Smarter Balanced Scoring Guide

For Selected Short-Text Mathematics Items (Field Test 2014)

Introduction

The Smarter Balanced Assessment Consortium provides this scoring guide to help educators understand how to score some of the short-text mathematics items that were included on the 2014 Smarter Balanced Field Test. While most of the test items administered as part of the Smarter Balanced assessments are machine-scored, some items must be scored by trained scorers using a process commonly called *handscoring*.

Professional scorers conducted the handscoring of students' responses following the 2014 Field test. These scorers were specifically trained to score student responses. Scorers used the Smarter Balanced general mathematics scoring rubrics and item-specific scoring criteria that teams of educators established and validated during rangefinding.

The process of rangefinding included a team of mathematics educators from Consortium states who worked with the contractor's handscoring staff to score a sample of student responses. A top-score response for each item was defined, and a range of responses representing the different score points was identified for each item. In this way, clear definitions of each score point were developed and agreed upon, and model responses, called *anchors*, were selected to represent the full range of responses for each possible score point.

These Field Test anchor sets for items become the training materials that are used to prepare scorers to score student responses for future administrations of the Smarter Balanced summative and interim assessments.

Each of the three mathematics items in this booklet includes the following information:[1]
- Claim
- Domain
- Target
- Depth of Knowledge (DOK)
- Common Core State Standards for Mathematical Content (CONTENT)
- Common Core State Standards for Mathematical Practice (MP)
- The actual item as it appeared in the 2014 Field Test
- The scoring guide for the item, which includes an example of a top-score response
- Sample (anchor) responses for each score point of the item
- Annotations for each sample response

The items that appear in this scoring guide were developed and field tested specifically to help build a common understanding of mathematical reasoning and determine how best to construct items that elicit autonomous chains of mathematical reasoning from students at different grade levels.

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[1] Most of these terms (Claim, Domain, Target, DOK, etc.) are defined in the Smarter Balanced *Content Specifications for the Summative Assessment of the Common Core State Standards for Mathematics*.

The three items in this guide are all 2-point short-text items. The general rubric that is used as a basis for scoring all 2-point short-text items is shown below.[2] Although item-specific rubrics are also provided to scorers to facilitate the handscoring of short-text items, every response should be able to map back to this general rubric in a consistent and reliable manner.

### Smarter Balanced Mathematics General Rubric for 2-Point Items

Score	Description
2	The student has demonstrated a **full and complete** understanding of all mathematical content and practices essential to this task. The student has addressed the task in a mathematically sound manner. The response contains evidence of the student's competence in problem solving, reasoning, and/or modeling to the full extent that these processes apply to the specified task. The response may, however, contain minor flaws that do not detract from a demonstration of full understanding.
1	The student has demonstrated a **partial** understanding of the mathematical content and practices essential to this task. The student's response contains some of the attributes of an appropriate response but lacks convincing evidence that the student fully comprehends the essential mathematical ideas addressed by this task. Such deficits include evidence of insufficient mathematical knowledge; errors in fundamental mathematical procedures; and other omissions or irregularities that bring into question the student's competence in problem solving, reasoning, and/or modeling related to the specified task.
0	The student has demonstrated **merely an acquaintance** with the topic, or provided a completely incorrect or uninterpretable response. The student's response may be associated with the task, but contains few attributes of an appropriate response. There are significant omissions or irregularities that indicate a lack of comprehension in regard to the mathematical content and practices essential to this task. No evidence is present that demonstrates the student's competence in problem solving, reasoning, and/or modeling related to the specified task.

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[2] While the items contained in this scoring guide are all 2-point short-text items, the total number of points for a short-text item can vary from 1 point to 4 points. The complete set of mathematics general rubrics for scoring short-text items is included in Appendix A.

Grade 4 Mathematics Short-Text Response
from 2014 Smarter Balanced Field Test

Claim	Domain	Target	DOK	CONTENT	MP
3	NF	B	3	4.NF.A, 4.NF.B.4	1

Liam is making lemonade. He needs 16 ounces of lemon juice. He has 10 lemons.
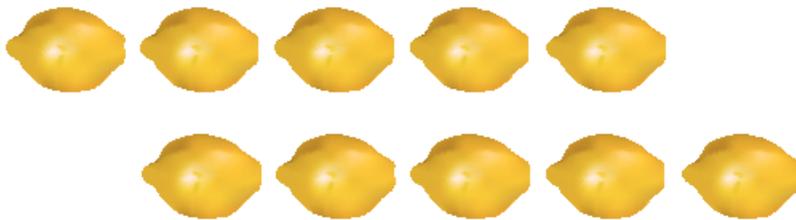
Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

Will he have enough lemon juice? Explain how you know.

Sample Top-Score Responses:

Sample 1

Liam does not have enough lemon juice. Ten lemons makes about 15 ounces since 10 x 1 1/2 = 15. This is less than the 16 ounces he needs.

Sample 2

Liam might have enough lemon juice. Since each lemon makes about 1 1/2 ounces of lemon juice, 10 lemons is about 15 ounces (10 x 1 1/2 = 15). If the 10 lemons are a little bit bigger than normal, it is possible that he can get the 16 ounces that he needs.

Item ID: 26990

Item-Specific Rubric for Grade 4 Item

<u>2-points*</u>

Student determines that Liam does not have enough lemon juice, supported by the total amount of lemon juice in the ten lemons (15 ounces).

OR

Student determines that Liam has close to the amount of lemon juice that he needs and supports this by describing that the total approximate amount of lemon juice (15 ounces) is close to the total needed (16 ounces).

<u>1-point*</u>

Student correctly determines the number of ounces for 10 lemons (15 ounces), but provides an incorrect decision or no decision regarding whether this is enough or includes extraneous incorrect or uninterpretable information that draws into question the student's ability to clearly articulate the basis for his or her decision.

OR

Student performs an incorrect computation using a correct process (e.g., shows multiplication 10 x 1 ½ with incorrect total), and reaches a correct conclusion based on the result of the computation.

<u>0-points</u>

Student provides a conclusion (enough juice or not enough juice; yes or no), but without any explanation or work that supports the conclusion.

OR

Student's response lacks necessary evidence of the student's ability to justify a decision with mathematical reasoning.
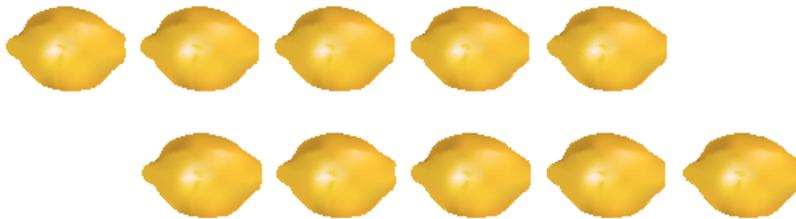
<u>*Scoring Note</u>

The response provides work or an explanation that shows some understanding of the relationship between 1 ½ ounces of juice per lemon to the amount of juice needed (16 ounces).

Note: No calculators are used for mathematics items in Grades 3–5.

Liam is making lemonade. He needs 16 ounces of lemon juice.
He has 10 lemons.

Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

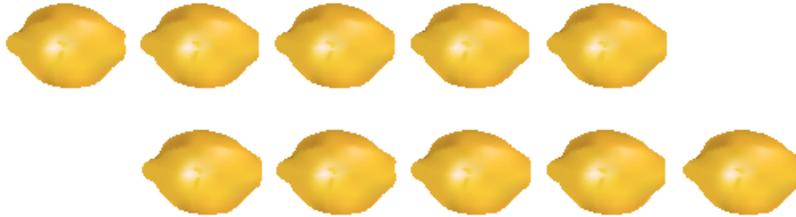Will he have enough lemon juice? Explain how you know.

> I know that Liam will not have enough lemon juice. I know this because one and one-half times ten equals fifteen ounces. Liam needed sixteen ounces. He will not have enough lemon juice.

SCORE POINT **2**

The student correctly finds that Liam does not have 16 ounces of lemon juice with the given 10 lemons. The student shows that given 1 ½ ounces of juice per lemon, 10 lemons yield 15 ounces of juice and uses this to conclude that Liam does not have enough. The student has demonstrated full and complete understanding of the task and receives full credit.

Liam is making lemonade. He needs 16 ounces of lemon juice. He has 10 lemons.

Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

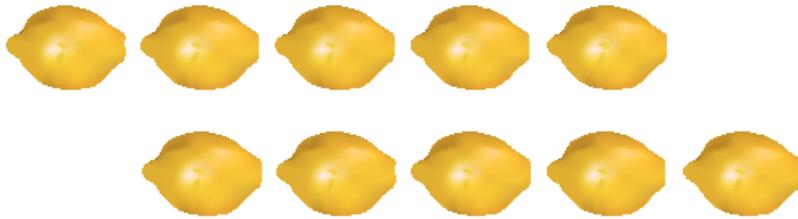Will he have enough lemon juice? Explain how you know.

> No because every two lemoens is three ounces 3 times 5=15 and thats one ounce short.

