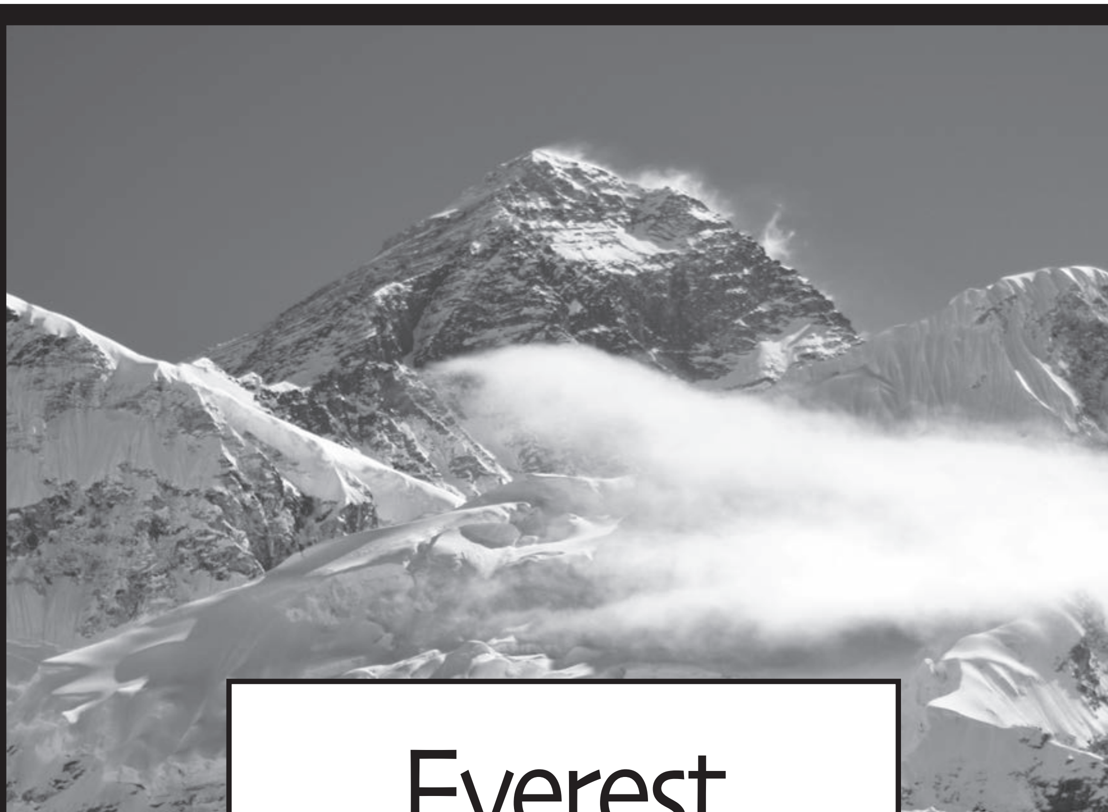


Everest Trek

Building Math

Integrating Algebra & Engineering

TABLE OF CONTENTS

EVEREST TREK OVERVIEW: STORY LINE AND LEARNING OBJECTIVES

	DESIGN CHALLENGE OVERVIEW	STUDENTS WILL:
DESIGN CHALLENGE 1: GEARING UP!	Students imagine that they are preparing to climb Mount Everest. They learn about the climate conditions and need to design a coat to protect them from the cold and wind. Students research the insulation performance of different materials to help determine which materials to choose for their design. The coat must keep the temperature above 65˚F for 30 seconds, not exceed a thickness of 2 cm, and be as low in cost as possible.	• Interpret a line graph. • Locate and represent the range of acceptable values on a graph to meet design criteria. • Extrapolate data based on trends. • Conduct two controlled experiments. • Collect experimental data in a table. • Produce and analyze graphs that relate two variables. • Determine when it's appropriate to use a line graph or a scatter plot to represent data. • Distinguish between independent and dependent variables. • Apply the engineering design process to solve a problem.
DESIGN CHALLENGE 2: CREVASSE CRISIS!	As students are "climbing" Mount Everest, they come to a large crevasse. They study the sagging effect of loading weight onto bridges of different sizes and shapes to design a bridge that will enable them to safely cross the crevasse. The bridge must meet these criteria and constraints: It should support a minimum amount of weight without sagging more than a specific amount, use as few ladders as possible for construction, and be a minimum width to allow for safe crossing.	• Use proportional reasoning to determine dimensions for a scale model. • Use physical and math models. • Conduct two controlled experiments. • Collect experimental data in a table. • Produce and analyze graphs that relate two variables. • Compare rates of change (linear versus non linear relationships). • Distinguish between independent and dependent variables. • Apply the engineering design process to solve a problem.
DESIGN CHALLENGE 3: SLIDING DOWN!	Students have reached the top of Mount Everest. But now they face the problem of altitude sickness and a need to quickly transport their sick classmates down the mountain. Students experiment to find a relationship between the angle of a zip-line and the speed of moving along the zip-line down the mountain. Students use the results of their research to design a zip-line transportation device that meets these criteria and constraints: It must move within a range of acceptable speeds, be stable and secure, and include a return mechanism.	• Conduct a controlled experiment. • Measure angles using a protractor. • Compare and discuss appropriate measures of central tendency (mean, median, mode). • Apply the distance-time-speed formula. • Produce and analyze a graph that relates two variables. • Locate and represent the range of acceptable values on a graph to meet a design criteria. • Distinguish between independent and dependent variables. • 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.

