# =틀 Building Educator Assessment Literacy 

Mathematics


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## Types of Assessments: Graphic Organizer

| Formative Assessment |  |
| :--- | :--- |
| Purpose: | What does formative assessment look like in my <br> context? |


| Interim Assessment |  |
| :--- | :--- |
| Purpose: | What does interim assessment look like in my <br> context? |

Figure 8.5. Types and Uses of Assessments Within Assessment Cycles

| Cycle | Methods | Information | Uses/Actions |
| :---: | :---: | :---: | :---: |
| Short |  |  |  |
|  | - Observation <br> - Questions (teachers and students) <br> - Instructional tasks <br> - Student discussions <br> - Written work/ representations | - Students' current learning status, relative difficulties and misunderstandings, emerging or partially formed ideas, full understanding | - Keep going, stop and find out more, provide oral feedback to individuals, adjust instructional moves in relation to student learning status (e.g., act on "teachable moments") |
|  | Planned and placed strategically in the lesson: <br> - Observation <br> - Questions (teachers and students) <br> - Instructional tasks <br> - Student discussions <br> - Written work/ representations <br> - Student self-reflection (e.g., quick write) | - Students' current learning status, relative difficulties and misunderstandings, emerging or partially formed ideas, full understanding | - Continue with planned instruction <br> - Instructional adjustments in this or the next lesson <br> - Find out more <br> - Feedback to class or individual students (oral or written) |
| $\begin{aligned} & \text { む } \\ & \text { Z } \end{aligned}$ | - Student discussions and work products <br> - Student self-reflection (e.g., journaling) | - Students' current learning status relative to lesson learning goals (e.g., have students met the goal[s], are they nearly there?) | - Instructional planning for start of new week <br> - Feedback to students (oral or written) |


| Cycle | Methods | Information | Uses/Actions |
| :---: | :---: | :---: | :---: |
| Medium |  |  |  |
|  | - Student work artifacts (e.g., portfolio, writing project, oral presentation) <br> - Use of rubrics <br> - Student self-reflection (e.g., short survey) <br> - Other classroom summative assessments designed by teacher(s) | - Status of student learning relative to unit learning goals | - Grading <br> - Reporting <br> - Teacher reflection on effectiveness of planning and instruction <br> - Teacher grade level/ departmental discussions of student work |
|  | - Portfolio <br> - Oral reading observation <br> - Test | - Status of achievement of intermediate goals toward meeting standards (results aggregated and disaggregated) | - Making within-year instructional decisions <br> - Monitoring, reporting; grading; sameyear adjustments to curriculum programs <br> - Teacher reflection on effectiveness of planning and instruction <br> - Readjusting professional learning priorities and resource decisions |
| Long |  |  |  |
|  | - Smarter Balanced Summative Assessment <br> - CELDT <br> - Portfolio <br> - District/school created test | - Status of student achievement with respect to standards (results aggregated and disaggregated) | - Judging students' overall learning <br> - Gauging student, school, district, and state year-to-year progress <br> - Monitoring, reporting and accountability <br> - Classification and placement (e.g., ELs) <br> - Certification <br> - Adjustments to following year's instruction, curriculum, programs <br> - Final grades <br> - Professional learning prioritization and resource decisions <br> - Teacher reflection (individual/grade level/ department) on overall effectiveness of planning and instruction |

Smarter Balanced Performance Task Specifications

## Smarter Balanced Assessment Consortium: Performance Task Specifications


#### Abstract

Role of Smarter Balanced Performance Tasks Taken during the final 12 weeks of the school year, the Smarter Balanced summative assessments for accountability will have two components: a comprehensive end-of-year computer adaptive assessment and performance tasks. These assessments in English language arts (ELA) and mathematics will provide measures of students' achievement (proficiency in meeting grade-level standards), academic growth, and progress toward college and career readiness. The focus of both assessment components will be the claims and targets identified in the Smarter Balanced content specifications for ELA/literacy and mathematics, which serve as "bridge documents" between the Common Core State Standards and the Smarter Balanced summative assessments. Through the use of technology and innovative item and task formats, the Smarter Balanced assessments will exemplify "next generation assessments," significantly improving upon traditional, large-scale accountability tests in terms of authenticity, accessibility, and coverage of skills that are identified in college and career standards (e.g., mathematics practices, problem solving, speaking and listening, use of technology), as described in the Smarter Balanced content specifications.

The domain of performance assessment is quite broad, encompassing a range of non-selectedresponse tasks. A Smarter Balanced performance task involves significant interaction of students with stimulus materials and/or engagement in a problem solution, ultimately leading to an exhibition of the students' application of knowledge and skills, often in writing or spoken language. Stimuli include a variety of information forms (e.g., readings, video clips, data), as well as an assignment or problem situation. A key component of college and career readiness is the ability to integrate knowledge and skills across multiple content standards. Smarter Balanced will address this ability through performance tasks, because it cannot be adequately assessed with selected-response or constructed-response items.



$\qquad$

## Identifying the Mathematics and Anticipating Issues*

Directions: After completing a performance task, reflect on the following questions. Record your thoughts.

What do students need to know and be able to do to accomplish this task?


Other:

What do you expect students to struggle with in this task?

| Content | Practices |
| :--- | :--- |
|  |  |

Other:

[^0]
## Smarter Balanced Assessment Consortium Assessment Targets for Mathematics Summative Assessment

## Claim \#2: Problem Solving

Target A: Apply mathematics to solve well-posed problems in pure mathematics and those arising in everyday life, society, and the workplace.

Target B: Select and use appropriate tools strategically.
Target C: Interpret results in the context of a situation.
Target D: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas).

## Claim \#3: Communicating Reasoning

Target A: Test propositions or conjectures with specific examples.
Target B: Construct, autonomously, chains of reasoning that will justify or refute propositions or conjectures.

Target C: State logical assumptions
Target D: Use the technique of breaking an argument into cases.
Target E: Distinguish correct logic or reasoning from that which is flawed, and - if there is a flaw in the argument - explain what it is.

Target F: Base arguments on concrete referents such as objects, drawings, diagrams, and actions.

Target G: At later grades, determine conditions under which an argument does and does not apply.

## Claim \#4: Modeling and Data Analysis

Target A: Apply mathematics to solve problems arising in everyday life, society, and the workplace.

Target B: Construct, autonomously, chains of reasoning to justify mathematical models used, interpretations made, and solutions proposed for a complex problem.

Target C: State logical assumptions being used.
Target D: Interpret results in the context of a situation.
Target E: Analyze the adequacy of and make improvements to an existing model or develop a mathematical model of a real phenomenon.

Target F: Identify important quantities in a practical situation and map their relationships.

Target G: Identify, analyze and synthesize relevant external resources to pose or solve problems.

## Aligning the Task

| Item | Mathematical Practice | Claim | Assessment Target |
| :---: | :--- | :--- | :--- |
| Item 1 |  |  |  |
| Item 2 |  |  |  |
| Item 3 |  |  |  |
| Item 4 |  |  |  |
| Item 5 |  |  |  |
| Item 6 |  |  |  |

## Analyzing Student Work ${ }^{*}$

Directions: As you score student work, keep a running list of examples for each category below.

## Examples of Successful (or Partially Successful) Strategies

## Examples of Good Explanations

## Common Errors and Misconceptions

*Adapted from Silicon Valley Math Initiative (SVMI)

Performance Task: $\qquad$

## Identifying the Mathematics and Anticipating Issues*

Directions: After completing a performance task, reflect on the following questions. Record your thoughts.

What do students need to know and be able to do to accomplish this task?


Other:

What do you expect students to struggle with in this task?

| Content | Practices |
| :--- | :--- |
|  |  |

## Other:

## Analyzing Student Work*

Directions: As you score student work, keep a running list of examples for each category below.

## Examples of Successful (or Partially Successful) Strategies

## Examples of Good Explanations

## Common Errors and Misconceptions

Patterns in the Evidence*


| Item(s) Samples | A | B | C | D | E | F | G | H | 1 | J | K |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| Productive approach/strategy |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
| Issue/challenge |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |

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Performance Task:
Preparing Feedback for Students


## Draft Performance Task: Owning a Pet [Scaffolded Version]

Your friend Michael has a new dog, which he has named Julius. Michael has asked you to help him create a plan to take care of Julius.


## Dog Facts:

- Dogs need between 30 and 60 minutes of exercise each day.
- A dog needs approximately 8 ounces of water for every 10 pounds it weighs.
- Dogs need to be groomed every day.
- Dogs' nails need to be trimmed once per month.

Table 1. Recommended Amount of Food

| Weight of Dog (Pounds) | Amount of Food (Ounces) |
| :---: | :---: |
| $3-12$ | 8 |
| $13-25$ | 16 |
| $26-50$ | 24 |
| $51-100$ | $32-40$ |

## Question 1:

Michael plans to walk his dog for 25 minutes in the morning and 35 minutes in the evening.
How many hours does Michael spend each week walking his dog?

## Question 2:

Use Dog Facts to help you answer this question.
Julius weighs approximately 48 pounds. How many ounces of water should Julius have each day?

## Question 3:

Michael claims he should feed Julius 1 cup of dry dog food in the morning and 1 cup at night.
Michael has made a mistake.
How many cups of food should Michael feed Julius in the morning, and how many cups should he feed him at night?

Use words and numbers to support your answer.
Conversion Note: 8 ounces = 1 cup

## Question 4:

Michael's family purchased a 25-pound bag of dog food.
Michael's father uses a scale to determine that one cup of this type of dog food weighs half a pound.
Michael claims there is a total of twelve-and-a-half cups of dog food in the bag.
Do you agree with Michael? Use words and numbers to support your answer.

## Question 5:

Four months after adopting Julius, Michael takes him to the veterinarian for a check-up. Julius now weighs 56 pounds. The veterinarian says Julius should go on a diet. He recommends that Julius be fed three-quarters of his normal amount of food for the next 3 weeks.

It is easiest for Michael to use a measuring cup to feed Julius.
How many total cups of dry dog food should Michael feed Julius each day? Explain.

## Question 6:

Use your answers from Questions 4 and 5 to help you answer this question.
Michael's family has an unopened 40-pound bag of dog food. Michael will only feed Julius using this bag of dog food.

Assume Michael correctly feeds Julius based on the veterinarian's recommendation.
What day will Michael need a new bag of dog food? Use words and numbers to support your answer.

## Draft Performance Task: Owning a Pet [Open-Ended Version]

You want to own a dog.


Dogs come in all shapes and sizes. Some weigh over 100 pounds, and others weigh under 5 pounds.

## Dog Facts:

- Dogs need between 30 and 60 minutes of exercise each day.
- A dog needs approximately 8 ounces of water for every 10 pounds it weighs.
- Dogs need to be groomed every day.
- Dogs' nails need to be trimmed once per month.

Table 1. Recommended Amount of Food

| Weight of Dog (Pounds) | Amount of Food (Ounces) |
| :---: | :---: |
| $3-12$ | 8 |
| $13-25$ | 16 |
| $26-50$ | 24 |
| $51-100$ | $32-40$ |

## Directions:

Choose a type of dog you want to own.
Describe the characteristics of this breed.
Include the demeanor, size, and activity level.
Create a PowerPoint presentation or video that you will use to convince your family to own this type of dog.

Information that must be included in the presentation:

- Describe the dog you selected
- Size
- Characteristics
- Demeanor
- Include a picture of this type of dog as a puppy and as an adult
- Expected cost of owning the dog
- Cost of the puppy or dog
- Cost of food (annual or monthly)
- Specify amount of food each day
- Recommend the size of bag of dog food to be purchased and how long it is expected to last
- Leash
- Collar and tags
- Toys
- Training
- Veterinarian visits
- Grooming
- Anticipated amount of time (daily or weekly) needed to care for the dog
- When will you or others in the family care for the dog?
- Where can the dog exercise and for how long?
- Benefits of owning a dog
- How owning a dog or pet will improve your lifestyle and health
- Additional information
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## On-Demand $\rightarrow$ Curriculum-Embedded Task Planning Worksheet

## Original task:

Standards-aligned success criteria:

Culminating product:

Adaptations to task design/implementation to generate more robust evidence of learning:

Plans for scaffolding and formative assessment:

Formative Assessment Lesson Planning Template
Activity 5.8


| Learning Goal(s) | Success Criteria |
| :--- | :--- |
|  |  |

Misconceptions students are likely to have as they work on the lesson Learning Goals

Strategies to share or co-construct Success Criteria with students

## Classroom strategies to elicit evidence

| Collecting Evidence <br> Start of Lesson | Collecting Evidence <br> Middle of Lesson | Collecting Evidence <br> End of Lesson |
| :--- | :--- | :--- |
| Key discussion questions I will ask during instruction |  |  |
| Discussion Questions <br> Start of Lesson | Discussion Questions <br> Middle of Lesson | Discussion Questions <br> End of Lesson |
|  |  |  |

## Strategies to provide descriptive feedback to students

## Classroom strategies for student peer and self-assessment

| Peer and Self-Assessment <br> Start of Lesson | Peer and Self-Assessment <br> Middle of Lesson | Peer and Self-Assessment <br> End of Lesson |
| :--- | :--- | :--- |

# Additional Resources <br> Designing for Deeper Learning: <br> How to Develop Performance Tasks for the Common Core 

## Recommended Performance Task Banks

General

## Buck Institute of Education

www.bie.org/project_search
The Buck Institute has a curated bank of projects, both their own, and those they have collected from other developers. Many of these projects include assessments and assessment tools, like rubrics. The bank is searchable by CCSS standards. Also, http://www.bie.org/objects/documents has great teacher resources for project based learning like planning forms, rubrics, group work contracts, etc.

## English/Language Arts

## Literacy Design Collaborative

www.literacydesigncollaborative.org
Bank of teacher-created modules that were created with CCSS-aligned LDC templates, which are explicitly CCSSaligned. Rubrics are also included. (Mostly 6-12 but beginning to branch into K-5).

## Reading and Writing Project

http://readingandwritingproject.org/resources/assessments/reading-writing-assessments
Offers CCSS-aligned performance assessments for grades K-8. Tasks are designed as on-demand but could be adapted to become curriculum-embedded. Tasks include rubrics.

## Understanding Proficiency

http://understandingproficiency.wested.org/ provides a set of Smarter Balanced performance tasks together with samples of student work at each score point for each task. Score rationales are provided for each sample response to support the analysis of student work.

## History/Social Studies

## Stanford History Education Group: Beyond the Bubble

https://beyondthebubble.stanford.edu/
This site, produced by the Stanford History Education Group, has short constructed response assessments (HATs) that focus on particular historical skills. Free registration is required to download assessments and rubrics at this site, but the resources are well worth it (Grades 6-12).

## College Board Advanced Placement Essay Questions

- http://media.collegeboard.com/digitalServices/pdf/ap/apcentral/AP_USH_DBQ.pdf The College Board releases questions from prior Advanced Placement tests. Download a pdf with Document-based questions for American history from 1973-1999.
- http://apcentral.collegeboard.com/apc/members/exam/exam_information/2090.html Find FreeResponse questions (that include documents) and accompanying scoring systems for World History from the past two years.
- http://apcentral.collegeboard.com/apc/public/courses/teachers_corner/index.html You can browse the list of home pages for all courses to pick a social science course and find a released sample test and other resources. These assessments may need adaptation as they are designed to be on-demand tests for AP courses, but they can provide a good starting point.


## Washington State OSPI---Developed Assessments

## http://www.k12.wa.us/SocialStudies/Assessments/default.aspx

Produced by the Office of Superintendent of Public Instruction of the state of Washington (in 2008), this collection of K-12 assessments includes one page of CCSS-aligned prompts and rubrics for civics, economics, geography, history and international perspectives.

## Mathematics

## Mathematics Assessment Project/Shell Centre

http://map.mathshell.org
The Mathematics Assessment Project (MAP) features updated MARS tasks, lessons, tests, rubrics, professional development, all aligned to the Common Core. Created by UC Berkeley, the Shell Centre, and University of Nottingham.

## Understanding Proficiency

http://understandingproficiency.wested.org/
Provides a set of Smarter Balanced performance tasks together with samples of student work at each score point for each item of each task. Score rationales are provided for each sample response to support the analysis of student work.

## Illustrative Mathematics

https://www.illustrativemathematics.org/
Provides a variety of task types, including short performance tasks, together with commentary about each task. Users can search for tasks by grade level Common Core content standard, by domain, or by practice standard. The site will eventually provide free middle school math curriculum from Open Up Resources.

## Connecticut Academic Performance Test (Released Items)

http://www.csde.state.ct.us/public/csde/cedar/assessment/capt/released_items.htm\#2
The Connecticut Academic Performance Test (CAPT) is one of the early pioneers of high quality performance tasks. Though these are designed for standardized administration, the tasks provide great starters for curriculum embedded tasks.

## Science

## Stanford Education Assessment Laboratory (SEAL)

http://web.stanford.edu/dept/SUSE/SEAL/
This site contains 14 primarily physical science performance assessments. The topics range from electricity, friction, and incline planes (physics); mystery powders and floating/sinking (chemistry); and rocks and astronomy (earth science). Each assessment contains the student directions, teacher instructions, scoring system, and list of materials.

## Stanford NGSS Assessment Project

https://web.stanford.edu/group/ngss_assessment/cgi-bin/snapgse/?page_id=1135
This site provides examples of NGSS aligned short performance assessments that are intended to be administered in 30 minutes. The sample assessments focus on the NGSS performance expectations for upper elementary and middle school. In the next few months, additional samples of short curriculum embedded performance assessments intended to take 5 class periods will be posted.

## Performance Assessment Links in Science (PALS)

http://pals.sri.com/tasks/index.html
PALS is a task bank of science performance assessments compiled by SRI International for grades K-12 and represent a large number of performance assessment developers. Go to the site and select the grade band you are interested in, then select course (physical, life, earth/space, and science/technology). Then select the specific topic of the performance assessments. Most assessments have the student and teacher materials, a scoring system, and a sample of student work. This is a great resource.

## Connecticut State Department of Education

http://www.sde.ct.gov/sde/cwp/view.asp?a=2618\&q=320892
This site provides sample laboratory investigations as well as performance assessments focusing on scientific issues in society. The site includes sample performance assessments in 6 stand areas focusing on Energy Transformations; Chemical Structures and Properties; Global Interdependence; Cell Chemistry and Biochemistry; and Genetics, Evolution and Biodiversity. Each assessment contains teacher and student materials. See http://www.csde.state.ct.us/public/csde/cedar/assessment/capt/released_items.htm\#2 for Connecticut Academic Performance Test (CAPT) tasks for multiple years in science and math.

## Further Readings

## General

Jaquith, A., Martin, D., \& Johnston, J. (2014). Developing a performance assessment system from the ground up: Lessons learned from three Linked Learning pathways. Stanford, CA: Stanford Center for Opportunity Policy in Education.

Parker, W., Mosborg, S., Bransford, J., Vye, N., Wilkerson, J. and Abbott, R. (2011). Rethinking advanced high school coursework: Tackling the depth/breadth tension in the AP US government and politics course. Journal of Curriculum Studies, 43(4), 533---559.
[SIPX --- \$8.63]

Shepard, L. (2000). The Role of Assessment in a Learning Culture. Educational Researcher, 29(7), 4--- 14. [SIPX --- \$2.41]

Stanford Center for Opportunity Policy in Education (SCOPE). (2014). Student---centered schools: Closing the opportunity gap. https://edpolicy.stanford.edu/publications/pubs/1200

Tashlik, P. (2010). Changing the National Conversation on Assessment. Phi Delta Kappan, 91(6), 55---
59. [SIPX --- FREE]

History
Wineburg, S. and Martin, D. (2009). Tampering with history: Adapting primary sources for struggling readers. Social Education, 73(5), 212-216.

## Other Resources

For additional resources related to performance assessment, we encourage you to browse the websites of SCALE's partner organizations. A full list of partners and descriptions of their work can be found here.

## General Guidelines for Development of Performance Tasks

The Smarter Balanced Performance Task Work Group has offered general guidance for the development of Smarter Balanced performance tasks by identifying the essential characteristics of tasks, listed below. These guidelines also serve as reminders of good instructional practices.
A performance task must:

1. Integrate knowledge and skills across multiple content standards or strands within a content area (RTTT, 2010; Khattri and Sweet, 1996).
2 Measure capacities such as depth of understanding, research skills, complex analysis, and identification/providing of relevant evidence (Darling-Hammond and Pecheone, 2010; RTTT, 2010; Wood, Darling-Hammond, Neill, and Roschewski, 2007; Ayala, Shavelson, Yin, and Schultz, 2002).

3 Require student-initiated planning, management of information and ideas, interaction with other materials (RTTT, 2010; Black and Wiliam, 1998; Wood, Darling-Hammond, Neill, and Roschewski, 2007). In the reading and writing tasks, students have an opportunity to plan their responses and manage and interact with information/data gained through reading or listening to/viewing texts. In mathematics, students determine and employ strategies for solving problems and use a variety of mathematical tools and techniques in doing so.
4 Require production of extended responses, such as oral presentations, exhibitions, and other scorable products, including more extended written responses which might be revised and edited (RTTT, 2010; Wiggins, 1989; Ayala, Shavelson, Yin, and Schultz, 2002).

5 Reflect a real-world task and/or scenario-based problem (Darling-Hammond, 1997; Wiggins, 1998). Performance tasks should incorporate real-world, college- and careerrelated skills that require students to accomplish complex goals during multiple testing sessions. Tasks should be multi-stepped and allow for reflection and revision.

