Standard #: MAFS.912.A-CED.1.3

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Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context. *For example, represent inequalities describing nutritional and cost constraints on combinations of different foods.* ★

Subject Area: Mathematics

Grade: 912

Domain-Subdomain: Algebra: Creating Equations

Cluster: Level 3: Strategic Thinking & Complex Reasoning

Cluster: Create equations that describe numbers or relationships. (Algebra 1 - Major Cluster) (Algebra 2 - Supporting Cluster) -
Clusters should not be sorted from Major to Supporting and then taught in that order. To do so would strip the coherence of the mathematical ideas and miss the opportunity to enhance the major work of the grade with the supporting clusters.

Date Adopted or Revised: 02/14

Content Complexity Rating: Level 3: Strategic Thinking & Complex Reasoning - More Information

Date of Last Rating: 02/14

Status: State Board Approved

Assessed: Yes

TEST ITEM SPECIFICATIONS

Item Type(s): This benchmark may be assessed using: MC item(s)

N/A

Assessment Limits :
In items that require the student to write an equation as a constraint, the equation may be a linear function.
In items that require the student to write a system of equations to represent a constraint, the system is limited to two variables.

In items that require the student to write a system of inequalities to represent a constraint, the system is limited to two variables

Calculator :
Neutral

Clarification :
Students will write constraints for a real-world context using equations, inequalities, a system of equations, or a system of inequalities.
Students will interpret the solution of a real-world context as viable or not viable.

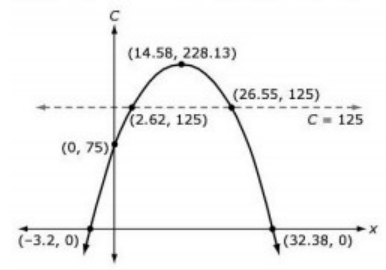
Stimulus Attributes :
Items must be set in a real-world context.
Items may use function notation.

Response Attributes :
Items may require the student to choose an appropriate level of accuracy.
Items may require the student to choose and interpret the scale in a graph.

Items may require the student to choose and interpret units. Items may require the student to apply the basic modeling cycle.

SAMPLE TEST ITEMS (1)

Test Item #: Sample Item 1
Question:
The production cost, C, in thousands of dollars, for a toy company to manufacture a ball is given by the model $C(x)=75+21x-0.72x^2$, where x is the number of balls produced in one day, in thousands. The company wants to keep its production cost at or below $125,000. The graph shown models the situation.



What is a reasonable constraint for the model?

Difficulty: N/A
Type: MC: Multiple Choice

Related Courses

Course Number	Course Title
1200310:	Algebra 1 (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
1200320:	Algebra 1 Honors (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
1200330:	Algebra 2 (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
1200340:	Algebra 2 Honors (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
1200370:	Algebra 1-A (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
1200400:	Intensive Mathematics (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
1200500:	Advanced Algebra with Financial Applications (Specifically in versions: 2014 - 2015 (course terminated))
1200410:	Mathematics for College Success (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
1200700:	Mathematics for College Readiness (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
7912070:	Access Liberal Arts Mathematics (Specifically in versions: 2014 - 2015, 2015 - 2018, 2018 - 2019, 2019 and beyond (current))
7912080:	Access Algebra 1A (Specifically in versions: 2014 - 2015, 2015 - 2018, 2018 - 2019, 2019 and beyond (current))
1200315:	Algebra 1 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
1200335:	Algebra 2 for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 - 2019 (course terminated))
1200375:	Algebra 1-A for Credit Recovery (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
7912100:	Fundamental Algebraic Skills (Specifically in versions: 2013 - 2015, 2015 - 2017 (course terminated))
1207300:	Liberal Arts Mathematics 1 (Specifically in versions: 2014 - 2015, 2015 and beyond (current))
7912075:	Access Algebra 1 (Specifically in versions: 2014 - 2015, 2015 - 2018, 2018 - 2019, 2019 and beyond (current))

Related Access Points

Access Point

Access Points Number	Access Points Title
MAFS.912.A-CED.1.AP.3a:	Identify and interpret the solution of a system of linear equations from a real-world context that has been graphed.