	Common Core State Standards for Mathematics (Grades 6–8)[1]	**ITEEA Standards for Technological Literacy (STL)**[2]
DESIGN CHALLENGE 1: GEARING UP!	**Mathematical Practices** 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 6. Attend to precision. **Standards** **6.RP.3.** Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios … double number line diagrams**, or equations**. ***See Optional CCSS Enhancement(s) on page 38.* b. Solve unit rate problems including those involving unit pricing and constant speed. **6.NS.3.** Fluently add, subtract, multiply, and divide multi-digit decimals using the standard algorithm for each operation. **6.NS.6.a.** Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; recognize that the opposite of the opposite of a number is the number itself, e.g., $-(-3) = 3$, and that 0 is its own opposite.** ***See Optional CCSS Enhancement(s) on page 32.* **6.NS.6.b.** Understand signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate plane; recognize that when two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes.** ***See Optional CCSS Enhancement(s) on page 41.*	**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

Gearing Up!

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:

- Have you ever been caught outside in cold weather without a coat? Why is it dangerous for the human body to be exposed to freezing temperatures without proper protection?

Possible Answer(s): Exposure can lead to frostbite, organ failure, and so forth.

INTERESTING INFO

Hypothermia results in lowered body temperature and slowed physiological activity. Hypothermia is sometimes artificially induced (usually with ice baths) for certain surgical procedures and cancer treatments. Accidental hypothermia can result from falling into cold water or from overexposure in cold weather. Hypothermia becomes serious when body temperature falls below 35˚C (95˚F). It is considered an emergency when body temperature goes below 32.2˚C (90˚F), at which point shivering stops. Pulse, respiration, and blood pressure are depressed. Even when the victim appears dead, revival may be possible with very gradual rewarming.

Design Challenge 1

Gearing Up!

INTRODUCTION

Your team is equipped and ready to climb Mount Everest! Upon arriving at base camp, you turn on the radio and hear the following weather report for the summit of Mount Everest:

"For all you new climbers out there, be prepared for some extreme temperatures on the glacier-covered mountain. In January, the coldest month, the summit temperature averages –36°C and can drop as low as –60°C. In July, the warmest month, the average summit temperature is –19°C. At no time of the year does the temperature on the summit rise above freezing. For the next few weeks, we are expecting an average temperature near –26°C."

1. DEFINE THE PROBLEM: GEARING UP!

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

CLASS Together, read the engineering criteria and constraints.

ASK THE CLASS:

- What types of insulators have you seen used in real life?
  Possible Answer(s): jackets, blankets, walls
- What materials make up these insulators?
  Possible Answer(s): down feathers, fiberglass, wool
- What characteristics of the material make it an effective insulator?
  Possible Answer(s): thick, fluffy, multi-layered
- Of the four materials you will use in your coat design, which one do you think will be the best insulator? Which one will be the worst? Why?
  Possible Answer(s): Answers will vary.
- Why do you think the criterion is that the temperature must remain above 18˚C?
  Possible Answer(s): 18˚C is the standard room temperature at which most humans are comfortable.

!

INTERESTING INFO: Math Problem
Base camp instructors are providing climbers with extra clothing because of freezing temperatures in the mountain. The only problem is, your backpack can't exceed 22.75 kg or reaching the summit would become seemingly impossible. Right now, your backpack is 21.75 kg. Which article(s) of clothing will keep you the warmest without exceeding 22.75 kg? Defend your choice.
Possible Answer(s): Basically, any combination that totals less than 1000 g: 1 thermal jacket; 1 parka and 1 T-shirt; 1 fleece jacket and 1 crew shirt; 4 crew shirts

CLOTHING	WEIGHT	SUITABLE TEMPERATURE RANGES
Fleece jacket	618 g	4°C–13°C
Parka	800 g	–7°C–2°C
Thermal jacket	927 g	–18°C– –4°C
Long-sleeve crew shirt	238 g	18°C–24°C
T-shirt	196 g	24°C and up

Name

STUDENT PAGE

DEFINE

1. DEFINE THE PROBLEM: GEARING UP!

When any part of your body is exposed to freezing temperatures for more than a few minutes, you are at risk for getting frostbite. Therefore, you will need to dress in outerwear that can keep your body warm in these extremely cold temperatures. Your task is to design a coat that is made of a good insulator to keep you warm, is thin enough to allow you to move easily, and is low in cost.