6 Allow for multiple approaches (Reed, 1993; Eisner, 1999). Writing or speaking tasks should encourage or allow multiple approaches to developing and organizing ideas. For example, narrative writing might be used to support the presentation of an argument, while analysis and synthesis might be used to convey ideas in a narrative. In mathematics, problems presented in tasks should lend themselves to multiple solutions and/or solution strategies.
7 Represent content that is relevant and meaningful to students (Henderson, Karr, and Kidwell, 1998). These attributes can be verified during the piloting stage of the development process.
8 Allow for demonstration of important knowledge and skills, including those that address 21st-century skills such as critically analyzing and synthesizing information presented in a variety of formats, media, etc. (CCSSI, 2010; Darling-Hammond and Pecheone, 2010). Performance tasks are really evidence that a student has collected all the relevant information necessary across years to successfully engage in the current grade-level standards. Thus, these tasks will incorporate knowledge and skills of prior grades by necessity, even though the major focus is on the standards for the current grade level.

9 Allow for multiple points of view and interpretations (Dana and Tippins, 1993; Eisner, 1999). In both ELA/literacy and mathematics, tasks should allow for more than one valid interpretation or viewpoint; for example, it is the quality of support that is marshaled in support of a position, not the particular position taken, that is important to the success of tasks asking for written argumentation in ELA or mathematical arguments. Multiple viable arguments should be possible based on the assignments and stimulus information provided in each performance task.

10 Require scoring that focuses on the essence of the task (Dana and Tippins, 1993; Kane and Mitchell, 1996). Scoring of student work from a task will use multiple rubrics uniquely matched to the primary content claims and targets identified by the task developer in the task forms.

11 Be feasible for the school/classroom environment (Dana and Tippins, 1993). Performance tasks are constructed so they can be delivered effectively in the school/classroom environment. Considerations for task specifications include, but are not limited to, student-teacher interactions, materials and technology needs, and allotted time for assessment. Performance tasks will adhere to a framework or specifications that can be used

- by item writers to develop new tasks that focus on different content but are comparable both qualitatively and statistically, and
- by classroom teachers for creating assessments providing meaningful evidence for both formative and summative purposes.


# Smarter Balanced <br> Practice Test 

Resources

# Grade 4 Mathematics <br> Art Day! Performance Task 

## Art Day!

You are helping your 4th grade class organize an Art Day.
There will be three stations:

- Painting
- Pottery
- Chalk Art

You have two tasks. You will help create the supply list and the schedule for Art Day.

## Task 1: Supply List

You need to make sure there are enough supplies at each station for everyone to participate. You will use the following information to create a list of art supplies for your class.

- There are 24 students in your class.
- Each student needs -
- 2 paint brushes for the Painting Station.
- 3 pounds of clay for the Pottery Station.
- 5 pieces of chalk for the Chalk Art Station.


## Task 2: Schedule

You also need to help plan the schedule for Art Day using the following information.

- The day starts at 9:00 a.m. and ends at 2:00 p.m.
- Your entire class will rotate through the three stations together.
- The Break has to be at least 10 minutes.
- The Break and Lunch together total 1 hour.
- The three stations (Painting, Pottery, and Chalk Art) do not need to be the same amount of time, but each one has to be 30 minutes or longer.
(1) According to the supply list, how many paint brushes are needed for 24 students?
$\square$


# Grade 4 Mathematics <br> Art Day! Performance Task 

(2) According to the supply list, how many pounds of clay are needed for 24 students?
$\square$
(3) You need 120 pieces of chalk for Art Day. Your teacher has 6 boxes of chalk. Each box has 18 pieces of chalk. Is this enough chalk for Art Day?

Explain the steps you used to figure this out.
(4) Your next task is to help plan the schedule for Art Day using the information from Task 2: Schedule.

Create a schedule for your class to follow on Art Day. You must follow the order given in the table.

Art Day Schedule*

| Activity | Start Time | End Time |
| :--- | :---: | :---: |
| Painting | $9: 00$ a.m. |  |
| Break |  |  |
| Pottery |  |  |
| Lunch |  |  |
| Chalk Art |  | 2:00 p.m. |

*Times must be given using a 12 -hour clock.

# Grade 4 Mathematics <br> Art Day! Performance Task 

(5) When the class went to the Painting Station at 9:00 a.m., the container of paint was completely full. After 6 of the 24 students got their share of paint, the paint level had dropped to the level shown in the following picture.



After 6 students got their share of paint, the level is here.

Katie thinks there is not enough paint for the rest of the students.

Do you agree with Katie? Explain why or why not. Use the information shown in your explanation.
(1) According to the supply list, how many paint brushes are needed for 24 students?
$\square$
(2) According to the supply list, how many pounds of clay are needed for 24 students?

\#1 and \#2 Equation numeric - 1 point each

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 1$ | 2 | OA | 2A, 2D | 2 | 3.OA.A.3 | 1 | 48 (paint brushes) |
| $\# 2$ | 2 | OA | $2 A, 2 D$ | 2 | 3.OA.A.3 | 1 | 72 (pounds of clay) |

## Rubric:

1 point each: Student writes each value correctly: 48 and 72 , respectively
0 points: All other responses

Commentary: The purpose of each question is primarily to assess whether the student (1) understands the context and (2) can identify and infer relevant quantities and perform typical calculations to solve a problem.

The context is reasonably authentic. Many schools plan for activities that require materials for each student. Keeping track of how many supplies are needed for an entire class is a good experience for students to record and represent quantities. This task is about deciding how to organize an art activity, including supplies needed and a potential schedule to follow for the day.

## Rationale for Content:

The numbers and operations involved are solidly in Grade 3.
3.OA.A. 3 Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities.

# Grade 4 Mathematics <br> Art Day! Performance Task 

## Rationale for Claim:

The fact that the student must extract the quantities, choose the procedure, and calculate the answer to solve this problem is what makes this a Target 2A (primary target) and Target 2D (secondary target).

Claim 2, Target A: Apply mathematics to solve well-posed problems in pure mathematics and arising in everyday life, society, and the workplace.

Claim 2, Target D: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas).

## Rationale for DOK:

Since the student needs to retrieve information from the context and select a procedure (in this case, multiplication), it meets the requirement for DOK 2. From the Depth of Thinking chart:

APPLY (DOK 2):
-Select a procedure and perform it
-Solve a routine problem applying multiple concepts or decision points
-Retrieve information to solve a problem
Note that the descriptors for APPLY DOK 1 are follow simple procedures, calculate, measure, apply a rule (e.g., rounding), apply algorithm or formula. The key idea is that the procedure or rule or algorithm is given or specified. This question, although intended to be straightforward, does not tell the student to multiply. This separates DOK 1 from DOK 2.
3) You need 120 pieces of chalk for Art Day. Your teacher has 6 boxes of chalk. Each box has 18 pieces of chalk. Is this enough chalk for Art Day?

Explain the steps you used to figure this out.
\#3 Short answer - 2 points

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \#3 | 3 | OA | $3 B$ | 2 | $3 . O A . A .3$ | 3,6 | See sample responses |

## Rubric:

2 points: Student develops an approach (compares the amount of chalk needed to the amount available) to determine whether more chalk is needed AND gives a justification for the result.

1 point: Student correctly calculates the amount of chalk available and determines that more chalk is needed, but does not provide a logical explanation why.

0 points: All other responses
Commentary: This question is designed to provide 4th-grade students an opportunity to develop and justify a result. It is reasonably authentic and addresses the overarching question of whether or not there are enough materials (in this case, chalk) for Art Day.

The key elements are that the students are not told what quantities to use, how they are operated on, nor what to conclude from them. This increases the depth of knowledge. This question is not meant to be overly difficult in terms of numeric computational complexity, which would distract students from the communicating reasoning aspect of the question.

## Rationale for Content:

The numbers and operations involved are solidly in Grade 3:
3.OA.A. 3 Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities.

This qualifies as securely held content knowledge.

# Grade 4 Mathematics Art Day! Performance Task 

## Rationale for Claim:

The work required of this problem has a few necessary steps: (1) Students must develop a chain of reasoning, i.e. interpret the context (Is there enough chalk?). This requires determining the total chalk in the boxes (by whatever method, additive or multiplicative) AND comparing to the required amount. Note that by design, this problem does not tell the students to add up the totals and compare. This takes away the scaffolding and requires students to select the quantities and appropriate operation on them based on the context. (2) Students must provide an explanation to justify a claim. Correctly calculating the amount of chalk does not provide a logical argument. The student must connect the computation to the reasoning, essentially, that there are 108 pieces of chalk and this total is less than the required amount of 120 .

Claim 3, Target B: Tasks used to assess this target should ask students to develop a chain of reasoning to justify or refute a conjecture. Tasks for Target B might include the types of examples called for in Target A as part of this reasoning, but should do so with a lesser degree of scaffolding than tasks that assess Target A alone.

## Rationale for DOK:

Since the student needs to retrieve information from the context and select a procedure (in this case, multiplication), it meets the requirement for DOK
2. From the Depth of Thinking chart:

APPLY (DOK 2):
-Select a procedure and perform it
-Solve a routine problem applying multiple concepts or decision points
-Retrieve information to solve a problem
Note that the descriptors for APPLY DOK 1 are follow simple procedures, calculate, measure, apply a rule (e.g., rounding), apply algorithm or formula. The key idea is that the procedure or rule or algorithm is given or specified. This question, although intended to be straightforward, does not tell the student what the solution method is. This question is also an example of routine, but there are multiple approaches. This separates DOK 1 from DOK 2.
\#4 Table item - 1 point

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :--- | :--- | :--- |
| $\# 4$ | 4 | MD | A | 4 | 2.MD.C. 7 | 4 | See exemplar |

## Rubric:

1 point: Student enters times that satisfy the restrictions listed in Task 2: Schedule (at least 10 minutes for Break, Break and Lunch take exactly one hour, and each station is at least 30 minutes in length).

0 points: All other responses
Scoring Note: Although students can enter a.m. and p.m. in the schedule, it is not required, nor should it count against the students if they use the wrong indication (a.m. or p.m.).

One example of a correct response:

| Art Day Schedule* |  |  |
| :---: | :---: | :---: |
| Activity | Start Time | End Time |
| Painting | 9:00 a.m. | 10:30 a.m. |
| Break | $10: 30$ a.m. | 10:45 a.m. |
| Pottery | $10: 45$ a.m. | 12:15 p.m. |
| Lunch | 12:15 p.m. | 1:00 p.m. |
| Chalk Art | 1:00 p.m. | 2:00 p.m. |
| *Times must be given using a 12-hour <br> clock |  |  |

Commentary: The purpose of this question is to increase the level of abstraction for a 4th-grade student to solve a reasonably authentic scheduling situation that would satisfy a list of requirements. Because students are given the flexibility to create their own schedule with a limited list of restrictions, there is not one correct answer. The nature of this question is for students to design under constraints. Students are not asked to explain why they chose the times that they did, but rather can determine for themselves if the times are appropriate based on the list of requirements from Task 2: Schedule.

# Grade 4 Mathematics <br> Art Day! Performance Task 

## Rationale for Content:

The content at the heart of this problem is working with time, but in the context of designing a schedule. Hence although "working" with time is a Grade 2 content standard, the addition and possible subtraction of times would put this into more grade level content.
2.MD.C Work with time and money.
7. Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m._Know relationships of time (e.g., minutes in an hour, days in a month, weeks in a year).

## Rationale for Claim:

Students are given the flexibility to create their own schedule with a limited list of restrictions. The nature of this question is for students to design under constraints. This is what makes this a Claim 4 item: Apply mathematics to solve problems arising in everyday life, society, and the workplace.

Claim 4, Target A: Problems used to assess this target for Claim \#4 should not be completely formulated (as they are for the same target in Claim \#2), and require students to extract relevant information from within the problem and find missing information through research or the use of reasoned estimates.

## Rationale for DOK:

Since the student needs to retrieve information from the context and design a model (in this case a schedule) that satisfies certain given constraints, it meets the requirement of DOK 4. From the Depth of Thinking chart:

CREATE: DOK 4
-Synthesize information across multiple sources or data sets
-Design a model to inform and solve a practical or abstract situation

# Grade 4 Mathematics <br> Art Day! Performance Task 

5 When the class went to the Painting Station at 9:00 a.m., the container of paint was completely full. After 6 of the 24 students got their share of paint, the paint level had dropped to the level shown in the following picture.



After 6 students got their share of paint, the level is here.

Katie thinks there is not enough paint for the rest of the students.

Do you agree with Katie? Explain why or why not. Use the information shown in your explanation.
\#5 Short answer - 1 point

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :--- | :---: | :---: |
| $\# 5$ | 2 | MD | $2 \mathrm{~A}, 3 \mathrm{~F}$ | 3 | 3.MD.A.2 | 1 | See sample responses |

## Rubric:

1 point: Student states whether he/she agrees or disagrees with Katie and provides a mathematically logical explanation as to why or why not.

0 points: The student may agree or disagree, but does not supply any logical explanation for his/her response.

# Grade 4 Mathematics Art Day! Performance Task 

Assessment Consortium
Commentary: This question is designed to provide students an opportunity to interpret a diagram (a picture of a paint container), as well as interpret and apply the information given in the prompt to determine whether there is enough paint to last the entire activity. Because 6 students have used their share of paint, $1 / 4$ of the class has used the paint from the container. Based on the height of the container, it would appear that $1 / 4$ of the paint has been used by $1 / 4$ of the class; however, because the bottle is not cylindrical, there has been less than $1 / 4$ of the paint used. Therefore, there should be sufficient paint left for the remaining 18 students ( $3 / 4$ of the class).

## Rationale for Content:

This is an application of 3rd Grade Measurement.
3.MD.A Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.
2. Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and English units (oz, lb.$)$, and liters (I).

Note that the content may also entail some fraction work, but students can avoid this and work more additively. Also note, that this question does NOT require students know how to compute the volume of a cylinder or other 3-D object. The problem is designed to promote problem solving.

## Rationale for Claim:

This is intended to be primarily about solving a problem arising "in everyday life." There are a variety of approaches available to students. The problem is asking students to determine whether there is enough paint left for the rest of the class.

Therefore, the primary alignment is Claim 2, Target A.
"Apply mathematics to solve well-posed problems in pure mathematics and those arising in everyday life, society, and the workplace. Under Claim 2, the problems should be completely formulated, and students should be asked to find a solution path from among their readily available tools."

However, because students are to take a position and argue in order to support or refute Katie's claim, a secondary alignment to Claim 3, Target F exists.
"Base arguments on concrete referents such as objects, drawings, diagrams, and actions. In earlier grades, the desired student response might be in the form of concrete referents. In later grades, concrete referents will often support generalizations as part of the justification rather than constituting the entire expected response."

# Grade 4 Mathematics <br> Art Day! Performance Task 

## Rationale for DOK:

The key point is that students need to understand and use the concept of liquid volumes, namely by breaking the paint container into fourths. Since the top fourth of the container (the level at which the paint is after $1 / 4$ of the class has used it) is tapered, it must contain less liquid volume than the other $3 / 4$ of the bottle. Hence comparing additively or multiplicatively, there will clearly be enough paint for the rest of the class.

As mentioned under the rationale for the content, this problem is not about finding volumes of cylinders. So for 4th-grade students this is designed to be non-routine. This increases the DOK to level 3. Furthermore, there is added complexity of comparing amounts of paint and numbers of students. This would be routine proportional thinking for students in middle school, but it is not routine for 4th-grade students. This requires students to have to connect different units with a DOK 3 level of understanding.

UNDERSTAND (DOK 3):
-Use concepts to solve non-routine problems
-Use supporting evidence to justify conjectures, generalize, or connect ideas

# Grade 4 Mathematics <br> Art Day! Performance Task 

Smarter Balanced Mathematics General Rubric for 1-Point Items

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

## Grade 4 / Unscored Students Samples

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

Focus
Standards and Claim

## Stimulus

## Claim 2

3.0A.A. 3

## Art Day!

You are helping your 4th grade class organize an Art Day.
There will be three stations:

- Painting
- Pottery
- Chalk Art

You have two tasks. You will help create the supply list and the schedule for Art Day.

## Task 1: Supply List

You need to make sure there are enough supplies at each station for everyone to participate. You will use the following information to create a list of art supplies for your class.

- There are 24 students in your class.
- Each student needs -
- 2 paint brushes for the Painting Station.
- 3 pounds of clay for the Pottery Station.
- 5 pieces of chalk for the Chalk Art Station.


## Task 2: Schedule

You also need to help plan the schedule for Art Day using the following information.

- The day starts at 9:00 a.m. and ends at 2:00 p.m.
- Your entire class will rotate through the three stations together.
- The Break has to be at least 10 minutes.
- The Break and Lunch together total 1 hour.
- The three stations (Painting, Pottery, and Chalk Art) do not need to be the same amount of time, but each one has to be 30 minutes or longer.


## Item Prompt

According to the supply list, how many paint brushes are needed for 24 students?


## Sample Responses

| Sample | 24 |
| :--- | :--- |
| Response A |  |


| Sample | 48 |
| :--- | :--- |
| Response B |  |

Sample Response C

12 paintbrushes

## Grade 4 / Unscored Students Samples

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

Focus
Standards and Claim

## Stimulus

## Item Prompt

## Claim 2

3.OA.A. 3

## Art Day!

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## Task 2: Schedule

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- Your entire class will rotate through the three stations together.
- The Break has to be at least 10 minutes.
- The Break and Lunch together total 1 hour.
- The three stations (Painting, Pottery, and Chalk Art) do not need to be the same amount of time, but each one has to be 30 minutes or longer.

According to the supply list, how many pounds of clay are needed for 24 students?


## Sample Responses

## Sample

Response A
24

Sample Response B

8

| Sample | 72 |
| :--- | :--- |
| Response C |  |

Sample
Response D74

## Grade 4 / Unscored Students Samples

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

Focus
Standards and Claim

## Stimulus

## Claim 3

3.OA.A. 3

## Art Day!

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There will be three stations:

- Painting
- Pottery
- Chalk Art

You have two tasks. You will help create the supply list and the schedule for Art Day.

## Task 1: Supply List

You need to make sure there are enough supplies at each station for everyone to participate. You will use the following information to create a list of art supplies for your class.

- There are 24 students in your class.
- Each student needs -
- 2 paint brushes for the Painting Station.
- 3 pounds of clay for the Pottery Station.
- 5 pieces of chalk for the Chalk Art Station.


## Task 2: Schedule

You also need to help plan the schedule for Art Day using the following information.

- The day starts at 9:00 a.m. and ends at 2:00 p.m.
- Your entire class will rotate through the three stations together.
- The Break has to be at least 10 minutes.
- The Break and Lunch together total 1 hour.
- The three stations (Painting, Pottery, and Chalk Art) do not need to be the same amount of time, but each one has to be 30 minutes or longer.


## Item Prompt

You need 120 pieces of chalk for Art Day. Your teacher has 6 boxes of chalk. Each box has 18 pieces of chalk. Is this enough chalk for Art Day?
Explain the steps you used to figure this out.

## Sample Responses

Sample
Response A
What I did to figure this out was first I divided 18 into 10 and 8 and then divided the 8 into 4 and 4 to make it easer and multiplyed 10,4 , and 4 to 60 and added them all up and did not get 120 . Instead I got 108, so it is not enogh.
$6 \times 18=108$
$6 \times(10+8)$
$6 \times(10+4+4)$
$6 \times 10=60$
$6 \times 4=24$
$6 \times 4=24$
Added up $=108$

| Sample | $24=20+4$ |
| :--- | :--- |
| Response B | $20 \times 5=100$ |
| $5 \times 4=20$ |  |
| $100+20=120$ |  |
|  | $6=5+1$ |
| $5 \times 8=40$ |  |
| $1 \times 8=8$ |  |
| $40+8=48$ |  |
|  | Check -120 |
| $18=10+8$ |  |
| $6 \times 8=48$ |  |
| $6 \times 10=60$ |  |
|  | $48+60=108$ (Not enough) |

$24=20+4$
$20 \times 5=100$
$5 \times 4=20$
$100+20=120$
$6=5+1$
$5 \times 8=40$
$1 \times 8=8$
$40+8=48$
Check-120
$18=10+8$
$6 \times 8=48$
$6 \times 10=60$
$48+60=108$ (Not enough)

Sample
Response C
18 pieces
18 pieces
18 pieces
18 pices
18 pieces
18 pices
There are 10 pieces of chalk left
$5+5+5+5+5$
$5+5+5+5+5$
$5+5+5+5+5$
$5+5+5+5+5$
$5+5+5+5$

Response D
Sample
Response E

Sample
Response F
$108=36+36+36=(18+18)+(18+18)+(18+18)$
$6 \times 18=(6 \times 10=60)+(6 \times 8=48)$
$60+48=108<120$
It is not enough. The teacher need to buy one more box of chalk, because there is only 108 pieces and 120 are needed.
$120+18+6=144+134=278$
278
Sample Response G

6 box: $18+18+18+18+18+18$
$2 \times 18=$
$2 \times 10=20$
$2 \times 8=16$
36
$2 \times 18=36$
$2 \times 18=36$
$36+36+36=$
$30+30+30=90$
$6+6+6=18$
108
There are only 108 pieces there is not enough for art day
Need 120 pieces of chalk

| Sample | 111111 |
| :---: | :---: |
| Response H | 111111 |
|  | 111111 |
|  | 111111 |
|  | 111111 |
|  | 111111 |
|  | 11111 |
|  | 11111 |
|  | 111111 |
|  | 11 |
|  | 11111 |
|  | 11111 |
|  | 11111 |
|  | 111 |
|  | 111111 |
|  | 111111 |
|  | 111111 |
|  | 111111 |
|  | 111111 |
|  | 11111 |
|  | 1 |
|  | 109 no becus we don't have enough |

## Grade 4 / Unscored Students Samples

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

Focus
Standards and Claim

## Stimulus

## Claim 4

## CCSS.MATH.CONTENT.

2.MD.C Work with time and money.
7. Tell and write time from analog and digital clocks to the nearest five minutes, using a.m. and p.m. Know relationships of time (e.g., minutes in an hour, days in a month, weeks in a year).