Related Resources

Lesson Plan

Name	Description
Alternative Fuel Systems:	The Alternative Fuel Systems MEA provides students with an engineering problem in which they must develop a procedure to decide the appropriate course for an automobile manufacturer to take given a set of constraints. The main focus of the MEA is to apply the concepts of work and energy to a business model.
Compacting Cardboard:	Students with investigate the amount of space that could be saved by flattening cardboard boxes. The analysis includes linear graphs and regression analysis along with discussions of slope and a direct variation phenomenon.
Don't Blow the Budget!:	Students use systems of equations and inequalities to solve real world budgeting problems involving two variables.
Efficient Storage:	The topic of this MEA is work and power. Students will be assigned the task of hiring workers to complete a given task. In order to make a decision as to which workers to hire, the students initially must calculate the required work. The power each worker can exert, the days each worker is available to work each week, the number of sick days each worker has taken over the past 12 months, and the salary each worker commands will then be provided. Full- and/or part-time positions are available. Through data analysis, the students will need to evaluate which factors are most significant in the hiring process. For instance, some groups may select the most efficient workers; other groups may select the group of workers that will cost the company the least amount of money; still other groups may choose the workers that can complete the job in the shortest amount of time. Each group will also be required to provide the rationale that justifies the selection of which workers to hire.
Exploring Systems with Piggies, Pizzas and Phones:	This lesson is intended to help students develop an understanding of how to solve realistic problems using two linear equations and in the process strengthen and support the skills involved in translating situations into algebraic expressions. The lesson includes printable materials for students to use during the lesson.
Feasible or Non-Feasible? - That is the Question (Graphing Systems of Linear Inequalities):	In this lesson, students learn how to use the graph of a system of linear inequalities to determine the feasible region. Students practice solving word problems to find the optimal solution that maximizes profits. Students will use the free application, GeoGebra (see download link under Suggested Technology) to help them create different graphs and to determine the feasible or non-feasible solutions.
	The focus of this MEA is oil spills and their effect on the environment. In this activity, students from a fictitious class are studying about the effects of an oil spill on marine ecosystems and have performed an experiment in which they

Preserving Our Marine Ecosystems:	were asked to try to rid a teaspoon of corn oil from a baking pan filled with two liters of water as thoroughly as possible in a limited timeframe and with limited resources. By examining, analyzing, and evaluating experimental data related to resource usage, disposal, and labor costs, students must face the tradeoffs that are involved in trying to preserve an ecosystem when time, money, and resources are limited.
Solving Linear Equations in Two Variables:	This lesson unit is intended to help you assess how well students are able to formulate and solve problems using algebra and, in particular, to identify and help students who have the following difficulties solving a problem using two linear equations with two variables and interpreting the meaning of algebraic expressions.

Video/Audio/Animation

Name	Description
Basic Linear Function:	This video demonstrates writing a function that represents a real-life scenario.