SCORE POINT **2**

The student correctly determines that Liam is one ounce short of the 16 ounces of lemon juice that he needs. The student explains that every two lemons will yield 3 ounces; then uses this to find that 5 groups of 2 lemons will yield 15 ounces (3 times 5=15). The correct response and process allows for full credit.

Liam is making lemonade. He needs 16 ounces of lemon juice. He has 10 lemons.

Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

Will he have enough lemon juice? Explain how you know.

B I U I_x	≔ ⋮≡	⟵ ⟶	ABC	Ω

No because 10 * 1 1/2 = 15 ounces.

SCORE POINT **2**

The student correctly responds to the prompt by determining Liam does not have enough lemon juice and supports this decision with the number of ounces of lemon juice that can be made from the 10 lemons. The work demonstrates enough understanding of justifying the decision mathematically to allow for full credit.

Liam is making lemonade. He needs 16 ounces of lemon juice. He has 10 lemons.

Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

Will he have enough lemon juice? Explain how you know.

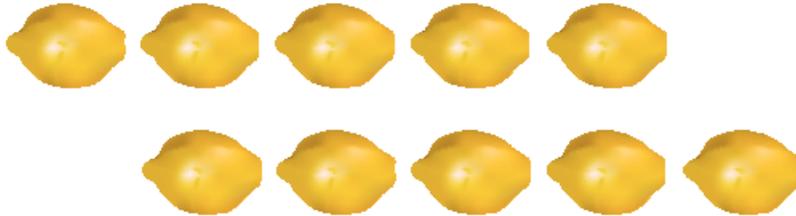| B | I | U | I_x | | | | | | | | | | ABC | Ω |

No he will not have enough lemon juice because he has 10 lemons and each makes about 1 and 1/2 and he needs 16 ounces but he onley has 15 ounces.

SCORE POINT **2**

The student correctly defends the decision of not enough lemon juice by comparing the calculated 15 ounces to the needed amount (16 ounces). The response shows sufficient evidence of justifying a decision mathematically and receives full credit.

Liam is making lemonade. He needs 16 ounces of lemon juice. He has 10 lemons.

Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

Will he have enough lemon juice? Explain how you know.

B	I	U	I_x									ABC		Ω

Liam has 10 lemons and they each make 1 1/2 ounces of juice. So 10 times 1 1/2 means he has 10 ounces plus 1/2 ounce. That is not enough juice because he needs 16 ounces.
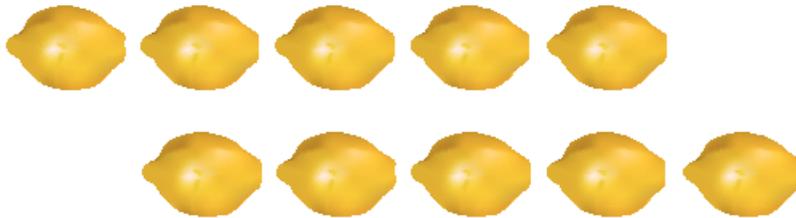
SCORE POINT 1

The student correctly responds to the prompt by determining Liam is not able to make enough lemon juice with the given 10 lemons and describes a correct process (multiplication), but makes an error in executing the process and therefore makes a comparison based on an incorrect computation result. This error prevents the response from earning full credit.

Liam is making lemonade. He needs 16 ounces of lemon juice. He has 10 lemons.

Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

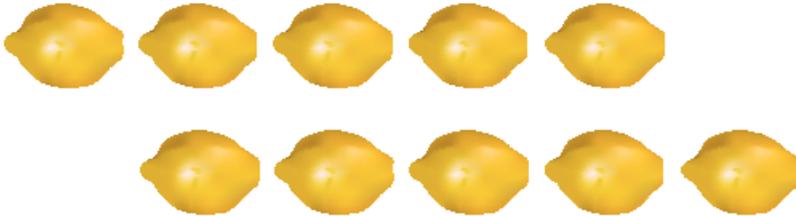Will he have enough lemon juice? Explain how you know.

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no he will not becaue when i added 1 pair of 1/2 i got 15 ounses witch will not be enough.

SCORE POINT 1

The student correctly responds to the prompt by determining Liam does not have enough lemon juice with the given 10 lemons and even indicates he has 15 ounces. However, the additional information in the student's response "I added 1 pair of ½" makes the response partially uninterpretable and draws into question the student's ability to clearly articulate his or her reasoning. The response therefore receives partial credit.

Liam is making lemonade. He needs 16 ounces of lemon juice. He has 10 lemons.

Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

Will he have enough lemon juice? Explain how you know.

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15 if you add all of them up you get 15

SCORE POINT 1

The student's response contains some of the attributes of an appropriate response (15) but does not address the question adequately as to whether Liam has enough lemon juice. This omission brings into question the student's competence in reasoning related to the specific question, and the response earns partial credit.

Liam is making lemonade. He needs 16 ounces of lemon juice. He has 10 lemons.
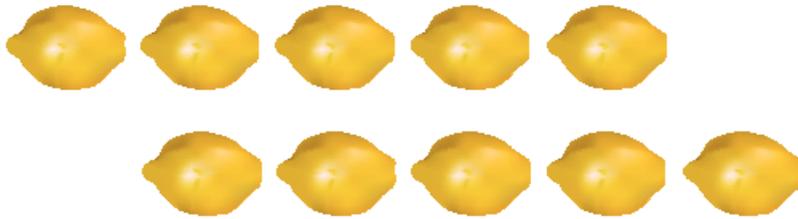
Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

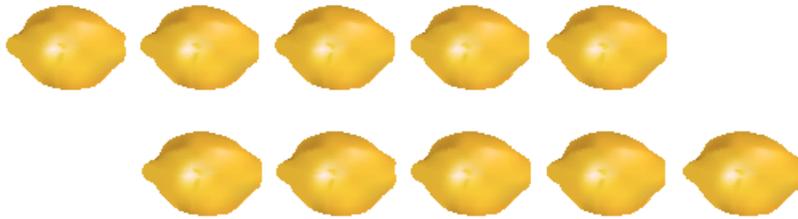Will he have enough lemon juice? Explain how you know.

| B | I | U | I_x | | | | | | X | | | | | | ABC | Ω |

He will need 1/2 more.

SCORE POINT **0**

The student has demonstrated **merely an acquaintance** with the topic. No evidence is present that demonstrates the student's competence in reasoning related to the specified task.

Liam is making lemonade. He needs 16 ounces of lemon juice. He has 10 lemons.

Each lemon makes about $1\frac{1}{2}$ ounces of lemon juice.

Will he have enough lemon juice? Explain how you know.

He will not have enough for his lemonade.

SCORE POINT 0

The student only presents an answer to satisfy the prompt (Yes/No) but makes no attempt to justify the decision mathematically.

Grade 8 Mathematics Short-Text Response
from 2014 Smarter Balanced Field Test

Claim	Domain	Target	DOK	CONTENT	MP
3	EE	B	3	6.G.A, 8.EE.A.4	1, 2, 3, 6

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.

B *I* U *I*ₓ | ≔ ≔ | ⇥ ⇤ | ✂ ▢ ▤ | ↶ ↷ | ABC | Ω

Sample Top-Score Response:

The Earth has more dry land. Since the area of the Earth covered in water is 71%, then the area not covered by water is 29%. So the area of the Earth not covered in water is 0.29(510,000,000), which is about 148,000,000 square km. The radius of the moon is about 1738 km, and the surface area is 4 × pi × the radius squared, which is about 38,000,000 square km. The Earth's dry land of 148,000,000 is greater than the moon's dry land of 38,000,000.

Item ID: 26964

Item-Specific Rubric for Grade 8 Item

2-points

The student has demonstrated a full and complete understanding of all mathematical content and practices essential to this task. The student has addressed the task in a mathematically sound manner by using the results of any computations to justify the decision that Earth has more dry land. In most responses, students correctly compute 29% of 5.1×10^8 for the dry land of Earth (about 1.48×10^8) and correctly find the surface area of the moon (about 3.8×10^7).

Scoring Notes:

- The surface area of a sphere can be determined using $4\pi r^2$ or πd^2.
- Alternate means for estimating the moon's surface area can be used (like comparing the surface area of the moon to the surface area of a cube with an edge length equal to the moon's diameter) to earn 2 points as long as sufficient reasoning/explanation is included in the response.

1-point

Work or explanation that shows some understanding of comparing and finding the surface areas of the dry land of Earth and the moon. In most cases, a correct value for the amount of dry land on Earth or correct surface area of the moon will be part of the response.

Scoring Note:

The item does not require students to show their intermediate work if they compare correct values. Some of the more common **incorrect** values that may allow for partial credit to be given are shown below, along with a lower and upper limit because of different approximations of pi being used.
- $4\pi r$ (forgets to square r): accept 21,283 through 21,850
- $d\pi$ (forgets to square d): accept 10,911 through 10,922
- πr^2 (forgets to multiply by 4): accept 9,479,365 through 9,493,453

0-point

The student has demonstrated merely an acquaintance with the topic, or a completely incorrect or uninterpretable response. The student's response may be associated with the task in the item but contains few attributes of an appropriate response. There are significant omissions or irregularities that indicate a lack of comprehension in regard to the mathematical content and practices essential to this task.

