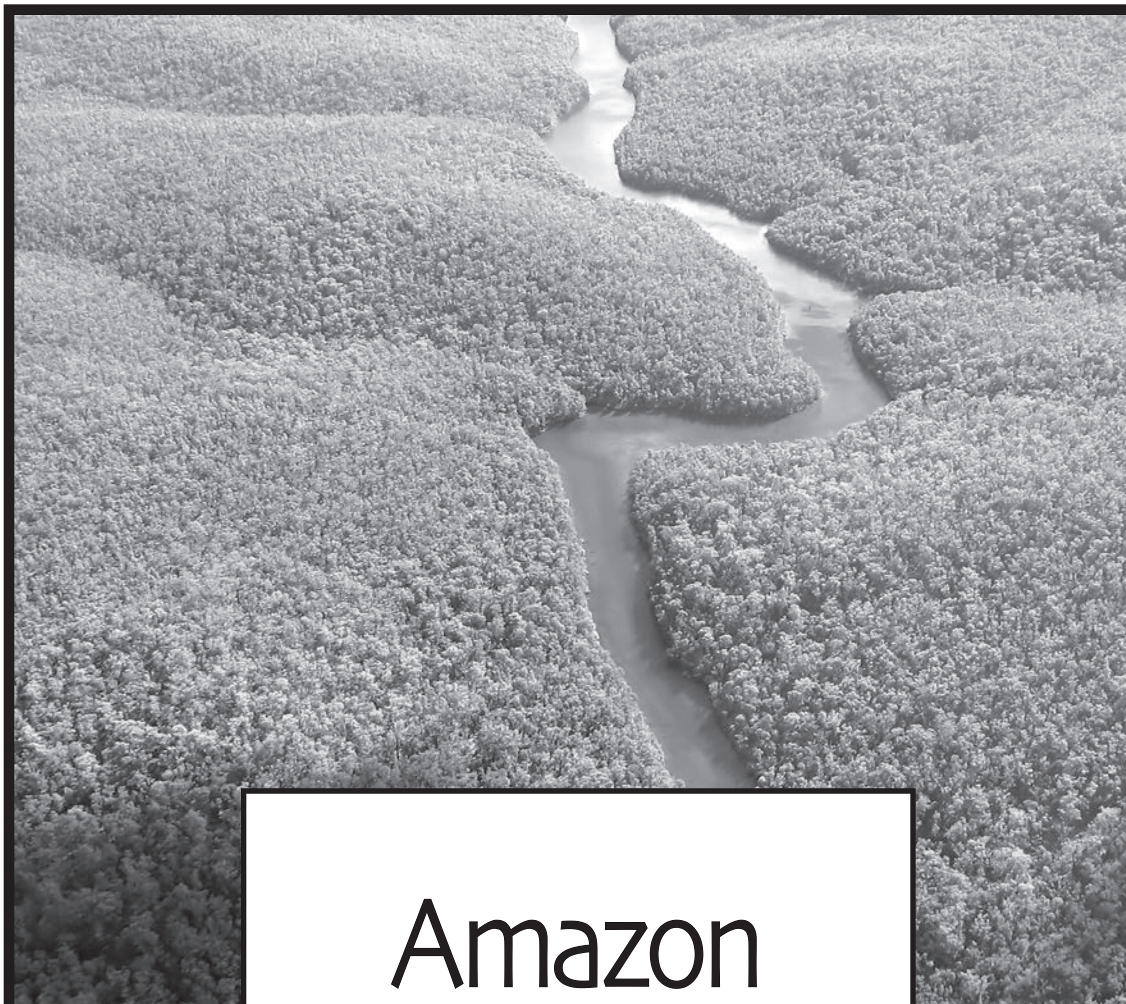


Amazon Mission

Building Math

Integrating Algebra & Engineering

TABLE OF CONTENTS

AMAZON MISSION OVERVIEW: STORY LINE AND LEARNING OBJECTIVES

	Design Challenge Overview	Students will:
DESIGN CHALLENGE 1: MALARIA MELTDOWN!	Students are responding to the needs of the Yanomami people in the Amazon. In their first challenge, they are to design a medicine carrier that can successfully transport malaria medicine. The carrier should keep the medicine within certain temperature constraints to protect it from heat, be rugged enough to prevent an egg from breaking when dropped, and be as low in cost as possible.	• calculate and interpret the slope of a line • graph a compound inequality • conduct two controlled experiments • collect experimental data in a table • produce and analyze a line graph that relates two variables • distinguish between independent and dependent variables • determine when it's appropriate to use a line graph to represent data • list combinations of up to five layers of two different kinds of materials • draw a three-dimensional object and its net • find the surface area of a three-dimensional object • apply the engineering design process to solve a problem
DESIGN CHALLENGE 2: MERCURY RISING!	As students arrive at the village, the Yanomami meet them with a new challenge–to design a water filter that can filter out at least 75% of the mercury in the freshwater near the mining operation. To do so, students research different sizes of Mercatrons, mercury-absorbing spheres. Students find which ones would meet the criteria of being low in cost and still effective at removing at least 75% of mercury from water. Students also calculate minimum and maximum flow rates for water and experiment with different factors that influence the flow rate.	• calculate the surface area of a sphere using a formula • solve a multistep problem • convert measurement units (within the same system) • use proportional reasoning • write a compound inequality statement • graph and analyze the relationship between two variables • determine when it's appropriate to use a line graph to represent data • design and conduct a controlled experiment • apply the engineering design process to solve a problem
DESIGN CHALLENGE 3: OUTBREAK!	The Yanomami are vulnerable to infectious diseases brought by outsiders. Students are challenged to select from a list of interventions to form a virus containment plan. Students conduct simulations of virus spread under different conditions, calculate percentage rate of infection with different combinations of interventions, and use their results to design a virus containment plan that would keep the percentage of infected villagers to no more than 25% for 30 days and be as low in cost as possible.	• identify and extend exponential patterns • generalize and represent a pattern using symbols • graph simulation data and describe trends • calculate compound probabilities • use a computer model • apply the engineering design process to solve a problem

COMMON CORE AND ITEEA STANDARDS CORRELATIONS