Problem-Solving Task

Name	Description
Bernardo and Sylvia Play a Game:	This task presents a simple but mathematically interesting game whose solution is a challenging exercise in creating and reasoning with algebraic inequalities. The core of the task involves converting a verbal statement into a mathematical inequality in a context in which the inequality is not obviously presented, and then repeatedly using the inequality to deduce information about the structure of the game.
Cash Box:	The given solutions for this task involve the creation and solving of a system of two equations and two unknowns, with the caveat that the context of the problem implies that we are interested only in non-negative integer solutions. Indeed, in the first solution, we must also restrict our attention to the case that one of the variables is further even. This aspect of the task is illustrative of mathematical practice standard MP4 (Model with mathematics), and crucial as the system has an integer solution for both situations, that is, whether or not we include the dollar on the floor in the cash box or not.
Dimes and Quarters:	Students are given a word problem that can be solved by using a pair of linear equations. This task does not actually require that the student solve the system but that they recognize the pairs of linear equations in two variables that would be used to solve the system. This is an important step in the process of solving systems.
Growing Coffee:	This task is designed to make students think about the meaning of the quantities presented in the context and choose which ones are appropriate for the two different constraints presented. In particular, note that the purpose of the task is to have students generate the constraint equations for each part (though the problem statements avoid using this particular terminology), and not to have students solve said equations. If desired, instructors could also use this task to touch on such solutions by finding and interpreting solutions to the system of equations created in parts (a) and (b).
MIT BLOSSOMS - The Broken Stick Experiment: Triangles, Random Numbers and Probability:	This learning video is designed to develop critical thinking in students by encouraging them to work from basic principals to solve a puzzling mathematics problem that contains uncertainty. One class session of approximately 55 minutes is necessary for lesson completion. First-year simple algebra is all that is required for the lesson, and any high school student in a college-preparatory math class should be able to participate in this exercise. Materials for in-class activities include: a yard stick, a meter stick or a straight branch of a tree; a saw or equivalent to cut the stick; and a blackboard or equivalent. In this video lesson, during in-class sessions between video segments, students will learn among other things: 1) how to generate random numbers; 2) how to deal with probability; and 3) how to construct and draw portions of the X-Y plane that satisfy linear inequalities.
Writing Constraints:	The purpose of this task is to give students practice writing a constraint equation for a given context. Instruction accompanying this task should introduce the notion of a constraint equation as an equation governing the possible values of the variables in question (i.e., "constraining" said values). In particular, it is worth differentiating the role of constraint equations from more functional equations, e.g., formulas to convert from degrees Celsius to degree Fahrenheit. The task has students interpret the context and choose variables to represent the quantities, which are governed by the constraint equation and the fact that they are non-negative (allowing us to restrict the graphs to points in the first quadrant only). The four parts are independent and can be used as separate tasks.

Formative Assessment

Name	Description
Constraints on Equations:	Students are asked to determine the constraint on a profit equation and to interpret solutions as being viable or not in the context of the problem.
Sugar and Protein:	Students are asked to model a problem involving constraints using inequalities.
The New School:	Students are asked to represent constraints using inequalities given in a problem context.

Perspectives Video: Professional/Enthusiast

Name	Description
Gear Heads and Gear Ratios:	Have a need for speed? Get out your spreadsheet! Race car drivers use algebraic formulas and spreadsheets to optimize car performance.
Hurricane Dennis & Failed Math Models:	What happens when math models go wrong in forecasting hurricanes?
Solving Systems of Equations, Oceans & Climate:	Angela Dial discusses how she solves systems of equations to determine how the composition of ocean floor sediment has changed over 65 million years to help reveal more information regarding climate change.

Perspectives Video: Expert

Name	Description
Problem Solving with Project Constraints:	It's important to stay inside the lines of your project constraints to finish in time and under budget. This NASA systems engineer explains how constraints can actually promote creativity and help him solve problems!

Assessment

Name	Description
Sample 2 - High School Algebra 1 State Interim Assessment:	This is a State Interim Assessment for 9th-12th grades.
Sample 3 - High School Algebra 1 State Interim Assessment:	This is a State Interim Assessment for 9th-12th grades.

Unit/Lesson Sequence

Name	Description
Sample Algebra 1 Curriculum Plan Using CMAP:	This sample Algebra 1 CMAP is a fully customizable resource and curriculum-planning tool that provides a framework for the Algebra 1 Course. The units and standards are customizable and the CMAP allows instructors to add lessons, worksheets, and other resources as needed. This CMAP also includes rows that automatically filter and display Math Formative Assessments System tasks, E-Learning Original Student Tutorials and Perspectives Videos that are aligned to the standards, available on CPALMS. Learn more about the sample Algebra 1 CMAP, its features and customizability by watching the following video: Using this CMAP To view an introduction on the CMAP tool, please click here. To view the CMAP, click on the "Open Resource Page" button above; be sure you are logged in to your iCPALMS account. To use this CMAP, click on the "Clone" button once the CMAP opens in the "Open Resource Page." Once the CMAP is cloned, you will be able to see it as a class inside your iCPALMS My Planner (CMAPs) app. To access your My Planner App and the cloned CMAP, click on the iCPALMS tab in the top menu. All CMAP tutorials can be found within the iCPALMS Planner App or at the following URL: http://www.cpalms.org/support/tutorials_and_informational_videos.aspx