Note: An online scientific calculator is available for use with this item.

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.

B *I* U I_x   ABC   Ω

(5.1*10^8)*.71 = 362099999.99999994

(5.1*10^8) − 362099999.99999994 = 147900000

147900000 of Earth's surface is covered by dry land.

3475*pi = 10917.0344712245

10917.0344712245*3475 = 37936694.78750514

37936694.78750514 is the Moon's surface area.

147900000 > 37936694.78750514

So the Earth has more dry land than the Moon.

SCORE POINT 2

The student correctly compares the surface area of Earth's dry land to the surface area of the moon. The student indirectly uses πd^2 to solve for the surface area of the moon. The student multiplies the diameter by pi (3475*pi = 10,917) and then multiplies the diameter again (10,917*3475=37,936,694). The student's response demonstrates sufficient reasoning to earn full credit.

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.

I know that 71% of the Earth is water so 29% is dry land. This is equal to .29 x 5.1 x 10^8 or about 148,000,000 sq km. If I pretend there is a cube around the moon, I can check to see how close that surfacre area is to the amount of dry land on Earth because honestly I don't know how to find the surface area of the moon exactly. So if I build my cube with each side equal to 3475 km, then I know that each side of the cube is 3475 x 3475 or 12,075,625 sq km. There are 6 sides so that's 12,075,625 x 6 = 72,453,750. As you can see, even if I make a cube around the moon that is bigger than the dry land on the actual moon, I'm still not even half of the dry land on Earth.
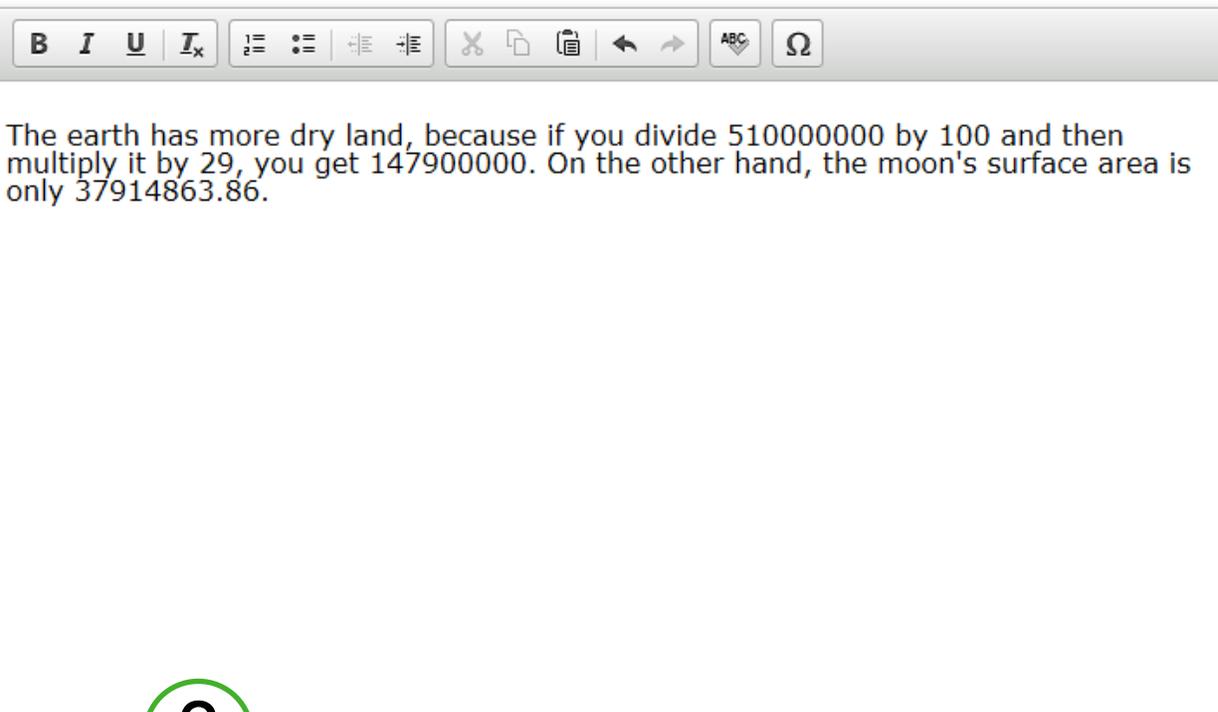
SCORE POINT **2**

The student correctly compares the surface area of Earth's dry land to an overestimate of the moon's dry land. The student's explanation clearly describes a viable way of determining an "over-estimate" of the moon's surface area. The magnitude of the difference between the two areas makes this approach completely viable. The reasoning supporting the correct conclusion allows this response to earn full credit.

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.

> The earth has more dry land, because if you divide 510000000 by 100 and then multiply it by 29, you get 147900000. On the other hand, the moon's surface area is only 37914863.86.

SCORE POINT 2

The student correctly compares the surface area of Earth's dry land to the surface area of the moon. Though the student doesn't explicitly compare Earth's dry land value (147900000) and the moon's dry land value (37914863.86), the comparison is implied in the correct conclusion that Earth has more dry land, and the response earns full credit.

Anchor Response 4

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.
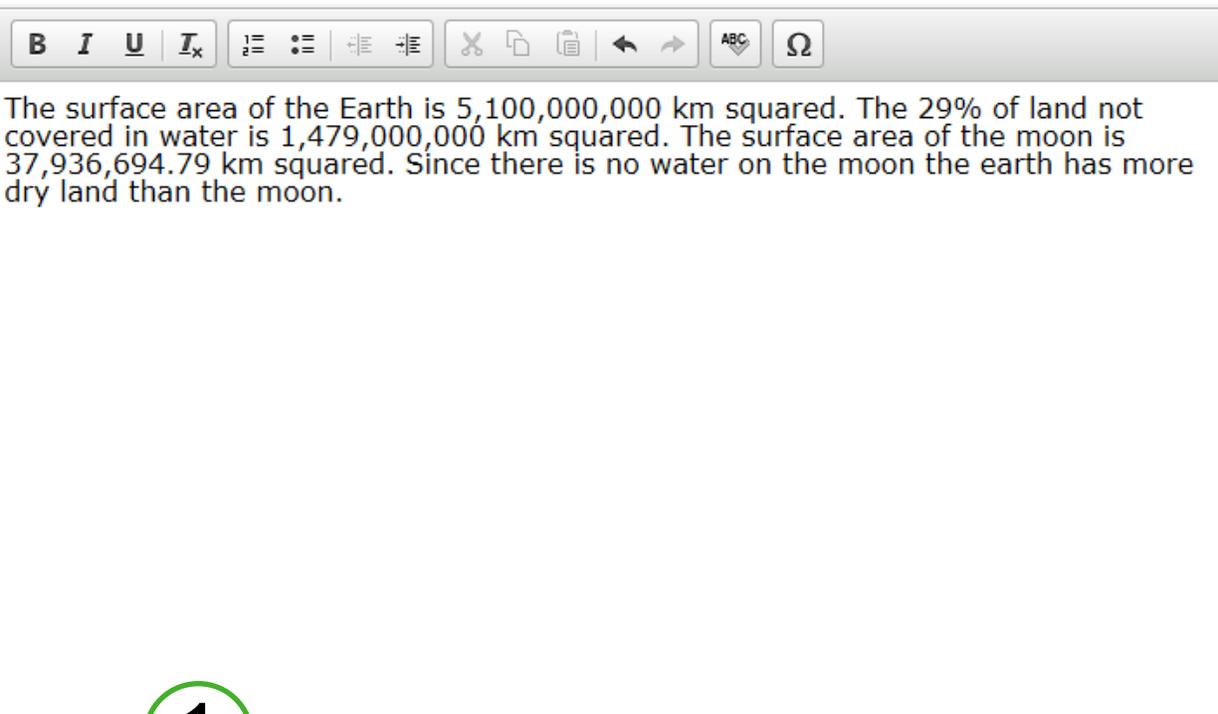
The surface area of the Earth is 5,100,000,000 km squared. The 29% of land not covered in water is 1,479,000,000 km squared. The surface area of the moon is 37,936,694.79 km squared. Since there is no water on the moon the earth has more dry land than the moon.


SCORE POINT 1

The student made an error converting scientific notation into standard notation, resulting in an unreasonably high estimate for the total surface area of Earth and subsequent value for dry land on Earth. The student uses an otherwise correct process and correct decision, but the significant error in obtaining one of the two values for comparison does not allow for full credit to be awarded.

