CHAPTER 15

Using Scale Anchoring to Interpret the TIMSS 2019 Achievement Scales

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Introduction

As described in Chapter 12: Implementing the TIMSS 2019 Scaling Methodology, the TIMSS 2019 achievement results are summarized using item response theory (IRT) scaling. Countries' average achievement scores are reported on the TIMSS achievement scales for mathematics and science, with most average achievement scores ranging from 300 to 700. Average achievement provides data users with information about how achievement compares among countries and whether scores are improving or declining over time.

To provide as much information as possible for policy and curriculum reform, however, it is important to describe the mathematics and science competencies associated with different locations within the range of scores on the achievement scales. For example, in terms of levels of proficiency in mathematics and science, what does it mean for a country to have average achievement of 513 or 426, and how different are these scores?

The TIMSS 2019 International Benchmarks provide information about what students know and can do at different points along the achievement scales. More specifically, TIMSS has identified four points along the achievement scales to use as international benchmarks of achievement—Advanced International Benchmark (625), High International Benchmark (550), Intermediate International Benchmark (475), and Low International Benchmark (400). For each assessment and International Report, the TIMSS & PIRLS International Study Center works with the expert international committee that guides assessment development, Science and Mathematics Item Review Committee (SMIRC), to conduct a scale anchoring analysis to describe student competencies at the TIMSS International Benchmarks.

This chapter describes the scale anchoring procedures that were applied to update the descriptions of student performance at the international benchmarks from TIMSS 2015 to TIMSS 2019. The analysis

was conducted separately for mathematics and for science at fourth and eighth grades. In brief, scale anchoring involved conducting a scale anchoring analysis to identify items that students scoring at the international benchmarks answered correctly, and then having experts examine the content of each item to determine the kind of knowledge, skill, or reasoning demonstrated by students who responded correctly to the item. The experts then summarized the detailed list of item competencies in a brief description of achievement at each international benchmark. Thus, the scale anchoring procedure yielded a content-referenced interpretation of the achievement results that can be considered in light of the TIMSS 2019 frameworks for assessing mathematics and science.

Classifying the Items

As the first step, students scoring within 5 scale-score points of each benchmark (i.e., the benchmark point plus or minus 5) were identified for the benchmark analysis. This 10-point range provided an adequate sample of students scoring at the benchmark, and yet was small enough so that performance at one international benchmark was still distinguishable from the next. The score ranges around each international benchmark and the number of students scoring in each range are shown in Exhibit 15.1.

Exhibit 15.1: **Range Around Each TIMSS 2019 International Benchmark and Number of Students Within Each Range**

		Low (400)	Intermediate (475)	High (550)	Advanced (625)
Range of Scale Scores		**395–405**	**470–480**	**545–555**	**620–630**
Grade 4 Mathematics (includes Less Difficult)	eTIMSS	3,255	6,798	8,222	4,248
	paperTIMSS	3,876	6,310	6,485	3,140
	Less Difficult	3,792	3,718	1,905	428
	Total	**10,923**	**16,826**	**16,612**	**7,816**
Grade 4 Science	eTIMSS	2,899	6,738	8,939	4,297
	paperTIMSS	3,513	6,062	6,736	2,805
	Total	**6,412**	**12,800**	**15,675**	**7,102**
Grade 8 Mathematics	eTIMSS	2,918	4,700	4,513	2,617
	paperTIMSS	4,468	4,464	3,513	1,831
	Total	**7,386**	**9,164**	**8,026**	**4,448**
Grade 8 Science	eTIMSS	2,485	4,531	5,066	3,092
	paperTIMSS	3,676	4,412	3,990	2,032
	Total	**6,161**	**8,943**	**9,056**	**5,124**

paperTIMSS sample sizes include bridge samples from eTIMSS countries.
Data analysis was conducted before achievement scaling completely finalized.

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The second step involved computing the percentage of those students scoring in the range around each international benchmark that answered each item correctly. To compute these percentages, students in each country were weighted proportionally to the size of the student population in the country. For multiple-choice items and constructed response items worth 1 point, it was a straightforward matter of computing the percentage of students at each benchmark who answered each item correctly. For constructed response items scored for partial and full credit, percentages were computed for students receiving partial credit (1-point) as well as for students receiving full credit (2-points). Because the students in about half the countries took the items in the eTIMSS format and the other half in the paper format, first the percent corrects were computed separately for computer-based and paper, including the bridge data. A comparison showed these to be very similar (recall that the detailed comparison between modes found more than 80% of the items to be mode invariant, see Chapter 12). So for most the items, the two percentages, one for computer-based and one for paper, were averaged for the scale anchoring analysis. For the remaining 20 percent or fewer items with differences in the percentages between the eTIMSS and paper format, the eTIMSS percentage was used as the better bridge to future assessments.

Third, the criteria described below were applied to identify the items that anchored at each benchmark. An important feature of the scale anchoring method is that it yields descriptions of the performance demonstrated by students reaching each of the international benchmarks on the scales, and that the descriptions reflect demonstrably different accomplishments by students reaching each successively higher benchmark. Because the process entails the delineation of sets of items that students at each international benchmark are likely to answer correctly and that discriminate between one benchmark and the next, the criteria for identifying the anchor items considers performance at adjacent benchmarks.

For multiple-choice items, 65 percent answering correctly was used as the criterion for anchoring at each benchmark being analyzed, since students would be likely (about two-thirds of the time) to answer the item correctly. In addition, a criterion of less than 50 percent was used for the next lower benchmark, because with this response probability, students were more likely to have answered the item incorrectly than correctly. A somewhat less strict criterion was used for the constructed response items, because students had much less scope for guessing. For constructed response items, the criterion of 50 percent answering correctly was used for the benchmark without any discrimination criterion for the next lower benchmark.

Using a multiple-choice items as an example, the criteria for each benchmark are outlined below:

- A multiple-choice item anchored at the Low International Benchmark (400) if at least 65 percent of students scoring in the range around the Low International Benchmark (395–405) answered the item correctly. Because this was the lowest benchmark described, there were no further criteria.

- A multiple-choice item anchored at the Intermediate International Benchmark (475) if at least 65 percent of students scoring in the range answered the item correctly, and less than 50 percent of students at the Low International Benchmark answered the item correctly.

- A multiple-choice item anchored at the High International Benchmark (550) if at least 65 percent of students scoring in the range answered the item correctly, and less than 50 percent of students at the Intermediate International Benchmark answered the item correctly.

- A multiple-choice item anchored at the Advanced International Benchmark (625) if at least 65 percent of students scoring in the range answered the item correctly, and less than 50 percent of students at the High International Benchmark answered the item correctly.

To include all of the multiple-choice items in the anchoring process and provide information about content domains and cognitive processes that might not otherwise have been represented by many anchor items, the concept of items that "almost anchored" was introduced. These were items that met slightly less stringent criteria for being answered correctly. The criteria to identify multiple-choice items that "almost anchored" were that 60 to 65 percent of students scoring in the range answered the item correctly and less than 50 percent of students at the next lowest benchmark answered the item correctly. To be completely inclusive for all items, items that met only the criterion that 60 to 65 percent of the students answered correctly (regardless of the performance of students at the next lower point) were also identified. The categories of items were mutually exclusive, and ensured that all of the items were available to inform the descriptions of student achievement at the anchor levels. A multiple-choice item was considered to be "too difficult" to anchor if less than 60 percent of students at the advanced benchmark answered the item correctly. A constructed response item was considered to be "too difficult" to anchor if less than 50 percent of students at the advanced benchmark answered the item correctly.

Exhibit 15.2 presents the number of TIMSS 2019 mathematics and science items that anchored at each international benchmark. A description of the items for mathematics at the fourth grade, science at the fourth grade, mathematics at the eighth grade, and science at the eighth grade can be found in Appendices 15A, 15B, 15C, and 15D, respectively. It should be noted that a partial credit item can anchor twice, typically at a higher benchmark for full credit (2 of 2 points), and a lower benchmark for partial credit (1 of 2 points), but sometimes both anchored at the same level. Only the full credit anchoring results were used to write the benchmark descriptions. For the mathematics scale anchoring at the fourth grade, TIMSS took advantage of data from the less difficult assessment items in developing the descriptions for the Low and Intermediate Benchmarks.

Exhibit 15.2: **Number of Items Anchoring and Almost Anchoring at Each TIMSS 2019 International Benchmark**

Content Domain	Low (400)	Intermediate (475)	High (550)	Advanced (625)	Above Advanced	Total
Grade 4 Mathematics						
Number	28	39	42	27	6	142
Measurement and Geometry	10	15	14	32	5	76
Data	12	14	17	10	3	56
Grade 4 Mathematics Total*	**50**	**68**	**73**	**69**	**14**	**274**
Grade 4 Science						
Life Science	2	15	28	24	8	77
Physical Science	1	15	25	17	4	62
Earth Science	1	2	14	15	3	35
Grade 4 Science Total	**4**	**32**	**67**	**56**	**15**	**174**
Grade 8 Mathematics						
Number	1	7	26	29	3	63
Algebra	0	2	24	29	7	55
Geometry	0	3	16	20	10	39
Data and Probability	0	8	12	14	6	34
Grade 8 Mathematics Total	**1**	**20**	**78**	**92**	**26**	**217**
Grade 8 Science						
Biology	3	16	37	23	10	89
Chemistry	1	5	13	16	11	46
Physics	1	5	15	25	8	54
Earth Science	1	4	15	14	10	44
Grade 8 Science Total	**6**	**30**	**80**	**78**	**39**	**233**

* Grade 4 Mathematics includes less difficult items at the Low and Intermediate Benchmarks.