The following tables show how each design challenge addresses Common Core State Mathematics Standards and International Technology and Engineering Standards. In the Common Core column, double asterisks (**) denote standards that are not expressly addressed by the design challenges, but that can be addressed by using optional suggestions included in the instructional text for that design challenge. References to the specific pages are included.

DESIGN CHALLENGE 1: MALARIA MELTDOWN!

Common Core State Standards for Mathematics (Grades 6–8)[1]	ITEEA Standards for Technological Literacy (STL)[2]
Mathematical Practices 2. Reason abstractly and quantitatively.** ***See Optional CCSS Enhancement(s) on page 49.* 5. Use appropriate tools strategically. 6. Attend to precision. **Standards** **6.EE.9.** Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. **6.G.4.** Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems. **7.RP.2.a.** Decide whether two quantities are in a proportional relationship, e.g., by testing for equivalent ratios in a table…. **7.RP.2.b.** Identify the constant of proportionality (unit rate) in tables … equations, diagrams, and verbal descriptions of proportional relationships. **7.RP.2.c.** Represent proportional relationships by equations.** ***See Optional CCSS Enhancement(s) on page 57.*	**1F** New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology. **1G** The development of technology is a human activity and is the result of individual and collective needs and the ability to be creative. **1H** Technology is closely linked to creativity, which has resulted in innovation. **2R** Requirements are the parameters placed on the development of a product or system. **2S** Trade-off is a decision process recognizing the need for careful compromises among competing factors. **8E** Design is a creative planning process that leads to useful products and systems. **8F** There is no perfect design. **8G** Requirements for design are made up of criteria and constraints. **9F** Design involves a set of steps, which can be performed in different sequences and repeated as needed. **9G** Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum. **9H** Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions. **11H** Apply a design process to solve problems in and beyond the laboratory-classroom.

[1]Common Core State Standards. Copyright 2010. National Governor's Association Center for Best Practices and Council of Chief State School Officers. All rights reserved.

[2]International Technology and Engineering Educators Association (ITEEA). 2007. *Standards for Technological Literacy: Content for the Study of Technology.* (Third ed.) Virginia.

Design Challenge 1

Malaria Meltdown!

INTRODUCTION

OBJECTIVE: Students will read and understand the problem presented for the first design challenge.

CLASS Together, read the introduction on the next page.

ASK THE CLASS:

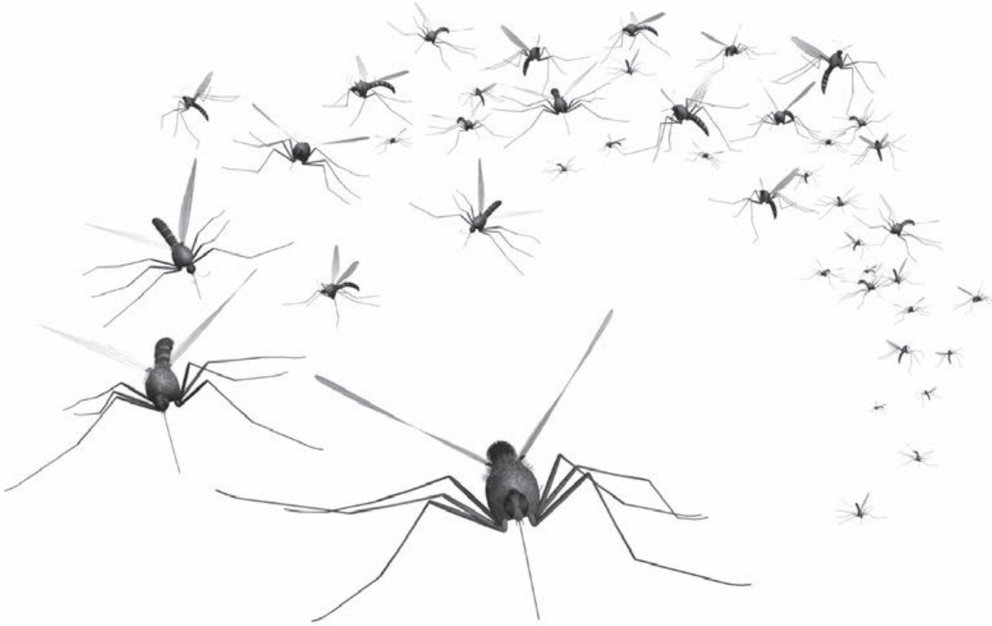
- Given what you know about rain forests, why might it be difficult to keep the medicine between 10˚C and 30˚C?
  Possible Answer(s): The climate in a rain forest is tropical, which means that the temperature is high—usually over 32˚C. So the challenge is to find a way to keep medicine cool in a hot climate.