## Art Day!

You are helping your 4th grade class organize an Art Day.
There will be three stations:

- Painting
- Pottery
- Chalk Art

You have two tasks. You will help create the supply list and the schedule for Art Day.

## Task 1: Supply List

You need to make sure there are enough supplies at each station for everyone to participate. You will use the following information to create a list of art supplies for your class.

- There are 24 students in your class.
- Each student needs -
- 2 paint brushes for the Painting Station.
- 3 pounds of clay for the Pottery Station.
- 5 pieces of chalk for the Chalk Art Station.


## Task 2: Schedule

You also need to help plan the schedule for Art Day using the following information.

- The day starts at 9:00 a.m. and ends at 2:00 p.m.
- Your entire class will rotate through the three stations together.
- The Break has to be at least 10 minutes.
- The Break and Lunch together total 1 hour.
- The three stations (Painting, Pottery, and Chalk Art) do not need to be the same amount of time, but each one has to be 30 minutes or longer.

Your next task is to help plan the schedule for Art Day using the information from Task 2: Schedule.

Create a schedule for your class to follow on Art Day. You must follow the order given in the table.

## Art Day Schedule*

*Times must be given using a 12 -hour clock.

| Activity | Start Time | End Time |
| :--- | :--- | :--- |
| Painting | 9:00 a.m. |  |
| Break |  |  |
| Pottery |  |  |
| Lunch |  |  |
| Chalk Art |  | 2:00 p.m. |

## Sample Responses

Sample
Response A

| Activity | Start Time | End Time |
| :--- | :--- | :--- |
| Painting | 9:00 a.m. | 9:30 a.m. |
| Break | 9:30 a.m. | 9:40 a.m. |
| Pottery | 9:40 a.m. | 10:10 a.m. |
| Lunch | 10:10 a.m. | 11:00 |
| Chalk Art | 11:00 | 2:00 p.m. |

Sample
Response B

| Activity | Start Time | End Time |
| :--- | :--- | :--- |
| Painting | $9: 00$ a.m. | $10: 00$ |
| Break | $10: 10$ | $10: 25$ |
| Pottery | $10: 30$ | $11: 30$ |
| Lunch | $11: 40$ | $12: 25$ |
| Chalk Art | $12: 30$ | $2: 00$ p.m. |

Sample
Response C

| Activity | Start Time | End Time |
| :--- | :--- | :--- |
| Painting | 9:00 a.m. | 10:00 am |
| Break | $10: 20 \mathrm{am}$ | $10: 30 \mathrm{am}$ |
| Pottery | $10: 30 \mathrm{am}$ | $11: 30 \mathrm{am}$ |
| Lunch | $12: 10 \mathrm{pm}$ | 1:10 pm |
| Chalk Art | $1: 30 \mathrm{am}$ | 2:00 p.m. |

Sample
Response D

| Activity | Start Time | End Time |
| :--- | :--- | :--- |
| Painting | $9: 00$ a.m. | $9: 55$ |
| Break | $10: 00$ | $10: 15$ |
| Pottery | $10: 20$ | $11: 20$ |
| Lunch | $11: 25$ | $12: 35$ |
| Chalk Art | $12: 40$ | 2:00 p.m. |

Sample
Response E

| Activity | Start Time | End Time |
| :--- | :--- | :--- |
| Painting | 9:00 a.m. | 10:10 a.m. |
| Break | 10:10 a.m. | 10:30 a.m. |
| Pottery | 10:30 a.m. | 11:20 a.m. |
| Lunch | 11:20 a.m. | 12:00 a.m. |
| Chalk Art | 12:00 | 2:00 p.m. |

Sample
Response F

| Activity | Start Time | End Time |
| :--- | :--- | :--- |
| Painting | $9: 00$ a.m. | $2: 00 \mathrm{pm}$ |
| Break | 12:20 | $1: 10$ |
| Pottery | $2: 50$ | $3: 40$ |
| Lunch | $3: 59$ | $4: 00$ |
| Chalk Art | $4: 30$ | 2:00 p.m. |

## Grade 4 / Unscored Students Samples

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

## Focus <br> Standards and Claim <br> Claim 2 <br> 3.MD.A

## Stimulus

## Art Day!

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- Painting
- Pottery
- Chalk Art

You have two tasks. You will help create the supply list and the schedule for Art Day.

## Task 1: Supply List

You need to make sure there are enough supplies at each station for everyone to participate. You will use the following information to create a list of art supplies for your class.

- There are 24 students in your class.
- Each student needs -
- 2 paint brushes for the Painting Station.
- 3 pounds of clay for the Pottery Station.
- 5 pieces of chalk for the Chalk Art Station.


## Task 2: Schedule

You also need to help plan the schedule for Art Day using the following information.

- The day starts at 9:00 a.m. and ends at 2:00 p.m.
- Your entire class will rotate through the three stations together.
- The Break has to be at least 10 minutes.
- The Break and Lunch together total 1 hour.
- The three stations (Painting, Pottery, and Chalk Art) do not need to be the same amount of time, but each one has to be 30 minutes or longer.


## Item Prompt

When the class went to the Painting Station at 9:00 a.m., the container of paint was completely full. After 6 of the 24 students got their share of paint, the paint level had dropped to the level shown in the following picture.


At 9:00 a.m. paint container is full.


After 6 students got their share of paint, the level is here.

Katie thinks there is not enough paint for the rest of the students.
Do you agree with Katie? Explain why or why not. Use the information shown in your explanation.

## Sample Responses

Sample
Response A

## Sample <br> Response B

No she is wrong there is enough because 6 kids got less than one fourth of paint but there's 24 kids, and $4 \times 6=24$ so there's enough for everybody to use some paint.

I disagree with Katie because some people will use more paint and some people will use less paint so it depends on students.

## Sample <br> Response C

No, I do not agree with katie because $4 \times 6=24$ so there is anough for everyone
people 6-1 group - less than 1/4
people 6-2 group - a little more than $1 / 4$
people 6-3 group - a little more than $1 / 4$
people 6-4 group - a little more than $1 / 4$

## Sample

Response D
Sample
Response E

## Sample <br> Response F

No there are 4 different levels each level 6 students use and $4 \times 6=24$ so there is enough

I think there is enough paint because there is only 3 stations so paint brushes and 3 pounds of clay and 5 pieces of chalk so I think it will be enough I do not agree with Katie

4 levels 4-4 = 0 levels left but everyone got to use.
24 students
$24-18=6$
$24 \div 6=4$ and 6 students $=1$ level of paint

## Art Day! (Grade 4) Scores and Score Rationales

Item 1

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 0 | The student responded that 24 paint brushes are needed. The student likely <br> did not take into account the part of the directions that stated each student <br> would need 2 paint brushes. The student either did not refer back to the <br> directions, or did not understand what the question was asking. |
| B | 1 | The response reflects an accurate calculation of the total number of paint <br> brushes needed. |
| C | 0 | The student indicated that 12 paint brushes were required. The student may <br> have divided the total number of students by 2. |

Item 2

| Sample | Score | Rationale |
| :---: | :--- | :--- |
| A | 0 | Incorrect response. The student may not have understood the question being <br> asked, or did not refer back to the directions, which indicate that 3 pounds of <br> clay per person are required. |
| B | 0 | Incorrect response. The student seemed to have misinterpreted the meaning of <br> the quantities, and divided 24 students into 3 equal groups, yielding a value of 8. |
| C | 1 | Correct response. The response reflects an accurate calculation of the total <br> number of pounds needed. |
| D | 0 | The student likely incorrectly calculated $3 \times 24=74$. |

Item 3

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 2 | The student used decomposition and the distributive property to accurately <br> calculate the number of pieces of chalk in the 6 boxes that the teacher <br> currently has. In addition, the student compared the amount available (108) to <br> the total amount needed (120) to determine that there is not enough chalk <br> available. |
| B | 1 | This response demonstrates an active use of decomposition and the distributive <br> property, first to show exactly how much chalk is needed (5 pieces of chalk for <br> 24 students). Next, the student calculated accurately how much chalk is <br> available, again using decomposition of larger numbers and the distributive <br> property. The response includes the word "Check," suggesting a comparison <br> between the "check" number of 120 and the derived amount available (108). <br> However, the student did not explicitly state or explain the comparison that <br> was made. The response consists of a collection of accurate and clear <br> calculations, but does not include sufficient explanation to fully support Claim <br> 3. The response earns partial credit of 1 point. |

## Art Day! (Grade 4) Scores and Score Rationales

## Item 3 (cont.)

| Sample | Score | Rationale |
| :---: | :---: | :---: |
| C | 0 | This response shows a partial, concrete understanding of the situation. The student attempted to set up the problem by showing twenty-four 5 s added together. The student also represented 6 boxes of chalk with six 18 s , but did not show any calculations to support finding either of the relevant total amounts of chalk (available chalk; needed chalk). The student stated, "There are 10 pieces of chalk left," but the response does not include an explanation of where this amount came from, or how it relates to whether or not there is enough chalk for Art Day. Without work or calculations to support this statement, the response receives 0 points. |
| D | 1 | The student accurately calculated the amount of chalk in 6 boxes by using a repeated addition strategy. The student clearly showed how the total was calculated, but there is no evidence of attempting to complete the second part of the problem, which requires a decision about whether or not there is enough chalk for Art Day. There is no explanation, nor is there a completed answer to the question. The response receives partial credit of 1 point. |
| E | 2 | The student calculated $6 \times 18$ by decomposing the factor 18 into one 10 and eight 1 s , and multiplying each of these numbers by the factor 6 . The student then added the products together to a sum of 108. The student compared the amount available ( 108 pieces) to what is needed ( 120 pieces), to conclude that the teacher needs to buy more chalk. The justification earns full credit for this response. |
| F | 0 | This response suggests that the student did not have a clear understanding of the situation, or what is being asked in the problem. The student used the numbers supplied in the problem, added them up to get a sum of 144, and then added this sum to 134 . The reasoning for these calculations is unclear. The student did not attempt to respond to the second part of the problem, which requires an explanation, and there is no attempt to provide an argument for whether or not there is enough chalk. The response earns 0 points. |
| G | 2 | The student developed an approach to calculating exactly how many pieces of chalk are currently available, using repeated multiplication and addition strategies to calculate the total number of pieces of chalk in 6 boxes. The student's written statements suggest a clear comparison between the amount of chalk needed and the total number of pieces available. The response provides an effective approach to determining that there is not enough chalk, and a justification based on the comparison suggested in the statements. The response earns full credit. |
| H | 0 | Although this response includes the statement, "no becus we don't have enough," the student did not accurately calculate how much chalk was available, and did not provide an explanation as to how he/she figured out that there is not enough chalk. The grouping of 1 s suggests some partially successful concrete reasoning about the boxes of 18 single pieces of chalk. The response earns 0 points. |

## Art Day! (Grade 4) Scores and Score Rationales

## Item 4

| Sample | Score | Rationale |
| :---: | :---: | :---: |
| A | 1 | The student met all of the requirements of this item by creating a schedule that correctly applies the provided information. The student allotted 30 minutes for the first 2 activities, with the time for the final activity being much longer, at 3 hours. The response contains evidence of the student's ability to retrieve information from the context and design a model that satisfies the given constraints. Perhaps this student loves chalk art, or has some personal experience with chalk art requiring a lot of time. |
| B | 1 | The student met all of the requirements of this item by creating a schedule that correctly applies the provided information. The student allotted equal time for each station, with each being 1 hour long, and appears to have considered time to transition from one station to the next in the schedule, as the end times and start times are not the same. The response contains evidence of reasoning carefully within the context, and an ability to design a model that satisfies the given constraints. |
| C | 0 | The student created a schedule that correctly applies the provided information about the time allotted for each station, however, the schedule does not reflect the requirement that the total time for lunch and break should be 1 hour. The student instead allotted 1 hour for lunch and 10 minutes for the break. Therefore, the response contains evidence of a model that satisfies most, but not all, of the given constraints. All of the given schedule constraints must be satisfied for full credit, so this response receives 0 points. |
| D | 0 | The student created a schedule that correctly applies the provided information about the stations. It also appears that the student considered transition times in the schedule, as end times and start times are not the same. However, the student did not meet the requirement that the total time for lunch and break should be 1 hour, allotting more than 1 hour for lunch. Therefore, the response contains evidence of a model that satisfies most, but not all, of the given constraints. Even though the response offers evidence of a very reasonable and thoughtful plan for Art Day, all requirements must be satisfied for full credit. |
| E | 1 | The student met all of the requirements of this item by creating a schedule that correctly applies the provided information. Although the student used "a.m." to indicate times through 12:00, the use of a.m. and p.m. in this item is not a focus of the assessment. Therefore, incorrect usage is not penalized. |
| F | 0 | This response demonstrates a partial understanding of the problem. The student placed the final end time of 2:00 p.m. as the first station's end time, and then went back in time to 12:20 to begin the break. The student continued to place times in the schedule, but they are not sequential, with the start time for Chalk Art 2.5 hours after the end time. There is just 1 minute for lunch in this schedule. The response earns 0 points. |

## Art Day! (Grade 4) Scores and Score Rationales

## Item 5

| Sample | Score | Rationale |
| :---: | :---: | :---: |
| A | 1 | The response includes a clear statement of disagreement with Katie. The student stated that 6 kids used less than $1 / 4$ of the paint, and provided a correct calculation of the number of groups of 6 students in the class of 24 students ( $4 \times 6=24$ ). Although the explanation would be more thorough if the ideas were more explicitly connected, the central comparison that is relevant for determining if there is enough paint is clearly present. This comparison is between the estimated portion of paint used (less than $1 / 4$ of the total available) and the portion of students in the class who have used the paint so far (exactly $1 / 4$ ). The response receives full credit of 1 point. |
| B | 0 | This response demonstrates an understanding that there is an element of unpredictability in the situation. It is unclear that all groups will use approximately the same amount of paint; this is an assumption that must be made. That said, the student did not demonstrate any mathematical thinking or reasoning, and the response earns 0 points. |
| C | 1 | The student stated that there is enough paint because $4 \times 46=24$. On its own, this statement would not be a sufficient explanation, however the student then used the information provided in the diagram to create a model to demonstrate a possible distribution of the paint across 4 equal groups of 6 people each. The response earns full credit of 1 point. |
| D | 1 | In this response, the student interpreted the diagram in a straightforward way, and used basic number sense and contextualized problem-solving skills to argue that there is enough paint: There are 4 levels identified on the paint container, and 6 students used up the amount of paint indicated by the first of the 4 levels. The student provided the fact that $4 \times 6=24$ to represent 4 groups of 6 in 24. Four levels of paint indicate 4 portions of paint for each group of 6 students, and there are 4 groups of 6 students in all. Because there is no evidence of recognition that the portion sizes are unequal, some may not want to give this response 1 point. However, the explanation is logical, and this response squeaks by for full credit of 1 point. |
| E | 0 | The response does not include evidence of logic or reasoning about the amount of paint left in the container compared to how many people used the paint and how many students still need to use the paint. The student used all of the given information from Task 1 to attempt to justify a disagreement with Katie, but did not provide a logical explanation that referred to the diagram given for the problem. The response earns 0 points. |
| F | 0 | It appears that the student attempted to apply his/her understanding of creating equal groups of 6 students, and used repeated subtraction to estimate if there would be enough paint. However, the response does not include a clearly expressed argument and does not include evidence of a logical explanation. The response earns 0 points. |

# Grade 5 Mathematics Clay Pottery Performance Task 

## Clay Pottery

Lizzie and Zela are interested in making pottery. The following chart shows how much clay is needed to make different projects.

| Project | Pounds of Clay <br> Needed |
| :---: | :---: |
| Small Plate | $2 \frac{1}{2}$ |
| Small Bowl | $1 \frac{1}{2}$ |
| Sinner Plate Bowl | $3 \frac{1}{4}$ |
| Mug | $\frac{3}{2}$ |

# Grade 5 Mathematics Clay Pottery Performance Task 

## 1

Which project needs the most clay?
A. Small Plate
B. Small Bowl
C. Large Bowl
D. Dinner Plate
E. Mug
(2)

How much more clay, in pounds, is needed to make a large bowl than a small bowl?

pounds

## (3)

Zela wants to make a set of 6 mugs. The clay only comes in 1-pound blocks.


What is the least number of blocks of clay Zela will need to make 6 mugs?
Explain how you figured out your answer.
Note: Zela knows that leftover clay from each block can be squished together and used.

# Grade 5 Mathematics Clay Pottery Performance Task 

4

Lizzie has 12 pounds of clay and wants to use all of it. She does not need to make all of the projects, and may make more than one of any project.

Describe a plan for Lizzie to use 12 pounds of clay making projects from the chart.

Show how you know she will use exactly 12 pounds of clay with this plan.

## 5

Zela is making a plan to use her 12 pounds of clay. She still wants to make 6 mugs. She also wants to make 6 small bowls.

## Lizzie says:

" 12 pounds is not enough to make 6 mugs and 6 small bowls. I know because I did the math."

## Zela says:

"It is enough if I make the bowls smaller!"
Make a plan for Zela to use no more than 12 pounds of clay to make 6 mugs and 6 bowls that are smaller than the bowls in the chart.

In the plan, state how much clay she should use for each of her smaller bowls. Her bowls should all be the same size.

Zela does not care about using exactly 12 pounds, but she does want to use as much of the clay as possible.

# Grade 5 Mathematics Clay Pottery Performance Task 

1
Which project needs the most clay?
A. Small Plate
B. Small Bowl
C. Large Bowl
D. Dinner Plate
E. Mug

## \#1 Multiple choice - 1 point

| Item | Claim | Domain | Target | DOK | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 1$ | 2 | NF | 2A | 1 | 1 | D - Dinner plate |

Key (1 point): The student selects option D - Dinner plate.
Commentary: The first two questions are entry level questions to ramp into the work of the task. The purpose of these questions are primarily to assess whether the student (1) understands the context and the representation (a table) and (2) can identify and infer relevant quantities and perform typical calculations (compare magnitudes).

The context is reasonably authentic. Many students have taken an art class or have interacted with clay in other settings. Understanding that different projects require different quantities of clay can be applied to many contexts besides art. These questions are about understanding which projects use more or less clay.

## Rationale for Content:

The content is securely held, as this question assesses a 4th-grade standard. Students are asked to determine how much more clay is needed to make the large bowl compared to the small bowl, which in essence is asking them to compare two fractions. This is why the content standard is 4.NF.A.2.
4.NF.A. 2 Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as $1 / 2$. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.

## Rationale for Claim:

The fact that the student must extract the quantities and compare them is what makes this a Claim 2, Target D.

Claim 2, Target D: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas).

## Rationale for DOK:

This is a straightforward DOK 1. From the Depth of Thinking chart:
ANALYZE (DOK 1):
-Retrieve information from a table or graph to answer a question.

## 2

How much more clay, in pounds, is needed to make a large bowl than a small bowl?
$\square$
\#2 Equation numeric - 1 point

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :--- | :---: | :--- |
| $\# 2$ | 2 | NF | 2A, 2D | 2 | 5.NF.A.2; 4.NF.A.2 | 1 | $13 / 4$ or 1.75 or equivalent |

Key (1 point): $13 / 4$ or 1.75 or equivalent

## Rationale for Content:

The content is part of the progression of standards in the NF domain that leads to understanding how to use equivalent fractions as a strategy to subtract fractions. This is why the primary content standard is 5.NF.A.2. However, the problem can be solved using the strategies linked to 4.NF.A. 2 as well.
5.NF.A. 2 Solve word problems involving addition and subtraction of fractions referring to the same whole, including cases of unlike denominators, e.g., by using visual fraction models or equations to represent the problem. Use benchmark fractions and number sense of fractions to estimate mentally and assess the reasonableness of answers. For example, recognize an incorrect result $2 / 5+1 / 2=3 / 7$, by observing that $3 / 7<1 / 2$.

# Grade 5 Mathematics Clay Pottery Performance Task 

4.NF.A. 2 Compare two fractions with different numerators and different denominators, e.g., by creating common denominators or numerators, or by comparing to a benchmark fraction such as $1 / 2$. Recognize that comparisons are valid only when the two fractions refer to the same whole. Record the results of comparisons with symbols >, =, or <, and justify the conclusions, e.g., by using a visual fraction model.

## Rationale for Claim:

The fact that the student must extract the quantities, choose the procedure, and calculate the answer to solve this problem is what makes this a Target 2A (primary target) and Target 2D (secondary target).

Claim 2, Target A: Apply mathematics to solve well-posed problems in pure mathematics and arising in everyday life, society, and the workplace.

Claim 2, Target D: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas).

## Rationale for DOK:

Since the student needs to retrieve information from the context and select a procedure (in this case, subtraction), it meets the requirement for DOK 2. From the Depth of Thinking chart:

APPLY (DOK 2):
-Select a procedure and perform it
-Solve a routine problem applying multiple concepts or decision points
-Retrieve information to solve a problem

Zela wants to make a set of 6 mugs. The clay only comes in 1-pound blocks.