Writing the Scale Anchoring Descriptions

Due to COVID-19, an online scale anchoring for TIMSS 2019 was conducted in the spring of 2020, instead of an in-person meeting of the Mathematics and Science SMIRC. In preparation for review by SMIRC, staff at the TIMSS & PIRLS International Study Center used examples from previous assessments to draft short descriptions of the student competencies demonstrated by a correct (or partially correct) response to each mathematics and science item. Then, the mathematics and science items were organized separately by grade, grouped by international benchmark, and within each benchmark the items were sorted by content area. The final categorization was by the anchoring criteria the items met—items that

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT   15.5

anchored, followed by items that almost anchored, then by items that met only the 60 to 65 percent criteria. Also, in addition to the short draft descriptions, the following information was included for each item: framework classification, answer key or scoring guide, secure status, percent correct at each benchmark, and overall international percent correct. Beyond the item-by-item descriptions and anchoring data, SMIRC members were given the benchmark descriptions from TIMSS 2015.

The members of SMIRC committee 1) worked through each item to review/revise the description of the student competencies demonstrated by a correct (or a partially correct) response, 2) updated the TIMSS 2015 summaries of the proficiency demonstrated by students reaching each international benchmark for publication in the TIMSS 2019 report, and 3) selected example items from TIMSS 2019 that supported and illustrated the benchmark descriptions to illustrate the types of items answered correctly by students at each of the four benchmarks..

Following the SMIRC review, the descriptions and example items were included in the TIMSS 2019 International Report for review by the TIMSS 2019 National Research Coordinators at their 8th meeting in July 2020 (scheduled for Prague, but held virtually).

Appendix 15A: Grade 4 Mathematics Item Descriptions Developed During the TIMSS 2019 Benchmarking

Items at Low International Benchmark (400)	
Number	
N01_02	Solves a word problem involving subtraction of a one-digit number from a two-digit number
N01_05	Multiplies a one-digit number by a two-digit number
N03_01	Orders four three-digit numbers
N03_02	Solves a word problem involving division of a two-digit number by a one-digit number
N03_03A	Identifies the largest of four three-digit numbers in context
N05_01	Identifies a four-digit number represented in words
N07_03	Solves a word problem involving subtraction of a one-digit number from a three-digit number
N07_04	Writes a number between two two-digit numbers
N09_02	Solves a word problem involving addition of two two-digit numbers
N11_02	Solves a word problem involving addition of two- and three-digit numbers
N11_04	Multiplies a three-digit number by a one-digit number
N12_01	Identifies the smallest of four four-digit numbers
N12_02	Identifies a multiple of a one-digit number
N13_01	Adds two two-digit numbers
N13_02	Divides a two-digit number by a one-digit number
N14_01	Supplies one factor of a two-digit number (1 of 2 points)

Items beginning with "N" are items unique to less difficult mathematics.

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT   15.7

N04_02	Divides a two-digit number by a one-digit number with a remainder
N07_02	Multiplies a one-digit number by a two-digit number
N04_04	Implements a one-step rule to generate the next number in a pattern
N07_07	Finds the missing term in an addition number sentence
N12_05	Identifies the missing term in an addition sentence
N12_06	Implements a one-step rule forward and in reverse to partially complete a table (1 of 2 points)
N14_04	Solves for the missing number in a multiplication sentence
N14_05	Identifies the operation for an expression that represents a situation
N01_07	Writes a fraction larger than a given unit fraction
N03_06	Recognizes a unit fraction represented pictorially
N04_07	Solves a word problem involving addition of one-place decimals
N09_08	Recognizes a non-unit fraction represented pictorially

Measurement and Geometry

N03_09	Solves a word problem involving addition of three one-digit numbers
M03_10	Relates a specified face of a cube to its net
N01_08	Identifies a cylinder
N03_08	Writes the names of four common two-dimensional shapes
N05_10	Completes a rectangle on a square grid
N11_11A	Identifies the tallest of four rectangular prisms represented pictorially

Items beginning with "N" are items unique to less difficult mathematics.

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT   15.8

N12_10	Completes a symmetric figure on a square grid given half the shape and the line of symmetry
N14_09	Determines the number of lateral faces of a given rectangular prism
N09_10	Identifies a cube
N11_11B	Identifies the greatest volume of four rectangular prisms represented pictorially

Data

M08_12	Labels bars on a bar graph to represent data given in a table
M10_11	Represents data from a table in a bar graph
N01_04A	Reads data from a bar graph
N04_13	Represents data from a table in a bar graph (1 of 2 points)
N04_14	Evaluates statements about data in a pictograph (1 of 2 points)
N05_05A	Reads data from a table
N05_05B	Compares data presented in a table
N07_05	Uses data from a table to complete a bar graph (2 of 2 points)
N07_05	Uses data from a table to partially complete a bar graph (1 of 2 points)
N13_04A	Reads data from a bar graph
N14_13A	Reads data from a table
N13_04B	Compares data presented on a bar graph

Items beginning with "N" are items unique to less difficult mathematics.

Items at Intermediate International Benchmark (475)

Number

M02_01	Identifies a three-digit number given the place values of two of its digits
M05_01	Adds a four-digit and a three-digit number
M06_02	Divides a three-digit number by a one-digit number
M09_02	Determines a four-digit number given the place values of the digits
M11_03	Multiplies a one-digit number by a three-digit number
M12_01	Identifies a four-digit number given in words in expanded form
N01_01	Subtracts a two-digit number from a three-digit number
N01_03	Determines a four-digit number given the values of two of its digits
N03_03B	Justifies the greatest number if one of four numbers is increased by 100
N05_02	Solves a two-step word problem involving subtraction of one- and two-digit numbers
N05_03	Solves a word problem involving division of a two-digit number by a one-digit number
N07_06	Finds the missing term in an addition word problem
N09_04	Determines the smallest 3-digit number with three given digits
N12_04	Solves a multi-step word problem involving multiplication of one-digit numbers and comparison of two-digit numbers
N13_03	Compares representations of a value in numbers and in words and explains answer
N13_05	Solves a multi-step word problem involving addition and subtraction of one- and two-digit numbers and explains answer
M03_01	Identifies a four-digit number given in expanded form

Items beginning with "N" are items unique to less difficult mathematics.

M04_01	Subtracts a three-digit number from a four-digit number
N11_06	Solves a multi-step word problem involving multiplication of one-digit numbers and addition of two-digit numbers
M09_01	Adds a four-digit, three-digit, and two-digit number
N03_05	Solves a word problem involving subtraction of one- and two-digit numbers
N04_01	Solves a word problem involving subtraction of two three-digit numbers
N07_01	Solves a word problem involving multiplication of one- and two-digit numbers
N09_01	Subtracts a two-digit number from a three-digit number
N09_03	Solves a word problem involving multiplication of one- and two-digit numbers
N11_01	Identifies a four-digit number given the digits in two places
N11_03	Divides a two-digit number by a one-digit number with a remainder
M04_03	Identifies the missing number in two number sentences with inequalities
M13_05	Solves for the missing number in a subtraction sentence
N04_06	Identifies an expression with addition and subtraction that represents a situation
N09_06	Determines the missing number in a well defined number pattern
N12_06	Implements a one-step rule forward and in reverse to complete a table (2 of 2 points)
M11_06	Determines the operation to complete a number sentence
N05_04	Identifies an arithmetic operation that represents a situation
N11_05	Identifies an expression that represents a situation
N05_07	Supplies a fraction larger than one half

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT   15.11

N05_08	Orders two decimals and a whole number
N13_07	Solves a word problem involving addition of decimals
M01_02	Identifies the representation of a non-unit fraction

Measurement and Geometry

M08_06	Measures the vertical height of an object with a ruler
N04_08	Solves a multi-step word problem involving multiplication and addition of mass
N05_11	Determines the number of unit cubes to fill a rectangular prism
N05_12	Solves a word problem involving addition of hours and minutes
N13_10	Determines the perimeter of a triangle given the side lengths
N13_11	Solves a word problem involving addition of hours and minutes
N14_08	Identifies the appropriate metric unit of volume for an object
N03_10	Solves a word problem involving subtraction of hours and minutes
N09_09	Identifies the appropriate metric unit of measurement for an object
M01_07	Identifies the number of triangular faces in a given three-dimensional shape
M02_09	Completes a symmetric figure on a square grid given half the shape and the line of symmetry
N13_08	Identifies a square
M01_06B	Identifies a street perpendicular to a given street
N05_09	Identifies a shape with equal angles
N07_10	Identifies a common shape inside another common shape

Items beginning with "N" are items unique to less difficult mathematics.

Data

M01_09A	Identifies the greatest value in a bar graph
M02_10A	Reads data from a line graph
M10_12A	Represents data in a table
M12_10	Identifies a title and axis labels for a bar graph
M13_10A	Reads data from a graph
N04_12	Reads data from a tally chart
N04_13	Represents data from a table in a bar graph (2 of 2 points)
N14_12	Labels a bar on a bar graph given data in a tally chart
M14_10	Solves a word problem involving reading data from a table
N12_11	Reads data from a table
N12_12A	Identifies the label for a bar in a bar graph given the data in a table
N14_11	Reads data from a table
M04_12	Determines one or two out of three missing values in a table given conditions for the data (1 of 2 points)
N09_05	Uses data from a bar graph to solve a problem

Items beginning with "N" are items unique to less difficult mathematics.