ENGINEERING CRITERIA	
GOOD INSULATOR →	When surrounded by ice, the material must keep the temperature above 18°C for 30 seconds.
THIN →	The total thickness of the materials must not exceed 2 cm.
LOW COST →	Your coat design should be as low in cost as possible.

ENGINEERING CONSTRAINTS

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

- denim
- fleece
- nylon
- wool

ANSWER KEY

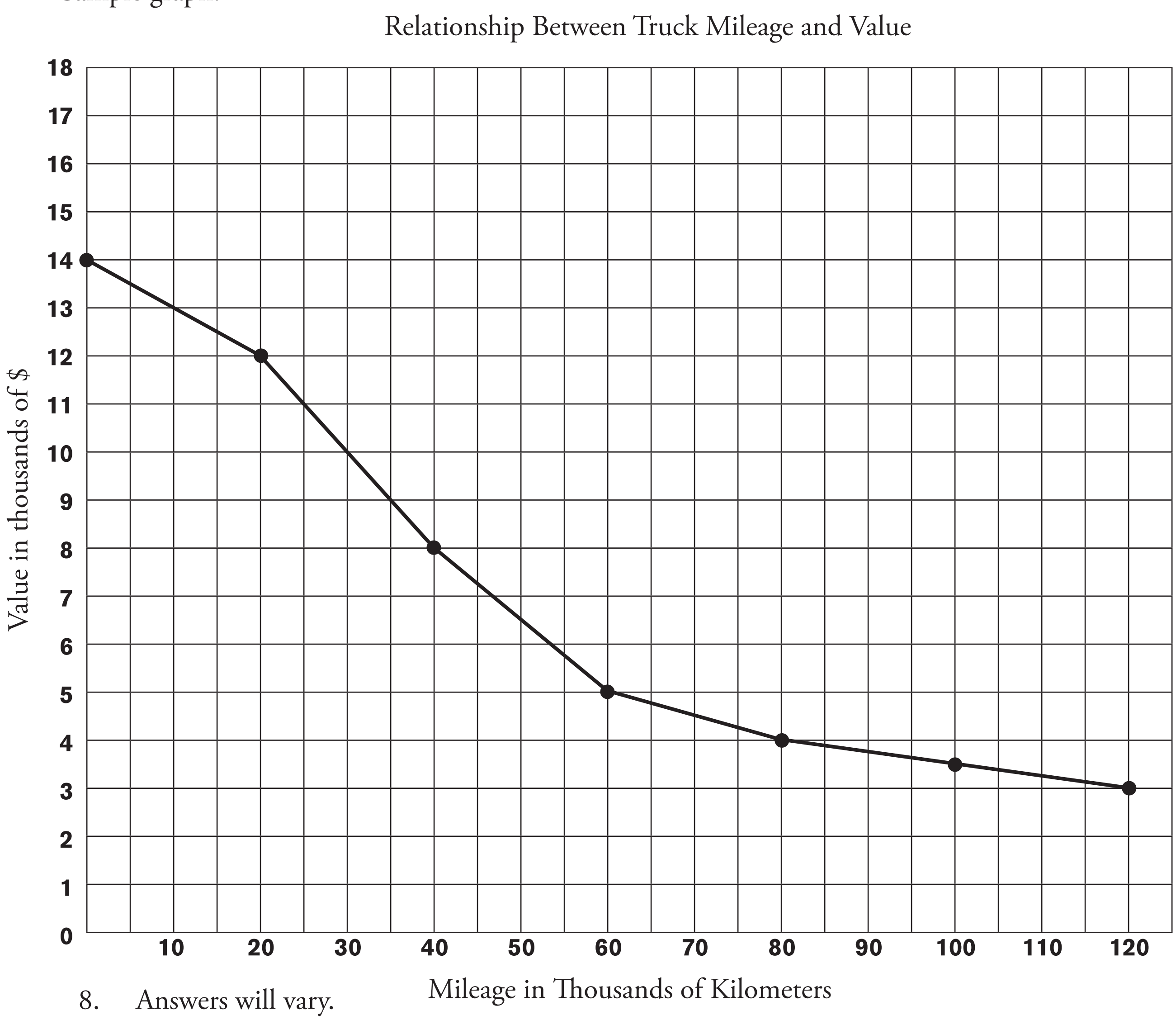
LINE GRAPH ACTIVITY

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:



8. Answers will vary.
9. $3,500
10. 20,000–40,000 kilometers
11. $6,500
12. $2,500, by extending the line or estimating the next decrease based on the previous decrease