What is the least number of blocks of clay Zela will need to make 6 mugs?
Explain how you figured out your answer.
Note: Zela knows that leftover clay from each block can be squished together and used.
\#3 Short answer - 2 points

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \#3 | 4 | NF | $4 D$ | 2 | 4.NF.A.4c | $2,3,4$ | See sample responses |

## Rubric:

2 points: Student develops an approach to determine the number of pounds of clay needed to make 6 mugs AND provides an explanation as to why 5 blocks are needed.

1 point: Student correctly calculates the amount of clay needed, but does not provide an explanation why. Or, student provides the correct answer but with a flawed justification.

0 points: All other responses
Commentary: Although the purpose of this question is to have students solve a problem in a real-life context, it has been designed to focus on interpreting results in such a context. This is achieved by making the amount of clay needed to be 4.5 pounds and requiring clay to be sold in 1-pound increments only. If the amount needed had been, for example, 4 pounds of clay, then this would not have necessitated the same degree of interpretation.

## Rationale for Content:

This content is securely held, being essentially 4th grade.
4.NF.B.4c Solve word problems involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem. For example, if each person at a party will eat $3 / 8$ of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed? Between what two whole numbers does your answer lie?

## Rationale for Claim:

There are a variety of approaches. Students may create a list or make a table showing the amount of clay needed for a set of 6 mugs. This requires understanding of the context, correctly calculating the amount of clay, and interpreting the result in context. Because clay only comes in 1-pound increments, students must correctly explain what to do with the 4.5 pounds of clay needed. This is what makes this a Claim 4, as is explicitly called out in the specifications:

Claim 4, Target D: Interpret results in the context of a situation. Tasks used to assess this target should ask students to link their answer(s) back to the problem's context. In early grades, this might include a judgment by the student of whether to express an answer to a division problem using a remainder or not based on the problem's context. In later grades, this might include a rationalization for the domain of a function being limited to positive integers based on a problem's context (e.g., understanding that the number of buses required for a given situation cannot be $321 / 2$, or that the negative values for the independent variable in a quadratic function modeling a basketball shot have no meaning in this context).

## Rationale for DOK:

This question has two parts that qualify as DOK 2. From the Depth of Thinking chart:

APPLY DOK 2: Select a procedure and perform it
And from Smarter Balanced specifications:
ANALYZE DOK 2: Interpret results in the context of a situation

What follows are sample responses and scoring annotations for Item 3.

# Grade 5 Mathematics Clay Pottery Performance Task 

Lizzie has 12 pounds of clay and wants to use all of it. She does not need to make all of the projects, and may make more than one of any project.

Describe a plan for Lizzie to use 12 pounds of clay making projects from the chart.

Show how you know she will use exactly 12 pounds of clay with this plan.
\#4 Short answer - $\mathbf{2}$ points

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 4$ | 3 | NF | B | 3 | 4.NF.A.4c | $2,3,4$ | See sample responses |

## Rubric:

2 points: Student describes a plan by which Lizzie uses all 12 pounds of clay making projects from the chart. A valid explanation is one that connects to the context. Numeric computations with no explanation are not considered valid.

1 point: Student provides either a correct explanation with incorrect calculations or has incorrect calculations that total 12, but has a valid explanation.

0 points: All other responses

## Commentary:

This question is about planning which combinations of projects can be made that require exactly 12 pounds of clay (which, mathematically, reduces to finding certain combinations of given fractions that add up to 12) and justifying the solution.

## Rationale for Content:

This content is securely held, being essentially $4^{\text {th }}$ grade.
4.NF.4c: Solve word problems involving multiplication of a fraction by a whole number, e.g., by using visual fraction models and equations to represent the problem. For example, if each person at a party will eat $3 / 8$ of a pound of roast beef, and there will be 5 people at the party, how many pounds of roast beef will be needed?

# Grade 5 Mathematics Clay Pottery Performance Task 

Between what two whole numbers does your answer lie?

## Rationale for Claim:

Because the problem is asking for an explanation, the expectation is that students connect the meaning of the context to suitable operations and show, mathematically, that conditions are met. Providing numeric calculations with no connections to the context does not comprise an explanation and is therefore not sufficient. It is this aspect that pushes it into Claim 3 from Claim 2.

## Rationale for DOK:

This is a straightforward DOK 3 problem. From the Depth of Thinking chart:
DOK 3, UNDERSTAND:

- Use concepts to solve non-routine problems
- Explain reasoning when more than one response is possible


# Clay Pottery Performance Task 

5

Zela is making a plan to use her 12 pounds of clay. She still wants to make 6 mugs. She also wants to make 6 small bowls.

## Lizzie says:

" 12 pounds is not enough to make 6 mugs and 6 small bowls. I know because I did the math."

## Zela says:

"It is enough if I make the bowls smaller!"
Make a plan for Zela to use no more than 12 pounds of clay to make 6 mugs and 6 bowls that are smaller than the bowls in the chart.

In the plan, state how much clay she should use for each of her smaller bowls. Her bowls should all be the same size.

Zela does not care about using exactly 12 pounds, but she does want to use as much of the clay as possible.

## \#5 Short answer - 2 points

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 5$ | 4 | NF | F | 3 | 3.NF.A.3, <br> 4.NF.B.4c | $2,3,4$ | See sample responses |

## Rubric:

2 points: The student describes an amount of clay that meets the criteria (6 mugs $\times 3 / 4$ and 6 bowls times a value between 1 and $11 / 2$ ) AND gives a valid explanation for how this value meets the criteria.

1 point: 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 may include evidence of insufficient mathematical knowledge; errors in fundamental mathematical procedures; and/or lack of explanation or clarity in the response.

0 points: All other responses

# Grade 5 Mathematics <br> Clay Pottery Performance Task 

Note: If the student uses an incorrect amount of clay from item \#3 in the response to determine the amount of clay needed, the response can still earn full credit.

## Commentary:

The purpose of the question is to provide a "design under constraint" type problem. This entails multiple steps: (1) Students must make sense of the constraints, (2) determine a value that satisfies the constraints, and (3) explain why this value works. We view this a modeling task, hence Claim 4. There is also, by design, a non-routine quality to mathematical work expected of the students in that 5th-grade students will not have algebraic tools to tackle this in generality, hence must devise their own strategy. In addition, there is no scaffolding, so even though the numbers involved are (by design) not too messy, the depth of knowledge is increased to level 3.

## Rationale for Content:

The content is securely held; the numeric comparisons of fractions are a Grade 3 content standard.
3.NF.3: Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.

## Rationale for Claim:

This question aligns with Claim 4, Target F because this problem asks students to design under constraints. This particular question is asking students to design bowls by (1) specifying values of essential parameters given, and (2) giving an explanation of how these values satisfy the constraint.

Claim 4, Target F: Identify important quantities in a practical situation and map their relationships.

## Rationale for DOK:

This question is DOK 3 for the following reasons. From the Depth of Thinking chart:

UNDERSTAND (DOK 3):
-Use concepts to solve non-routine problems
-Explain reasoning when more than one response is possible

# Grade 5 Mathematics Clay Pottery Performance Task 

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

## Grade 5 / Unscored Students Samples <br> ITEM \#1

MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

Focus
Standards
and Claim

Claim 2
4.NF.A. 2

Clay Pottery
Lizzie and Zela are interested in making pottery. The following chart shows how much clay is needed to make different projects.

| Project | Pounds of Clay Needed |
| :---: | :---: |
| Small Plate | $2 \frac{1}{2}$ |
|  <br> Small Bowl | $1 \frac{1}{2}$ |
|  | $3 \frac{1}{4}$ |
|  | $4 \frac{1}{2}$ |
|  | $\frac{3}{4}$ |

# Item Prompt 

Which project needs the most clay?
A. Small Plate
B. Small Bowl
C. Large Bowl
D. Dinner Plate
E. Mug

## Sample Responses

Sample Response A
D. Dinner Plate
Sample
C. Large Bowl
Response B

## Grade 5 / Unscored Students Samples ITEM \#2

MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

## Focus <br> Standards and Claim

Stimulus

Claim 2
5.NF.A. 2
4.NF.A. 2

Clay Pottery
Lizzie and Zela are interested in making pottery. The following chart shows how much clay is needed to make different projects.

| Project | Pounds of Clay <br> Needed |
| :---: | :---: |
|  | $2 \frac{1}{2}$ |
| Small Plate |  |

## Item Prompt

How much more clay, in pounds, is needed to make a large bowl than a small bowl? pounds

## Sample Responses

## Sample <br> Response A <br> $21 / 2$

## Sample

Response B
$13 / 4$

| Sample | 0 |
| :--- | :--- |
| Response C | 0 |

## Grade 5 / Unscored Students Samples ITEM \#3

MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

Focus
Standards and Claim

Stimulus

Claim 4
4.NF.B.4c

Clay Pottery
Lizzie and Zela are interested in making pottery. The following chart shows how much clay is needed to make different projects.

| Project | Pounds of Clay Needed |
| :---: | :---: |
| Small Plate | $2 \frac{1}{2}$ |
|  <br> Small Bowl | $1 \frac{1}{2}$ |
|  | $3 \frac{1}{4}$ |
|  | $4 \frac{1}{2}$ |
|  | $\frac{3}{4}$ |

## Item Prompt

Zela wants to make a set of 6 mugs. The clay only comes in 1 -pound blocks.


What is the least number of blocks of clay Zela will need to make 6 mugs?
Explain how you figured out your answer.
Note: Zela knows that leftover clay from each block can be squished together and used.

## Sample Responses

Sample
Response A
1 mug $3 / 4+2$ mugs $3 / 4+3$ mugs $3 / 4=9 / 4$
4 mugs $3 / 4+5$ mugs $3 / 4+6$ mugs $3 / 4=9 / 4$
$9 / 4+9 / 4=18 / 4$
She will need $18 / 4$ of clay to make six mug because 1 mug is $3 / 4$. for you can get your answer add all of them.

Sample
Response B

$$
75+75=150
$$

$150+150=300$
$300+300=600$
I doubled 753 times and got 600 which is equal to 6 pounds of clay.

## Sample

Response C

$$
\begin{aligned}
& \frac{3}{4}+\frac{3}{4}+\frac{3}{4}+\frac{3}{4}+\frac{3}{4}+\frac{3}{4}=\frac{18}{4} \\
& 1=\frac{4}{4}=\frac{14}{4}-\frac{4}{4}=\frac{10}{4}-\frac{4}{4}=\frac{6}{4}-\frac{4}{4}=\frac{2}{4}
\end{aligned}
$$

The least number is 5 .
Sample
Response D

## Sample

Response E
$3 \times 6=18 / 4$
18/4= 6 mugs
Do not add demonaters!
Only 1 pound blocks.
Question: How many 4s in 18 ?
$4 \times 4=16$
$18 / 4-4 / 4=14 / 4$
$14 / 4-4 / 4=10 / 4$
$10 / 4-4 / 4=6 / 4$
6/4-4/4-2/4
About leftover $=2 / 4$
So you will need 5 pounds.

Zela will need 5 pounds. I know this because I subtracted $18 / 4$ by $4 / 4$ and so on. After that $2 / 4$ were left and without the $2 / 4$ will be 4 pounds. But Zela needs that $2 / 4$ so she will actually need 5 pounds.
wants to make 6 mugs
clay only comes in 1-pound
least number of blocks of clay zela will need
$\frac{3}{4} \frac{3}{4} \frac{3}{4} \frac{3}{4} \frac{3}{4} \frac{3}{4}$
$\frac{18}{4}$
45
Zela will need 5 pounds to make 6 mugs because I wrote $3 / 46$ times and added all the numerators and got 18 and multiplyed $4 \times 4=16$ and got 5 and 4 then 1 knew it was 5 .

## Sample <br> Response F

4 mugs

## Sample

Response G

$$
\begin{aligned}
& \frac{3}{4}+\frac{3}{4}+\frac{3}{4}+\frac{3}{4}+\frac{3}{4}+\frac{3}{4}=\frac{18}{4} \\
& \frac{4}{4}=1 \\
& \frac{18}{4} \div 4=\frac{14}{4} \div 4=\frac{10}{4} \div 4=\frac{6}{4} \div 4=\frac{2}{4}
\end{aligned}
$$

Zela will need at least 5 pound for 6 mugs. She will need 5 pounds because Zela will need an extra half pound to make 6 mugs.

Sample
Response H
1 clay block $=1.25$ mugs
$1.25+1.25+1.25+1.25+1.25=6.25$

It will take Zela 5 blocks of clay to make 6 mugs. I figured out my answer by knowing that there will be $1 / 4$ left from each clay block.
Sample Response I

$$
\begin{aligned}
& \frac{3}{4}+\frac{3}{4}=1 \frac{1}{2} \\
& \frac{3}{4}+\frac{3}{4}=1 \frac{1}{2} \\
& \frac{3}{4}+\frac{3}{4}=1 \frac{1}{2} \\
& 1 \frac{1}{2}+1 \frac{1}{2}=3 \\
& 3+1 \frac{1}{2}=4 \frac{1}{2} \\
& 4 \frac{1}{2}+\frac{1}{2}=5 \text { (extra } 1 / 2 \text { is to make a whole pound) }
\end{aligned}
$$

The least number of blocks of clay Zela could get is 5 .

## Grade 5 / Unscored Students Samples ITEM \#4

MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

## Focus <br> Standards and Claim

Claim 3
4.NF.4c

Clay Pottery
Lizzie and Zela are interested in making pottery. The following chart shows how much clay is needed to make different projects.

| Project | Pounds of Clay <br> Needed |
| :---: | :---: |
|  | $2 \frac{1}{2}$ |
| Small Plate |  |

## Item Prompt

Lizzie has 12 pounds of clay and wants to use all of it. She does not need to make all of the projects, and may make more than one of any project.

Describe a plan for Lizzie to use 12 pounds of clay making projects from the chart.
Show how you know she will use exactly 12 pounds of clay with this plan.

## Sample Responses

Sample
Response A
$21 / 2+21 / 2=5$ pounds
$11 / 2+11 / 2=3$ pounds
$5+3=81 b$
$8 \mathrm{lb}+31 / 4=111 / 4+3 / 4=12 \mathrm{lb}$
Lizzie would need to make two small plates, two small bowls, one large bowl, and one mug to use exactly 12 pounds of clay.

## Sample

Response B

## Sample

Response C

Lizzie needs to make 1 dinner plate, 1 small bowl, 1 large bowl, 1 small plate, and 2 mugs to make 12 pounds.
$21 / 2+21 / 2+21 / 2=71 / 2$
$71 / 2+11 / 2+11 / 2=91 / 2$
$91 / 2+21 / 2=12$ pounds
I know that she will get exactly 12 pounds if she makes 4 small plates and 2 small bowls.

## Sample

 Response DDinner plate: $4 \frac{1}{2}$

Small plate: $2 \frac{1}{2}$
Small bowl: $1 \frac{1}{2}$
Small bowl: $1 \frac{1}{2}$
Mug: $\frac{3}{4}$
Mug: $\frac{3}{4}$
$4 \frac{1}{2}+2 \frac{1}{2}=7$ pounds
$2 \frac{1}{2}+1 \frac{1}{2}=3$ pounds
$\frac{3}{4}+\frac{3}{4}=2 \frac{1}{4}$ pounds
$7+3=10$ pounds
$10+2 \frac{1}{4}=12 \frac{1}{4}$ pounds

## Sample

She can 8 small bowls to ecxactly use 12 pound of clay because each bowl you use $11 / 2$ pound so if you do two of them that will equal 3 and since $I$ know that $3 \times 4=12$ so thats 12 pound, so I do $4 \times 2=8$ so $I$ did the small bowl.

## Sample

Response F
Small bowl + large bowl + large bowl + dinner plate + small bowl
$1 \frac{1}{2}+3 \frac{1}{4}+3 \frac{1}{4}+4 \frac{1}{2}+1 \frac{1}{2}$
$1 \frac{1}{2}+3 \frac{1}{4}+3 \frac{1}{4}=7 \frac{3}{10}+4 \frac{1}{2}+1 \frac{1}{2}=12 \frac{5}{14}$
If she needs dishes she can make a small bowl, $2 x$ large bowl, dinner plate, small bowl because she said she doesn't want to waste anything.

Sample
Response G
$4 \frac{1}{2}+2 \frac{1}{2}=7+3 \frac{1}{4}=10 \frac{1}{4}+\frac{3}{4}=11$
She can get the small bowl, dinner plate, large bowl, and a mug.

## Sample

Response H

Lizzie will use 12 pounds with 2 dinner plates because $41 / 2$ can be 12 pounds to use all of her clay.

## Grade 5 / Unscored Students Samples

Focus
Standards and Claim

## Stimulus

CCSS.MATH.CONTENT.
3.NF.3.

Explain equivalence of fractions in special cases, and compare fractions by reasoning about their size.

## Clay Pottery

Lizzie and Zela are interested in making pottery. The following chart shows how much clay is needed to make different projects.

| Project | Pounds of Clay <br> Needed |
| :---: | :---: |
| Small Plate | $2 \frac{1}{2}$ |
| Small Bowl | $1 \frac{1}{2}$ |
| Minner Plate |  |

## Item Prompt

Zela is making a plan to use her 12 pounds of clay. She still wants to make 6 mugs. She also wants to make 6 small bowls.
Lizzie says:
"12 pounds is not enough to make 6 mugs and 6 small bowls. I know because I did the math."
Zela says:
"It is enough if I make the bowls smaller!"
Make a plan for Zela to use no more than 12 pounds of clay to make 6 mugs and 6 bowls that are smaller than the bowls in the chart.
In the plan, state how much clay she should use for each of her smaller bowls. Her bowls should all be the same size.
Zela does not care about using exactly 12 pounds, but she does want to use as much of the clay as possible.

## Sample Responses

Sample
Response A

## Sample

Response B

## Sample <br> Response C

## Sample <br> Response D

She should use $\frac{1}{3}$ for each mug and bowl because it is 6 bowls and 6 mugs. Zela is correct because you could use $\frac{1}{3}$ of clay.
$1+1+1+1+1=6$
$\frac{1}{2}+\frac{1}{2}+\frac{1}{2}+\frac{1}{2}+\frac{1}{2}+\frac{1}{2}=3$
Each bowl will need $1 \frac{1}{4}$ pounds of clay. That would be under 12 for Zela

Zela is write because she did the math. Zela does not care about using exactly 12 pounds.

6 mugs $=4.5 \mathrm{lbs}$
7.5 lbs of clay left

$$
1.25+1.25+1.25+1.25+1.25+1.25=7.5
$$

Zela would have to make six mugs and six bowls that are 1.25 pound each.

## Sample

Response E
6 mugs $=4 \frac{1}{2}$
$7 \frac{1}{2}$ pounds left over for the bowls
$1 \frac{1}{4}+1 \frac{1}{4}+1 \frac{1}{4}+1 \frac{1}{4}+1 \frac{1}{4}+1 \frac{1}{4}=7 \frac{1}{4}$
Zela could need to make the bowls $\frac{1}{4}$ smaller so that she could make them so they are $\frac{1}{4}$ smaller than 12 pounds. Which could make them $11 \frac{3}{4}$ big.

Sample
Response F
6 mugs $=41 / 2$
$12+41 / 2=71 / 2$ pounds
$1+1+1+1+1+1=6$
$1 / 2+1 / 2+1 / 2+1 / 2+1 / 2+1 / 2=3$
$6+3=9$
bigger 6 mugs $=5$ pounds
$9+5=14$
If Zela doesn't make the bowls smaller she'll get 14 pounds.
12 pounds would be enough is Zela made the bowls smaller. If the bowls were $11 / 4$ pounds you could use 12 pounds. Small bowl = $11 / 4$ pounds

## Sample

Response G
I know $\frac{1}{4} \times 6=7 \frac{1}{2}$
$\frac{3}{4} \times 6=4 \frac{1}{2}$ then $I$ added and got 12 .

## Sample

$$
.75+.75+.75+.75+.75+.75=4.50
$$

Response H

$$
1.25+1.25+1.25+1.25+1.25+1.25=7.50
$$

$$
4.50+7.50=12.00
$$

1.25 for smaller bowls

## Sample Response I

She can make the bowls with 1 pound of clay and it will take 6 pounds to make 6 . I added $\frac{3}{4}$
6 times and got $4 \frac{1}{2}$. In the end I added that and the 6 pounds and got $10 \frac{1}{2}$.