Items at High International Benchmark (550)

Number

M01_01	Identifies the set of numbers having a given number as a factor
M02_02	Solves a word problem involving division of a two-digit number by a one-digit number
M03_02	Multiplies a two-digit number by a two-digit number
M05_02	Identifies the number closest in size to a given four-digit number
M05_03	Solves a word problem involving division
M06_01	Classifies two- and three-digit numbers as even or odd
M06_03	Devises one way of grouping objects that satisfy two conditions (1 of 2 points)
M07_01	Solves a multi-step word problem involving multiplication and addition of whole numbers
M07_03	Solves a word problem involving multiplication of two-digit numbers
M08_01	Solves a word problem involving division of a two-digit number by a one-digit number with a remainder
M08_02	Solves a word problem involving subtraction of a two-digit number from a four-digit number
M09_03	Devises one way to allocate money in a given context (1 of 2 points)
M10_02	Solves a word problem involving multiplication of a three-digit number by a one-digit number
M11_01	Rounds a four-digit number to the thousands place
M11_04	Solves a problem set in a novel situation involving addition and comparison of whole numbers and justifies the solution
M11_09	Given two positions on a curved path, follows specified moves and labels another position (1 of 2 points)
M12_02	Solves a word problem involving addition of one-, two-, and three-digit numbers

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT   15.14

M13_03	Identifies a true statement about comparison of two- and three-digit numbers
M03_09	Finds the distance between two positions on a number line
M11_02	Identifies a number that satisfies two conditions of multiples
M09_08	Finds the halfway point between two positions on a number line
M14_02	Solves a word problem involving subtraction of two three-digit numbers
M01_05	Follows a two-step rule to extend a number pattern
M03_06	Solves for a repeated missing number in a subtraction sentence
M06_06	Determines the operation to complete a number sentence with operations on both sides
M06_07	Identifies an expression that represents a situation
M07_05	Solves a number sentence involving division
M08_03	Determines the place of three numbers in a number sentence with operations on both sides
M09_06	Identifies an expression that represents a situation
M12_04A	Implements a two-step arithmetic rule to a given number
M13_02	Determines whether three pairs of numbers follow a given two-step rule
M13_07	Follows a two-step rule to generate the next number in a pattern
M14_03	Identifies an expression with multiplication and subtraction that represents a situation
M14_04	Determines the one-step rule that relates five numbers in a pattern
M02_04	Identifies the operation for an expression that represents a situation
M03_07	Identifies an expression that represents a situation

M01_04A	Solves a word problem involving rectangular representations of fractions	
M01_04B	Solves a word problem involving rectangular representations of fractions	
M06_04	Solves a word problem involving subtraction of a non-unit fraction from 1	
M07_06	Adds a whole number and a two-place decimal	
M09_05	Solves a word problem involving subtracting one-place decimals	
M14_05	Solves a word problem involving addition of three two-place decimals	

Measurement and Geometry

M02_06	Identifies the appropriate metric unit of measurement for three objects
M04_06A	Solves a word problem involving multiplication of lengths
M05_04	Solves a word problem involving addition of time
M05_11	Solves a problem by filling a three-dimensional shape with rectangular solids
M14_07	Solves a word problem involving conversion of minutes to hours
M10_06	Estimates the total length of an object given the length of part of it
M12_06	Estimates the length of an object given the length of another object
M11_08	Classifies angle types in a figure
M12_05	Identifies a pair of shapes that make a rectangle
M13_09	Identifies a two-dimensional view of an irregular three-dimensional figure
M14_09	Completes a shape on a square grid to satisfy four conditions
M05_08	Identifies a shape with a right angle

M07_09	Identifies the two-dimensional view of a three-dimensional object
M09_09	Identifies a solid given two faces

Data

M02_11	Represents data from a table in a pictograph
M04_10B	Compares data in a table
M05_12	Completes a bar graph using information from a pictograph
M07_12	Identifies a pie chart that has the same information as a bar graph
M08_11	Determines whether questions can be answered with data in a table
M08_13	Determines the key for a pictograph and uses it to complete the graph (1 of 2 points)
M10_10A	Reads data from a line graph
M11_11A	Uses a key to retrieve data from a pictograph
M12_09A	Uses a key to retrieve data from a pictograph
M12_11	Labels sections of a pie chart given three conditions for the data
M14_11A	Evaluates statements about data in a bar graph
M14_13	Completes a table for a given data series
M06_11	Identifies a pie chart that represents given data
M07_11	Uses information from a bar graph to solve a problem
M10_10B	Extrapolates a point on a line graph with constant slope
M10_12B	Interprets data in a table to solve a problem
M13_10B	Extrapolates from a graph to solve a problem

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT   15.17

Items at Advanced International Benchmark (625)	
Number	
M01_03	Solves a multi-step problem involving division and gives a reason for their answer
M03_03	Solves a multi-step word problem involving addition and subtraction of two- and three-digit numbers
M04_02	Determines a number that meets two conditions of multiples and one condition of order
M06_03	Devises two ways of grouping objects that satisfy two conditions (2 of 2 points)
M09_03	Devises two ways to allocate money in a given context (2 of 2 points)
M10_03	Solves a multi-step word problem involving division of one- and two-digit numbers with remainders
M11_09	Given two positions on a curved path, follows specified moves and labels another position (2 of 2 points)
M13_01	Recognizes equivalent three-digit numbers written in expanded form
M14_01	Divides a three-digit number by a one-digit number
M09_07	Identifies the missing number in a number sentence with operations on both sides
M12_04B	Implements a two-step rule in reverse to generate the previous number in a pattern
M13_06	Identifies an operation that represents a situation
M04_04	Identifies an expression with division and addition that represents a situation
M10_04	Solves a word problem by extending a pattern
M11_07	Identifies number sentence that represents a situation
M02_03	Identifies non-unit fractions greater than a given unit fraction
M03_04	Solves a problem to identify a fraction that represents the shaded portion of a figure

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M03_05	Solves a word problem involving division with a remainder (1 of 2 points)
M05_05	Identifies a fraction equivalent to a given fraction
M05_06	Solves a multi-step problem involving fractions
M06_05	Draws a complete shape on a grid given a picture of a fraction of the shape
M07_02	Identifies a fraction equivalent to a one place decimal
M08_05	Identifies a decimal given the place values of two of its digits
M10_05	Identifies the larger number among pairs of one- and two-place decimals
M11_05	Solves a word problem involving adding fractions with different denominators
M13_04	Identifies a number between a one-place decimal and two-place decimal
M07_04	Identifies a set of objects with a given fraction shaded

Measurement and Geometry

M02_08	Determines the number of three different shapes that cover the area of a square (2 of 2 points)
M02_08	Determines the number of two different shapes that cover the area of a square (1 of 2 points)
M04_06B	Solves a word problem involving division of lengths
M05_10	Reads a ruler to find the length of one side of an equilateral triangle and finds its perimeter
M06_08	Reads a ruler to find the length of a line segment beginning and ending at half-units
M07_07	Reads a ruler to find the length of an object beginning at a half-unit
M08_07	Solves a word problem involving subtraction of volumes
M08_10	Determines two sides lengths of a hexagon given the other four side lengths and its perimeter

M10_07	Draws a rectangle with a given perimeter on a square grid
M10_09	Solves a multi-step word problem involving multiplication and division of lengths, with a remainder (1 of 2 points)
M12_07	Determines the number of unit cubes to fill a rectangular prism and explains method (2 of 2 points)
M12_07	Determines the number of unit cubes to fill a rectangular prism and explains method (1 of 2 points)
M12_08	Measures a horizontal object with a ruler and applies a scale to determine its length
M14_06	Identifies the speed shown on a speedometer
M02_07	Solves a multi-step word problem involving multiplication and division of weights
M04_05	Estimates the height of an object given the height of another object
M04_07	Determines the weight of an object given a series of three balanced scales
M07_10	Finds the area of a rectangle given its dimensions
M08_08	Analyzes information in a time table to solve a word problem
M14_08	Identifies the area of a rectangle drawn at an angle on a square grid
M03_08	Identifies parallel lines on a geometric shape
M04_08	Draws a line on a square grid that is parallel to a given line and passes through a specified point
M04_09	Identifies properties of two pentagons
M06_09	Recognizes acute angles in an irregular quadrilateral
M06_10	Determines the number of square and triangular faces of three-dimensional shapes (2 of 2 points)
M06_10	Determines the number of square and triangular faces of three-dimensional shapes (1 of 2 points)
M07_08	Given a line, draws another line to form an angle less than a right angle

M09_10A	Draws a parallel line on a square grid given conditions
M13_08	Draws an obtuse angle on a square grid given one side
M01_06A	Identifies a street parallel to a given street
M05_09	Identifies a shape that has both line and rotational symmetry
M11_10	Identifies a net of a hexagonal prism

Data

M02_12	Determines the y-axis scale for a bar graph given the data in a table
M03_11	Represents data from a table in a pie chart
M08_13	Determines the key for a pictograph and uses it to complete the graph (2 of 2 points)
M14_12	Identifies the optimal data display for data given in a table
M01_09B	Interprets a bar graph to solve a two-step problem
M04_12	Determines three missing values in a table given conditions for the data (2 of 2 points)
M11_11B	Uses information in a pictograph to solve a problem
M12_09B	Uses data from a pictograph to solve a problem
M12_12	Compares the slope of two lines on a graph for a specific period and explains answer
M14_11B	Uses data from a bar graph to determine whether a conclusion is true and explains answer.