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.
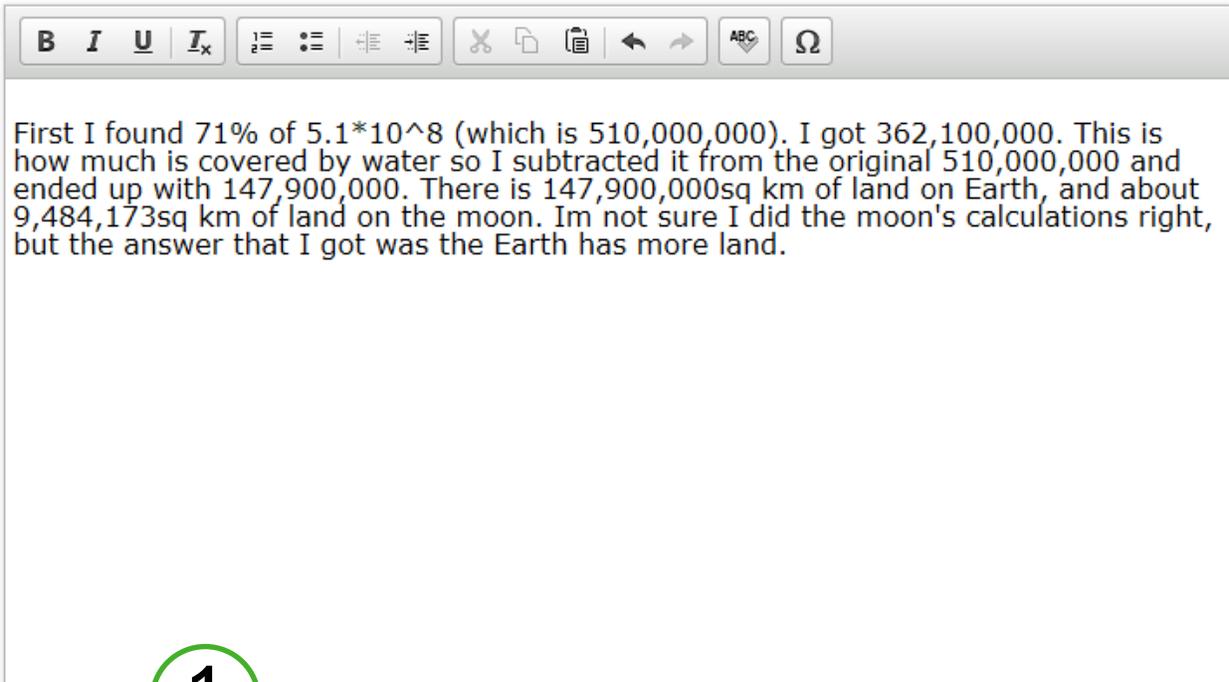

First I found 71% of 5.1*10^8 (which is 510,000,000). I got 362,100,000. This is how much is covered by water so I subtracted it from the original 510,000,000 and ended up with 147,900,000. There is 147,900,000sq km of land on Earth, and about 9,484,173sq km of land on the moon. Im not sure I did the moon's calculations right, but the answer that I got was the Earth has more land.

SCORE POINT 1

The student correctly compares the surface area of Earth's dry land to an incorrect value for the surface area of the moon (9,484,173). According to the scoring note for the 1-point item-specific rubric, this value is likely a result of the student forgetting to multiply by 4 when determining the moon's surface area. This error prevents the student from earning full credit for the response, but the work and reasoning shown is enough to earn partial credit.

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.

B *I* <u>U</u> | I_x | ≡ ≔ | ≔ ≔ | ✂ ▢ ▤ | ↩ ↪ | ABC | Ω
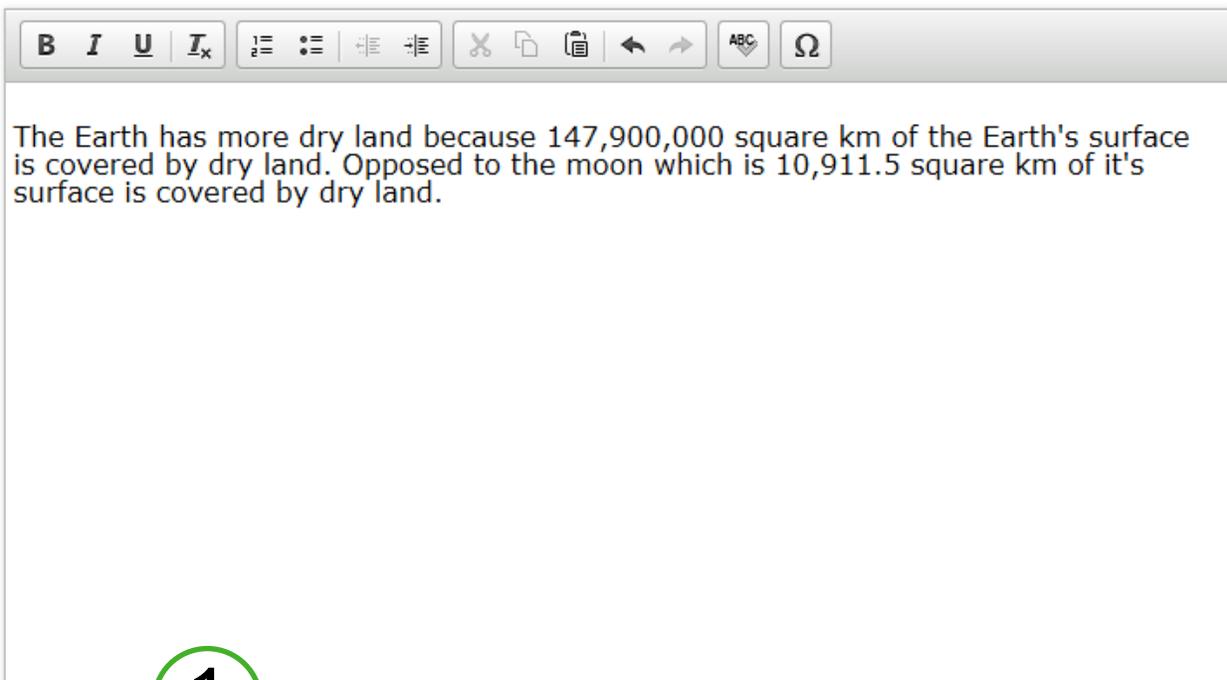
The Earth has more dry land because 147,900,000 square km of the Earth's surface is covered by dry land. Opposed to the moon which is 10,911.5 square km of it's surface is covered by dry land.
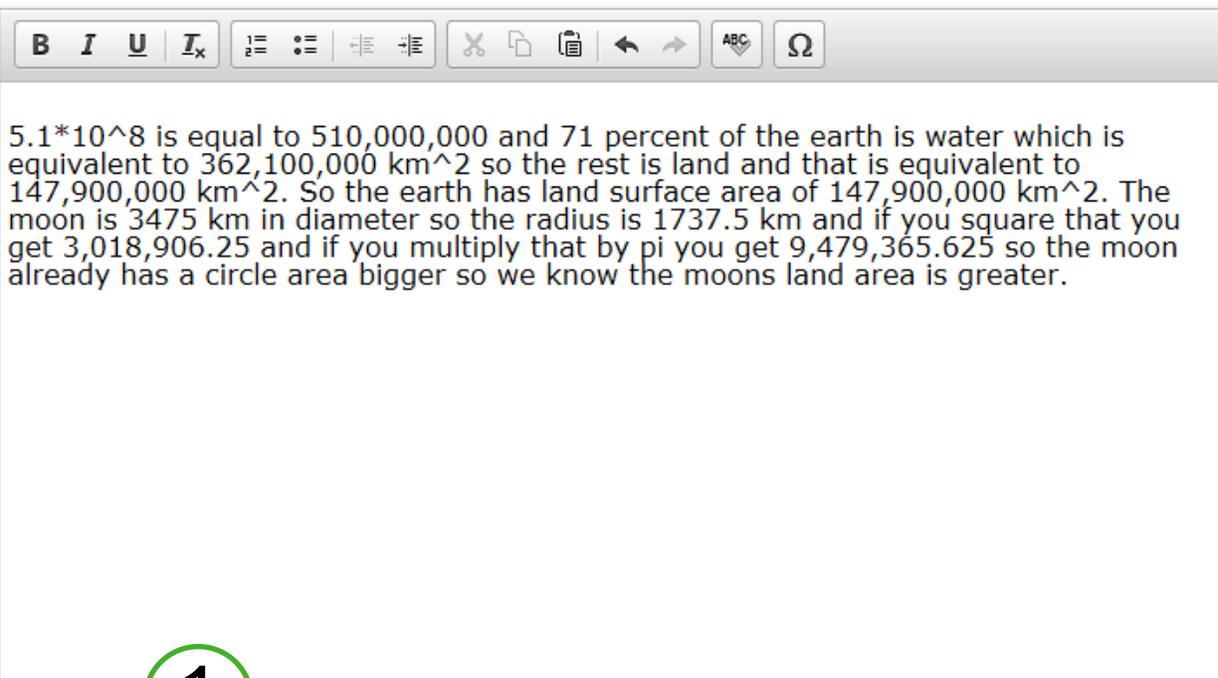

SCORE POINT 1

The student correctly compares the surface area of Earth's dry land (147,900,000) to an incorrect value for the surface area of the moon (10,911.5). According to the scoring note for the 1-point item-specific rubric, this value is likely a result of the student forgetting to square the diameter when determining the moon's surface area. This error prevents the student from earning full credit for the response, but the work and reasoning shown is enough to earn partial credit.

