	
Portugal	47 (3.0)	
Italy	44 (2.4)	
England	44 (2.7)	
Hungary	43 (3.0)	
Oman	42 (2.2)	▼
Japan	42 (1.9)	▼
² Saudi Arabia	40 (2.0)	▼
Iran, Islamic Rep. of	40 (2.1)	▼
France	39 (2.2)	▼
² Egypt	37 (1.9)	▼
† Norway (9)	37 (2.3)	▼
¹ Georgia	36 (2.7)	▼
Morocco	34 (1.6)	▼
Malaysia	33 (1.7)	▼
† New Zealand	30 (1.9)	▼
Lebanon	29 (2.0)	▼
Chile	24 (1.8)	▼
South Africa (9)	20 (1.1)	▼
Benchmarking Participants		
Moscow City, Russian Fed.	79 (1.7)	▲
² Dubai, UAE	66 (2.0)	▲
Ontario, Canada	49 (2.5)	
‡ Quebec, Canada	42 (2.7)	▼
Abu Dhabi, UAE	37 (1.5)	▼
Western Cape, RSA (9)	33 (1.8)	▼
Gauteng, RSA (9)	32 (1.7)	▼

▲ Percent significantly higher than international average

▼ Percent significantly lower than international average

See Appendix B.7 for population coverage notes 1, 2, and 3. See Appendix B.10 for sampling guidelines and sampling participation notes †, ‡, and ≡.
() Standard errors appear in parentheses. Because of rounding some results may appear inconsistent.

SOURCE: IEA's Trends in International Mathematics and Science Study - TIMSS 2019
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Exhibit 4.12.2: High International Benchmark of Science Achievement – Example Item 2

Content Domain: Chemistry
Cognitive Domain: Reasoning
Description: Explains the effect of temperature on diffusion in the context of an investigation

Country	Percent Full Credit
² Russian Federation	69 (1.8) ▲
Japan	67 (2.0) ▲
² Singapore	64 (1.9) ▲
Korea, Rep. of	63 (2.4) ▲
Lithuania	59 (2.4) ▲
† United States	55 (1.9) ▲
† New Zealand	52 (1.8) ▲
Chinese Taipei	52 (2.0) ▲
Portugal	51 (2.8) ▲
Hungary	51 (2.2) ▲
Australia	49 (2.0) ▲
Turkey	49 (2.4) ▲
Ireland	49 (2.4) ▲
³ Israel	48 (2.5) ▲
Finland	48 (1.7) ▲
² Sweden	45 (2.6) ▲
† Hong Kong SAR	40 (2.4)
² Kazakhstan	40 (2.8)
Bahrain	39 (1.9)
International Average	39 (0.3)
France	38 (2.3)
Chile	35 (2.3)
Qatar	35 (2.6)
Cyprus	34 (2.4)
Italy	33 (2.4) ▼
Romania	32 (2.4) ▼
† Norway (9)	32 (2.1) ▼
England	31 (2.5) ▼
Morocco	29 (1.6) ▼
Malaysia	27 (1.5) ▼
Iran, Islamic Rep. of	27 (2.1) ▼
¹ Georgia	27 (2.9) ▼
Oman	26 (1.7) ▼
Kuwait	23 (1.7) ▼
United Arab Emirates	21 (0.9) ▼
² Saudi Arabia	20 (1.4) ▼
South Africa (9)	20 (0.9) ▼
Jordan	15 (1.4) ▼
Lebanon	13 (1.5) ▼
² Egypt	5 (0.7) ▼
Benchmarking Participants	
‡ Quebec, Canada	63 (2.5) ▲
Moscow City, Russian Fed.	59 (2.3) ▲
Ontario, Canada	56 (2.5) ▲
Western Cape, RSA (9)	37 (1.8)
Gauteng, RSA (9)	36 (1.7)
² Dubai, UAE	35 (2.0)
Abu Dhabi, UAE	15 (1.1) ▼

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

See Appendix B.7 for population coverage notes 1, 2, and 3. See Appendix B.10 for sampling guidelines and sampling participation notes †, ‡, and ≡.
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Maria placed two identical pieces of solid paint at the bottom of two identical tubes, X and Y, filled with water. On Day 1 she put one tube in a refrigerator and left the other in the warm room. Maria took a picture of each tube at the same time for five days. The diagram shows Maria's pictures from each day.

Which tube was in the refrigerator?

(Click one box.)

Tube X

Tube Y

Explain your answer.

The paint in Tube X spread through the water faster. The test tube is fully dark on day 4 for Tube X. The test tube is not fully dark until day 5 for Tube Y. The cold water made the mixing go more slowly in Tube Y.

The answer shown illustrates the type of response that would receive full credit (1 point).