Items Above Advanced International Benchmark (625)

Number

M02_05	Solves a multi-step word problem involving unit price (2 of 2 points)
M02_05	Solves a multi-step word problem involving unit price (1 of 2 points)
M09_04	Determines the missing digit for a two-digit number that satisfies two conditions
M08_04	Solves a word problem by implementing a one-step rule to generate numbers in a pattern
M03_05	Solves a word problem involving division with a remainder and justifies the solution (2 of 2 points)
M12_03	Adds a one-place decimal and a two-place decimal

Measurement and Geometry

M10_09	Solves a multi-step word problem involving multiplication and division of lengths, with a remainder (2 of 2 points)
M01_08	Identifies a net of a given object
M05_07	Identifies a rule to sort shapes into two sets
M09_10B	Draws a perpendicular line on a square grid given conditions
M10_08	Identifies properties of a parallelogram and a rectangle

Data

M04_11	Analyzes data in two bar graphs to refute a conclusion
M08_14	Represents data from a table in a line graph (2 of 2 points)
M08_14	Represents data from a table in a line graph (1 of 2 points)

Appendix 15B: Grade 4 Science Item Descriptions Developed During the TIMSS 2019 Benchmarking

Items at Low International Benchmark (400)	
Life Science	
S06_01	Recognizes an animal that has a backbone
S10_01	Identifies 4 or 5 of 6 animals as birds, insects, mammals, or reptiles (1 of 2 points)
Physical Science	
S04_10	Identifies the most likely material making up a spoon that gets hot sitting in a pot of boiling soup
Earth Science	
S04_12	Identifies natural resources used to grow plants

Items at Intermediate International Benchmark (475)	
Life Science	
S14_05	Explains why a plant kept by a window is healthier than a plant kept in a closed closet
S12_05	Identifies the characteristic used to sort animals into two groups
S04_01	Recognizes the function in common between a hedgehog's spines and snail's shell
S13_03	Analyzes a diagram to explain which flower will grow better
S01_01	Recognizes that in mammals, a male and female of the same kind are needed to reproduce
S11_06	Describes one way a polar bear's fur helps it survive (1 of 2 points)
S03_05	Describes how human heart rate changes during exercise

TIMSS & PIRLS
International Study Center
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S06_04	States two reasons why a plant will not survive by analyzing given conditions
S05_04	States one reason why plastic objects in the ocean are dangerous for sea animals
S03_03	Recognizes a living thing that produces its own food (1 of 2 points)
S04_03	Identifies a predator and its prey
S09_02	States two things that plants need from their environment to make their own food
S13_04	Evaluates two diagrams to explain which environment is better for sharks
S10_02	Explains why a person should wash their hands before eating even if they do not appear dirty
S09_01	Recognizes why milk is important in a balanced diet

Physical Science

S06_06	Recognizes the states of matter of three different materials
S09_08	Classifies materials as solids, liquids, or gases
S10_10	Recognizes an object that could be used to complete a circuit to light a bulb
S13_08	Identifies the best material to complete a circuit
S07_09	Using a model of a flashlight, identifies an object that can be used to complete an electrical connection
S08_08	Predicts what will happen to magnets in plastic and iron cups when the cups are turned upside down
S14_08	Identifies which of six objects can be picked up using a magnet
S10_07	Explains why a flashlight needs batteries in order to turn on
S12_07	Describes what will happen to the temperature of a table where it touches the bottom of a hot cup of tea
S04_07	Identifies the diagram that shows a circuit where a bulb will be lit

S11_10	Identifies why a bulb will not light in a model of an electric circuit
S07_08	Gives a reason why two objects of the same shape and size travel different distances after a push
S09_09	Explains why one object requires more force to start its motion than another
S02_10	Recognizes the best explanation for why a box on a cart is easier to pull than a box resting directly on the floor
S08_07	Recognizes the ramp that will make it easiest to move a heavy box onto a table

Earth Science

| S05_10 | Matches each item in a list of Earth's landscape features to its description |
| S14_11 | Recognizes the cause of the movement of sand dunes in a desert |

| **Items at High International Benchmark (550)** | |

Life Science

S02_01	Lists two living things and two nonliving things shown in a picture of a desert ecosystem
S02_03	Identifies characteristics that describe either a toy duck and a living duck or only a living duck
S06_02	Describes two ways that a mammal helps its young survive
S03_04	Recognizes a feature of how snakes eat
S01_05	Identifies a function of a plant's stalk by interpreting an observation from an investigation
S02_02	Identifies the human organ with the same function as a fish's gills
S11_03	Completes a diagram describing the stages in the life cycle of a flowering plant
S12_01	Orders the life stages of a butterfly within a diagram

S08_04	Identifies the process that must have occurred in a strawberry plant from two pictures of the plant taken four weeks apart
S14_02	Recognizes another life stage of a caterpillar
S04_05	Identifies the characteristics that a female rabbit's mate must have
S10_05	Recognizes a characteristic of a seedling that will show whether it is a fir tree or a cherry tree
S08_02	Identifies the picture showing the seedling form of an adult plant
S02_06	Describes how holding its tail over its head helps a ground squirrel survive in hot, dry environments
S05_03	Recognizes an advantage of thin, pointed leaves compared to broad, flat leaves
S11_04A	Interprets data from an investigation to recognize the best condition for growing plants
S09_03	Identifies a reason that some mammals pant on hot days
S11_05	Relates factory pollution to its effect on farm fields
S14_01	Identifies which of six animals could live in a desert
S02_04	Explains how an increase in the number of bats in an area could lead to a decrease in the number of insects
S03_02	Uses a list of living things in an Arctic ecosystem to complete a food chain
S08_03	Completes a food chain using three given animals
S06_03A	Uses a food web to identify what a predator eats
S05_05	Provides a possible reason why some trees in a group do not grow as well as others
S01_02	Explains that germs can be transmitted even when people do not appear to be sick
S04_06	Describes how germs can still spread if a person covers their mouth with their hands when they cough
S12_02	Explains how one way of eating ice cream exposes a person to fewer germs than another way of eating ice cream

| S09_06 | Recognizes a way to avoid spreading the flu |

Physical Science

S05_07	Describes a difference between ice and water in addition to their physical states
S11_07	Identifies a physical property of metal pot that makes it good for boiling water
S01_09	Using a diagram, identifies which hidden object could complete an electric circuit
S01_07	Observes that two metal bars repel and determines whether they are magnets
S12_10	Identifies an explanation for why magnets push against each other when they are brought together
S03_06	Identifies a way to sort objects containing metals
S10_08	Recognizes a pair of carts carrying magnets that will move away from each other
S03_08	Recognizes what happens to the water when a puddle of water on a metal tray becomes smaller
S11_09A	Explains why boiling decreases the amount of water in a container
S11_09B	Predicts the effect on a cold window glass of boiling water nearby
S07_06	States a reason for the color change and surface roughening of a metal object over time
S03_10	Explains why pressing a guitar string stops the sound
S05_09A	Identifies from a diagram how a shadow is formed
S03_07	Analyzes a diagram to identify one way to make a shadow bigger
S04_09	Identifies a graph showing the relationship between increasing the force used to hit a drum and the loudness of the drum's sound
S01_08	Explains that heat in a metal object reaches the nearest point soonest
S12_08	Recognizes the energy change occurring in a circuit with a battery and a lightbulb

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International Study Center
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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT 15.27

S14_09	Explains which of two circuits will have a lit bulb
S02_09	Recognizes the energy change that occurs when a flashlight is turned on
S14_07	Recognizes the energy change that occurs in an electric iron
S08_10	States the force that causes a skydiver and a book to fall
S14_10	Recognizes the force that makes it more difficult to move a sofa on a rug than on a wood floor
S02_08	Recognizes the force that causes a skydiver to fall to Earth
S12_06	Identifies the force that makes an open parachute fall more slowly than a crumpled parachute
S08_09	Identifies a description of how a pulley makes it easier to move a heavy box

Earth Science

S08_11	Recognizes what covers most of Earth's surface
S14_12	Recognizes the best way to replenish a forest from which wood is taken
S12_12	Explains what a fish fossil reveals about the history of a desert area
S08_12	Interprets data in a table to identify which of two locations is a desert and explains reasoning
S06_10A	Interprets information from a graph to recognize which crops will grow best in an area with given precipitation
S03_12	Recognizes which step in a diagram of a water cycle shows evaporation
S11_01	Recognizes which place is likely to have weather that is hot and wet
S01_11	Recognizes that the solar system is made up of the Sun and its planets
S03_11	Using two pictures of the same location, explains that the Moon can look different at different times
S10_13	Recognizes pictures of shapes the Moon can have

S12_13	Identifies a diagram that represents the Solar System
S07_11	Recognizes a feature of the Moon from observations over a month
S11_02	Recognizes seasons north and south of the Equator
S04_11	Interprets a diagram of the Sun and the Earth to identify the season in a labeled city

Items at Advanced International Benchmark (625)

Life Science

S01_04	States two things in addition to water that animals need to survive
S05_01	States one difference between living things and nonliving things
S10_01	Identifies 6 of 6 animals as birds, insects, mammals, or reptiles (2 of 2 points)
S07_01	Recognizes the function of muscles attached to bones
S07_05	Draws a conclusion by relating one function of feathers to keeping a body warm in the case of dinosaurs
S03_01	Recognizes the plant part that produces seeds
S09_04	Identifies a difference in the life cycles of a grasshopper and a butterfly
S04_04	States either an advantage for a dandelion to make many seeds or an advantage for a dandelion to make light, fluffy seeds (1 of 2 points)
S07_03Z	Recognizes whether labeled features of a bird are inherited
S12_03	Identifies an explanation for why laying many eggs is helpful for insects' survival
S01_03B	Identifies a desert plant and describes one feature that helps it survive in the desert
S10_04	States why it is better for a lemur to sit in the sun with its arms outstretched rather than at its sides in order to get warm

S11_06	Describes two ways a polar bear's fur helps it survive (2 of 2 points)
S07_04	Evaluates three experimental designs and explains which is best to test if plants need light to grow
S08_06	States one way that the human body reacts to cold temperatures
S11_04B	Identifies a conclusion about plant growth using data from an investigation
S10_06	Recognizes the ecosystem where a set of living things is most likely to be found
S02_05	Recognizes how a Venus flytrap differs from most other plants
S09_05	Predicts the consequences of removing a predator from an animal's habitat
S12_04	Explains why the number of mice in a town increased after trees were cut down
S10_03	Identifies the food chain that best shows how energy is transferred from the Sun to an owl
S06_03B	Uses a food web to determine which animals are competitors
S13_02	States two ways to avoid catching illness in a crowded space
S13_05	Describes how boiling water makes it safe to drink