## Clay Pottery (Grade 5) Scores and Score Rationales

Item 1

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 1 | The student correctly identified option D, the dinner plate, as the project <br> requiring the most clay. |
| B | 0 | Incorrect response. The student incorrectly identified option C, the large bowl, <br> as the project requiring the most clay. |

Item 2

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 0 | Incorrect response. The response does not reflect an accurate calculation of the <br> difference between the pounds of clay needed to make the large bowl (3 $1 / 4$ <br> pounds) and the pounds of clay needed to make the small bowl (1 $1 / 2$ pounds). |
| B | 1 | Correct response. The student accurately calculated the difference between the <br> pounds of clay needed to make the large bowl and the small bowl. |
| C | 0 | Incorrect response. The response does not reflect an accurate calculation of the <br> difference between the pounds of clay needed to make the large bowl ( $31 / 4$ <br> pounds) and the pounds of clay needed to make the small bowl (1 1/2 pounds). |

Item 3

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 1 | This response indicates a clear understanding of how much clay is needed to <br> make 6 mugs. However, the response does not provide evidence of considering <br> the fact that the clay only comes in 1-pound blocks. The student explained how <br> he/she determined the total amount of clay needed ("1 mug is 3/4," and then <br> "add all of them"), but did not give the correct number of blocks of clay that <br> Zela needs. The response receives partial credit of 1 point. |
| B | 0 | The student incorrectly determined that 6 pounds of clay would be needed to <br> make 6 mugs. The student provided three calculations that are correct, but do <br> not fit the situation, and then incorrectly interpreted what the calculations <br> mean. The student concluded by stating that he/she doubled 75 three times, <br> which would yield a numeric value of 450 (4.50 in decimal form), not 600 (6.00 <br> in decimal form), as is stated in the response. The response receives 0 points. |
| C | 1 | The student used repeated addition to successfully determine that 18/4 is the <br> sum of 3/4 added 6 times. The next set of calculations indicate a use of <br> repeated subtraction of 4/4. However, the response does not earn full credit <br> because the concluding statement, though correct, does not connect the <br> calculations with a justification of why Zela would need to purchase 5 pounds <br> of clay. |

## Clay Pottery (Grade 5) Scores and Score Rationales

Item 3 (cont.)

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| D | 2 | The student applied multiplication of fractions to determine that $18 / 4$ pounds <br> of clay would be needed to make 6 mugs. The student then used repeated <br> subtraction to determine how many 4s are in 18, successively subtracting 4/4 <br> from 18/4. Finally, the student accurately concluded that Zela would need an <br> extra 2/4 pounds of clay, beyond 4 pounds of clay, in order to make all of the <br> mugs, which means that Zela would need 5 pounds of clay. |
| E | 1 | The student's response indicates an understanding that 6 mugs would require <br> 18/4 pounds of clay, and that this fractional amount is between 4 and 5 whole <br> pounds of clay. However, the student's justification is only partially complete in <br> detailing how the determination of 5 pounds was made. The response receives <br> partial credit of 1 point. |
| F | 0 | The student's response suggests a limited understanding of the problem. The <br> response earns 0 points |
| G | Using repeated addition of fractions, the student calculated that 6 mugs would <br> require 18/4 pounds of clay. The student then used repeated subtraction <br> (although notated as division) to determine how many whole pounds of clay are <br> contained within the 18/4 pounds. The student's calculations indicate that 4 <br> and 2/4 pounds would be needed. The final statement of the response indicates <br> that the student accurately interpreted the need to purchase an additional <br> pound of clay in order to have enough clay to make 6 mugs. |  |
| H | 2 | The student began by reasoning that 1 clay block would make 1.25 mugs. <br> Although this value is incorrect (1 clay block is enough to make 1 and $1 / 3$ <br> mugs), the reasoning is promising. The student then added 1.25 five times <br> (likely representing the number of mugs that could be made from 5 blocks of <br> clay), and correctly indicated that the sum is 6.25 . The student stated that "by <br> knowing that there will be $1 / 4$ left from each clay block," he/she was able to <br> figure out that Zela needs 5 pounds of clay. Although the connection between <br> these ideas is fuzzy and the calculations do not clearly support the statement, <br> the calculations are extraneous to a logical justification. Full credit. |
| I | 2 | The student used an adding-on strategy to determine that $41 / 2$ pounds of clay <br> would be needed to make 6 mugs. The student then added an extra $1 / 2$ pound <br> to reach 5 whole pounds of clay as the least number of blocks of clay that Zela <br> could get in order to make 6 mugs. |

## Clay Pottery (Grade 5) Scores and Score Rationales

Item 4

| Sample | Score | Rationale |
| :---: | :---: | :---: |
| A | 2 | The student's response identifies a series of items that, when added together, would use exactly 12 pounds of clay. The equations model the student's thinking process and support the student's plan, expressed in words. The explanation connects the mathematics to the context. The response earns full credit of 2 points. |
| B | 0 | The student's plan exceeds 12 pounds of clay, and there are no calculations provided to support the plan. The response earns 0 points. |
| C | 1 | The student's calculations represent an attempted plan to use exactly 12 pounds of clay. The student's equations outline the thinking process used to correctly determine first that 3 small plates would use $71 / 2$ pounds. The student then attempted to add $71 / 2$ to the amount of clay needed for 2 small bowls, and indicated an incorrect sum of $91 / 2$ pounds. Using this incorrect sum, the student then added the amount of clay needed for a 4th small bowl and found a total sum of 12 pounds. Although the student's reasoning is clearly expressed and the explanation clearly connects the mathematics to the context, the stated plan does not fit the requirements due to the incorrect calculation. The response earns 1 point. |
| D | 1 | This response includes a set of values and calculations that are both contextually sensible and accurate, except for one: $3 / 4+3 / 4=21 / 4$. The provided total sum of $121 / 4$ pounds suggests that the plan does not fit the given requirements of the problem. Moreover, even if all calculations had been correct, the total sum would not be 12 pounds. The student provided the amounts of clay needed for each project taken directly from the provided table, which does indicate a connection between the values in the calculations and the context. However, there is no stated plan to make an explicit connection between the values, the projects to be made, and how many of each are to be made. The response earns partial credit of 1 point. |
| E | 2 | This response, though a little hard to follow, connects all of the essential points of a valid explanation that relates to the context. The plan is to make 8 small bowls. The explanation begins with a statement about the amount of clay used for each bowl ( $1 \frac{1}{2}$ pounds) and the amount of clay used for 2 bowls ( 3 pounds). The student then provided calculations showing that the second value, 3 , must be multiplied by 4 to get 12 , so to use 12 pounds, 2 bowls would also be multiplied by 4 . In other words, 8 bowls would use ( $11 / 2$ pounds per bowl)( $4 \times 2$ bowls), which equals exactly 12 pounds of clay. The response earns full credit of 2 points. |
| F | 1 | The student's response explicitly presents a plan that exceeds the amount of 12 pounds required in the problem, as well as incorrect calculations. Though the conclusion connects well to the context of the problem, the excess clay needed for this plan suggests a reasoning error in relation to the given constraints. The response earns 1 point. |

Item 4 (cont.)

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| G | 1 | The student provided contextually sensible and correct calculations that yield a <br> sum of 11 pounds of clay, rather than 12 pounds of clay, so the plan does not <br> meet the requirements given in the problem. The student clearly stated what <br> projects are represented in the calculations, connecting the mathematics to the <br> context. The shortcoming in the stated plan appears to be a reasoning error, <br> and not due to a calculation error. The response earns partial credit of 1 point. |
| H | 0 | The student's plan to make two dinner plates will not use 12 pounds of clay, <br> and there are no calculations to support the student's reasoning. The response <br> earns 0 points. |

## Item 5

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 0 | The student indicated that Zela "should use $1 / 3$ for each mug," but did not <br> provide a calculation or plan indicating the new total amount of clay, or an <br> explanation of how this reduction would meet the criteria for making 6 mugs <br> and 6 bowls using no more than 12 pounds of clay. The response earns 0 points. |
| B | 1 | The student correctly determined that each bowl could be reduced to $11 / 4$ <br> pounds of clay, and the response includes relevant, though partial, calculations. <br> However, the explanation lacks clarity and makes a minimal and imprecise <br> connection between the reduced size of the bowl and the 12 pounds of clay. <br> The response receives partial credit of 1 point. |
| C | 0 | The student response does not provide clear evidence of understanding the <br> mathematics of the problem. |
| D | 2 | The response begins with a statement of how much clay is used by the 6 mugs <br> and how much clay remains (from an implicit total of 12 pounds). The student <br> reduced the bowls to 1.25 pounds of clay, and provided a calculation to show <br> that 6 bowls using the reduced amount of clay would use exactly the remaining <br> amount of 7.5 pounds of clay. The response concludes with a statement of the <br> plan, including which projects to make, how many of each, and the reduced <br> amount of clay for the bowls. The response earns full credit. |
| E | 1 | This response begins with correct statements about the amount of clay used <br> and amount of clay remaining after 6 mugs are made. The student correctly <br> determined that each bowl could be reduced to $11 / 4$ pounds of clay. However, <br> the student made a calculation error when finding the total amount of clay used <br> by 6 of these bowls, and his/her explanation appears to confuse the $1 / 4$ pound <br> reduction of each bowl with a 1/4 pound reduction of the total amount of clay. <br> Although there is some evidence that the student comprehended the essential |
| mathematical idea of the problem, the explanation is unclear and is directly |  |  |
| based on an error in a fundamental mathematical procedure. The response |  |  |
| earns partial credit of 1 point. |  |  |

Item 5 (cont.)

| F | 2 | The student's calculations show a thinking process about the total amount of <br> clay used by projects that are different sizes. This thinking appears to include <br> consideration of bigger mugs, which use 5 pounds in total, rather than $41 / 2$ <br> pounds. The response shows a reasoning process that leads to a conclusion that <br> 12 pounds is enough to support the bowls if the bowls are smaller, specifically 1 <br> $1 / 4$ pounds. Although circuitous, the response presents a plan that works for <br> Zela. The response earns full credit. |
| :---: | :---: | :--- |
| G | 0 | The first calculation is incorrect, though the student may have intended to write <br> $11 / 46=71 / 2$. The response does not include a clear statement of the new size <br> of the bowls or an explanation of the size of the bowls. The response earns 0 <br> points. |
| H | 1 | The student converted the fractions into decimals and determined that the <br> bowls should be reduced to 1.25 pounds in order for 6 bowls to equal 7.5 <br> pounds. While the student's calculations are accurate and result in an <br> appropriate amount of clay for each small bowl, the student did not provide a <br> plan or an explanation of the calculations. The response earns 1 point. |
| I | The student reduced the size of the bowls to 1 pound each and stated the total <br> amount of clay used by 6 of these bowls. The student then reported adding this <br> amount (6 pounds) to the total for the mugs (3/4 added 6 times) and finding the <br> overall pounds of clay used, which is less 12 pounds. Although this plan does <br> not reflect a rigorous attempt to "use as much of the clay as possible," it is <br> perfectly reasonable within the context and fits the requirements to a degree <br> appropriate for grade 5 . The response includes both clear reasoning and the <br> relevant specific values to support the plan. The response earns full credit. |  |

# Grade 7 Mathematics Let's Paint a Room Performance Task 

## Let's Paint a Room

Your friend Sam wants to paint her room. She wants to paint the ceiling white and the four walls purple.

You are helping Sam determine the cost and the amount of time needed to paint her room.

The room is shaped like a rectangular prism with a height of 8 feet, length of 12 feet, and width of 10 feet as shown.


Additional information about Sam's room:

- The door has an area of 22 square feet.
- The room has 2 square windows.
- Each window opening is 2 feet by 2 feet.


# Grade 7 Mathematics Let's Paint a Room Performance Task 

(1)

What is the area, in square feet, of the ceiling?


## 2

Sam needs to figure out how much purple paint to buy.
Calculate for her the total area, in square feet, of the four walls.
She will not paint the door or windows.

(3)

Part way through painting her room, Sam runs out of paint.

- She estimates that there are about 125 square feet left to paint.
- The purple paint that Sam is using is only available in 1-quart cans. (Assume she must buy whole cans of paint.)
- Each can of paint covers 40 square feet.

How many cans of paint does Sam need to buy to finish painting her room?
Explain to Sam why she needs this many cans of paint.

# Grade 7 Mathematics Let's Paint a Room Performance Task 

4

You decide to paint your room, too.
Your room has 300 square feet of wall space to paint.
Sam says it took her 10 minutes to paint 25 square feet.

At this rate, how many hours would it take Sam to paint your room?


## 5

Sam and you are going to paint your room together.
Sam takes 10 minutes to paint 25 square feet.
It takes you 5 minutes to paint 25 square feet.
Sam says, "If we paint together, then it will take 15 minutes for us to cover 50 square feet."

Give an explanation to convince Sam that she is incorrect.

# Grade 7 Mathematics Let's Paint a Room Performance Task 

What is the area, in square feet, of the ceiling?

\#1 Equation/ Numeric - 1 point

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 1$ | 4 | G, MD | 4 F | 2 | 6.G.A, 4.MD.A.3 | 1,5 | 120 |

## Rubric:

1 point: Correct response - 120
0 points: All other responses
Commentary: The purpose of the question is primarily to assess whether the student (1) understands the context and the representation and (2) can identify and infer relevant quantities and perform typical calculations.
In this question, the student is given a fairly typical 2 -dimensional diagram representing a 3 -dimensional room. The context is reasonably authentic. Many students have had experience with painting. The context is also a natural place for important mathematics of proportional relationships, rates, and geometry.

## Rationale for Content:

The content is essentially the Grade 6 Geometry Domain header:
6.G.A Solve real-world and mathematical problems involving area, surface area, and volume.

Additionally, this content builds on Grade 4 Measurement:
4.MD.A. 3 Apply the area and perimeter formulas for rectangles in real world and mathematical problems. For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.

## Grade 7 Mathematics Let's Paint a Room Performance Task

Since this question is intended to be accessible for most students, the numbers have been kept simple so as not to create arithmetic computational obstacles in obtaining evidence of Claims 2,3 , or 4.

The mathematical work of this question involves identifying the quantities (lengths of relevant edges). The ceiling is a rectangle. One side is directly labeled ( 12 ft ). The other side length must be inferred from the parallel side of the wall ( 10 ft ).

The next step for the student is choosing the relevant mathematical tool or procedure. For this question, the formula for the area of a rectangle is $A=I \times w$. So the solution is $12 \times 10=120$ square feet.

## Rationale for Claim:

The fact that the student must extract the quantities, choose the procedure, and calculate the answer is what makes this a Target 4F.

Claim 4, Target F: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas).

By design, the representation does not label all of the edge lengths making it unlikely that students could guess (e.g., select random numbers and perform a computation) and get the correct answer.

## Rationale for DOK:

The fact that this question requires a couple of steps and inferences and is not a direct recall or single-step application of a known and identified procedure makes this a DOK 2. Recall that difficulty is not the same as depth of knowledge. This is not intended to be a particular difficult question, but it involves more than one-step recall or rote procedures. This is not a DOK 3 since the representation is fairly standard, the formulas are applied in a typical way, and there is not really a choice of strategies.

# Grade 7 Mathematics Let's Paint a Room Performance Task 

## (2)

Sam needs to figure out how much purple paint to buy.
Calculate for her the total area, in square feet, of the four walls.
She will not paint the door or windows.

\#2 Equation/Numeric - 1 point

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 2$ | 2 | $G$ | 2 A | 2 | 6.G.A | 1,5 | 322 |

## Rubric:

1 point: Correct response - 322
0 points: All other responses
Commentary: This question continues with the same context and representation as question \#1. The mathematical work now is focused on problem solving in the sense that students need to "find a solution path" using readily available tools. The expectation is that students know the area of a rectangle, can infer the relevant quantities from the diagram, as in question \#1, but this time they have to combine several steps and have several options.

Students can calculate the area of each wall and subtract the areas of the door and windows, or add up the area of all the walls and then subtract the total area of the door and windows. Students may even do more complex decomposition of the figure. Regardless, the primary mathematics involve applying a known tool multiple times after choosing a particular solution path.

## Grade 7 Mathematics Let's Paint a Room Performance Task

## Rationale for Content:

The content is essentially the Grade 6 Geometry Domain header:
6.G.A Solve real-world and mathematical problems involving area, surface area, and volume.

Additionally, this content builds on Grade 5 Measurement:
5.MD.C. 5 Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.

## Rationale for Claim:

The question is completely formulated. There are a variety of solution paths that involve readily available mathematical tools (area of a rectangle, concept of area, strategy of decomposing figures). This work qualifies as evidence for Target 2A.

Claim 2, Target A: Apply mathematics to solve well-posed problems arising in everyday life, society, and the workplace. Under Claim 2, the problems should be completely formulated, and students should be asked to find a solution path from among their readily available tools.

## Rationale for DOK:

Because this question requires organizing or managing several pieces of information, this qualifies for DOK 2. It does not cross the threshold for DOK 3 since the mathematical tools are expected to be known (area of a rectangle) and the combination is fairly typical. Students are expected to know how to find areas of figures by decomposing or subtracting areas.

## Grade 7 Mathematics Let's Paint a Room Performance Task

## 3

Part way through painting her room, Sam runs out of paint.

- She estimates that there are about 125 square feet left to paint.
- The purple paint that Sam is using is only available in 1-quart cans. (Assume she must buy whole cans of paint.)
- Each can of paint covers 40 square feet.

How many cans of paint does Sam need to buy to finish painting her room? Explain to Sam why she needs this many cans of paint.
\#3 Short-answer - 2 points

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 3$ | 4 | RP | $4 D$ | 2 | $6 . R$ P.A | 1,6 | See sample responses |

## Rubric:

2 points: Correct response -4 cans AND correct explanation
1 point: Correct response, 4 cans, BUT no correct explanation OR 3.15 or equivalent with an acceptable explanation that clearly leaves out the fact that only whole cans can be bought

0 points: All other responses; including 3, 3.15 cans, or $35 / 40$ cans without an explanation

Note: Due to the fact that 3.15 is very close to 3 cans, a student might successfully argue for just 3 cans if he/she acknowledges that Sam's estimate may in fact be too high (it could be just 120 feet) or that she could possibly stretch the paint to finish the job. The key is that the explanation is thorough enough to show understanding that 3 cans is not enough unless some other factor is considered.

Commentary: This question is a fairly typical ratio reasoning problem. The key is that it is asking for an interpretation of the division in the context AND asking for an explanation. Students do not get full credit for merely indicating the correct number of cans. The explanation has to in some way state that cans must be bought in whole numbers of cans. The division of $125 / 40$ results in 3.125 cans.

## Grade 7 Mathematics Let's Paint a Room Performance Task

## Rationale for Content:

The content is securely held, being essentially about ratio reasoning in the Grade 6 Domain header:
6.RP.A Understand ratio concepts and use ratio reasoning to solve problems.

The numbers are kept simple so as not to create arithmetic computational obstacles in obtaining evidence of Claim 4. The purpose is to provide evidence for students to show proficiency in Claim 4.

## Rationale for Claim:

There are a variety of approaches. Students may list or make a table showing the amount of paint covered for a given number of cans: 1 can covers 40 sq ft, 2 cans $80 \mathrm{sq} \mathrm{ft}, 3$ cans $120 \mathrm{sq} \mathrm{ft}, 4$ cans 160 sq ft , hence because you must buy a whole number of cans, 4 cans are needed. Or they can do the division: 125/40 and interpret accordingly. The student must interpret the remainder in the context as requiring an additional can, hence 4 cans are needed. This is explicitly called out in the specifications:

Claim 4, Target D: Interpret results in the context of a situation. Tasks used to assess this target should ask students to link their answer(s) back to the problem's context. In early grades, this might include a judgment by the student of whether to express an answer to a division problem using a remainder or not based on the problem's context. In later grades, this might include a rationalization for the domain of a function being limited to positive integers based on a problem's context (e.g., understanding that the number of buses required for a given situation cannot be $321 / 2$, or that the negative values for the independent variable in a quadratic function modeling a basketball shot have no meaning in this context).

## Rationale for DOK:

As described in the text for Claim 4 Target D, interpreting the results in the context of a situation qualifies as a DOK 2.

# Grade 7 Mathematics Let's Paint a Room Performance Task 

You decide to paint your room, too.
Your room has 300 square feet of wall space to paint.
Sam says it took her 10 minutes to paint 25 square feet.

At this rate, how many hours would it take Sam to paint your room?

\#4 Equation/ Numeric - 1 point

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 4$ | 2 | RP | 2 A | 2 | 6. RP.A.3b | 1 | 2 |

## Rubric:

1 point: Correct response - 2
0 points: All other responses
Commentary: The purpose is to provide an opportunity for students to solve a problem that requires coordinating several quantities (area, time, rate) and track change of units (minutes to hours). By design, the numbers are kept simple to avoid arithmetic computational obstacles.

## Rationale for Content:

The content in this question is grounded in Grade 6 Ratios and Proportional Relationships, namely:
6.RP.A.3.b Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.
b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?

## Grade 7 Mathematics Let's Paint a Room Performance Task

## Rationale for Claim:

This question is fully formulated, asking how long it would take to paint the room and the student is provided with the quantities. The student must select how to relate these quantities and how to combine them to find the solution. This qualifies the question for Claim 2, Target A.

Claim 2, Target A: Apply mathematics to solve well-posed problems arising in everyday life, society, and the workplace. Under Claim 2, the problems should be completely formulated, and students should be asked to find a solution path from among their readily available tools.

## Rationale for DOK:

The problem is formulated and the relevant quantities are given (and no extraneous quantities are given). So this does not cross the threshold of DOK 3. The student is required to select how the quantities relate and how to combine them. This coordination, including the unit conversion, makes this more than a rote one-step computation, so it does cross the threshold into DOK 2.

5
Sam and you are going to paint your room together.
Sam takes 10 minutes to paint 25 square feet. It takes you 5 minutes to paint 25 square feet.

Sam says, "If we paint together, then it will take 15 minutes for us to cover 50 square feet."

Give an explanation to convince Sam that she is incorrect.

# Grade 7 Mathematics Let's Paint a Room Performance Task 

## \#5 Short text - 2 points

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 5$ | 3 | $R P$ | $3 B$ | 3 | 6.RP.A | 3 | See sample responses |

## Rubric:

2 points: Correct explanation
1 point: Elements of the explanation are correct, but the logic of the argument is fragmented or flawed.