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.

> **B** *I* <u>U</u> I_x | ≔ ≔ | ⁝ ⁝ | ✂ ⬚ 📋 ↰ ↱ | ABC | Ω
>
> 5.1*10^8 is equal to 510,000,000 and 71 percent of the earth is water which is equivalent to 362,100,000 km^2 so the rest is land and that is equivalent to 147,900,000 km^2. So the earth has land surface area of 147,900,000 km^2. The moon is 3475 km in diameter so the radius is 1737.5 km and if you square that you get 3,018,906.25 and if you multiply that by pi you get 9,479,365.625 so the moon already has a circle area bigger so we know the moons land area is greater.
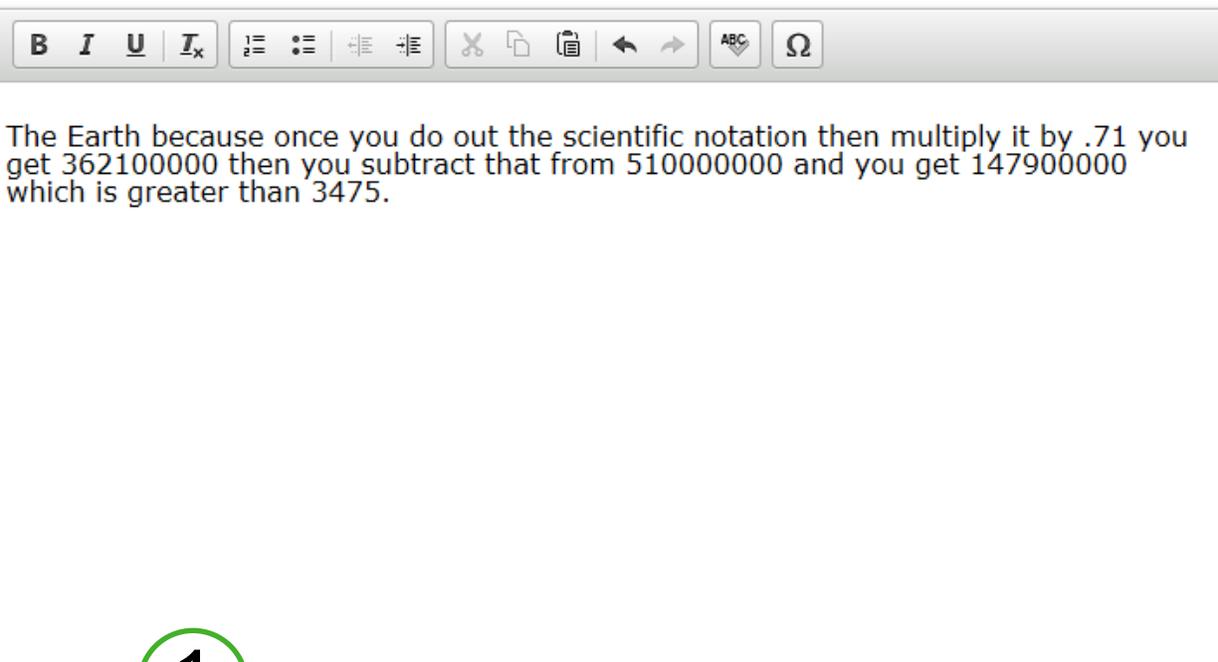
SCORE POINT 1

The student correctly compares the surface area of Earth's dry land (147,900,000) to an incorrect value for the surface area of the moon (9,479,365.625). The student compounded this calculation error by concluding the moon has more dry land. However, the student's response contains enough of the attributes of an appropriate response to earn partial credit.

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.

B *I* U I_x

The Earth because once you do out the scientific notation then multiply it by .71 you get 362100000 then you subtract that from 510000000 and you get 147900000 which is greater than 3475.


SCORE POINT 1

While the student is able to determine the surface area of Earth's dry land (147,900,000), that is all that the student is able to correctly determine. The student fails to compare the amount of Earth's dry land to the moon's dry land, because the student didn't show any attempt to compute the surface area of the moon. While the Earth does have more dry land, the student's conclusion was not made using correct reasoning, nor with correct mathematical support. These errors in fundamental mathematical procedures and omissions bring into question the student's competence in problem solving and reasoning essential to this task. However, the response does address enough of the task (the surface area of Earth's dry land and correct comparison of two values) sufficiently to earn partial credit. This response is representative of a "low" 1.

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.
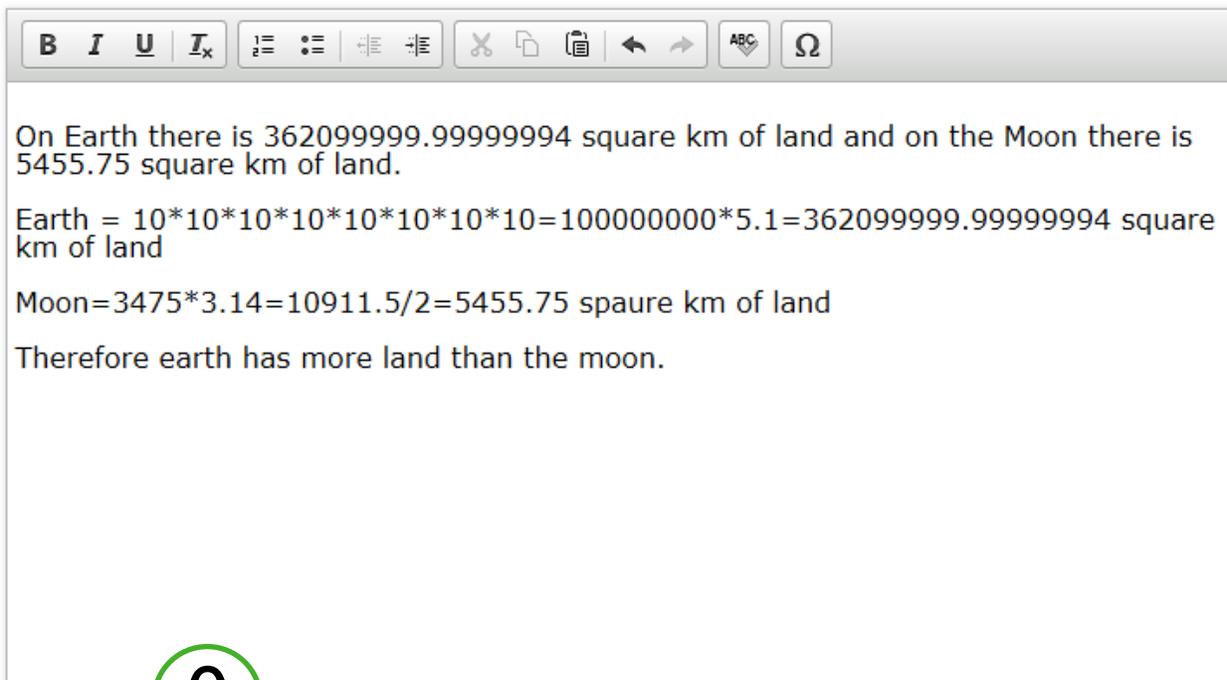
On Earth there is 362099999.99999994 square km of land and on the Moon there is 5455.75 square km of land.

Earth = 10*10*10*10*10*10*10*10=100000000*5.1=362099999.99999994 square km of land

Moon=3475*3.14=10911.5/2=5455.75 spaure km of land

Therefore earth has more land than the moon.

SCORE POINT 0

The student makes an incorrect comparison (surface area of Earth's water to ½*d*pi for the moon). While Earth does have more dry land, the student's conclusion was not made using correct reasoning, nor with correct mathematical support. These omissions indicate a lack of comprehension in regard to the mathematical content and practices essential to this task. Therefore, there is not enough evidence for the response to earn credit.

The surface area of Earth is 5.1×10^8 square km, and 71% of Earth's surface is covered in water. The diameter of the moon is 3475 km, and there is no water on the surface of the moon.