Physical Science

S13_06	Recognizes one property of a liquid
S01_06	Identifies that two objects of the same size and shape have the same volume and, from a diagram, that they have different masses
S06_08	Explains how to separate a mixture of two types of solids of different sizes
S09_07	Predicts which of two objects is a better conductor of heat with supporting explanation
S11_08A	Evaluates the best way to separate a mixture of solids of similar size
S05_08	Identifies that the temperature at which an object melts depends on the material from which it is made

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S11_08B	Evaluates the best way to separate a mixture of things that dissolve and things that do not dissolve
S04_08	Predicts how a train car with a magnet attached will move when another train car with a magnet attached is brought towards it
S02_07	Recognizes a change in which the materials in objects stay the same
S06_09A	Recognizes set-ups that will more quickly dissolve a solid in water
S06_09B	Explains the importance of controlling a variable in an experiment
S13_07	Evaluates the best set-up to investigate whether temperature affects the rate at which a solid dissolves in water
S14_06	Identifies a statement describing the change that occurs when water boils
S10_09	Identifies conclusions that are supported by the results of an experiment during which a gas is collected in a balloon
S05_09B	Recognizes that a shadow produced in colored light is black
S09_10	States one form of energy present in a model of an electric circuit (1 of 2 points)
S13_09	Recognizes a diagram that demonstrates motion due to gravity

Earth Science

S01_10	Identifies the diagram that shows relative amounts of water and land on the Earth's surface
S02_11A	States one advantage of farming near a river
S02_11B	States one disadvantage of farming near a river
S05_11	Identifies how fish fossils are formed
S09_12	From pictures of rock formations, identifies how a given rock may have looked long ago
S10_12	Identifies the best explanation for finding a tropical plant fossil in a cold region
S13_10	Relates two different environments and weathering effects on rocks

S13_12	Interprets information from temperature graphs to identify which of two places has certain climate properties
S06_10B	Synthesizes precipitation information from a graph and diagram to recognize the best area to plant a crop in a given climate
S07_10	Identifies that clouds are made of water droplets
S09_11	Recognizes a diagram showing the correct relative positions of the Earth, Moon, and Sun
S02_12	Places the Earth in a model to show its position relative to the Sun when a labeled city is experiencing summer
S07_12	Interprets a diagram of the Earth and the Sun to describe how Earth turning on its axis causes day and night in a particular location
S08_13	Identifies a picture of a tree and its shadow in the afternoon based on a picture of the tree and its shadow in the morning
S12_11	Interprets a diagram of a man and his shadow to identify the Sun's relative position when his shadow will be shorter

Items Above Advanced International Benchmark (625)

Life Science

S04_02	Identifies which of four animals have backbones
S07_02	Recognizes the main function of leaves on a plant
S04_04	States both an advantage for a dandelion to make many seeds and an advantage for a dandelion to make light, fluffy seeds (2 of 2 points)
S14_04	Explains why a single elephant calf has a better chance of survival than a single frog egg
S01_03A	Explains that to test the survival of plants, they should be compared under different conditions
S05_06	Identifies that more use of public transportation will decrease air pollution in a large city
S03_03	Recognizes a living thing that produces its own food and describes the process (2 of 2 points)
S08_05	Identifies the animal that competes with giraffes for food

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT 15.32

Physical Science

S07_07	Explains why a metal spoon in hot soup feels hotter than a wooden spoon in hot soup
S06_07	Explains the process by which wet objects become dry
S03_09	States one source of energy other than sunlight that can be changed into electricity
S09_10	States two forms of energy present in a model of an electric circuit (2 of 2 points)

Earth Science

S13_11	Recognizes four true statements about recycling metals
S14_13	Explains one benefit of using sunlight or wind to produce electricity compared to oil or natural gas
S10_11	Interprets data in a table to identify the place where is it most likely to rain

Appendix 15C: Grade 8 Mathematics Item Descriptions Developed During the TIMSS 2019 Benchmarking

Items at Low International Benchmark (400)	
Number	
M09_01	Recognizes a 7-digit number given in words

Items at Intermediate International Benchmark (475)	
Number	
M01_02A	Solves a word problem involving addition of time
M06_01	Solves a word problem involving subtraction of negative numbers
M07_03	Solves a two-step word problem involving whole numbers
M05_02	Solves a word problem involving subtraction of negative numbers
M04_03	Determines whether a series of decimals are greater than, less than, or equal to fractions (1 of 2 points)
M06_02	Identifies equivalent ratios
M10_05	Given a ratio, represents an equivalent ratio pictorially
Algebra	
M04_07A	Solves a word problem involving an inequality and explains answer
M08_08A	Extends a given geometric pattern to supply the value of the 7th term
Geometry	
M02_10	Determines the value of an angle in an irregular quadrilateral given the values of the other angles

M14_10	Identifies the reflections of irregular shapes
M11_11	Determines the total number of stacked unit cubes

Data and Probability

M05_12	Finds and compares the unit prices of four objects
M05_14	Identifies the bar graph that matches the information shown in a table
M07_12A	Compares data from two line graphs to solve a problem
M07_12B	Reads data from a line graph
M09_12A	Calculates mean and median for one ordered lists of data (1 of 2 points)
M13_11	Evaluates information given by a time/distance graph
M01_12	Solves a problem given the chance of an outcome
M03_14A	Estimates an expected value given an observed sample

Items at High International Benchmark (550)

Number

M03_01	Identifies an expression equivalent to a given division expression
M05_01	Evaluates an expression involving negative whole numbers and parentheses
M05_05A	Solves a word problem involving multiplication and addition of whole numbers
M10_01	Adds two numbers with different exponents and bases
M11_02	Solves a word problem involving division of whole numbers with a remainder

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M14_01	Identifies the number with the most factors
M01_03	Understands a property of adding multiples
M01_04	Writes a decimal with three places as a fraction
M03_03	Finds the missing value in an addition problem with both fractions and decimals
M04_03	Determines whether a series of decimals are greater than, less than, or equal to fractions (2 of 2 points)
M05_04	Given the two parts of a whole in a word problem, identifies the fraction which represents one part
M07_04	Determines what fraction of a 10X10 grid is shaded
M13_02	Solves a two-step word problem involving subtraction of whole numbers and multiplication of a fraction
M14_02	Determines the numerator that makes two fractions equivalent
M01_01	Identifies the representation of a fraction equivalent to a given representation of a fraction
M08_02	Adds two decimals represented in words
M11_01	Solves a word problem involving a fraction of a whole
M12_03	Identifies a decimal equivalent to the sum of two fractions with denominators that are powers of ten
M04_04	Solves a word problem involving a fraction of a whole
M02_04	Solves a word problem involving a three-part ratio
M03_04	Shades a percent of a figure
M10_04	Solves a word problem involving ratios
M13_04	Solves a word problem involving ratios and decimals
M14_04A	Determines a ratio to model a situation

M14_04B	Determines a ratio to model a situation
M07_01	In a word problem for dividing a given quantity in a given ratio, determines the quantity of one of the parts.

Algebra

M01_06	Identifies the equivalent algebraic expression involving exponents and multiplication
M02_07	Solves a word problem involving evaluating a formula with exponents
M10_06	Evaluates an expression with two variables
M10_09	Solves a pair of simultaneous linear equations in two variables
M12_06	Evaluates a formula with an exponent
M12_08	Solves a word problem involving simultaneous linear equations in two variables
M14_05	Identifies an expression that represents a situation
M14_06	Solves a linear equation involving fractions
M14_07	Solves a word problem involving evaluating a formula with two variables
M05_07	Evaluates an algebraic expression involving fractions and integers
M08_05	Evaluates an expression with a square root and two variables with exponents
M08_07	Solves a multi-step word problem involving linear inequalities
M11_06	Identifies an equation that models a situation
M02_05	Evaluates an expression with two variables
M03_07	Identifies an algebraic expression that represents the perimeter of an irregular shape
M04_06	Evaluates an equation with three variables

M07_06	Evaluates the power of an expression given its value
M11_07	Identifies an expression for the area of part of a geometric figure
M13_05	Solves a linear equation in two-variables given the value of one variable
M01_07A	Extends a given geometric pattern to find the value of the 10th term
M03_08	Determines a missing coordinate for a linear relationship given in a table
M04_08A	Extends a given geometric pattern to supply the value of the 10th term
M11_08	Uses values for a linear function to determine an extrapolated value
M13_07	Identifies the true statement about a linear relationship given in a graph

Geometry

M02_11	Compares properties of two open cylinders made by rolling the same rectangle in different directions
M02_12	Determines the coordinates of a trapezoid's missing vertex given a congruent trapezoid in the Cartesian plane
M03_10	Finds the coordinates of a midpoint given two points in the Cartesian plane
M03_12	Draws rectangle on square grid given area and perimeter (1 of 2 points)
M05_10	Identifies the value of an angle involving properties of corresponding and supplementary angles
M07_10	Solves a problem involving similar triangles
M08_09A	Determines the area of a parallelogram given its base and height
M08_09B	Uses the Pythagorean theorem to solve for a side length of a parallelogram and calculates the perimeter (1 of 2 points)
M08_10	Completes a parallelogram in the Cartesian plane given three of its vertices
M09_09	Recognizes congruent quadrilaterals