0 points: All other responses
Commentary: This question requires students to confront and refute a common misconception about combining rates. Part of the design is that students are not required to actually solve the problem of figuring out how much time it would take to paint a room together. Rather, the purpose is to give Sam a convincing explanation that her reasoning is incorrect. This design allows for multiple logical approaches for refuting a claim.

## Rationale for Content:

The content in this question is grounded in Grade 6 Ratios and Proportional Relationships, namely:
6.RP.3.b Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.
b. Solve unit rate problems including those involving unit pricing and constant speed. For example, if it took 7 hours to mow 4 lawns, then at that rate, how many lawns could be mowed in 35 hours? At what rate were lawns being mowed?

However, by asking about the combination of rates (i.e., two people who paint at different rates, what is their rate if they paint together?), this provides an opportunity for more sophisticated reasoning. By design, the numbers are selected to be simple and easy to work with so as to avoid arithmetic computational obstacles. Furthermore, although some students will opt to calculate the combined rate, others can chose to refute the claim more directly by providing a logical counterargument (see the student responses for examples).

## Grade 7 Mathematics Let's Paint a Room Performance Task

## Rationale for Claim:

This question is directly asking students to "refute a proposition" posed by another person. This squarely lands in the descriptor for Claim 3, Target B. Claim 3, Target B: Construct, autonomously, chains of reasoning that will justify or refute propositions or conjectures. By "autonomous" we mean that the student responds to a single prompt, without further guidance within the task. Tasks used to assess this target should ask students to develop a chain of reasoning to justify or refute a conjecture. Tasks for Target B might include the types of examples called for in Target A as part of this reasoning, but they should do so with a lesser degree of scaffolding than tasks that assess Target A alone.

## Rationale for DOK:

There is very little scaffolding and many possible methods of refuting the claim. Although the content is technically Grade 6 rates, the combining of rates is typically challenging for Grade 7 students. Again, noting that the student does not need to determine the actual combined rate, so there are methods that only use securely held content available, including the use of counterexample. All these reasons qualify this question as DOK 3.

# Grade 7 Mathematics <br> Let's Paint a Room Performance Task 

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

## Grade 7 / Unscored Students Samples

Focus
Standards
and Claim

## Claim 4

6.G.A
4.MD.A. 3

## Let's Paint a Room

Your friend Sam wants to paint her room. She wants to paint the ceiling white and the four walls purple.

You are helping Sam determine the cost and the amount of time needed to paint her room. The room is shaped like a rectangular prism with a height of 8 feet, length of 12 feet, and width of 10 feet as shown.


Additional information about Sam's room:

- The door has an area of 22 square feet.
- The room has 2 square windows.
- Each window opening is 2 feet by 2 feet.

What is the area, in square feet, of the ceiling?


Sample Responses

| Sample <br> Response A | 22 ft |
| :--- | :--- |
| Sample <br> Response B | 52 feet |
| Sample <br> Response C | 120 |
| Sample <br> Response D | 12 ft |

## Grade 7 / Unscored Students Samples

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

| Focus | Claim2 |
| :--- | :--- |
| Standards | 6.G.A |
| and Claim | 5.MD.C. |

## Stimulus

## Let's Paint a Room

Your friend Sam wants to paint her room. She wants to paint the ceiling white and the four walls purple.

You are helping Sam determine the cost and the amount of time needed to paint her room.
The room is shaped like a rectangular prism with a height of 8 feet, length of 12 feet, and width of 10 feet as shown.


Additional information about Sam's room:

- The door has an area of 22 square feet.
- The room has 2 square windows.
- Each window opening is 2 feet by 2 feet.


## Item Prompt

Sam needs to figure out how much purple paint to buy.
Calculate for her the total area, in square feet, of the four walls.
She will not paint the door or windows.


## Sample Responses

## Sample Response A

Sample
Response B
70

Sample
Response C
80 ft

## Sample <br> Response D <br> $(12)(10)(8)=1,060$

Sample
Response E

## Sample <br> Response F <br> 352

## Grade 7 / Unscored Students Samples

Focus
Standards and Claim

## Stimulus

## Let's Paint a Room

Your friend Sam wants to paint her room. She wants to paint the ceiling white and the four walls purple.

You are helping Sam determine the cost and the amount of time needed to paint her room.
The room is shaped like a rectangular prism with a height of 8 feet, length of 12 feet, and width of 10 feet as shown.


Additional information about Sam's room:

- The door has an area of 22 square feet.
- The room has 2 square windows.
- Each window opening is 2 feet by 2 feet.


## Item Prompt

Part way through painting her room, Sam runs out of paint.

- She estimates that there are about 125 square feet left to paint.
- The purple paint that Sam is using is only available in 1-quart cans. (Assume she must buy whole cans of paint.)
- Each can of paint covers 40 square feet.

How many cans of paint does Sam need to buy to finish painting her room? Explain to Sam why she needs this many cans of paint.

## Sample Responses

## Sample Response A

## Sample Response B

Sample Response C

## Sample <br> 80

Response D

## Sample

Response E

## Sample

Response F

4 cans
125 divided by 40 is 3.125 to make them whole cans she would need 4 cans of paint.
$125 \div 40=31.02$
She will need about 32 cans because there is about 125 square feet to paint and each can paint 40 square feet so she will need about 32 cans.

4 cans because if she gets three she will have five feet left to paint.

$$
125 \text { divided by } 40 \text { is } 3.125 \text { to make them whole cans she would need } 4 \text { cans of paint. }
$$

40
120
40
160
4 cans of paint.
40

She needs to buy 4 more cans to finish painting her room.
31.22 cans of paint

Rounded equals 32 cans of paint

Sample
Response G

Sample
Response H

## Sample

Response I
Sample
Response J

## Sample

Response K
$125-40=85$
$85-40=45$
$45-40=5$

Sam by buying 3 cans you would have 5 square feet left to paint. I you get 4 you won't have any more square feet to paint. Also you would have extra paint left over for times when you need it.

She need 3 cans of paint. That will equal 120 , so it need a little bit more.

Sam only needs 4 cans of paint. Sam you only need 4 cans of paint because you only have 125 square feet left when 4 cans of paint equals 160 which is more then enough.
$125 \div 40=3.12$
$40 \times 3=120$
She would need to buy 4 full cans or 161 quart cans. The exact amount she needs is 3.12 but since you can't have a uneven amount she has to round and get 4 cans.

## $31 / 8$ of paint cans or 4 cans and there is $5 \mathrm{ft}^{2}$ left

so dividing the 5 by 40 equals 8 and turn into $1 / 8$ because there is no need for another can

## Grade 7 / Unscored Students Samples

Focus
Standards and Claim

## Stimulus

## Claim 2

6.RP.A.3.b

## Let's Paint a Room

Your friend Sam wants to paint her room. She wants to paint the ceiling white and the four walls purple.

You are helping Sam determine the cost and the amount of time needed to paint her room.
The room is shaped like a rectangular prism with a height of 8 feet, length of 12 feet, and width of 10 feet as shown.


Additional information about Sam's room:

- The door has an area of 22 square feet.
- The room has 2 square windows.
- Each window opening is 2 feet by 2 feet.


## Understanding



## Sample Responses

Sample Response A

| Sample |  |
| :--- | :--- |
| Response B | 2 |

Sample Response C

Sample
Response D

1 hour 20 minutes

2
about 12 hours

2hours 10 min

## Grade 7 / Unscored Students Samples

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

## Focus

Claim 6.RP.3.b
Standards and Claim

## Stimulus

## Let's Paint a Room

Your friend Sam wants to paint her room. She wants to paint the ceiling white and the four walls purple.

You are helping Sam determine the cost and the amount of time needed to paint her room.
The room is shaped like a rectangular prism with a height of 8 feet, length of 12 feet, and width of 10 feet as shown.


Additional information about Sam's room:

- The door has an area of 22 square feet.
- The room has 2 square windows.
- Each window opening is 2 feet by 2 feet.

Item Prompt

Sam and you are going to paint your room together.
Sam takes 10 minutes to paint 25 square feet.
It takes you 5 minutes to paint 25 square feet.
Sam says, "If we paint together, then it will take 15 minutes for us to cover 50 square feet."
Give an explanation to convince Sam that she is incorrect.

## Sample Responses

## Sample

 Response A
## Sample Response B

## Sample Response C

## Sample <br> Response D

## Sample

Response E

## Sample <br> Response F

Sam is incorrect because I would be done first, and It would only take 10 mins for 50 square feet.

When I am done painting my 25 she will still be painting so I will be painting another 25 square feet which will add up to 75 feet of area and then there will still be 5 more minutes so then I can paint another 25 which will add it up to $100 \mathrm{ft}^{2}$.

Sam's explanation is incorrect. It would take 10 minutes to paint 50 square feet. If Sam and I painted at the same time I would finish first ( 5 minutes). Sam would finish 5 minute (after 10 minutes). After we both finish we would have covered 50 square feet in 10 minutes. It would take 10 min for 50 if she stopped painting. If she continued it would take 10 min for 75 ft .

Sam would be incorrect because $10 \times 5=50$ not 15 . It would be $50.25+25$ is 50 .

Sam is incorrect because he/she takes 10 minutes to cover 25 square feet. It is not going to take 15 minutes because what if I take longer or we run out of paint.

Sam is incorrect because if it takes us 5 minutes to paint 25 square feet, double of 25 is 50 and double of 5 is 10 so it would only take us 10 minutes to paint 50 square feet.

## Sample <br> Response G

Alone it would take me 10 minutes to paint 50 square feet. With you alone it would take 20 minute just to paint 50 square feet. If we paint together for 15 minutes I would have painted 75 square feet, while you would have made 30 square feet. So if we work together for 15 minutes we would have painted 105 square feet.

She is incorrect cause it will take 30 mins to cover 50 square feet.

Sam's statement is wrong because she just added the time and the number of square feet. In reality Sam would paint $37.5 \mathrm{ft}^{2}$ and $\mathrm{I}^{\prime} l l$ paint $75 \mathrm{ft}^{2}$. In 15 minutes we would paint $112.5 \mathrm{ft}^{2}$.

## Let's Paint a Room (Grade 7) Scores and Score Rationales

Item 1

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 0 | Incorrect response. It appears that the student correctly inferred the missing <br> side length, but then added two sides of the rectangle, 10 ft and 12 ft, instead <br> of multiplying using the formula A = I x w. |
| B | 0 | Incorrect response. The student may have attempted to use the formula for <br> finding the perimeter of a quadrilateral, and incorrectly added the side <br> lengths. |
| C | 1 | Correct Response. |
| D | 0 | Incorrect response. The student reported the width of the ceiling instead of <br> the area. |

Item 2

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 1 | "Correct response. |
| B | 0 | The response suggests that the student correctly calculated the area of each of <br> the surfaces, and accounted for the areas of the two windows and door." |
| C | 0 | Incorrect response. The student may have attempted to add relevant lengths <br> together, instead of adding the products of the lengths to find the total surface <br> area. |
| D | 0 | Incorrect response. The response suggests that the student calculated the area <br> of one of the four walls. |
| E | 0 | Incorrect response. The student applied the formula for the volume of a <br> rectangular prism. |
| F | 0 | Incorrect response. The student may have calculated the area of one wall to be <br> 80 square feet, then subtracted the area of the door, and finally subtracted the <br> area of the two windows. |

## Item 3

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 0 | The student divided the correct amounts; however, the division, the decimal <br> placement, and the rounding are all incorrect. |
| B | 2 | The response indicates that the student understood that 4 cans are needed to <br> paint the room completely, and that 3 cans of paint will leave "...five feet left to <br> paint." |
| C | 2 | The student accurately divided and clearly understood that the paint can only <br> be purchased in "whole cans." |
| D | 1 | The response shows calculations for adding 4 cans of paint, and includes the <br> correct number of cans needed, but does not include any explanation. |

## Let's Paint a Room (Grade 7) Scores and Score Rationales

## Item 3 (cont.)

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| E | 1 | There is no explanation as to why 4 more cans are needed to finish painting the <br> room. |
| F | 0 | The student divided the correct amounts; however, the decimal is placed <br> incorrectly and the rounding is incorrect. |
| G | 2 | Using repeated subtraction, the student calculated that with only "3 cans you <br> would have 5 square feet left to paint." Without explicitly stating that partial <br> cans of paint cannot be bought, the student understood that by purchasing 4 <br> cans, Sam can paint the entire room. |
| H | 0 | The student clearly understood that 3 cans are not enough, "so it need a little <br> bit more." However, the response does not include evidence of taking into <br> account that paint can only be purchased in whole cans. |
| I | 1 | The student stated that 4 cans "is more than enough," but did not indicate why <br> 4 cans, versus a lesser amount, are needed. |
| J | 2 | The student clearly understood that " 3.12 " is the exact amount needed to <br> complete the room, so Sam must get 4 cans "since you can't have an uneven <br> amount." The "or 16 1 quart cans" is extraneous and suggests that the student <br> was thinking about gallons and quarts. |
| K | 1 | The student stated "or 4 cans," but the explanation supports the reasoning for <br> 3 1/8 cans "because there is no need for another can." |

Item 4

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 0 | The response suggests that the student was able to coordinate the various <br> quantities, but did not understand the change in units. |
| B | 1 | This response suggests that the student accurately coordinated time, area, and <br> rate, and succeeded in converting units to arrive at the correct amount of time: <br> 2 hours. |
| C | 0 | The response suggests that the student did not understand the relationship <br> among the various quantities and multiplied 25 and 12, which is the area of the <br> given wall space. |
| D | 0 | The student may have inaccurately converted the minutes into hours and <br> minutes. |

## Let's Paint a Room (Grade 7) Scores and Score Rationales

## Item 5

| Sample | Score | Rationale |
| :---: | :---: | :---: |
| A | 1 | This response provides evidence of robust mathematical reasoning in context, and could arguably be given full credit. However, the explanation does not take into consideration Sam's painting rate, or a role for Sam at all. The first part of Sam's claim is, "If we paint together. . . ." The student seemed to ignore this premise, which is an important aspect of the situation. |
| B | 2 | Although the student only accounted for the area painted by himself/herself after the first 10 minutes of painting together ("there will still be 5 more minutes so then I can paint another 25 "), the argument makes clear that more than 50 ft 2 will be painted in 15 minutes by both the student and Sam together. The response provides evidence of using the context to reason informally, but correctly, about the two different given rates and to coordinate these rates with appropriate time intervals. Note: This response could reasonably be given a score of 1 point, in part because the student did not address Sam's claim directly and the item is aligned to Claim 3 . We gave the response full credit for being a clear and correct explanation that is well-reasoned within the context. |
| C | 2 | The student was able to refute Sam's claim by focusing on the time. Specifically, the explanation focuses on what could happen in 10 minutes: The student could paint 25 square feet and then stop, which would be 5 minutes of elapsed time. Sam could paint during this time, and then continue to paint for the remaining 5 minutes, which would result in completing 25 more square feet. Together, they would paint a total of 50 square feet in 10 minutes, as opposed to the 15 minutes claimed by Sam. Although there is not a lot of evidence of explicit reasoning about unit rates or how to handle two different constant rates, the student provided clear evidence of using the context to reason about the relevant quantities, including pointing out that 75 (square) feet could be covered in 10 minutes if both painters continued painting during the 10 minutes. |
| D | 0 | This response includes fragmented mathematical reasoning and no evidence of understanding the significance of the given rates. It is unclear why the student multiplied the given painting times (" $10 \times 5=50$ not 15 "), but perhaps this was an attempt to consider a product rather than a sum, since the context involves square feet. |
| E | 0 | The student did not demonstrate why Sam is incorrect. The argument includes some mathematical reasoning, but relies on rather extraneous hypotheticals ("what if I take longer or we run out of paint"). |
| F | 1 | This response addresses Sam's claim directly, and the student was correct in stating that it takes less than 15 minutes to paint 50 square feet. However, the student seemed to only take into account the amount painted by one person ("takes us 5 minutes to paint 25 square feet"); this is the rate for the student alone, and there is no consideration of Sam's painting rate. |

Item 5 (cont.)

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| G | 2 | The student demonstrated that Sam is incorrect by focusing on the relevant <br> rates. The response does include mathematical errors: The area covered by <br> "you" in 15 minutes is incorrect (30 square feet), and as a result, the statement <br> about the combined painted area is incorrect (105 square feet). However, there <br> is strong evidence of reasoning about rates in context, including a clear <br> understanding that in 15 minutes the student alone would have painted 75 <br> square feet, and by working together for 15 minutes, Sam and the student <br> would cover their combined total areas, which is a lot more than the 50 square <br> feet in Sam's claim. |
| H | 0 | The student provided no evidence to explain or support the statement in <br> his/her response. |
| I | 2 | This response provides clear evidence of reasoning successfully about the two <br> different given constant rates. The student used the given painting rates for <br> each person to correctly calculate the square feet each person would cover in <br> 15 minutes. The student would paint 75 ft2 in 15 minutes, while Sam would <br> paint 37.5 ft2 in the same amount of time. This totals more than the 50 ft2 in <br> Sam's claim. |

## Lights, Candles, Action!

Your friend Abbie is making a movie. She is filming a fancy dinner scene and she has two types of candles on the table. She wants to determine how long the candles will last.

She takes a picture, lights the candles, and then lets them burn for 1 hour. She then takes a second picture. You can assume that each candle burns at its own constant rate.

First Picture:


Time = 0 hrs

Second Picture:


Time = $1 \mathbf{h r}$

Candle Type A initial height $=20 \mathrm{~cm}$
Candle Type B initial height $=10 \mathrm{~cm}$
Candle Type A height after burning for 1 hour $=16 \mathrm{~cm}$
Candle Type B height after burning for 1 hour $=9 \mathrm{~cm}$
You will use this information to help Abbie think about the candles she might use for her film.

High School Mathematics<br>Lights, Candles, Action! Performance Task

## 1

Candles $A$ and $B$ are lit at the same time. What will be the height, in cm , of each candle after 3 hours of burning?

Candle Type A: $\square$

Candle Type B: $\square$

Candles of each type were lit at the same time. Abbie thinks that since Candle Type A burns more quickly than Candle Type B, that it will burn out (have a height of 0 cm ) first.

Julie thinks that since Candle Type B starts out much shorter than Candle Type A, it will be the candle to burn out first.

Which candle will burn out first? Give a mathematical explanation to convince Abbie and Julie of your solution. Clearly identify the quantities involved.

Abbie has 3 hours left to film. She lights a new Candle Type A and Candle Type $B$ and then starts filming.

In the 3 hours she has left, will Abbie capture the moment when the candles are exactly the same height?

Explain to Abbie how you can determine the answer.

# High School Mathematics <br> Lights, Candles, Action! Performance Task 

(4)

You have decided to use functions to help Abbie think about the candles.
You show her how to represent the height of a candle, $\boldsymbol{h}$, as a function of time, $\boldsymbol{t}$, using this equation:

$$
h=k+n t
$$

First, explain to Abbie what $\mathbf{k}$ and $\mathbf{n}$ represent in order to model the different candles. Be specific in your explanation.

## 5

Now, choose either Candle A or Candle B to create an equation that will tell Abbie the height of the candle at $\boldsymbol{t}$ hours after it is lit.

Determine what the numerical values for $\mathbf{k}$ and $\mathbf{n}$ should be for the candle you chose.

Using these $\mathbf{k}$ and $\mathbf{n}$ values, write an equation that tells Abbie the height $\boldsymbol{h}$ of the candle, in cm, at $\boldsymbol{t}$ hours after it is lit.
$\square$

# High School Mathematics <br> Lights, Candles, Action! Performance Task 

6
For her next film, Abbie wants candles that will burn for exactly 8 hours. You want to give her a choice by designing two different candles (Type C and Type D).

Using the equation $\boldsymbol{h}=\mathbf{k}+\mathbf{n t}$, determine two different pairs of values for $\mathbf{k}$ and $\mathbf{n}$ that will meet the requirement to burn down to a height of 0 cm in exactly 8 hours.

Complete the table to show two possible sets of values for $\mathbf{k}$ and $\mathbf{n}$ for your new candle designs.

|  | k | n |
| :--- | :--- | :--- |
| Candle Type C |  |  |
| Candle Type D |  |  |

# High School Mathematics <br> Lights, Candles, Action! Performance Task 

## 1

Candles $A$ and $B$ are lit at the same time. What will be the height, in cm , of each candle after 3 hours of burning?

Candle Type A:


Candle Type B:

\#1 Equation/numeric - $\mathbf{2}$ response boxes - 1 point for both correct answers

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 1$ | 2 | $R P$ | D | 2 | 6.RP.A.3 | 1 | Candle A: 8 <br> Candle B: 7 |

## Rubric:

1 point: The student provides both correct answers: Candle Type A will be 8 cm and Candle Type B will be 7 cm .

0 points: All other responses

## Commentary:

The purpose of the question is to assess whether the student (1) understands the context and the information given and (2) can identify and infer relevant quantities and perform routine calculations.

The context is reasonably authentic. Many students have experience with watching a candle burn and understand the concept of a candle getting shorter as it burns.

## Rationale for Content:

This content is securely held, being essentially Grade 6. 6.RP.A.3: Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations.

Since the question is intended to be accessible for most students, the numbers have been kept simple so as not to create arithmetic computational obstacles in obtaining evidence of Claims 2,3 , or 4.