Exhibit 4.12.3: High International Benchmark of Science Achievement – Example Item 3

Content Domain: Physics
Cognitive Domain: Applying
Description: Applies knowledge of sound transmission to explain whether a ringing cell phone in a vacuum can be heard outside the vacuum chamber

Country	Percent Full Credit
Chinese Taipei	78 (1.8) ▲
Turkey	61 (2.1) ▲
² Singapore	59 (2.5) ▲
Japan	56 (2.2) ▲
Lithuania	56 (2.8) ▲
Korea, Rep. of	53 (2.6) ▲
Malaysia	52 (2.0) ▲
† Hong Kong SAR	51 (3.3) ▲
Qatar	50 (2.8) ▲
Jordan	46 (2.3) ▲
² Sweden	46 (2.3) ▲
France	44 (2.5) ▲
Finland	44 (2.1) ▲
Hungary	43 (2.2) ▲
² Russian Federation	42 (2.8)
² Kazakhstan	42 (2.0)
² Saudi Arabia	41 (2.2)
¹ Georgia	40 (2.8)
United Arab Emirates	39 (1.1)
International Average	38 (0.4)
Portugal	38 (2.7)
† United States	37 (2.3)
Cyprus	36 (2.4)
England	35 (2.8)
Oman	33 (1.9) ▼
Australia	33 (2.1) ▼
Kuwait	33 (2.8) ▼
Ireland	33 (2.3) ▼
² Egypt	32 (2.0) ▼
† New Zealand	31 (2.1) ▼
Romania	30 (2.3) ▼
Morocco	29 (1.7) ▼
Bahrain	29 (1.8) ▼
³ Israel	26 (2.1) ▼
† Norway (9)	26 (2.0) ▼
Italy	22 (2.3) ▼
Lebanon	19 (1.7) ▼
Iran, Islamic Rep. of	15 (1.4) ▼
South Africa (9)	11 (0.7) ▼
Chile	7 (1.3) ▼
Benchmarking Participants	
Moscow City, Russian Fed.	73 (2.2) ▲
² Dubai, UAE	52 (2.0) ▲
Abu Dhabi, UAE	32 (1.7) ▼
‡ Quebec, Canada	28 (2.7) ▼
Ontario, Canada	23 (2.0) ▼
Western Cape, RSA (9)	22 (1.6) ▼
Gauteng, RSA (9)	17 (1.9) ▼


▲ Percent significantly higher than international average

▼ Percent significantly lower than international average

See Appendix B.7 for population coverage notes 1, 2, and 3. See Appendix B.10 for sampling guidelines and sampling participation notes †, ‡, and ≡.
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Nada hangs her cell phone under a glass bowl as shown. The ringer on the phone is turned on. She removes the air from under the bowl so that her phone is in a vacuum.



Nada asks her friend to call her phone. Will they hear it ring?
 (Click one box.)

Yes
 No

Explain your answer.

There is no air under the bowl for the sound waves to travel through.

The answer shown illustrates the type of response that would receive full credit (1 point).



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Exhibit 4.12.4: High International Benchmark of Science Achievement – Example Item 4

Content Domain: Earth Science
Cognitive Domain: Reasoning
Description: Identifies evidence that the Earth is becoming warmer over time

Country	Percent Correct	
Chinese Taipei	87 (1.3)	▲
Finland	82 (1.8)	▲
Ireland	79 (1.9)	▲
Hungary	77 (2.1)	▲
Lithuania	76 (2.1)	▲
² Singapore	76 (1.9)	▲
Japan	75 (1.8)	▲
Turkey	74 (2.0)	▲
† Norway (9)	70 (2.0)	▲
² Sweden	70 (2.0)	▲
England	69 (2.8)	▲
† New Zealand	68 (2.0)	▲
Korea, Rep. of	67 (2.6)	▲
Australia	67 (1.5)	▲
Italy	65 (2.4)	▲
† United States	65 (2.4)	▲
² Russian Federation	63 (2.7)	▲
† Hong Kong SAR	63 (2.8)	▲
Cyprus	63 (2.3)	▲
Chile	60 (2.2)	
³ Israel	58 (2.8)	
France	57 (2.5)	
International Average	57 (0.4)	
Portugal	54 (2.8)	
² Kazakhstan	52 (2.5)	▼
Romania	52 (2.7)	
Qatar	48 (2.5)	▼
United Arab Emirates	47 (1.1)	▼
Kuwait	45 (2.5)	▼
Bahrain	44 (2.6)	▼
¹ Georgia	44 (2.9)	▼
Oman	43 (2.0)	▼
Malaysia	43 (1.7)	▼
² Egypt	40 (1.9)	▼
² Saudi Arabia	39 (2.3)	▼
Jordan	36 (1.8)	▼
Iran, Islamic Rep. of	28 (1.5)	▼
Morocco	28 (1.6)	▼
South Africa (9)	24 (1.1)	▼
Lebanon	24 (2.1)	▼
Benchmarking Participants		
‡ Quebec, Canada	78 (2.1)	▲
Ontario, Canada	75 (2.4)	▲
Moscow City, Russian Fed.	72 (2.1)	▲
² Dubai, UAE	65 (2.1)	▲
Abu Dhabi, UAE	39 (1.6)	▼
Western Cape, RSA (9)	35 (2.1)	▼
Gauteng, RSA (9)	25 (1.6)	▼

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Scientists have evidence of changes in Earth's climate over the last 650,000 years.

Which of the following statements would be evidence that the Earth is becoming warmer?

- A** a decrease in the size of Earth's polar ice caps
- B** a decrease in the average depth of Earth's oceans
- C** an increase in the number of volcanoes erupting
- D** an increase in the number of sunspots