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT 15.38

M13_08A	Solves a word problem involving the length around a hexagonal prism
M13_09	Determines the number of exposed faces for unit-cubes that make up a larger cube (1 of 2 points)
M01_11	Solves a problem involving angles of a triangle
M10_13	Identifies the net of a triangular prism
M11_09	Identifies the reflection of a partly shaded shape
M12_10	Solves a two-step word problem involving volume of a rectangular prism and cost

Data and Probability

M02_13	Computes the mean of five positive and negative values
M02_14	Identifies an appropriate graph for three different types of data
M06_13A	Computes the mean of four given values
M08_11A	Determines the mean value of data represented by four bars in a bar graph
M10_14	Identifies relevant considerations for systematic data collection
M12_14A	Computes the mean of five six-digit numbers
M14_14	Estimates the value of a bar in a bar graph without a scale given the value of another bar
M01_13B	Uses and interprets data sets in pie charts to solve a problem involving percentages
M08_12	Estimates the probability of an event given an observed sample
M11_14	Draws a spinner that has given probabilities
M12_13	Estimates the probability of an event given an observed sample
M06_12	Estimates the number of objects in a given probability sample

Items at Advanced International Benchmark (625)	
Number	
M02_01	Recognizes true or false statements based on properties of operations
M03_02	Solves a two-step word problem involving whole numbers
M04_01	Identifies numbers that are perfect squares
M04_02	Analyzes truth of statements about the properties of a whole number
M05_05B	Solves a non-routine word problem involving whole numbers
M06_04	Uses four different digits to write two two-digit numbers with the smallest product
M08_01	Justifies that a given number satisfies a condition for its parity and factors
M12_01	Determines two integers that satisfy two conditions involving their sum and product
M07_02	Identifies a prime number
M13_01	Identifies an expression equivalent to a given multiplicative expression
M02_03	Solves a multi-step problem involving addition and subtraction of fractions
M08_03	Determines the missing value in a multiplication sentence involving fractions
M10_02	Determines the location of the product of two fractions on a number line
M12_02	Orders fractions and decimals
M12_04	Determines the denominator that makes the sum of a fraction and a whole number equivalent to a decimal
M14_03	Uses four different digits to write two fractions with the largest product

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BOSTON COLLEGE

CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT   15.40

M02_02	Identifies the location of a fraction on a number line
M01_02B	Solves a word problem involving percentages and elapsed time
M05_03	Solves a two-step word problem involving percentages
M06_03	Determines the dimensions of a rectangle that is similar to a given rectangle
M08_04	Recognizes fractions and decimals equivalent to a given percentage
M09_02	Given the volume of a fraction of a container, determines the total volume for multiple containers of the same size
M09_03	Solves a word problem involving price per unit and explains reasoning
M11_03	Completes a table of equivalent proportions and percentages (2 of 2 points)
M11_03	Partially completes a table of equivalent proportions and percentages (1 of 2 points)
M11_04	Solves a word problem involving ratios
M12_05	Solves a word problem involving ratios
M13_03	Identifies a percentage using a given ratio
M07_05	Identifies a true statement about percentages of given numbers

Algebra

M02_08	Constructs a linear equation for the perimeter of a triangle and solves for the length of one side
M05_06	Identifies an equivalent algebraic expression
M05_08	Uses a given formula involving fractions to solve a word problem
M06_08	Constructs a linear equation for the perimeter of a rectangle and finds the area (2 of 2 points)
M06_08	Constructs a linear equation for the perimeter of a rectangle and finds the area (1 of 2 points)

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M08_06	Identifies an inequality that represents the relationship between the areas of two rectangles
M09_05	Simplifies an algebraic expression
M09_08	Constructs a linear equation for the perimeter of a triangle and solves for the length of one side
M10_07	Adds two expressions with two variables and simplifies the result
M12_07	Identifies a simplified expression equivalent to a given expression with parentheses
M14_08	Identifies a simplified expression equivalent to a given expression with fractions and two variables
M14_09	Identifies a pair of linear equations in two variables that represent a situation
M01_05	Identifies an algebraic expression that represents the area of a given rectangle
M02_06	Identifies an expression with parentheses equivalent to a given expression without parentheses
M04_07B	Identifies an inequality that represents a situation
M06_05	Identifies an expression that represents a situation
M10_08	Solves a word problem involving evaluating a formula with an exponent
M01_08	Identifies the graph of a linear equation
M04_08B	Constructs an expression for the nth term of a geometric pattern
M05_09	Demonstrates an understanding of slope by relating graphs and their equations
M06_06	Constructs a linear equation to represent a situation
M08_08B	Extends a given geometric pattern to supply the value of the 50th term
M09_06	Retrieves coordinate points from a graph of a function
M10_10	Constructs an equation to describe the relationship between two quantities

M12_09A	Extends a given geometric pattern to supply the value of the 5th term
M12_09B	Constructs an expression for the nth term of a geometric pattern
M13_06	Identifies the slope of a line given its equation
M02_09	Identifies a point that is collinear with three given collinear points
M03_06	Identifies a line with positive slope
Geometry	
M01_10	Determines the surface area of a prism given the dimensions of its net
M03_09	Uses properties of triangles and quadrilaterals to solve for an angle
M03_12	Draws rectangle on square grid given area and perimeter (2 of 2 points)
M04_09	Draws the image of a triangle translated horizontally and vertically on in the Cartesian plane
M04_10	Solves a two-step problem involving the area of a triangle inscribed in a square (2 of 2 points)
M04_10	Solves a two-step problem involving the area of a triangle inscribed in a square (1 of 2 points)
M05_11	Draws an angle of a given measure on a square grid
M06_10	Finds vertices of triangles created from trapezoids in the Cartesian plane (1 of 2 points)
M06_11	Uses properties of supplementary angles to solve for an angle
M07_09	Draws all lines of symmetry on a regular polygon
M10_11	Determines the area of a square given the side length of a regular hexagon with the same perimeter
M10_12	Solves a word problem involving circles and similar triangles
M11_10	Determines the number of faces of a solid with unit cubes removed

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M12_11	Solves for a missing side length given two similar triangles in context
M13_08B	Solves a word problem involving the lateral surface area of a hexagonal prism
M13_10	Solves a word problem involving the Pythagorean theorem
M14_11	Uses properties of corresponding and supplementary angles to solve for an angle in a geometric figure
M14_12	Justifies that a right triangle and obtuse triangle with the same base and height have the same area
M14_13	Determines the surface area of a rectangular prism given its length, width, and height
M09_10	Finds the coordinates of a vertex of a rectangle given the other three vertices

Data and Probability

M01_13A	Uses and interprets data sets in pie charts to solve a problem involving percentages
M04_11	Identifies relevant considerations for systematic data collection
M06_13B	Determines the change in a mean given changes in individual scores
M07_14	Justifies a conclusion resulting from comparing two distributions
M09_12A	Calculates mean and median for two ordered list of data (2 of 2 points)
M14_16	Explains the change in a mean given changes in individual values
M07_13	Interprets data in a pictograph to solve a multi-step problem
M11_13	Interprets a histogram to identify a proportion
M14_15	Identifies the optimal data display to answer a given question
M03_14B	Compares observed and expected values
M04_12A	Computes the probability of an event given the number of each type of object in a set

M04_12B	Computes the probability of an event given the number of each type of object in a set
M09_13	Solves a multi-step problem involving probability
M13_13	Identifies the conditional probability of an event

Items Above Advanced International Benchmark (625)

Number

M02_01	Recognizes equivalent expressions based on properties of operations (2 of 2 points)
M09_04	Given four different containers, identifies the container with the greatest fraction filled
M04_05	Given a ratio in a table, completes two equivalent ratios with one part missing in each

Algebra

M03_05	Identifies the equivalent form of a linear inequality in one variable
M07_07	Identifies an algebraic expression involving parentheses and negative terms
M07_08	Solves a pair of simultaneous linear equations
M11_05	Identifies equivalent rational expressions
M01_07B	Gives a rule for the nth term of a geometric pattern
M08_08C	Constructs an expression for the nth term of a geometric pattern
M09_07	Determines a collinear point given another point on the line and the slope

Geometry

M01_09	Identifies the image of a shape after rotation and reflection
M03_11	Solves for a missing side length given two similar triangles
M06_09	Estimates area of an irregular shape on a square grid
M06_10	Finds the coordinates of the vertices of triangles created from trapezoids in the Cartesian plane
M07_11	Solves a multi-step word problem involving ratios between volumes
M08_09B	Uses the Pythagorean theorem to solve for a side length of a parallelogram and calculates the perimeter (2 of 2 points)
M09_11	Explains why two shaded areas of overlapping congruent triangles are equal
M12_12	Solves a word problem involving a quarter of the circumference of a circle (2 of 2 points)
M12_12	Solves a word problem involving a quarter of the circumference of a circle (1 of 2 points)
M13_09	Determines the number of exposed faces for unit-cubes that make up a larger cube (2 of 2 points)

Data and Probability

M02_15	Explains why a statement about data in a bar graph with a y-axis scale that does not start at 0 is incorrect
M03_13	Compares characteristics of two dot plots to justify a conclusion
M05_13	Explains why a data representation could be misleading
M08_11B	Converts the value of a bar in a bar graph to a percent
M10_15	Compares data in two pie charts with different totals to refute a conclusion
M11_12	Solves a word problem involving averages

Appendix 15D: Grade 8 Science Item Descriptions Developed During the TIMSS 2019 Benchmarking

Items at Low International Benchmark (400)	

Biology

S11_04	Describes one characteristic of mammals that is advantageous for survival in cold weather (1 of 2 points)
S01_01	States one reason why male penguins' incubation behavior helps their eggs survive (1 of 2 points)
S13_01B	Uses a food web to identify which organisms eat only plants

Chemistry

S10_10	Identifies the form of wood that will burn fastest based on its size (1 of 2 points)