## High School Mathematics <br> Lights, Candles, Action! Performance Task

## Rationale for Claim:

The purpose of this first question is to provide an entry-level ramp into the work of the task. This question assesses whether students understand the context, can identify relevant quantities in the given representations, and can perform routine calculations as part of problem solving.

Claim 2, Target D: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas).

## Rationale for DOK:

This is a DOK 2. From the Depth of Thinking chart:
APPLY (DOK 2):

- Retrieve information to solve a problem
- Select a procedure and perform it

Because students have to retrieve the information and decide how to use it, this qualifies as DOK 2.

## 2

Candles of each type were lit at the same time. Abbie thinks that since Candle Type A burns more quickly than Candle Type B, that it will burn out (have a height of 0 cm ) first.

Julie thinks that since Candle Type B starts out much shorter than Candle Type A, it will be the candle to burn out first.

Which candle will burn out first? Give a mathematical explanation to convince Abbie and Julie of your solution. Clearly identify the quantities involved.
\#2 Short text - 2 points

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 2$ | 3 | EE | B | 3 | 7.EE.B.4 | 3 | See sample responses |

## High School Mathematics Lights, Candles, Action! Performance Task

## Rubric:

2 points: The student correctly determines that Candle Type A will burn out first AND provides a valid mathematical explanation that includes the initial heights and the burn rates.

Note: The students are not required to calculate the burn out times.
1 point: The student correctly determines that Candle Type A will burn out first, but does not provide a valid mathematical explanation that includes the initial heights and the burn rates.

OR Student correctly reasons from an incorrect calculation.
0 points: All other responses

## Commentary:

The purpose of this question is to confront a pair of reasonable sounding arguments. The student is required to use mathematics to justify which of the two claims is correct. The question requires attending to both parameters (initial height and burn rate) of the context and using those to construct a viable argument.

## Rationale for Content:

The content is securely held, being Grade 7 Expressions and Equations.
7.EE.B.4: Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

Although students are not specifically asked to solve this problem using an equation, the underlying mathematical structure is that of analyzing linear relationships of the form $p x+q=r$.

## Rationale for Claim:

The fact that students are given two ideas as to which candle will burn out first and asked to defend which one they agree with based on a mathematical argument is what makes this a Target 3B.

Claim 3, Target B: Construct, autonomously, chains of reasoning that will justify or refute propositions or conjectures.

## High School Mathematics Lights, Candles, Action! Performance Task

## Rationale for DOK:

This question qualifies as DOK 3 (Evaluate) because students are required to:
-Cite evidence and develop a logical argument.
-Compare/contrast solution methods.

Abbie has 3 hours left to film. She lights a new Candle Type A and Candle Type $B$ and then starts filming.

In the 3 hours she has left, will Abbie capture the moment when the candles are exactly the same height?

Explain to Abbie how you can determine the answer.
\#3 Short text - 2 points

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 3$ | 2 | EE | A | 3 | 8. EE.C.8 | 2 | See sample responses |

## Rubric:

2 points: The student correctly answers No, Abbie will not capture the moment when Candle Type A and Candle Type B are the same height during the 3 hours of filming, AND supports the claim with a mathematically valid argument.

Note: The underlying content is about Systems of Linear Equations; however, students are not required to set up, symbolically, a system of linear equations in order to solve this problem.

1 point: Student correctly answers No, Abbie will not capture the moment when Candle Type A and Candle Type B are the same height during the 3 hours of filming, but does not support the claim with a mathematically valid argument.

OR Student correctly reasons from an incorrect calculation.
0 points: All other responses

# High School Mathematics <br> Lights, Candles, Action! Performance Task 

## Commentary:

The purpose of the question is to have students engage with a meaningful context, where the underlying mathematical content is systems of linear equations. By design, the question does not specify or require the student to use any particular solution method. This is to allow more access and opportunities for students to engage in problem solving. By requiring the solution method to be explained, rather than just give an answer, this increases the depth of knowledge.

## Rationale for Content:

This content is securely held, being Grade 8 Expressions and Equations. 8.EE.C.8: Analyze and solve pairs of simultaneous linear equations.

## Rationale for Claim:

The fact that students are given a context (candles burning) and asked a question (Will the candles reach the same height during a specified time?), the problem is well-posed, but students are not told what technique or procedure they must use to solve.

Claim 2, Target A: Apply mathematics to solve well-posed problems in pure mathematics and arising in everyday life, society, and the workplace.

## Rationale for DOK:

This question qualifies as DOK 3 (Evaluate) because students are asked to:
-Cite evidence and develop a logical argument.
-Compare/contrast solution methods.
Note: If the rubric gave credit for the student merely getting the correct answer, this would qualify as DOK 2, but because the rubric demands a logical argument, this qualifies it as DOK 3.

## High School Mathematics <br> Lights, Candles, Action! Performance Task

You have decided to use functions to help Abbie think about the candles.
You show her how to represent the height of a candle, $\boldsymbol{h}$, as a function of time, $\boldsymbol{t}$, using this equation:

$$
h=k+n t
$$

First, explain to Abbie what $\mathbf{k}$ and $\mathbf{n}$ represent in order to model the different candles. Be specific in your explanation.
\#4 Short text - 2 points

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\# 4$ | 2 | F-LE | A, D | 2 | F-LE.B.5 | 1 | See sample responses |

## Rubric:

2 points: The student correctly identifies that " $k$ " represents the initial height of the candle and " $n$ " represents the burn rate of the candle.

1 point: The student is only able to correctly identify one of the parameters, not both.

0 points: All other responses
Note: It is necessary for the student to identify " $k$ " as the initial or original height in order to receive full credit, because the height of the candle changes as it burns and it represented by " $h$ " in the equation.

## Commentary:

This question is designed to assess a critical aspect of problem solving, namely identifying important quantities in a real-world context and interpreting their meaning in a symbolic representation. For this problem, the students have been provided a linear model and asked to determine the meaning and values of the parameters.

## High School Mathematics <br> Lights, Candles, Action! Performance Task

## Rationale for Content:

The content is securely held (typically Algebra/Integrated 1), primarily focusing on identifying meaning and finding values of parameters in a linear model. This is part of FLE.B.5:

Interpret the parameters in a linear or exponential function in terms of a context.

## Rationale for Claim:

The purpose of this question is to assess whether students can determine the meaning of parameters in a linear function. Because the form of the linear function is explicitly given to the students, this question fits the criteria for Claim 2, Targets A and D.

Claim 2, Target A: Apply mathematics to solve well-posed problems in pure mathematics and arising in everyday life, society, and the workplace.

Claim 2, Target D: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas).

## Rationale for DOK:

This question qualifies for a DOK 2, Understand, because students are asked to specify and explain relationships.

## 5

Now, choose either Candle A or Candle B to create an equation that will tell Abbie the height of the candle at $\boldsymbol{t}$ hours after it is lit.

Determine what the numerical values for $\mathbf{k}$ and $\mathbf{n}$ should be for the candle you chose.

Using these $\mathbf{k}$ and $\mathbf{n}$ values, write an equation that tells Abbie the height $\boldsymbol{h}$ of the candle, in cm, at $\boldsymbol{t}$ hours after it is lit.
$\square$

## \#5 Equation/numeric - 1 point

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \#5 | 4 | F | F | 2 | 8.F.B | 4 | Either $h=20-4 t$ or <br> $h=10-t$ (and <br> equivalents) |

## Rubric:

1 point: The student provides either $h=20-4 t$ or $h=10-t$ or equivalent.
0 points: All other responses

## Commentary:

Students need to understand that the candles are characterized by two parameters: initial height and burn rate. Students must identify a correct initial height and burn rate. This question is designed for students to arrive at a single answer. Students will need to understand how the height, as a function of time, depends on these two parameters. Students will need to interpret the burn time algebraically in order to create an equation which labels this item as mathematical modeling as opposed to problem solving.

## Rationale for Content:

The content is securely held from Grade 8, focusing on identifying meaning and finding values of the parameters in a linear model. This is part of 8.F.B:

Use functions to model relationships between quantities.

## Rationale for Claim:

This question aligns with Claim 4, Target F.
Claim 4, Target F: Identify important quantities in a practical situation and map their relationships (e.g., using diagrams, two-way tables, graphs, flowcharts, or formulas).

## Rationale for DOK:

Since the student needs to determine an equation that models the height of the candle, this aligns to DOK 2.

DOK 2: Understand, because students are asked to specify and identify a relationship.

# High School Mathematics <br> Lights, Candles, Action! Performance Task 

## (6)

For her next film, Abbie wants candles that will burn for exactly 8 hours. You want to give her a choice by designing two different candles (Type C and Type D).

Using the equation $\boldsymbol{h}=\mathbf{k}+\mathbf{n} \boldsymbol{t}$, determine two different pairs of values for $k$ and n that will meet the requirement to burn down to a height of 0 cm in exactly 8 hours.

Complete the table to show two possible sets of values for $\mathbf{k}$ and $\mathbf{n}$ for your new candle designs.

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C |  |  |
| Candle Type D |  |  |

\#6 Fill-in Table - 2 points (make this machine-scored)

| Item | Claim | Domain | Target | DOK | Content | MP | Key |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| \#6 | 4 |  |  |  |  |  | Many sets of values work. |

## Rubric:

2 points: The student creates values for $k$ and $n$ that result in Candle Type $C$ and Candle Type D burning out in 8 hours.

1 point: The student creates values for $k$ and $n$ that result in Candle Type $C$ or Candle Type D burning out in 8 hours.

0 points: All other responses

## Commentary:

As the culminating question in this task, the students need to understand that candles are characterized by two parameters: initial height and burn rate. This question is designed to have infinitely many solutions; hence it is not the type of problem where students solve an equation and arrive at a single answer. Students will need to understand how the height, as a function of time, depends on these two parameters. Students will have to interpret the constraint (burn time of 8 hours) algebraically in order to create examples that satisfy this constraint. It is this aspect of the work that pushes this question into mathematical modeling as opposed to problem solving.

Note that this problem provides some scaffolding by asking students to fill in a table with the parameters. Based on piloting, this was to help students focus on the mathematical work of finding parameters that met the requirement, rather than spend time trying to decide what the parameters were or what specifies a candle.

Also, even though this is a high school task, the numbers have been kept purposefully simple in order to have the students focus on the design under constraint element of this work, rather than the arithmetic complexity.

## Rationale for Content:

The content is securely held (typically Algebra/Integrated 1), primarily focusing on identifying meaning and finding values of parameters in a linear model. This is part of FLE.B.5:

Interpret the parameters in a linear or exponential function in terms of a context.

## Rationale for Claim:

This question aligns with Claim 4, Target E because this problem asks students to develop a model of a real phenomenon (at least parts of the model). This particular question is asking students to design candles by specifying values of essential parameters in a linear model.

Claim 4, Target E: Analyze the adequacy of and make improvements to an existing model or develop a mathematical model of a real phenomenon.

## High School Mathematics <br> Lights, Candles, Action! Performance Task

## Rationale for DOK:

Since the student needs to design new candles while meeting certain requirements, finding parameters to meet given constraints in a context is asking students to apply and create. For these reasons, this question would satisfy the requirements for DOK 3.

DOK 3:
Apply: Use reasoning, planning, and supporting evidence Create: Develop an alternative solution

## Sample full-credit responses:

|  | $\mathbf{k}$ | $\mathbf{n}$ |
| :---: | :---: | :---: |
| Candle Type C | 16 | -2 |
| Candle Type D | 8 | -1 |


|  | $\mathbf{k}$ | $\mathbf{n}$ |
| :---: | :---: | :---: |
| Candle Type C | 12 | -1.5 |
| Candle Type D | 24 | -3 |

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

## High School / Unscored Students Samples ITEM \#1

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

## Focus <br> Standards and Claim <br> Claim 2 <br> 6.RP.A.3:

## Lights, Candles, Action!

Your friend Abbie is making a movie. She is filming a fancy dinner scene and she has two types of candles on the table. She wants to determine how long the candles will last.

She takes a picture, lights the candles, and then lets them burn for 1 hour. She then takes a second picture. You can assume that each candle burns at its own constant rate.

First Picture:
Second Picture:


Time = 0 hrs


Time = $1 \mathbf{h r}$

Candle Type A initial height $=20 \mathrm{~cm}$
Candle Type B initial height $=10 \mathrm{~cm}$
Candle Type A height after burning for 1 hour $=16 \mathrm{~cm}$
Candle Type $B$ height after burning for 1 hour $=9 \mathrm{~cm}$
You will use this information to help Abbie think about the candles she might use for her film.

Item Prompt
Candles A and B are lit at the same time. What will be the height, in cm , of each candle after 3 hours of burning?


Sample Responses
Sample
Response A


Sample
Response B


Sample Response C


Sample
Response D


## Sample Response E

## High School / Unscored Students Samples ITEM \#2

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

## Focus <br> Standards and Claim <br> Claim 3 <br> 7.E.B.B.4:

## Stimulus

## Lights, Candles, Action!

Your friend Abbie is making a movie. She is filming a fancy dinner scene and she has two types of candles on the table. She wants to determine how long the candles will last.
She takes a picture, lights the candles, and then lets them burn for 1 hour. She then takes a second picture. You can assume that each candle burns at its own constant rate.

First Picture:


Time = 0 hrs

Second Picture:


Time = $1 \mathbf{h r}$

Candle Type A initial height $=20 \mathrm{~cm}$
Candle Type B initial height $=10 \mathrm{~cm}$

Candle Type A height after burning for 1 hour $=16 \mathrm{~cm}$
Candle Type B height after burning for 1 hour $=9 \mathrm{~cm}$
You will use this information to help Abbie think about the candles she might use for her film.

## Item Prompt

Candles of each type were lit at the same time. Abbie thinks that since Candle Type A burns more quickly than Candle Type B, that it will burn out (have a height of 0 cm ) first.
Julie thinks that since Candle Type B starts out much shorter than Candle Type A, it will be the candle to burn out first.
Which candle will burn out first? Give a mathematical explanation to convince Abbie and Julie of your solution. Clearly identify the quantities involved.

## Sample Responses

## Sample Response A

A initial: $20 \mathrm{~cm} \quad-4 \mathrm{~cm} / \mathrm{hr}$
B initial: $10 \mathrm{~cm} \quad-1 \mathrm{~cm} / \mathrm{hr}$
$20-4=16-4=12-4=8-4=4-4=0$
$10-1=9-1=8-1=7-1=6-1=5$
---1hr------2hr-------3hr-----4hr-----5hr-----

Candle A will burn out first. Every hour, candle $A$ decreases in height by 4 cm while candle $B$ decreases in height by 1 cm . After 5 hours, candle $A$ will be 0 cm and candle $B$ will still be 5 cm tall.

## Sample <br> Response B

Candle A will burn out first because the rate of the decrease in height per hour is greater. Candle $A$ burns at $4 \mathrm{~cm} /$ hour. Candle $B$ burns at $1 \mathrm{~cm} /$ hour.

Candle $\mathrm{A} y=4 \mathrm{x}+20$
Candle $B y=x+10$

| Sample Response C | Type A. |
| :---: | :---: |
|  | Type A |
|  | 0 hrs - 20 |
|  | $1 \mathrm{hr}-16$ |
|  | $2 \mathrm{hr}-12$ |
|  | $3 \mathrm{hr}-8$ |
|  | $4 \mathrm{hr}-4$ |
|  | $5 \mathrm{hr}-0$ |
|  | Type B |
|  | 0 hrs - 10 |
|  | $1 \mathrm{hr}-9$ |
|  | $2 \mathrm{hr}-8$ |
|  | $3 \mathrm{hr}-7$ |
|  | $4 \mathrm{hr}-6$ |
|  | $5 \mathrm{hr}-5$ |
|  | $6 \mathrm{hr}-4$ |
|  | $7 \mathrm{hr}-3$ |
|  | $8 \mathrm{hr}-2$ |
|  | $9 \mathrm{hr}-1$ |
|  | $10 \mathrm{hr}-0$ |


| Sample <br> Response D | I think Candle A will burn out first because it burns out more quickly than Candle B. That's because candle A has a much smaller circumference than Candle B. <br> Ex. <br> Every hour, candle A burns 4 cm and candle B burns only 1 cm <br> You could make a chart to represent this. |
| :---: | :---: |
| Sample Response E | Candle A and B are burning at different time. Candle A is thinner and B is thicker but smaller so it burns first. |
| Sample Response F | $\begin{aligned} & 20-4 h=0 \quad 4 h=5 \\ & 10-h=0 h=10 \end{aligned}$ |
| Sample <br> Response G | Candle Type A will burn out first because mathematically, every hour candle A's height decreases by 4 centimeters while candle B only decreases by 1 cm . <br> Candle A: <br> Number of Hours Burned: $\begin{array}{lllllll}1 & 2 & 3 & 4 & 5 & 6\end{array}$ <br> Height after each hour: $\begin{array}{llllll}16 & 12 & 8 & 4 & 0 & X\end{array}$ <br> Candle B: <br> $\begin{array}{lcccccccccc}\text { Number of Hours Burned: } & 1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 \\ \text { Height after each hour: } & 8 & 8 & 7 & 6 & 5 & 4 & 3 & 2 & 1 & 0\end{array}$ <br> Using the table, we could clearly see that candle A burns out way quicker than candle B because candle $A$ burns out within 5 hours of being lit while candle $B$ burns out within 10 hours of being lit. |

## Sample <br> Response H

Sample
Response I

Candle Type A will be the first one to reach the height of 0 cm first since it burns out at a faster rate. Type B will be at 4 cm by the time type A has completely burnt out.

Candle $A$ will burn out first because even though the candle is long in height, it burns out 3 times the length of candle B. Example, candle A is 20 cm but it burns out $4 \mathrm{~cm} / \mathrm{hr}$ which results to 16 and now it will burn out after 4 hours. Candle B will burn out after 9 hrs since it only burns $1 \mathrm{~cm} / \mathrm{hr}$ and the height of candle $B$ is 10 .

## High School / Unscored Students Samples ITEM \#3

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

## Focus <br> Standards and Claim <br> Claim 2 <br> 8.EE.C.8:

## Lights, Candles, Action!

Your friend Abbie is making a movie. She is filming a fancy dinner scene and she has two types of candles on the table. She wants to determine how long the candles will last.
She takes a picture, lights the candles, and then lets them burn for 1 hour. She then takes a second picture. You can assume that each candle burns at its own constant rate.

First Picture:


Time $=\mathbf{0}$ hrs

Second Picture:


Time = $1 \mathbf{h r}$

Candle Type A initial height $=20 \mathrm{~cm}$
Candle Type B initial height $=10 \mathrm{~cm}$

Candle Type A height after burning for 1 hour $=16 \mathrm{~cm}$
Candle Type B height after burning for 1 hour $=9 \mathrm{~cm}$
You will use this information to help Abbie think about the candles she might use for her film.

Item Prompt

Abbie has 3 hours left to film. She lights a new Candle Type A and Candle Type B and then starts filming.

In the 3 hours she has left, will Abbie capture the moment when the candles are exactly the same height?

Explain to Abbie how you can determine the answer.

## Sample Responses

## Sample Response A

Abbie can determine her answer by remodifying the equations I used.
$H=$ total height of the candle
Oa = Original Height of Candle Type A
$\mathrm{Ob}=$ Original Height of Candle Type B
$\mathrm{t}=$ hours spent burning
$\mathrm{n}=$ difference of height lost in 1 hour of burning
n1 = Candle A
n2 = Candle B
$\mathrm{H}=\mathrm{O} a-\mathrm{n} 1 \mathrm{t}$
$\mathrm{H}=\mathrm{Ob}-\mathrm{n} 2 \mathrm{t}$

By using these equations, Abbie can determine if Candle Type A and Candle Type B will be the exact same height by determining the candles' height after a \# of hours burning.

## Sample <br> Response B

Yes it is possible, because since candle A loses 4 cm in 1 hour and Candle B only loses 1 cm in 1 hour then around the third hour they should be the same height. She would have to subtract 4 cm from the height of candle $A$ and subtract 1 cm from the height of candle B until they reach the same height, but she can only subtract them 3 times or else she'll exceed her 3 hour goal.

## Sample <br> Response C

$X=$ hours
$A_{h}=20-4 x$
$B_{h}=10-x$
$20-4 x=10-x$
$10=3 x$
$X=\frac{10}{3}$ hour
$X=3 \frac{1}{3}$
No Abbey will not be able to capture the moment where the candles are the same height because equations that represent the decreasing height can be constructed for A and B . When those equations are set equal to each other, it represents when at what time the height of candles are equal. Solving that equation, $x$ is found equal to $31 / 3$ hour which is past 3 hours. Also a table with the height of both A and B can be constructed.

| Hour | 1 | 2 | 3 |
| :--- | :---: | :---: | :---: |
| Candle A | 16 | 12 | 8 |
| Candle B | 9 | 8 | 7 |

## Sample

Response D
Type A = 5 hours
Type $B=10$ hours

Type B7-3 $=4 \mathrm{~cm}$
Type A after $3 \mathrm{hr}=8 \mathrm{~cm}$

No, Abbie will not capture the moment when the candles are exactly the same because after she burns 3 hrs before she only have 7 cm left. Then after she burns another 3 hrs she will only have 4 cm left. With Candle Type A after burning 3 hrs it will go down to 8 cm because every hour it will burns off 4 cm . So the height of both Type A \& B are different by 2 times.

## Sample <br> Response E

X = \# of hours
$X=$ final height (cm)
$-4 x+20=-x+10$
$10=3 x$
$10 / 3=x$

You first create two equations, one for Candle A and one for Candle B. You then make them equal to each other, therefore making you solve for x . After finding x , you will find out that it will take around 3.3 hours to capture the moment when the candles are the same height. But with the time constraint of 3 hours, she won't be able to see the moment.