Which has more dry land, Earth or the moon? Show and/or explain the work necessary to support your answer.
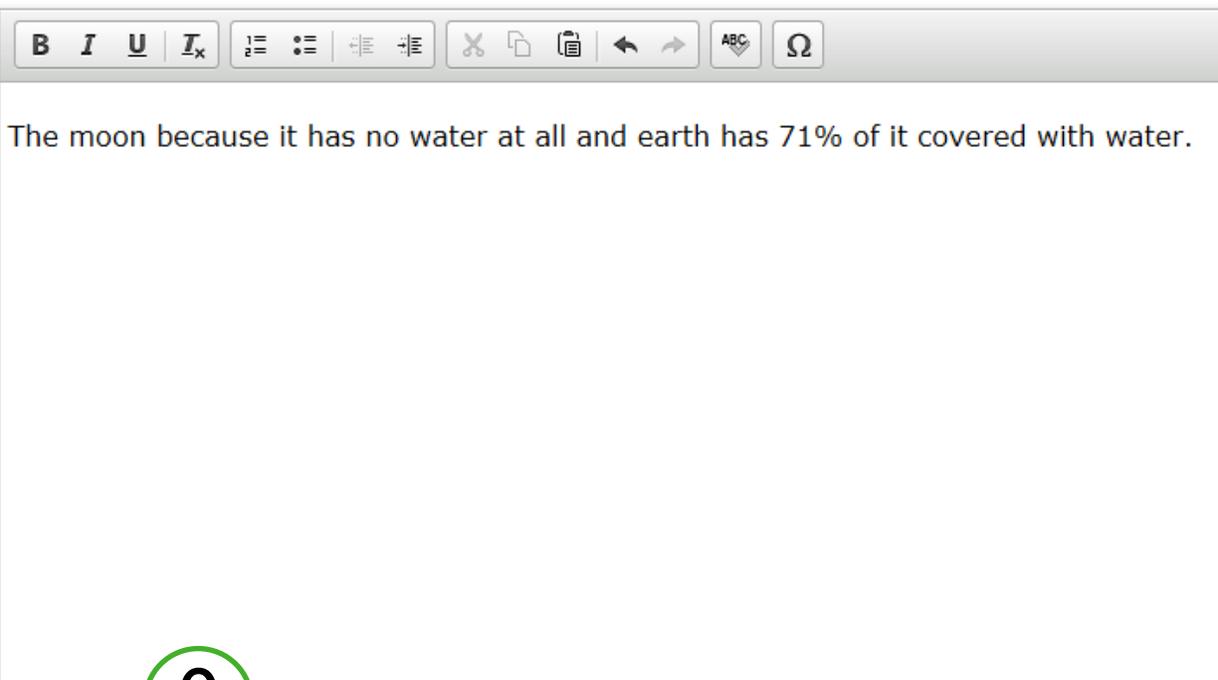
The moon because it has no water at all and earth has 71% of it covered with water.

SCORE POINT 0

The student provides an incorrect conclusion based solely on the percentage of Earth versus the moon that is not covered with water. No evidence is present that demonstrates the student's competence in problem solving and reasoning related to the specified task.

High School Mathematics Short-Text Response
from 2014 Smarter Balanced Field Test

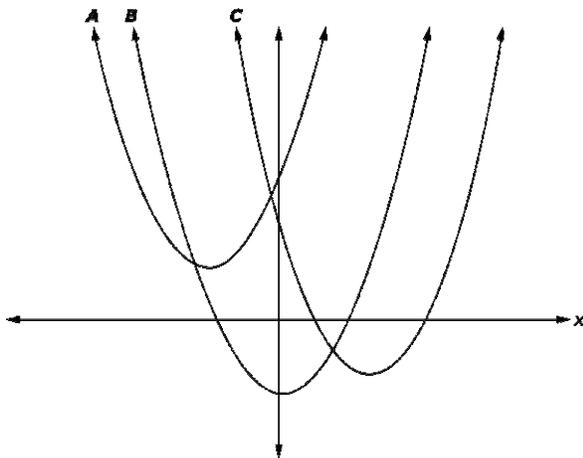| Claim	Domain	Target	DOK	CONTENT	MP
3	A-SSE	B	3	HAS-SSE.B.3	2, 3

The graphs of three quadratic functions $f(x)$, $g(x)$, and $h(x)$ are shown below, along with the coordinate axes. The three functions are:

$f(x) = 1.1(x + 1.3)^2 + 1.18$
$g(x) = 1.2x^2 - 4.6x + 3$
$h(x) = 1.05(x - 1.5)(x + 1.2)$

Match the three functions with their graphs. Include all work and/or reasoning necessary to support your answer.

Note: The actual graph presented to students is larger than the one shown here. This graph was reduced to enable the item and response to fit on one page.

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Sample Top-Score Response:

The expression for $f(x)$ is given in vertex form. The graph of $f(x)$ is a concave up parabola with the vertex at (-1.3, 1.18). The only parabola with a vertex in the second quadrant is graph **A**, so $f(x)$ must match graph **A**.

The expression for $h(x)$ is in a factored form that shows the zeros of the function are at $x = 1.5$ and $x = -1.2$. These should correspond to x-intercepts on the graph. The only parabola that has a negative x-intercept and a positive x-intercept is graph **B**, so $h(x)$ much match graph **B**.

When replacing x with 0 in $g(x)$, I get $g(0) = 3$, which means that the graph of $g(x)$ intersects the vertical axis at (0, 3), which is a positive number. However, there are values of x for which $g(x)$ is negative; for example $g(1) = 1.2 - 4.6 + 3 = -0.4$. The only parabola that intersects the vertical axis at a positive value but also goes below the x-axis is graph **C**. So $g(x)$ matches graph **C**.

Item ID: 26926

Item-Specific Rubric for High School Item

<u>2-points</u>

Student matches all three parabolas correctly.

AND

Student gives full justification for the matching of at least two of the parabolas based on the functions. The justification for the third parabola may be by elimination, implied elimination, or may be incomplete.

Scoring Note: Parabola A corresponds to $f(x)$; parabola B corresponds to $h(x)$; parabola C corresponds to $g(x)$.

The third parabola may be justified by the process of elimination. However, if a justification is provided for all the parabolas, they must not contain any errors.

<u>1-point</u>

Student matches three, two, or one of the parabolas correctly, with appropriate justification for at least one of them.

<u>0-points</u>

Student matches three, two, one, or zero parabolas correctly, but does not provide any appropriate justification for the match(es).

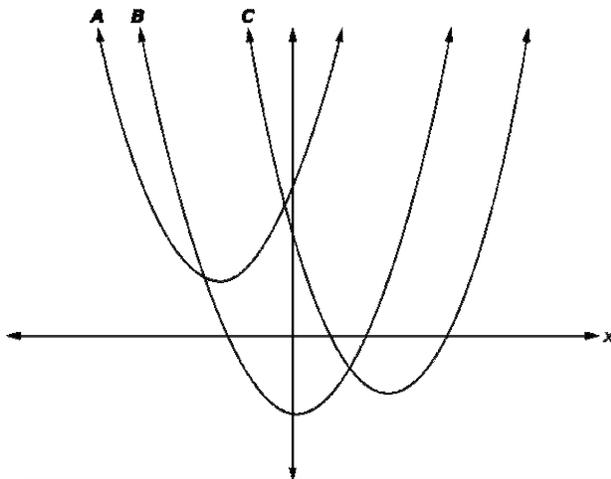**Note:** No calculator is available for use with this item.

The graphs of three quadratic functions $f(x)$, $g(x)$, and $h(x)$ are shown below, along with the coordinate axes. The three functions are:

$f(x) = 1.1(x + 1.3)^2 + 1.18$
$g(x) = 1.2x^2 - 4.6x + 3$
$h(x) = 1.05(x - 1.5)(x + 1.2)$

Match the three functions with their graphs. Include all work and/or reasoning necessary to support your answer.

I can see that f(x) has a vertex at (-1.3, 1.18) because it is in vertex form. The only parabola that could possibly have this vertex is graph A.

Because h(x) is factored, i know the graph has to cross the x-axis at 1.5 and -1.2. The only parabola that crosses the x-axis on the positive side and negative side is graph B.

That leaves g(x) to match graph C. But I can check it to be sure by substituting x=0 and I get 3. Which means the parabola has to cross the y-axis at (0, 3). Graph C looks like it crosses the y-axis at this point, so it must be correct.

The result is that f(x) matches graph A, h(x) matches graph B, and g(x) matches graph C.

SCORE POINT **2**

The student correctly matches all three functions to their respective graphs and provides valid reasoning for each match. The student has demonstrated a full and complete understanding of all mathematical content and practices essential to this task, and the response earns full credit.
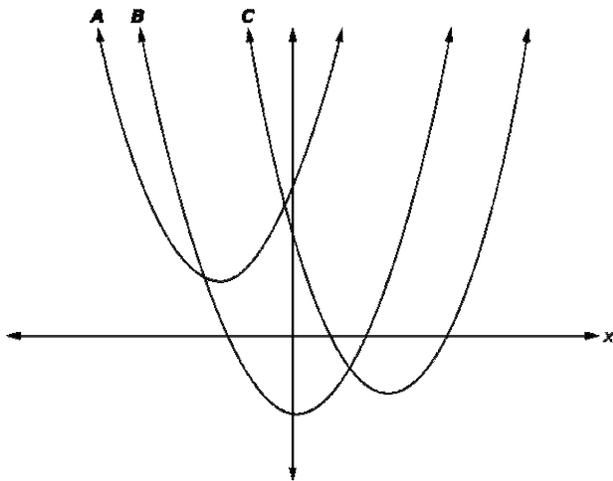
The graphs of three quadratic functions $f(x)$, $g(x)$, and $h(x)$ are shown below, along with the coordinate axes. The three functions are:

$f(x) = 1.1(x + 1.3)^2 + 1.18$
$g(x) = 1.2x^2 - 4.6x + 3$
$h(x) = 1.05(x - 1.5)(x + 1.2)$

Match the three functions with their graphs. Include all work and/or reasoning necessary to support your answer.