Student Resources

Name	Description
Basic Linear Function:	This video demonstrates writing a function that represents a real-life scenario.
Bernardo and Sylvia Play a Game:	This task presents a simple but mathematically interesting game whose solution is a challenging exercise in creating and reasoning with algebraic inequalities. The core of the task involves converting a verbal statement into a mathematical inequality in a context in which the inequality is not obviously presented, and then repeatedly using the inequality to deduce information about the structure of the game.
Cash Box:	The given solutions for this task involve the creation and solving of a system of two equations and two unknowns, with the caveat that the context of the problem implies that we are interested only in non-negative integer solutions. Indeed, in the first solution, we must also restrict our attention to the case that one of the variables is further even. This aspect of the task is illustrative of mathematical practice standard MP4 (Model with mathematics), and crucial as the system has an integer solution for both situations, that is, whether or not we include the dollar on the floor in the cash box or not.
Dimes and Quarters:	Students are given a word problem that can be solved by using a pair of linear equations. This task does not actually require that the student solve the system but that they recognize the pairs of linear equations in two variables that would be used to solve the system. This is an important step in the process of solving systems.

Growing Coffee:	This task is designed to make students think about the meaning of the quantities presented in the context and choose which ones are appropriate for the two different constraints presented. In particular, note that the purpose of the task is to have students generate the constraint equations for each part (though the problem statements avoid using this particular terminology), and not to have students solve said equations. If desired, instructors could also use this task to touch on such solutions by finding and interpreting solutions to the system of equations created in parts (a) and (b).
Problem Solving with Project Constraints:	It's important to stay inside the lines of your project constraints to finish in time and under budget. This NASA systems engineer explains how constraints can actually promote creativity and help him solve problems!
Writing Constraints:	The purpose of this task is to give students practice writing a constraint equation for a given context. Instruction accompanying this task should introduce the notion of a constraint equation as an equation governing the possible values of the variables in question (i.e., "constraining" said values). In particular, it is worth differentiating the role of constraint equations from more functional equations, e.g., formulas to convert from degrees Celsius to degree Fahrenheit. The task has students interpret the context and choose variables to represent the quantities, which are governed by the constraint equation and the fact that they are non-negative (allowing us to restrict the graphs to points in the first quadrant only). The four parts are independent and can be used as separate tasks.

Parent Resources

Name	Description
Bernardo and Sylvia Play a Game:	This task presents a simple but mathematically interesting game whose solution is a challenging exercise in creating and reasoning with algebraic inequalities. The core of the task involves converting a verbal statement into a mathematical inequality in a context in which the inequality is not obviously presented, and then repeatedly using the inequality to deduce information about the structure of the game.
Cash Box:	The given solutions for this task involve the creation and solving of a system of two equations and two unknowns, with the caveat that the context of the problem implies that we are interested only in non-negative integer solutions. Indeed, in the first solution, we must also restrict our attention to the case that one of the variables is further even. This aspect of the task is illustrative of mathematical practice standard MP4 (Model with mathematics), and crucial as the system has an integer solution for both situations, that is, whether or not we include the dollar on the floor in the cash box or not.
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Growing Coffee:	This task is designed to make students think about the meaning of the quantities presented in the context and choose which ones are appropriate for the two different constraints presented. In particular, note that the purpose of the task is to have students generate the constraint equations for each part (though the problem statements avoid using this particular terminology), and not to have students solve said equations. If desired, instructors could also use this task to touch on such solutions by finding and interpreting solutions to the system of equations created in parts (a) and (b).
Problem Solving with Project Constraints:	It's important to stay inside the lines of your project constraints to finish in time and under budget. This NASA systems engineer explains how constraints can actually promote creativity and help him solve problems!
Writing Constraints:	The purpose of this task is to give students practice writing a constraint equation for a given context. Instruction accompanying this task should introduce the notion of a constraint equation as an equation governing the possible values of the variables in question (i.e., "constraining" said values). In particular, it is worth differentiating the role of constraint equations from more functional equations, e.g., formulas to convert from degrees Celsius to degree Fahrenheit. The task has students interpret the context and choose variables to represent the quantities, which are governed by the constraint equation and the fact that they are non-negative (allowing us to restrict the graphs to points in the first quadrant only). The four parts are independent and can be used as separate tasks.