Physics

S11_15	Recognizes whether an electromagnet would attract objects made of various materials

Earth Science

S10_15	States what must be removed from clean ocean water in order for a person to be able drink it

Items at Intermediate International Benchmark (475)	

Biology

S12_03	Matches 4 of 5 organism groups to defining biological characteristics (1 of 2 points)
S09_04	Justifies an advantage of hollow bones for birds
S14_01	Evaluates a diagram to identify an advantage of a fish's field of vision
S06_04A	Identifies one way that plant and animal cells are similar (1 of 2 points)

S13_04	Recognizes the functions of 2 of 4 tissues found in the human stomach (1 of 2 points)
S06_02	States one substance plants obtain from their environment and use in photosynthesis (1 of 2 points)
S09_03	Recognizes characteristics inherited by rabbits in a given context
S05_03B	Reasons how a crocodile's angle of vision helps it to survive in the environment
S14_05	Identifies the rock layer containing the oldest fossils and justifies the choice
S10_05	Places four organisms in a model of an energy pyramid
S13_01A	Uses a food web to identify which organisms are producers
S08_01	Identifies the best description of the advantages to bird and crocodile in the symbiotic relationship formed when a bird picks food from around a crocodile's teeth
S05_02	Analyzes information about an ecosystem and explains the effect of introducing a new population
S04_04	Explains how reducing the number of vehicles in a city center affects air quality
S07_01A	Recognizes the agent that causes influenza
S14_02	Identifies diseases associated with 4 of 4 human behaviors

Chemistry

S07_05Z	From a list of symbols and formulas, recognizes which are elements and which are compounds
S01_07	Applies knowledge of concentration to explain why one solution is paler than another solution
S12_09	Explains that volume is one factor that can be used to identify the solution with a higher concentration of solute (1 of 2 points)
S07_07	Recognizes an everyday occurrence that is an example of a chemical change
S03_01	Recognizes a chemical process that involves the absorption of light

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT   15.48

Physics

S14_12	Identifies the glass of ice cubes that will melt faster based on the ice cubes' size (1 of 2 points)
S03_09	Recognizes the type of energy change that occurs as a child slides down a slide
S10_13	Recognizes 5 of 5 materials as conductors or insulators based on a graph showing the electric current in circuits containing the materials
S12_13B	Identifies a statement describing the movement of a motorbike in a chronophotograph
S02_12	Recognizes why a vehicle has a different weight on Mars than it does on Earth

Earth Science

S01_12	Recognizes the reason for cold temperatures outside an airplane in flight
S13_15	Synthesizes information in rainfall and temperature graphs to match 2 of 4 animals with the climate where they live (1 of 2 points)
S04_13	Identifies 5 or 6 of 7 activities as examples of reducing, reusing, or recycling (1 of 2 points)
S14_15	Interprets a diagram to identify the position of the Moon in orbit during a specific phase of the Moon

Items at High International Benchmark (550)

Biology

S04_01	Applies knowledge of mammals to identify how echidna differ from most mammals
S04_02	Identifies examples of animals belonging to 4 of 4 groups of organisms
S10_06	States one biological difference between fish and mammals (1 of 2 points)
S12_03	Matches 5 of 5 organism groups to defining biological characteristics (2 of 2 points)
S08_02	Identifies the body systems to which 4 of 4 organs belong

S09_02	Recognizes 2 of 3 major organs in a diagram (1 of 2 points)
S14_04	Explains why the percentage of oxygen differs in inhaled and exhaled air or why the percentage of nitrogen is the same in inhaled and exhaled air (1 of 2 points)
S11_04	Describes two characteristics of mammals that are advantageous for survival in cold weather (2 of 2 points)
S13_03	Predicts how heart rate changes in response to exercise, based on a set of given conditions
S04_03	Recognizes where new cells come from as an organism grows
S10_01	Identifies the functions of 5 of 5 human cell types (2 of 2 points)
S10_01	Identifies the functions of 4 of 5 human cell types (1 of 2 points)
S13_02	Explains how a fossil can be classified as plant or animal, based on its cellular structure
S01_02	Recognizes an organism that is made up of cells with cell walls
S08_03	Identifies an implication of removing a plant cell's chloroplasts
S09_01	Recognizes what happens to an animal's cells as it grows
S08_05	Identifies where DNA is located in a human body cell
S10_02	Identifies acquired characteristics of a pet bird
S06_03	Recognizes why rabbits inherit traits that their parents do not have
S14_03	Interprets a diagram to identify the source of DNA responsible for a plant's flower petal color
S12_05	Identifies the statement about python and boa evolution that is best supported by given information
S11_03	Identifies the conclusion best supported by a diagram of rock layers with embedded fossils
S01_03	Recognizes how decomposers get their energy
S02_03	Explains how roof gardens in cities help reduce the amount of carbon dioxide in the air

S12_01	States the part of tomato plant that releases the most water
S02_04	Recognizes an explanation for why the mass of leaves removed from a tree decreases over time
S01_04	Given a food chain, explains which organism competes most with humans in a farming community
S01_05Z	For pairs of animals, distinguishes between predatory and competitive relationships
S08_06	Uses information in a table to explain why the abundance of one specie in an ecosystem changed between two given years (1 of 2 points)
S04_05	Interprets a food web to identify a predator/prey relationship
S02_01	Recognizes the relationship that occurs when insects that feed on nectar pollinate flowering plants
S03_06A	Evaluates data from a table to draw a conclusion about the reason for a change in population of a species
S07_04	Explains how flooding leads to a shortage of drinking water or the spread of disease (1 of 2 points)
S11_02	Explains why it is unlikely for someone to get sick with the measles a second time
S03_05	Selects and classifies 3 of 4 foods from a list that comprise a balanced diet (1 of 2 points)
S05_01	Recognizes which food is the best source of carbohydrates
S11_01	Recognizes a list of food that comprises a healthy, balanced meal

Chemistry

S02_06	Identifies the subatomic particle that is locates outside of an atom's nucleus
S11_06	Identifies the number of atoms of each element in nitric acid
S03_02	Recognizes a model of a carbon dioxide molecule
S08_10	Identifies an explanation of how carbon dioxide can extinguish a fire
S12_07	Recognizes a chemical property

S10_08	Identifies a necessary property for a liquid in a thermometer
S04_08B	States one variable to hold constant when investigating reactivity of different types of steel with water (1 of 2 points)
S07_10	Explains the effect of temperature on diffusion in the context of an investigation
S11_07	Uses data in a table to order set-ups according to the rate at which a solute will dissolve in water
S05_07	Recognizes a property that is common to both acids and bases
S05_08	Recognizes which process makes bronze dark and dull over time
S13_11	Explains whether a reaction between two solutions in a given context can occur a second time
S08_08	Interprets a diagram to identify the number of hydrogen atoms present before a chemical reaction

Physics

S08_12	States that the amount of a substance present in its liquid form and present in its solid form is the same (1 of 2 points)
S02_11	Recognizes steps that should be taken to ensure an experiment will show whether iron or copper is the better conductor of heat
S09_05	Relates knowledge of heat transfer to recognize a graph that shows how two substances eventually reach temperature equilibrium
S13_07	Recognizes whether a red object will absorb or reflect different colors of light
S02_13	Applies knowledge of sound transmission to explain whether a ringing cell phone in a vacuum can be heard outside the vacuum chamber
S06_07	Recognizes which graph represents a musical note with given specifications for volume and pitch
S01_09B	Explains that in a parallel arrangement of two bulbs, one bulb failing does not affect the other bulb
S08_14	Recognizes for 5 statements about magnets whether they are true or false
S01_10	Recognizes the best explanation of why two bar magnets repel each other
S04_12	States the force represented by an arrow in a diagram of a falling object

S05_06	Recognizes and explains which substance will float on water using a table of densities
S05_10	Given the densities of two objects and three liquids, and diagrams showing the objects floating or sinking in the liquids, identifies each liquid
S10_11	Explains how deploying a parachute slows a skydiver's fall
S13_06	Relates knowledge of density to indicate the order in which three liquids will settle after being poured in a beaker
S06_08	Recognizes a free-body diagram that has a total force acting towards the right

Earth Science

S13_14	Recognizes sources of fresh and salt water in a diagram
S02_16	Interprets a diagram to identify the natural resource that is formed during the process depicted
S06_01	Recognizes the process in the water cycle indicated in a diagram of an ecosystem
S02_15	Identifies evidence that the Earth is becoming warmer over time
S06_13A	Relates information in temperature graphs and maps to recognize climatic attributes of two cities
S11_11A	Interprets information in a climate graph to determine the warmest and driest month of the year
S13_13	Identifies how the melting of permafrost can affect the Earth's climate
S13_15	Synthesizes information in rainfall and temperature graphs to match 4 of 4 animals with the climates where they live (2 of 2 points)
S05_13	Uses a graph of average monthly temperature to identify the city most likely to be located at the equator
S09_13	Identifies a disadvantage of using solar energy
S04_14	Recognizes the best explanation for why a river floods more often after a forest is cleared
S01_11B	Synthesizes information from tables about revolution times around and distances from the Sun to infer relative distances of planets from the Sun
S12_14	Identifies the best explanation for why Saturn is visible from Earth

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT 15.53

| S01_11A | Uses information in a table with characteristics of planets to identify the planet with the shortest day length |
| S04_15 | Recognizes a description of how the Sun produces its own light |

Items at Advanced International Benchmark (625)