Since f(x) has a y-intercept of 3.039 when x = 0 and g(x) has a y-intercept valure of 3 when x=0. It can be reasoned that f(x) has a greater y-intercept than g(x) which means that the graph of f(x) must have the highest point on the x-axis where the functions f(x), g(x) and h(x) cross.

Therefore:

f(x) goes with graph A

g(x) goes with graph C

h(x) goes with graph B

SCORE POINT 2

The student correctly determines the *y*-intercepts of the graphs of *f*(*x*) and *g*(*x*) and matches them with graphs A and C, respectively. This is valid reasoning for this problem. The third parabola can be matched using the process of elimination, allowing the response to receive full credit. Note: Stating that "*f*(*x*) must have the highest point on the *x*-axis" is considered a minor flaw that does not detract from the response demonstrating full understanding.
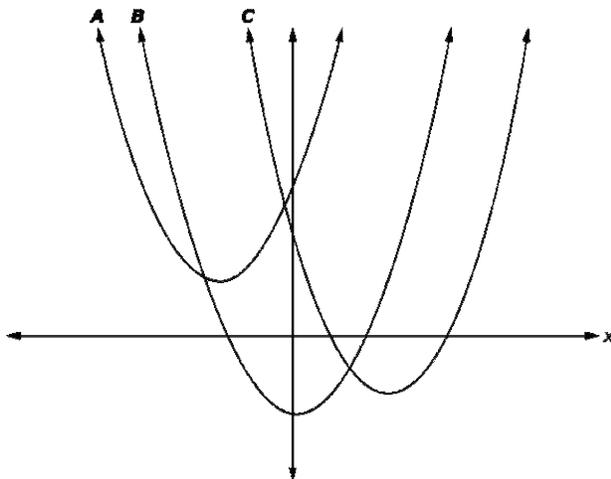
The graphs of three quadratic functions $f(x)$, $g(x)$, and $h(x)$ are shown below, along with the coordinate axes. The three functions are:

$f(x) = 1.1(x + 1.3)^2 + 1.18$
$g(x) = 1.2x^2 - 4.6x + 3$
$h(x) = 1.05(x - 1.5)(x + 1.2)$

Match the three functions with their graphs. Include all work and/or reasoning necessary to support your answer.

h(x) is graph B, because h(x) is the only equation with a negative zero

f(x) is graph A, because (x+1.3)^2 dictates a shift to the left, and graph A is the only graph with a shift to the left

g(x) is graph C, because of the shift to the right, and process of elimination

SCORE POINT 2

The student correctly identifies that $h(x)$ has a negative x-intercept (zero) and graph B is the only graph that has a negative x-intercept. The student also recognizes that the graph of $f(x)$ is shifted to the left and A is the only graph that matches this description. The student's description of "shift to the right" is insufficient (but not incorrect) in describing $g(x)$. However, using the process of elimination for the last match is a valid method and earns full credit.
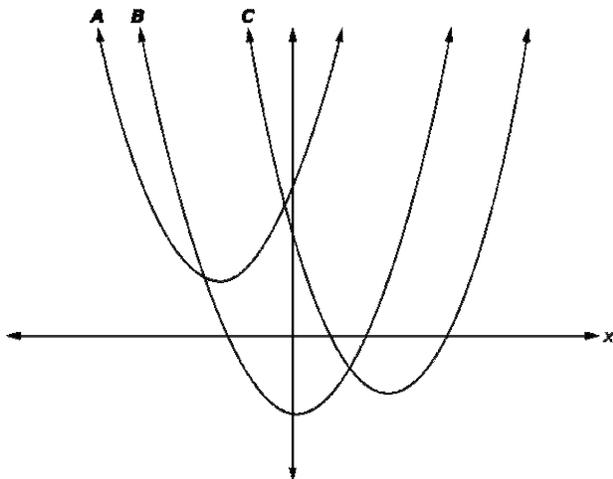
The graphs of three quadratic functions $f(x)$, $g(x)$, and $h(x)$ are shown below, along with the coordinate axes. The three functions are:

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$g(x) = 1.2x^2 - 4.6x + 3$
$h(x) = 1.05(x - 1.5)(x + 1.2)$

Match the three functions with their graphs. Include all work and/or reasoning necessary to support your answer.

The equation f(x) = 1.1(x+1.3)^2 +1.8 matches with graph A because if you look at the function f(x) = (x-h)^2+k, 1.3 goes to the negative side of the graph on the x-axis and up 1.18 on the y-axis.

The equation h(x) = 1.05(x-1.5)(x+1.2) matches with graph B because if you do an x and y chart, you can see the graph and understand that it is graph B.

The equation g(x) = 1.12^2 - 4.6x + 3 matches with graph C because when you put it into f(x) = x-h)^2 + k form, you will see graph B.

SCORE POINT **1**

The student correctly matches all three functions with their graphs, but only provides a valid justification for $f(x)$. The student uses (h, k) to show that that vertex of the graph has been shifted left 1.3 units and up 1.18 units from the origin. Graph A is the only graph that behaves like this. The reasoning shown for $h(x)$ and $g(x)$ is insufficient and contains omissions and errors that prevent this response from earning full credit.
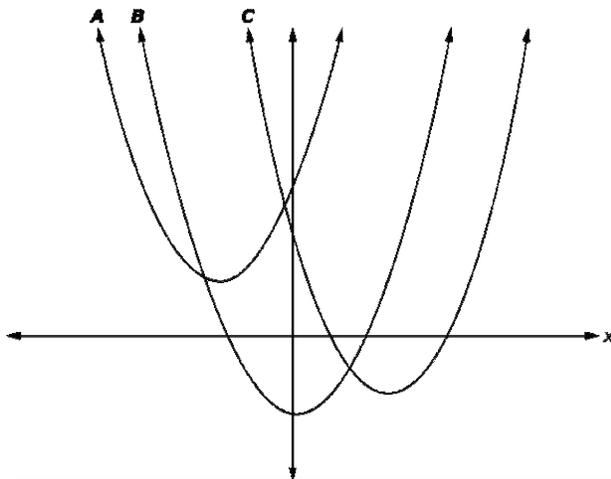
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$h(x) = 1.05(x - 1.5)(x + 1.2)$

Match the three functions with their graphs. Include all work and/or reasoning necessary to support your answer.

h(x) matches with b, since one zero is positive, other is negative

f(x) matches with a, since x coordinate of vertex is negative, y coordinate of vertex is positive

g(x) matches with c, when x is 0, y value is negative

SCORE POINT 1

Although the student correctly matches all three equations with their graphs and provides justification, the student includes incorrect reasoning for $g(x)$. The x-intercepts (zeros) of $h(x)$ can easily be determined to be 1.5 and -1.2 by looking at the equation. Since B is the only graph with positive and negative x-intercepts, it can be matched to $h(x)$. The student also recognizes that $f(x)$ is in vertex form, and graph A is the only graph with a vertex that has a negative x-coordinate and positive y-coordinate. However, the justification for graph C has an error in that the y value when $x = 0$ is positive, not negative. While the student could have used the process of elimination to justify the match for graph C, because he or she made an incorrect assertion, the response cannot receive full credit.
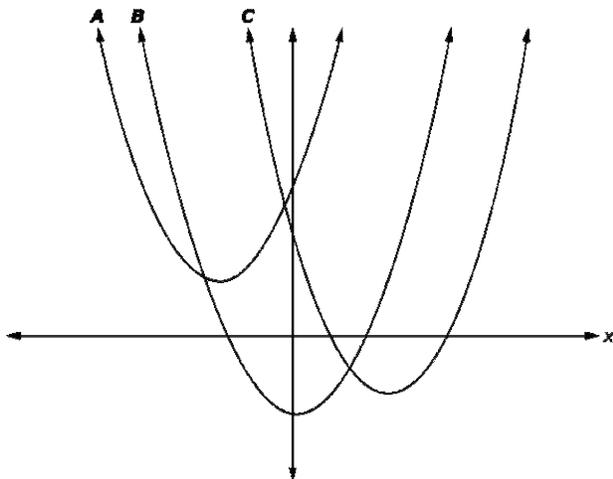
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$h(x) = 1.05(x - 1.5)(x + 1.2)$

Match the three functions with their graphs. Include all work and/or reasoning necessary to support your answer.

f(x) is A becuase it will be graphed in the 2nd quadrent.

h(x) is B becuase it has roots on either side of the y axis.

g(x) is C becuase I can use common sense.

SCORE POINT 1

The student matches all three functions with their graphs, but only has one complete justification for $h(x)$. The student recognizes $h(x)$ has one negative and one positive x-intercept (aka root), and graph B is the only graph that matches this description. The justification for $f(x)$ is not incorrect, but it skips a major step. To be able to say $f(x)$ will be graphed in the 2nd quadrant, the student needs to be able to locate the vertex or shift the vertex from the origin using the given equation. Because the justification for $f(x)$ is incomplete, using the process of elimination (common sense) is invalid for $g(x)$, and the response is limited to partial credit.