## Sample Response F

## Sample <br> Response G

## Sample Response H

Yes, maybe.
Because candle A burns faster than candle b, candle A is just 1 cm off of candle $B$, so at a point in the 3 hours, they will have the same height.

In three hours, she will see the candles be about the same height. Since type A starts out at 20 cm \& type $B$ starts out at 10 cm , in three hours, type $A$ would go down 12 cm and type $B$ would go out 3 cm . It would be 8 cm for $A \& 7 \mathrm{~cm}$ for $B$.

According to the given evidence, candle A \& B will both burn out before the new set of candles can match because the constant rate will make them decrease over time and the old candles have had more time to burn so they will run out quicker than the new ones.

## Sample <br> Response I

1 hour:
$20-4=16$
$10-1=9$

2 hours:
$16-4=12$
$9-1=8$

3 hours:
$12-4=8$
$8-1=7$

No , the candles won't be exactly the same height. Candle type A will be 8 cm while candle type B will be 7 cm . Take the initial height subtract 4 cm (candle type A) or 1 cm (candle type B) for each hour that passes.

# High School / Unscored Students Samples ITEM \#4 

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

## Focus <br> Standards and Claim

## Stimulus

## Claim 2

FLE.B. 5

## Lights, Candles, Action!

Your friend Abbie is making a movie. She is filming a fancy dinner scene and she has two types of candles on the table. She wants to determine how long the candles will last.
She takes a picture, lights the candles, and then lets them burn for 1 hour. She then takes a second picture. You can assume that each candle burns at its own constant rate.

First Picture:


Time = $\mathbf{0} \mathbf{h r s}$

Second Picture:


Time = $1 \mathbf{h r}$

Candle Type A initial height $=20 \mathrm{~cm}$
Candle Type B initial height $=10 \mathrm{~cm}$

Candle Type A height after burning for 1 hour $=16 \mathrm{~cm}$
Candle Type $B$ height after burning for 1 hour $=9 \mathrm{~cm}$
You will use this information to help Abbie think about the candles she might use for her film.

## Item Prompt

You have decided to use functions to help Abbie think about the candles. You show her how to represent the height of a candle, $\boldsymbol{h}$, as a function of time, $\boldsymbol{t}$, using this equation:

$$
h=k+n t
$$

First, explain to Abbie what $\mathbf{k}$ and $\mathbf{n}$ represent in order to model the different candles. Be specific in your explanation.

## Sample Responses

## Sample Response A

$\mathrm{k}=$ is how much the candle burns in one hour
$y=-1 x+10$
(burns 1 cm in an hour)
$y=-4 x+20$
(burns 4 cm in an hour)
$\mathrm{n}=$ the height of the candle originally

## Sample <br> Response B

$\mathrm{k}=$ initial height
$\mathrm{n}=$ number of cm dropped
$20=20+0(0)$
$20=20$

## Sample <br> Response C

For candle A:
$k=20$, original height of candle
$n=-4$, rate at it burns/hr
For candle B:
$k=10$, original height of candle
$n=-1$, rate at it burns/hr
$\mathrm{k}=$ original height of candle
$\mathrm{n}=$ rate at which candle burns $\mathrm{cm} / \mathrm{hr}$
Sample
Response D
$\mathrm{k}=$ initial height
$\mathrm{n}=$ constant rate of the candle burning
Candle A: h=20 (4)t
Candle B: $\mathrm{h}=10$ - (1)t

## Sample

Response E
$k$ represents the height after burning the candle for a specific amount of time.
n represents the height of how much is burned off during the time for example:
$\mathrm{k}=16 \mathrm{~cm} \mathrm{n}=4 \mathrm{~cm}$
$\mathrm{h}=\mathrm{k}+\mathrm{nt}$
$h=16+4(1)=h=16+4$
$h=20 \mathrm{~cm}$

## Sample

Response F
The " $h$ " is the height of the candle, as the function of time is "t." The letter " $k$ " symbolizes to be the subtraction of both candles in every hour. And " $n$ " is the missing value that needs to solve.

## Sample Response G

h = height
t = time
n will be the amount of hours
$k$ will be the height of the candle from the beginning
Sample
Response I
Candle A $=20-4 \mathrm{~cm}(\mathrm{t})$
Initial amount $=20=k$
Amount decreases by hour $=4 \mathrm{~cm}=\mathrm{n}$
Candle $B=10-1 \mathrm{~cm}$
Initial amount $=10=k$
Amount decreases by hour $=1 \mathrm{~cm}=\mathrm{n}$
Sample
Response J
$k$ is the original height of Candle Type A and Candle Type B before they began to burn.
n is negative. It's the difference of height after candle Type A \& Candle Type B's 1 hour of burning.

Sample
Response K
$k$ is the rate of change and $n$ is

## High School / Unscored Students Samples ITEM \#5

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

Focus
Standards and Claim

## Stimulus

8.F.B

## Lights, Candles, Action!

Your friend Abbie is making a movie. She is filming a fancy dinner scene and she has two types of candles on the table. She wants to determine how long the candles will last.

She takes a picture, lights the candles, and then lets them burn for 1 hour. She then takes a second picture. You can assume that each candle burns at its own constant rate.

First Picture:
Second Picture:


Time $=\mathbf{0} \mathbf{h r s}$

Candle B


Time = $1 \mathbf{h r}$

Candle Type A initial height $=20 \mathrm{~cm}$
Candle Type B initial height $=10 \mathrm{~cm}$
Candle Type $A$ height after burning for 1 hour $=16 \mathrm{~cm}$
Candle Type B height after burning for 1 hour $=9 \mathrm{~cm}$
You will use this information to help Abbie think about the candles she might use for her film.

## Item Prompt

Now, choose either Candle A or Candle B to create an equation that will tell Abbie the height of the candle at $\boldsymbol{t}$ hours after it is lit.

Determine what the numerical values for $\boldsymbol{k}$ and $\boldsymbol{n}$ should be for the candle you chose.
Using these $\boldsymbol{k}$ and $\boldsymbol{n}$ values, write an equation that tells Abbie the height $h$ of the candle, in cm , at $\boldsymbol{t}$ hours after it is lit.


## Sample Responses

Sample
Response A

$$
h=(-1) n+10
$$

Sample
Response B

$$
\begin{gathered}
k=4 \\
n=3 \\
n=k+n t \\
20=8+4(3)
\end{gathered}
$$

## Sample

Response C

$$
t=\frac{-h_{\mathrm{a}}+20}{4}
$$

Sample
Response D

$$
h_{A}=20-4 t
$$

Sample
Response E

$$
\begin{aligned}
& h=k+n t \\
& h=0+4 t
\end{aligned}
$$

Sample
Response F
Sample Response G

$$
h=10-t
$$

$$
t=\frac{h-k}{n}
$$

## High School / Unscored Students Samples ITEM \#6

## MATH ANNOTATIONS * SMARTER BALANCED PERFORMANCE TASK

Focus
Standards and Claim

## Stimulus

Claim 4
CCSS.MATH.CONTENT.
FLE.B.5:
Interpret the parameters in a linear or exponential function in terms of a context.

## Lights, Candles, Action!

Your friend Abbie is making a movie. She is filming a fancy dinner scene and she has two types of candles on the table. She wants to determine how long the candles will last.

She takes a picture, lights the candles, and then lets them burn for 1 hour. She then takes a second picture. You can assume that each candle burns at its own constant rate.

First Picture:
Second Picture:


Time = 0 hrs


Time = $1 \mathbf{h r}$

Candle Type A initial height $=20 \mathrm{~cm}$
Candle Type B initial height $=10 \mathrm{~cm}$

Candle Type $A$ height after burning for 1 hour $=16 \mathrm{~cm}$
Candle Type B height after burning for 1 hour $=9 \mathrm{~cm}$
You will use this information to help Abbie think about the candles she might use for her film.

For her next film, Abbie wants candles that will burn for exactly 8 hours. You want to give her a choice by designing two different candles (Type C and Type D).

Using the equation $\boldsymbol{h}=\mathbf{k}+\boldsymbol{n t}$, determine two different pairs of values for $k$ and $n$ that will meet the requirement to burn down to a height of 0 cm in exactly 8 hours.

Complete the table to show two possible sets of values for $\mathbf{k}$ and $\mathbf{n}$ for your new candle designs.

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C |  |  |
| Candle Type D |  |  |

## Sample Responses

Sample
Response A

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C | 24 | -3 |
| Candle Type D | 16 | -2 |

Sample
Response B

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C | -9 | 1 |
| Candle Type D | -16 | 2 |

Sample
Response C

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C | 2 | 1 |
| Candle Type D | 4 | $\frac{1}{2}$ |

Sample
Response D

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C | 8 | -1 |
| Candle Type D | 8 | 1 |

Sample
Response E

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C | 8 | -1 |
| Candle Type D | 16 | -2 |

Sample
Response F

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C | 2 | 16 |
| Candle Type D | 4 | 32 |

Sample
Response G

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C | 40 | 5 |
| Candle Type D | 8 | -1 |

Sample
Response H

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C | 8 cm | -1 cm |
| Candle Type D | 10 cm | $-5 / 4 \mathrm{~cm}$ |

Sample
Response I

|  | k | n |
| :---: | :---: | :---: |
| Candle Type C | 24 | 3 |
| Candle Type D | 40 | 5 |

## Lights, Candles, Action! (High School) Scores and Score Rationales

Item 1

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 0 | Incorrect response. Instead of providing the correct height, in cm, of each <br> candle after 3 hours of burning, the values suggest that the student may have <br> found how much of each candle is burned in three hours: $4 \times 3=12 \mathrm{~cm} ; 1 \times 3=$ <br> 3 cm. |
| B | 0 | Incorrect response. The values suggest the student may have found the height <br> of each candle, in cm, after 4 hours of burning. |
| C | 1 | Correct response. The student correctly gave the height, in cm, of Candle Type <br> A and Candle Type B after 3 hours of burning. |
| D | 0 | Incorrect response. The height for Candle Type A is correct, but the height for <br> Candle Type B is not. |
| E | 0 | Incorrect response. The student may have made a minor calculation error in <br> finding the difference between 12 and 4. The height for Candle Type B is <br> correct. |

Item 2

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 2 | The student correctly determined that Candle Type A will burn out first, and <br> developed a model to represent the first 5 hours of burning for each candle. The <br> model incudes the burn rate and initial height of each candle. The response <br> includes a valid and clear mathematical explanation as to why Candle Type A <br> reaches 0 cm first. This response receives full credit. |
| B | 1 | The student correctly determined that Candle Type A will burn out first by <br> comparing the burn rates of Candle Type A and Candle Type B. However, the <br> student did not include a consideration of the initial height of each candle in <br> his/her explanation. Then, in the student's attempt to support the claim, the <br> equation he/she wrote for each candle does not fit the explanation: the <br> coefficient of x (representing the burn rate) is positive instead of negative. This <br> response earns 1 point since the student reasoned correctly from incorrect <br> equations. |
| C | 1 | The student indicated correctly that the answer is Candle Type A, and provided <br> evidence of valid mathematical reasoning to support this choice. However, the <br> response does not include clear identification of the quantities involved. <br> Specifically, the height values of the candles each hour are unlabeled and the <br> burn rates are not mentioned. The response does not include a clear <br> explanation to connect the values in the model to a comparison between two <br> different burning candles. The response receives partial credit of 1 point. |
| D |  | The student determined correctly that Candle Type A will burn out first, and <br> provided a chart to represent the height of each burning candle for 5 hours. The <br> response includes valid reasoning to support the explanation, as well as both the <br> burn rate and initial height of each candle. This response receives full credit. |

## Lights, Candles, Action! (High School) Scores and Score Rationales

## Item 2 (cont.)

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| E | 0 | The student concluded that Candle Type B will burn out first because it is <br> smaller in height than Candle Type A. The first part of the response suggests an <br> attempt to compare the burn rates. The student did not provide sufficient <br> evidence of valid mathematical reasoning to support the claim or earn any <br> points. |
| F | 0 | The student did not state which candle will burn out first, and did not provide <br> any explanation. Although there is clear evidence of strong algebraic reasoning <br> in this response, the reasoning is not developed into a valid response. Without <br> a clear statement of which candle burns out first, without any mention of initial <br> heights or burn rates of the candles, and without an explanation, the response <br> earns 0 points. |
| G | 2 | The student correctly stated that Candle Type A will burn out first, clearly <br> indicated the burn rate for each candle, and developed two tables of values to <br> compare the heights of each candle after every hour of burning. The response <br> includes a clear and valid explanation of the values and the reasoning, and <br> earns full credit. |
| H | 1 | The student correctly identified that Candle Type A will burn out first, but did <br> not indicate the initial height and burn rate of each candle. The explanation to <br> support the claim contains a minor calculation error, and does not provide <br> sufficient explicit evidence of considering all of the relevant quantities. The <br> response earns 1 point. |
| I | 1 | The student identified that Candle Type A will burn out first, and clearly stated <br> the burn rate of each candle. However, the explanation includes evidence of <br> inconsistent reasoning and does not sufficiently support the claim. The <br> response earns partial credit of 1 point. |

## Lights, Candles, Action! (High School) Scores and Score Rationales

Item 3

| Sample | Score | Rationale |
| :---: | :---: | :---: |
| A | 1 | The student identified a thorough set of variables to consider in the process of determining if both candles can be the same height in 3 hours. The student also wrote clear equations for the candles with these variables, positioned to correctly represent the relationships among the variables. The explanation suggests the student understood that solving the equations simultaneously would solve the problem. However, the response does not indicate if there will be time to capture the desired moment, nor does it include an argument. The response earns partial credit for providing evidence of reasoning correctly about a valid approach to solving the problem. |
| B | 0 | The student described the situation in a way that is approximately accurate, but not accurate enough to reach a correct conclusion about what will happen within 3 hours. There is partial evidence of an attempt to support the initial (incorrect) claim, but the response does not include a valid mathematical argument. The response earns 0 points. |
| C | 2 | The student developed a valid mathematical argument to support the claim that Candle Type A and Candle Type B will not reach the same height within the 3 -hour time frame. The student also wrote and solved a system of two linear equations to show that both candles will have the same height at exactly $31 / 3$ hours after being lit, and provided a table of values to further support the argument. The response earns full credit. |
| D | 1 | The student correctly determined that both candles will not reach the same height within 3 hours. However, the response provides insufficient evidence of valid mathematical reasoning and includes a calculation error in the attempt to support the claim. The final statement of the response is hard to interpret. The response earns 1 point. |
| E | 2 | The student developed and solved a system of linear equations to show that it will take "around 3.3 hours," which is beyond the 3 -hour time limit, to capture the moment when both candles are the same height. The response also includes a clear and valid mathematical argument that connects the solution to the system of equations to the context. This response earns full credit. |
| F | 0 | After presenting some initial uncertainty, the student claimed that within 3 hours, the candles will have the same height. However, the response does not show enough mathematical work to support this incorrect claim, and there is not a clear argument. The response earns 0 points. |
| G | 1 | This response includes a reasonable attempt to construct a mathematical argument to support the claim that the candles will be about the same height in 3 hours. However, the explanation does not clearly indicate the burn rate of each candle, and is not precise enough to constitute a valid argument. The response earns 1 point. |

## Lights, Candles, Action! (High School) Scores and Score Rationales

Item 3 (cont.)

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| H | 0 | This response suggests that the student may have misunderstood the situation <br> and may have been confused about what is asked in the prompt. There is <br> evidence of some reasoning about the two candles, but a reference to "the <br> constant rate" suggests that the student interpreted the candles to have the <br> same constant rate. There also seems to be an unfortunate issue in <br> understanding the meaning of "new set of candles" (versus "old candles"). The <br> response earns 0 points. |
| I | 2 | The student presented calculations of the change in height of each candle for <br> each hour of burning. These calculations are organized clearly to connect with <br> the valid mathematical reasoning presented in the concluding argument. <br> Although the response does not include setting up or solving a system of linear <br> equations, this is not a requirement for full credit. The reasoning presented is <br> clear, and the argument provided is valid and directly supports the claim that <br> the candles will not be the same height within the 3-hour time frame. The <br> response earns full credit. |

Item 4

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 0 | The student switched the meaning of $k$ and $n$ in the context of the problem. <br> Although the equations and their notations provide clear evidence of a solid <br> understanding of the relationships among the quantities, the statements about <br> $n$ and $k$ are both incorrect, and this response earns 0 points. |
| B | 1 | The student correctly identified $k$, but not $n$. If the student had included the <br> number of cm dropped per hour, or each hour, this could have earned full <br> credit, but as written the response earns partial credit of 1 point. |
| C | 2 | The student correctly identified what $k$ and $n$ represent in the context of the <br> problem. |
| E | 1 | The student correctly determined what $k$ and $n$ stand for, and further used <br> appropriate values to specify the function for the height of each candle at time <br> t, in hours after it is lit. |
| F | The student identified $n$ partially correctly, but the given interpretation of $k$ is <br> incorrect. The response includes an attempt to use equations to support the <br> stated meaning of each of the parameters, and provides evidence of some valid <br> sense-making about the relationships among the quantities. This response <br> earns 1 point. |  |
| G | 2 | Although there is evidence of a lot of interpretive work in this response, the <br> student did not provide the correct meaning of $k$ and $n$ in the equation $h=k+$ <br> $n t . ~ T h e ~ r e s p o n s e ~ e a r n s ~$ |
| Points. |  |  |

## Lights, Candles, Action! (High School) Scores and Score Rationales

Item 4 (cont.)

| H | 1 | The student correctly identified what k means in the context of the problem, <br> but not n. The response earns 1 point. |
| :---: | :---: | :--- |
| I | 2 | The student wrote the function for the height of each candle after burning $t$ <br> hours, and correctly identified both the values and meanings of k and n for each <br> candle. |
| J |  | The student identified the meaning of k correctly, and provided two correct <br> statements about what $n$ represents. The first of these statements, " n is <br> negative," is about the value of n, not about what it represents, but together <br> with the second statement, the response reflects a mathematically accurate <br> interpretation of n that is connected to the context. Although the response <br> does not mention burn rate or constant rate explicitly, the final statement <br> reflects the essential idea of a constant rate: the difference in height after 1 <br> hour of burning. If the student had written "each hour" or "per hour," this <br> response would have been more clearly deserving of full credit. This one <br> squeaks by. |
| K | 0 | The student provided an incomplete answer and did not include the correct <br> meaning of either k or n. The response earns 0 points. |

Item 5

| Sample | Score | Rationale |
| :---: | :---: | :--- |
| A | 0 | The response does not include a correct equation for either Candle $A$ or Candle <br> B. Although the provided equation would work if the meaning of $n$ were <br> reassigned, the item prompt assigns each letter to a specific quantity, and it is <br> unclear if the student misunderstood or simply ignored those assignments. The <br> response earns 0 points. |
| B | 0 | The student did not determine correct numerical values for $n$ and $k$, nor provide <br> a correct equation for either Candle A or Candle B. The response earns 0 points. |
| C | 1 | The student wrote an equation that is equivalent to $h=20-4 t$. The response <br> earns full credit. |
| D | 1 | The student provided a correct equation for Candle $A$. The response earns full <br> credit. |
| E | 0 | The student did not determine correct numerical values for $n$ and $k$, nor provide <br> a correct equation for either Candle A or Candle $B$. The response earns 0 points. |
| F | 1 | The student provided a correct equation for Candle B. The response earns full <br> credit. |
| G | 0 | The equation provided by the student would work for Candle $A$, but the <br> response does not include a numerical value for $n$, as required by the <br> problem. The response earns 0 points. |

## Lights, Candles, Action! (High School) Scores and Score Rationales

Item 6

| Sample | Score | Rationale |
| :---: | :---: | :---: |
| A | 2 | The student identified values for $k$ and $n$ that result in Candle Type $C$ and Candle Type D burning out in exactly 8 hours. |
| B | 0 | The student provided values for $k$ and $n$ that are not reasonable in this situation for either candle. This response earns 0 points. |
| C | 0 | The student provided values for $k$ and $n$ that would work for Candle Type $D$ if the equation were $h=k-n t$, instead of the given equation, $h=k+n t$. Because neither set of values fits the given requirements, this response earns 0 points. |
| D | 1 | The student provided appropriate values of $k$ and $n$ for Candle Type $C$ only. This response earns partial credit of 1 point. |
| E | 2 | The student identified values for $k$ and $n$ that result in Candle Type C and Candle Type D burning out in exactly 8 hours. |
| F | 0 | The student provided values for $k$ and $n$ that do not fit the requirements for either candle. The student likely switched the meanings of $k$ and $n$, and also did not consider the need for negative values for the burn rate. This response earns 0 points. |
| G | 1 | The student provided appropriate values of $k$ and $n$ for Candle Type D only. This response earns partial credit of 1 point. |
| H | 2 | The student identified values for $k$ and $n$ that result in Candle Type C and Candle Type D burning out in exactly 8 hours. Even though the units given for n are incorrect (should be cm/hour), the problem requires correct numerical values only, so this response earns full credit. |
| I | 0 | The student provided values for $k$ and $n$ that would work for both candles if the equation was $h=k-n t$ instead of the given equation, $h=k+n t$. Because neither set of values fits the given requirements, this response earns 0 points. |


[^0]:    *Adapted from Silicon Valley Math Initiative (SVMI)