Biology

S02_05A	Classifies 7 of 7 animals as mammals or nonmammals
S10_06	States two biological differences between fish and mammals (2 of 2 points)
S14_04	Explains why the percentage of oxygen differs in inhaled and exhaled air and why the percentage of nitrogen is the same in inhaled and exhaled air (2 of 2 points)
S07_02	Interprets a diagram to identify what happens to biceps and triceps when an elbow bends
S02_02	Recognizes where DNA replication takes place in an animal cell
S06_04A	Identifies two ways that plant and animal cells are similar (2 of 2 points)
S06_04B	States one way that plant and animal cells are different (1 of 2 points)
S13_04	Recognizes the functions of 4 of 4 tissues found in the human stomach (2 of 2 points)
S10_04	Identifies an explanation for why plants in a tank with woodlice grow faster than plants in a tank without woodlice
S10_03	Identifies the tube containing two substances bacteria need for cellular respiration
S12_06	Identifies how fermentation differs from typical cellular respiration
S05_04	States one similarity between the life cycles of a bird and a frog
S07_03	Recognizes a human characteristic that is acquired
S01_01	States two reasons why male penguins' incubation behavior helps their eggs survive (2 of 2 points)

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT 15.54

S05_03A	Justifies a statement about crocodiles' adaptation to their environment, based on given facts
S03_04	Applies knowledge about the theory of evolution to identify the best conclusion supported by a diagram of limbs from different animals
S08_04	Identifies where the largest energy transfer occurs in an energy pyramid
S11_05	Recognizes an example of a symbiotic relationship between two organisms
S03_06B	Selects and evaluates data from a table to draw a conclusion about the likely reason for a change in population of a species
S14_06	States two ways that planting trees is beneficial for the environment
S12_02	Identifies a human activity that can increase the amount of nutrients in a pond
S14_07	Recognizes the function of white blood cells in the human immune system
S03_05	Selects and classifies 4 of 4 foods from a list that comprise a balanced diet (2 of 2 points)
Chemistry	
S04_07	States the subatomic particle that is not included in a diagram of an atom
S06_11	Recognizes what happens to the atoms in an object pounded flat
S09_08	Recognizes whether 4 of 5 substances are elements, compounds, or mixtures (1 of 2 points)
S02_07	Uses a portion of the periodic table to order four elements from the smallest atomic number to the largest atomic number
S14_08	Uses atomic numbers to identify the position of 4 of 4 elements in a portion of the periodic table
S10_09	Identifies a similarity between two elements in the same group of the periodic table
S04_08A	Explains how measuring the amount of rust on discs made from different types of steel will show which type of steel is more reactive with water
S07_06	Identifies an element as a metal or a nonmetal, based on a list of physical properties and predicts one additional property
S14_09	Compares/contrasts substances in a table to identify the property used to sort them into two groups

S03_03	Applies knowledge of density to identify and explain which liquid will leave a dropper first after a mixture separates
S12_08	Identifies pieces of equipment that could be used to separate and collect substances from 4 of 4 mixtures
S12_09	Applies knowledge of concentration to identify the cup of tea with the higher concentration of sugar (2 of 2 points)
S09_11	Explains whether a reaction took place after a pH indicator is added to a solution based on information provided about the indicator
S09_10	Identifies and explains whether a described change is physical or chemical
S06_10	Recognizes which model best illustrates the results of a chemical reaction
S12_10	Identifies the statement that best describes what occurs when iron sulfide is formed

Physics

S02_10	Recognizes a diagram of what happens to gas molecules inside a balloon when the balloon expands
S06_09	Explains the difference between a solid and air in terms of particle spacing in context
S11_13	Draws a conclusion about the states of substances in two pistons, based on the different amounts of compression that occurred
S05_09	Recognizes why gases are easier to compress than solids and liquids
S12_11	Recognizes what happens to water molecules in an ice cube when the ice cube melts
S14_11	Interprets a temperature graph to identify the process happening in a given section of the graph
S08_12	Applies the law of conservation of mass to compare the mass of a substance before and after a state change (2 of 2 points)
S01_08	Recognizes an everyday process that is an example of a physical change
S06_05	Recognizes how the mass of a metal ball will change as it cools down
S11_14	Recognizes the type of energy transformation that occurs when a car begins to move from rest
S10_12	Recognizes an experimental design that will determine whether an aluminum, iron, or ceramic bar conducts heat the fastest

S09_07	Recognizes an explanation for why a ball appears a certain color in a given context
S04_11	Uses a diagram to determine a position where an observer's shadow would not fall on a monument
S03_07	Recognizes which property of sound allows animals to navigate and find food
S14_13	Identifies a description of the relationship between sounds made by the longest and shortest bars on a xylophone
S01_09A	States one reason why a bulb in a diagram of an electrical circuit does not light
S08_13	Identifies the components that must be included in a circuit that will turn a bell on and off
S13_08	Indicates whether parts of a light bulb are electrical conductors or insulators
S01_09C	Recognizes a correct statement about battery life and bulb brightness in two given electrical circuits
S07_09	Recognizes how to increase the strength of an electromagnet
S08_11	States the two measurements needed to calculate average speed in an everyday context
S12_13A	Identifies the movement of a motorbike in a chronophotograph and explains how the chronophotograph reveals the motorbike's movement
S03_10	Identifies and explains which of three methods will require the smallest force to move a heavy box onto a truck
S12_12	Explains why a person slides down a waterslide faster when the water is turned on
S07_11	Applies knowledge about the relationship between depth and water pressure to recognize a conclusion about the pressure at different depths

Earth Science

S05_12	States one condition below Earth's crust that can be inferred from volcanic eruptions
S03_11	Recognizes a major source of water for desalinization plants
S09_12	Recognizes the gas that makes up most of Earth's atmosphere
S02_14	Recognizes why a balloon gets bigger as its height above the ground increases

S09_14A	Recognizes the process that forms rock layers
S14_14	Recognizes climatic conditions that cause rock to erode the fastest
S03_13	Uses a diagram of a mountain range on the ocean and a given wind direction to recognize which location will have the greatest rainfall
S07_12	Recognizes the source of energy for the water cycle
S04_13	Identifies 7 of 7 activities as examples of reducing, reusing, or recycling (2 of 2 points)
S06_12	Describes one geographic factor to consider when selecting a safe location for a nuclear power plant
S07_13	Explains one way trees protect soil from erosion
S13_12	Recognizes a negative effect that fertilizer can have on the environment
S08_17	Recognizes the main cause of water level changes in a harbor over the course of 24 hours
S07_14	Justifies a claim that the Moon travels around the Sun

Items Above Advanced International Benchmark (625)

Biology

S02_05B	States the biological characteristic used to distinguish vertebrates from invertebrates
S09_02	Recognizes 3 of 3 major organs in a diagram (2 of 2 points)
S06_04B	States two ways that plant and animal cells are different (2 of 2 points)
S06_02	States two substances plants obtain from their environment and use in photosynthesis (2 of 2 points)
S05_05	Identifies an explanation for disappearance of a trait over generations
S04_06	Identifies where the carbon in wood comes from

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CHAPTER 15: USING SCALE ANCHORING TO INTERPRET THE ACHIEVEMENT SCALES
METHODS AND PROCEDURES: TIMSS 2019 TECHNICAL REPORT 15.58

S08_06	Uses information in a table to explain why the abundance of two species in an ecosystem changed between two given years (2 of 2 points)
S03_06C	Predicts which species would best survive in a given environment, using information in a table, and provides a supporting explanation
S07_04	Explains how flooding leads to a shortage of drinking water and the spread of disease (2 of 2 points)
S07_01B	Explains how influenza can be spread rapidly around the world

Chemistry

S13_10	Recognizes a true statement about neutral atoms
S09_08	Recognizes whether each of five substances is an element, a compound, or a mixture (2 of 2 points)
S04_08B	States two variables to hold constant when investigating reactivity of different types of steel with water (2 of 2 points)
S08_07	Evaluates whether a series of steps will separate a mixture of salt, sand, and iron
S02_08	Interprets information in a table to determine if 3 of 3 solutions are acidic, basic, or neutral
S02_09	Recognizes the reason for a temperature increase when an acid and base are combined
S04_09	Identifies and explains the solution that should be combined with an acidic solution to neutralize it
S11_08	Recognizes a property of a basic solution
S14_10	Predicts the color of flowers that are produced when peat moss is added to soil with a given pH
S13_09	Explains how painting a metal prevents rust from forming
S10_10	Identifies the form of wood that will burn fastest based on its surface area (2 of 2 points)

Physics

S07_08	Recognizes the property of a gas in a dented ping pong ball that stays constant if the ball is heated
S09_09	Explains how a substance can be in two different states in a container at one time in a given context

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S14_12	Identifies the glass of ice cubes that will melt faster based on the ice cubes' surface area (2 of 2 points)
S10_14	Recognizes the position in a diagram where a thrown stone has the greatest kinetic energy
S03_08	Recognizes how the temperature of water changes over time when heated
S04_10	Interprets a graph to identify the description of how heat is transferred between a substance and its surroundings
S06_06	Uses a diagram to explain one way to increase the strength of an electromagnet
S09_06	Explains why a vehicle with tires is more likely to sink in the mud than a vehicle with treads

Earth Science

S14_16	Recognizes the diagram that best represents the structure of the Earth
S11_10	Recognizes the relative composition of gases in Earth's atmosphere
S09_14B	Given a diagram, explains a process that shaped a rock formation in the ocean
S11_09	Recognizes how oil is formed on Earth
S06_13B	Synthesizes information in temperature graphs and maps to recognize an explanation for the difference in seasonal climates of two cities at similar latitudes
S10_16	Identifies best explanation for why temperatures are hotter in a city center than in a meadow
S11_11B	Evaluates a conclusion about climate data, based on one week of weather observations
S08_16	Explains why oil, gas, and coal are nonrenewable resources
S08_15	Evaluates what kind of area would benefit most from a desalination plant
S05_14	Identifies an explanation for why a constellation visible one night is no longer visible six months later