The graphs of three quadratic functions $f(x)$, $g(x)$, and $h(x)$ are shown below, along with the coordinate axes. The three functions are:

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$h(x) = 1.05(x - 1.5)(x + 1.2)$

Match the three functions with their graphs. Include all work and/or reasoning necessary to support your answer.

f(x) = A

g(x) = C

h(x) = B

SCORE POINT **0**

The student matches all three equations with their graphs, but does not provide any justification for the matches. The focus of this item is for students to demonstrate a chain of reasoning to support their answer. Since no evidence is present that demonstrates the student's competence in reasoning, no credit is awarded.
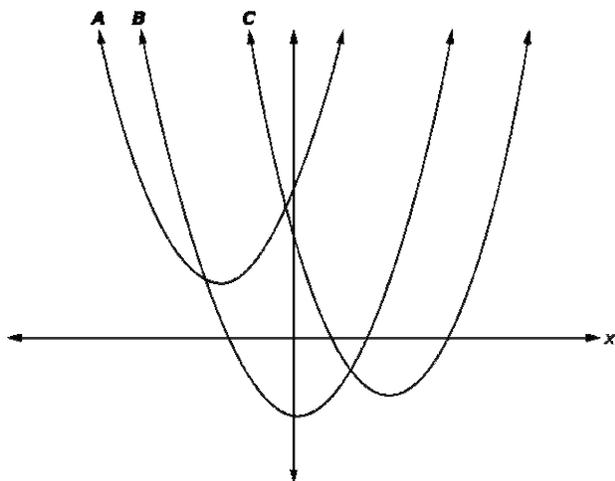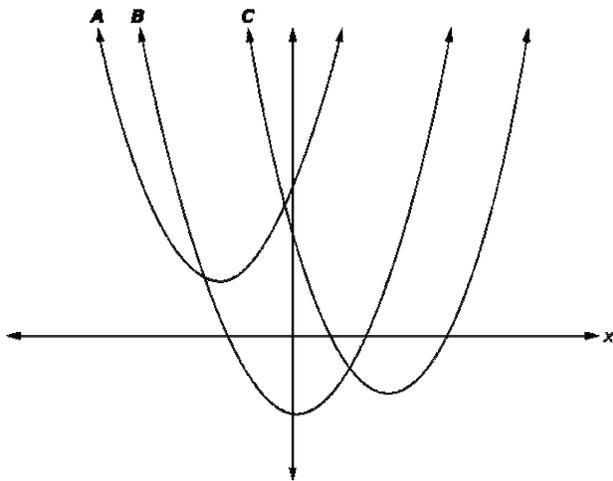
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Match the three functions with their graphs. Include all work and/or reasoning necessary to support your answer.

A = g(x) because b=3 which A has the highest y-intersection on the graph.

B = h(x) because it has the lowest y-intercept on the graph.

C = f(x) because b=1.18 and it is the second highest y-interception the graph.

SCORE POINT 0

The student correctly identifies graph B as $h(x)$, but has insufficient reasoning to support this assertion. The student misidentifies graphs A and C as $g(x)$ and $f(x)$, respectively. Furthermore, the attempted comparison of y-intercepts is incorrect. These omissions and irregularities indicate a lack of comprehension in regard to the mathematical content and practices essential to this task. Insufficient evidence is present in the response to support the student's competence in reasoning, and therefore the response earns no credit.

Smarter Balanced Mathematics General Rubric for 4-Point Items

Score	Description
4	The student has demonstrated a **full and complete** understanding of the mathematical content and practices essential to this task. The student has addressed the task in a mathematically sound manner. The response contains evidence of the student's competence in problem solving, reasoning, and/or modeling to the full extent that these processes apply to the specified task. The response may, however, contain minor flaws that do not detract from a demonstration of full understanding.
3	The student has demonstrated a **reasonable** understanding of the mathematical content and practices essential to this task. The student has addressed most of the task in a mathematically sound manner. The response contains sufficient evidence of the student's competence in problem solving, reasoning, and/or modeling, but not enough evidence to demonstrate a full understanding of the processes he or she applies to the specified task. The response may contain errors that can be attributed to misinterpretation of the prompt; errors attributed to insufficient, non-mathematical knowledge; and errors attributed to careless execution of mathematical processes or algorithms.
2	The student has demonstrated a **partial** understanding of the mathematical content and practices essential to this task. The student's response contains some of the attributes of an appropriate response but lacks convincing evidence that the student fully comprehends the essential mathematical ideas addressed by this task. Such deficits include evidence of insufficient mathematical knowledge; errors in fundamental mathematical procedures; and other omissions or irregularities that bring into question the student's competence in problem solving, reasoning, and/or modeling as applied to the specified task.
1	The student has demonstrated a **limited** understanding of the mathematical content and practices essential to this task. The student's response is incomplete and exhibits many errors. Although the student's response has addressed at least one of the conditions of the task, the student reached an inadequate conclusion and/or demonstrated problem solving, reasoning, and/or modeling that was faulty or incomplete as related to the specified task.
0	The student has demonstrated **merely an acquaintance** with the topic, or provided a completely incorrect or uninterpretable response. The student's response may be associated with the task, but contains few attributes of an appropriate response. There are significant omissions or irregularities that indicate a lack of comprehension in regard to the mathematical content and practices essential to this task. No evidence is present that demonstrates the student's competence in problem solving, reasoning, and/or modeling related to the specified task.

Smarter Balanced Mathematics General Rubric for 3-Point Items

Score	Description
3	The student has demonstrated a **full and complete** understanding of all mathematical content and practices essential to this task. The student has addressed the task in a mathematically sound manner. The response contains evidence of the student's competence in problem solving, reasoning, and/or modeling to the full extent that these processes relate to the specified task. The response may, however, contain minor flaws that do not detract from a demonstration of full understanding.
2	The student has demonstrated a **reasonable** understanding of the mathematical content and practices essential to this task. The student has addressed most of the task in a mathematically sound manner. The response contains sufficient evidence of the student's competence in problem solving, reasoning, and/or modeling, but not enough evidence to demonstrate a full understanding of the processes he or she applies to the specified task. The response may contain errors that can be attributed to misinterpretation of the prompt; errors attributed to insufficient, non-mathematical knowledge; and errors attributed to careless execution of mathematical processes or algorithms.
1	The student has demonstrated a **partial** understanding of the mathematical content and practices essential to this task. The student's response contains some of the attributes of an appropriate response but lacks convincing evidence that the student fully comprehends the essential mathematical ideas addressed by this task. Such deficits include evidence of insufficient mathematical knowledge; errors in fundamental mathematical procedures; and other omissions or irregularities that bring into question the student's competence in problem solving, reasoning, and/or modeling related to the specified task.
0	The student has demonstrated **merely an acquaintance** with the topic, or provided a completely incorrect or uninterpretable response. The student's response may be associated with the task, but contains few attributes of an appropriate response. There are significant omissions or irregularities that indicate a lack of comprehension in regard to the mathematical content and practices essential to this task. No evidence is present that demonstrates the student's competence in problem solving, reasoning, and/or modeling related to the specified task.

Appendix A
General Scoring Rubrics

Smarter Balanced Mathematics General Rubric for 2-Point Items

Score	Description
2	The student has demonstrated a **full and complete** understanding of all mathematical content and practices essential to this task. The student has addressed the task in a mathematically sound manner. The response contains evidence of the student's competence in problem solving, reasoning, and/or modeling to the full extent that these processes apply to the specified task. The response may, however, contain minor flaws that do not detract from a demonstration of full understanding.
1	The student has demonstrated a **partial** understanding of the mathematical content and practices essential to this task. The student's response contains some of the attributes of an appropriate response but lacks convincing evidence that the student fully comprehends the essential mathematical ideas addressed by this task. Such deficits include evidence of insufficient mathematical knowledge; errors in fundamental mathematical procedures; and other omissions or irregularities that bring into question the student's competence in problem solving, reasoning, and/or modeling related to the specified task.
0	The student has demonstrated **merely an acquaintance** with the topic, or provided a completely incorrect or uninterpretable response. The student's response may be associated with the task, but contains few attributes of an appropriate response. There are significant omissions or irregularities that indicate a lack of comprehension in regard to the mathematical content and practices essential to this task. No evidence is present that demonstrates the student's competence in problem solving, reasoning, and/or modeling related to the specified task.

Smarter Balanced Mathematics General Rubric for 1-Point Items

Score	Description
1	The student has demonstrated a **full and complete** understanding of all mathematical content and practices essential to this task. The student has addressed the task in a mathematically sound manner. The response contains evidence of the student's competence in problem solving, reasoning, and/or modeling to the full extent that these processes apply to the specified task. The response may, however, contain minor flaws that do not detract from a demonstration of full understanding.
0	The student has demonstrated **merely an acquaintance** with the topic, or provided a completely incorrect or uninterpretable response. The student's response may be associated with the task, but contains few attributes of an appropriate response. There are significant omissions or irregularities that indicate a lack of comprehension in regard to the mathematical content and practices essential to this task. No evidence is present that demonstrates the student's competence in problem solving, reasoning, and/or modeling related to the specified task.