!

INTERESTING INFO

There are five different climate zones:

1. **TROPICAL** climate zones have annual and monthly temperature averages above 20°C.
2. **SUBTROPICAL** climate zones have an average temperature range of 10°C to 20°C and four to eleven months with temperature averages above 20°C.
3. **TEMPERATE** climate zones have an average temperature range of 10°C to 20°C for four to twelve months.
4. **COLD** climate zones have an average temperature range of 10°C to 20°C for one to four months and the rest cooler.
5. **POLAR** climate zones have an average temperature below 10°C for all twelve months.



Design Challenge 1

Malaria Meltdown!

INTRODUCTION

One of the Yanomami villages has already contacted the community service team at your school, requesting your help. More than half of the villagers are sick with malaria, suffering from severe fevers, chills, and fatigue. Some of the sickest villagers are on the verge of death. The only thing that can save them now is antimalarial medication, but the village has run out! The Yanomami people have asked that you bring a new supply of medicine to the village, and now desperately await your arrival!

Malaria is spread through the bite of the anopheles mosquito. Abandoned mining pits, which are filled with still, warm water, are a breeding ground for these mosquitoes. It seems impossible to stop the spread of the disease. For now, the Yanomami people must rely on antimalarial medicine to treat their symptoms and cure them of the disease. Scientists have just developed a new drug that is 98% effective in curing malaria. The Yanomami need a supply of this new medicine immediately. The drug is highly sensitive. It must be kept between 15°C and 30°C at all times. If the medicine's temperature drops below 15°C or goes above 30°C, it becomes permanently ineffective. You need to transport the medicine to the village while controlling its temperature carefully.

1. DEFINE THE PROBLEM: MALARIA MELTDOWN!

OBJECTIVE: Students will read and understand the criteria and constraints of the design challenge.

CLASS Read about the design challenge on the next page so students understand the criteria and the constraints.

Name
STUDENT PAGE

DEFINE

1. DEFINE THE PROBLEM: MALARIA MELTDOWN!

In order to get the medicine to the village, you and your classmates will first fly to Manaus, Brazil. From there, you will take a helicopter to a clearing that is approximately 13 km from the Yanomami village. The medicine will remain safe during the flights, stored in a large temperature-controlled refrigerator. However, once you've reached the helicopter landing, you must carry the medicine the rest of the way to the village by foot. The hike to the village will take 2 hours. The Amazon rain forest has an average temperature of 37˚C this time of year. In the heat of the rain forest, medical officials think that their current medicine carrier will not be able to keep the medicine below 30˚C for very long. They fear the medicine will spoil before it reaches the village. The hospital needs your engineering team's help to design a new medicine carrier that can keep the medicine between 15˚C and 30˚C for the entire hike!

ENGINEERING CRITERIA	
GOOD INSULATOR →	In an environment that is 37°C, the inside of your model carrier must stay between 15°C and 30°C for 2 hours. ***
LOW COST →	Your model should be as low in cost as possible.
RUGGED AND PROTECTIVE →	You will place an egg inside of the carrier, and you will drop the carrier from a height of 1 meter. Both the egg and the carrier must remain intact.

*** Due to time constraints, you will let 1 minute represent 2 hours. Your model will perform to the same level in 1 minute as a carrier that is 11 times thicker would in 2 hours. Therefore, your actual carrier design will be 11 times thicker than your model design.

ENGINEERING CONSTRAINTS

You are limited to the following materials for your carrier design:

- corrugated cardboard
- foam board
- bubble wrap
- aluminum foil
- heavy-duty tape

LINE GRAPH ACTIVITY

Exercise 1

1. Mileage; it is an "input."
2. Value; it is an "output."
3. *x* mileage (independent variable)
4. *y* value (dependent variable)
5. a. 0–120,000; 120,000
   b. 25
   c. 120,000, 25; data range is greater than number of boxes so 120,000 ÷ 25 = 4,800
   d. Every box is worth 4,800.
   e. *x*-axis should be labeled "Mileage" with appropriate units.

6–7. See sample graph; answers will vary.

Sample graph: