LIFEPAC®

SCIENCE

STUDENT BOOK

8th Grade | Unit 7

Alpha Omega PUBLICATIONS

SCIENCE 807
Machines 1

LIFEPAC Test is located in the center of the booklet. Please remove before starting the unit.

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Machines 1

Introduction

All of the people in the world have had to work for a living since Adam and Eve were expelled from the garden of Eden (Genesis 3). In this LIFEPAC® you will learn about work as a scientist views it and about distance, force, and friction.

Do you work? Whenever you pick something up or move it against friction you perform work

Objectives

Read these objectives. The objectives tell you what you will be able to do when you have successfully completed this LIFEPAC. When you have finished this LIFEPAC, you should be able to:

1. Measure distances in the metric and English systems.
2. Measure distances indirectly.
3. Define force.
4. Construct force diagrams.
5. Solve problems involving forces.
6. Explain and to apply Newton's Laws of motion.
7. Define work and energy.
8. Solve problems involving work and power.

Survey the LIFEPAC. Ask yourself some questions about this study and write your questions here.

1. DISTANCE

When you were small, distances were limited to your house and your yard. As you got older, your activities covered greater areas and your range increased to include church, school, homes of friends, and the streets joining those places.

Distance has varied meanings to people of different times and places. Society has therefore developed systems of measurement. Specific dimensions enable everyone to understand what is meant regardless of who is measuring or what is being measured.

SECTION OBJECTIVES

Review these objectives. When you have completed this section, you should be able to:

1. Measure distances in the metric and English systems.
2. Measure distances indirectly.

VOCABULARY

Study these words to enhance your learning success in this section.

cubit (kyü´ bit). An ancient measure of length equal to 18 or 22 inches.

English system (Ing´ glish sis´ tum). The system of measurement that includes units like foot, pound, and gallon.

metric system (met´ rik sis´tum). A system of measurement based on the meter as a unit of length.

Note: *All vocabulary words in this LIFEPAC appear in* **boldface** *print the first time they are used. If you are not sure of the meaning when you are reading, study the definitions given.*

Pronunciation Key: h**a**t, **ā**ge, c**ã**re, f**ä**r; l**e**t, **ē**qual, t**ė**rm; **i**t, **ī**ce; h**o**t, **ō**pen, **ô**rder; **oi**l; **ou**t; c**u**p, p**u̇**t, r**ü**le; **ch**ild; lo**ng**; **th**in; /ŦH/ for **th**en; /zh/ for mea**s**ure; /u/ represents /a/ in **a**bout, /e/ in tak**e**n, /i/ in penc**i**l, /o/ in lem**o**n, and /u/ in circ**u**s.

DESCRIBING DISTANCE

Have you given someone directions to get to your house from school? What words did you use to describe the distance between the two places? In this section you will study ways to express distance.

Comparison. Many societies have no words to compare. One word may be used for *building* with no way to tell if the building is a tool shed or a skyscraper. Sometimes words, such as *far* or *near, large* or *small, high* or *low,* are as good as, or better than, exact measurement. Comparative words such as these can be used accurately in descriptions. People who use comparative words in conversation need more exact terms at other times.

With numbers. Over a period of several thousand years, people developed systems of measurement of distance. In Genesis 6 God commanded Noah to build an ark that was to be 300 **cubits** long, 50 cubits wide, and 30 cubits high. A cubit was the length of a forearm—from 46 to 56 centimeters (18 to 22 inches) long. The cubit, however, varied with the length of the arm. Another measurement from that portion of history was a *step* or a *pace.* The word *mile* comes from the Latin term for a thousand paces.

In the United States the common units used to measure distance are the *inch, foot, yard,* and *mile.* The problem with this system is the conversion from one unit to another. We have all learned that 5,280 feet equals a mile. A mile therefore is 63,360 inches, or 1,760 yards. Converting dimensions from feet to inches or from miles to feet requires clumsy multiplication or division. Engineers have used decimals to express fractions; but few others use decimals to express parts of feet, inches, or miles in the **English system**.

The history of the English system of units indicates that its origins are varied. At one time *inch* was the length of three dried barley corns laid end to end. At another time the inch was the width of a man's thumb. The *yard* was defined in 1120 AD by King Henry I of England as the distance from the end of his thumb to the tip of his nose when his arm was level.

France adopted the **metric system** in 1793. It was an entirely new system of measurement. The metric system is exact and easy to use because it is based on the decimal system, or multiples of ten. The metric system is used by scientists all over the world. In 1866 Congress legalized the use of the metric system in the United States. The Congress passed the Metric Conversion Act in 1975. However, each of these acts called for voluntary changeover and so very few Americans have learned the metric system. Therefore, the metric system is unfamiliar to most people in the United States. Using this system will require practice. Learning the metric system is like learning rules for a new game. The metric system will be used in most cases in this LIFEPAC.

The modern metric system is known as the International System of Units. The name International System of Units with the international abbreviation SI was given to the system by the General Conference on Weights and Measures in 1960.

In the SI system (from the French, *Systeme International d'Unites*) the fundamental unit of distance is the meter. For comparison, a meter is a little longer than a yard. A meter is divided into 100 units called *centimeters* and into 1,000 units called *millimeters.* The width of a large wire paper clip is about a centimeter and the diameter of the wire is about a millimeter. For long distances the convenient unit is the *kilometer,* 1,000 meters.

Match these items.

1.1	________	Jeff's house is near school.	a.	comparative
1.2	________	Sheri is nearly home.	b.	numerical
1.3	________	Uncle Bob drives twenty miles to work.	c.	neither
1.4	________	Jan is closer than Debbie to the goal.		
1.5	________	February is shorter than June.		
1.6	________	Dr. Davis is taller than Dr. Brown.		
1.7	________	Dr. Davis is over six feet tall.		

Try this investigation to build your own cubit.

These supplies are needed:

- 10 strips of paper about 5 cm wide and at least 62 cm long
- scissors
- tape
- string

Follow these directions and answer the questions. Put a check in the box when each step is completed.

☐ 1. Ask each of ten students to place his forearm with fingers outstretched on a strip of paper. Mark the position of the elbow and the tip of the middle finger on each strip.

☐ 2. Trim the excess paper from the ends of each strip.

☐ 3. Organize the strips parallel to each other in order of length and tape one end of each along the edge of a table.

1.8 Do the strips vary in length? ____________________

1.9 Which strip represents a cubit? ____________________

____

Standardized Measurement Experiment

☐ 4. Along some straight line (the wall, a floor board, an aisle) lay off twelve longest "cubits." Mark the starting point and the end.

☐ 5. From the same starting point lay off twelve shortest "cubits."

1.10 Using a shortest cubit as a unit of length (the same way you would use a ruler), what is the difference between twelve longest cubits and twelve shortest cubits?

____

____

☐ 6. Substitute a length of string for a strip of paper and remeasure a forearm.

1.11 What disadvantage is obvious in the use of string? ____

____

1.12 What common procedure could be used to make your classroom cubit more acceptable as a standard unit of length? ____

____

1.13 How could you communicate the length of your classroom cubit to a science class in another school? ____

____

Some things can be measured by counting. One example is the number of students in your class. Other things are measured using numbers but do not require counting; for instance, the distance from home to school.

Standardized Measurement Experiment

Write count before each quantity that is measured by counting.

1.14 ____________ number of teachers in your school

1.15 ____________ yesterday's high temperature

1.16 ____________ length of the hall

1.17 ____________ number of coins in a coin collection

1.18 ____________ value of a coin in the collection

1.19 ____________ number of centimeters in your height

1.20 ____________ number of milliliters of water in a glass

1.21 ____________ number of fans in a stadium

Answer these questions.

1.22 How could you find out, without counting, if more desks or more students were in a room?

____

____

1.23 How could you find out, without measuring, which of two cows gave more milk?

____

____

1.24 Without using numbers, how could you tell a store clerk the length of shoelace you need for your left sneaker? ________________________________

____

1.25 Without using a ruler, which line is longer, or are the lines the same length?

____

A **B**

1.26 How did you discover the answer to 1.25? ________________________

____

Measure the following objects with a pac.

1 pac = the width of the front cover of this LIFEPAC.

1.27 Measure the longer dimension of your desk top in pacs. ______________

1.28 Measure the shorter dimension of your desk top in pacs. ______________

1.29 Measure the length of your classroom in pacs. ______________

1.30 Measure the width of your pen or pencil in pacs. ______________________________

____

TEACHER CHECK __________ __________
initials date

Answer these questions.

1.31 What disadvantages are built into the pac as a standard unit of length? ______________

____

____

1.32 How could you use the front cover of this LIFEPAC to measure the width of your pen or pencil? ____

____

____

1.33 What clue does activity 1.32 give to the development of the English system? __________

____

____

Multiply or divide to make these English distance conversions. Time yourself as you do the ten exercises without a calculator.

1 mile	=	5,280 feet

1.34 174 inches = ________________ feet

1.35 7 feet = ________________ inches

1.36 29 feet = ________________ yards

1.37 29 feet = ________________ inches

1.38 3 miles = ________________ feet

1.39 10,000 feet = ________________ miles

1.40 10,000 feet = ________________ yards

1.41 10,000 feet = ________________ inches

1.42 79 yards = ________________ feet

1.43 100 yards = ________________ feet

Answer these questions.

1.44 How long did you take to work 1.34-1.43? ________________

1.45 Which of the conversions were easier or faster than the rest? ________________

____

1.46 Why were the conversions easier? ________________________________

____

Multiply or divide to make these metric distance conversions. Time yourself as you do the ten exercises without a calculator.

1 kilometer = 1,000 meters

1 meter = 100 centimeters or 1,000 millimeters

1.47 174 centimeters= ________________ meters

1.48 7 meters = ________________ centimeters

1.49 29 centimeters = ________________ millimeters

1.50 29 centimeters = ________________ meters

1.51 3 kilometers = ________________ meters

1.52 10,000 meters = ________________ kilometers

1.53 10,000 meters = ________________ centimeters

1.54 10,000 meters = ________________ millimeters

1.55 79 millimeters = ________________ centimeters

1.56 1,000 meters = ________________ kilometers

Answer these questions.

1.57 How long did you take to work 1.47-1.56? ______________________________

1.58 Explain the difference in your times. ____

____

____

Research and report.

1.59 Use outside sources to research one of these topics.

Isaac Newton — Robert Boyle

Nicolaus Copernicus — history of metric or English system

The report should be at least five handwritten, double-spaced pages including a short bibliography. Especially include a section on their Christian testimony.

TEACHER CHECK ____________ ____________
initials date

MEASURING DISTANCE

This section will cover direct and indirect measurement. You will learn to use a scale drawing to find unmeasurable distances.

Estimation. Between comparative words such as *large* and *small* and precise measurement lies the estimate. An estimate is a rough calculation or an educated guess.

Estimates are influenced by the surroundings. Many people underestimate distances indoors and overestimate them outdoors. Distances seem different over smooth and rough ground.

Distances are sometimes estimated by pacing. A pace is about 75 centimeters (30 inches). Estimating is visually or mentally comparing a distance to one that is known. An example of estimation is using the floor tiles to estimate the size of a room.

Estimation is sometimes used in science. Science, however, usually requires an exact statement of distance and other dimensions.

Direct measurement. Measurement with a meter stick is an example of direct measurement. It is the method preferred by scientists. Direct measurement using the metric system is used in track and field competition.

Short distances can be measured with a ruler or a tape. Laboratories try to use direct measurement for experiments. Accurate devices, such as *micrometers* and *vernier calipers,* have been developed for small distances. In the home the meter stick, yard stick, and tape measure are used. Surveyors use accurate steel tape measures for measuring distances for roads, canals, bridges, and boundaries.

Indirect measurement. Long ago the Greeks developed a form of mathematics called *geometry*. The word means *earth measure*. Euclid wrote a book 300 years before Christ that contained most of the mathematics of his time. This book, *Elements*, was a basic mathematics book for 2,000 years and was the beginning of geometry. It was translated into English in 1570.

Geometry is used by surveyors and mapmakers to represent distances that cannot be measured directly. A map is a *scale drawing* of an area of the earth's surface. In order to represent many miles of distance on the earth, the mapmaker uses lines on a paper that are shorter and *in proportion* to the actual distances. For example, a distance of 1 mile might be represented on a map by 1 inch. At that scale, 5 miles would equal 5 inches, 7.4 miles would equal 7.4 inches, and so on.

Complete these activities.

1.60 Write the *actual* distances represented by the following scale distances if the scale is 1 centimeter = 1 kilometer.

a. 23 centimeters = ________________ kilometers

b. 1.6 centimeters = ________________ kilometers

c. 0.5 centimeters = ________________ kilometers

d. $\frac{3}{4}$ centimeters = ________________ kilometers

e. $1\frac{3}{5}$ centimeters = ________________ kilometers

f. 9 centimeters = ________________ kilometers

1.61 Write the *scale* distances that represent the following actual distances if the scale is 1 inch = 1,000 feet.

a. 4,000 feet = ________________ inches

b. 10,000 feet = ________________ inches

c. 21,000 feet = ________________ inches

d. 900 feet = ________________ inches

e. 1,500 feet = ________________ inches

f. 40 feet = ________________ inch

1.62 Write the *actual* distances represented by the following scale distances if the scale is 1 centimeter = 5 kilometers.

a. 2 centimeters = ________________ kilometers

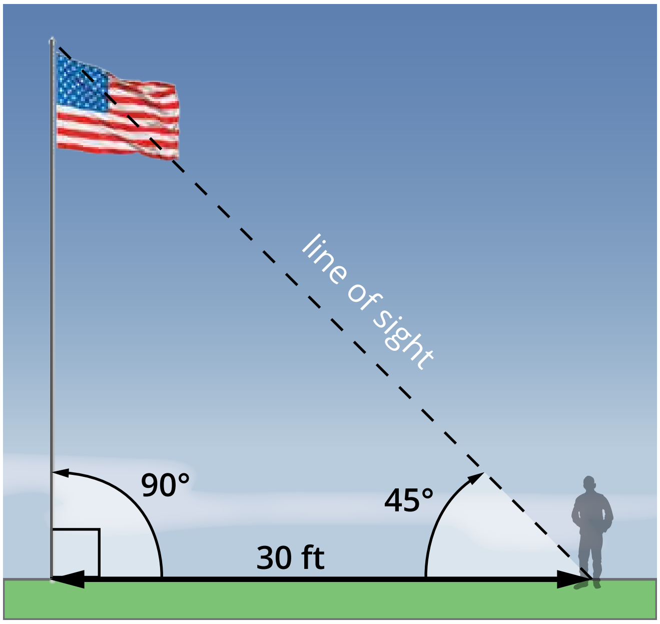
b. 5 centimeters = ________________ kilometers

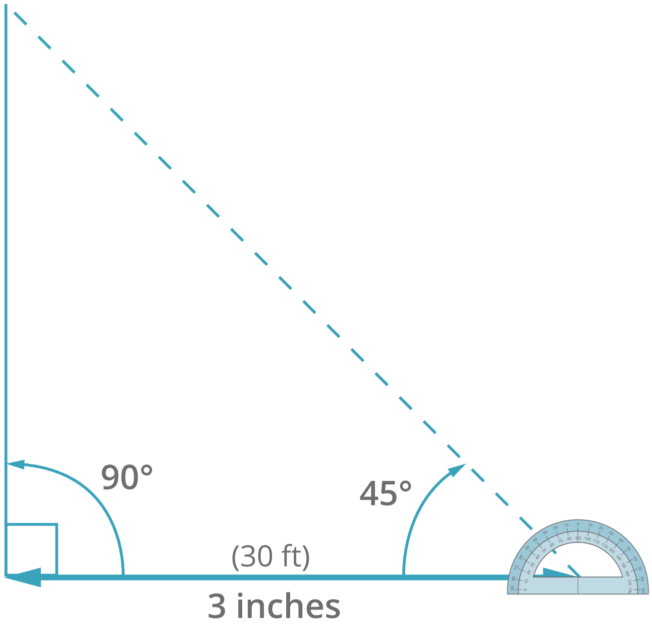
c. 10 centimeters = ________________ kilometers

d. 4.5 centimeters = ________________ kilometers

e. 0.8 centimeters = ________________ kilometers

f. 0.1 centimeters = ________________ kilometer





When an actual distance cannot be measured directly, a scale drawing can be set up that uses angles. For example, climbing a flagpole to measure its height is inconvenient at best. If, on the other hand, you measure the angle that the *line of sight* to the top of the pole makes with the ground, a scale drawing can be used to measure the height. We can say that, at a distance of 30 feet from the pole, the line of sight to the top makes an angle of 45° with the ground.

To construct a scale drawing, use a draftsman's triangle or the corner of a sheet of paper to draw the pole and the ground. Next, set up some convenient scale; say, 1 inch = 10 feet. Mark 3 inches (30 feet) from the base of the flagpole, and use a protractor to construct a 45° angle.

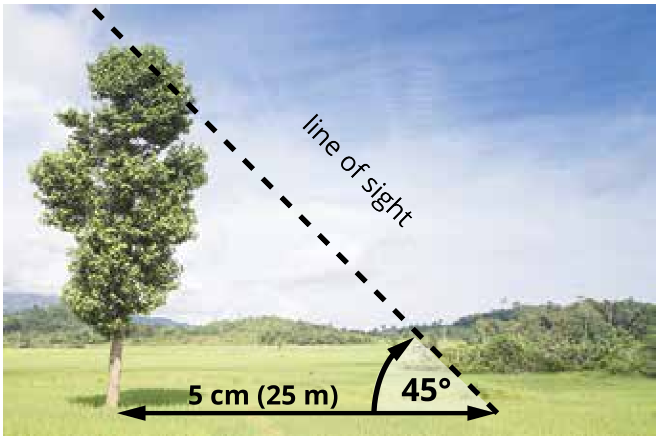
When the scale drawing is complete, measure the length of the line that represents the pole. You find that it is 3 inches long. At a scale of 1 inch = 10 feet, the pole must be 30 feet tall.

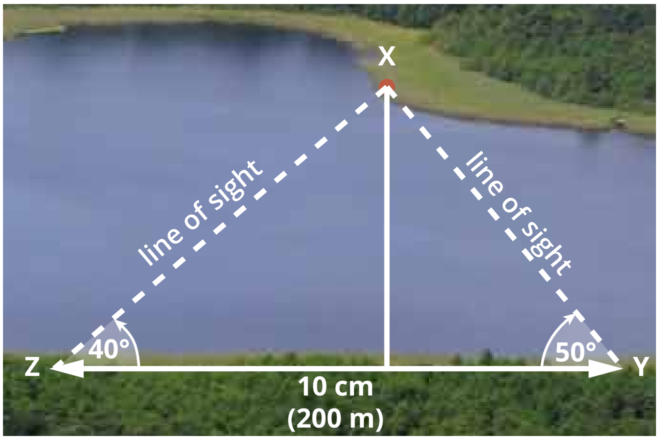
Answer these questions.

1.63 How many degrees are contained in the angle at a corner of this page? _______________

1.64 How could you construct a 45° angle if you had neither a draftsman's triangle nor a protractor? ____

____





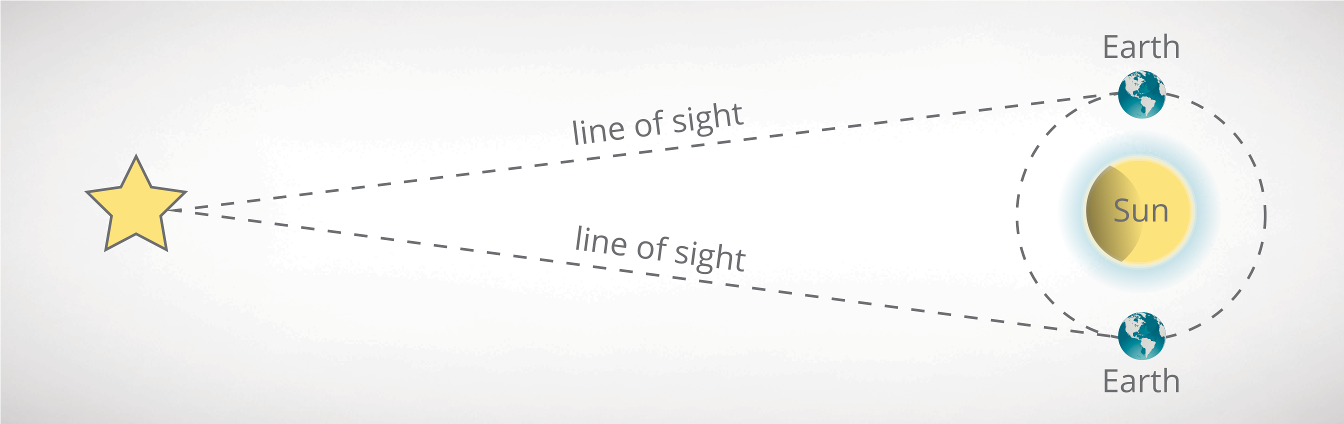
Example 1. Find the height of a tree. An observer notes that at 25 meters from the base, the line of sight to the top of the tree makes an angle of 45° (half a right angle) with the ground.

The observer makes a scale drawing with a scale of 1 cm = 5 m. The base line is 5 cm long with a 45° angle at one end, and the line of sight is drawn to form a triangle. If the tree is 5 cm on the scale drawing, the tree is actually 25 meters high.

Example 2. From two points on Lakeshore Drive (Z and Y) a boulder (X) is sighted across the lake. The sketch is a scale drawing. What is the shortest distance between the boulder and the highway?

The base line representing 200 meters is 10 centimeters (1 cm = 20 m). The angles are laid out with the use of a protractor. The vertex of the triangle represents the boulder. The line on the sketch representing the shortest distance across the lake is 4.9 centimeters. The actual distance across the lake is therefore 98 meters.

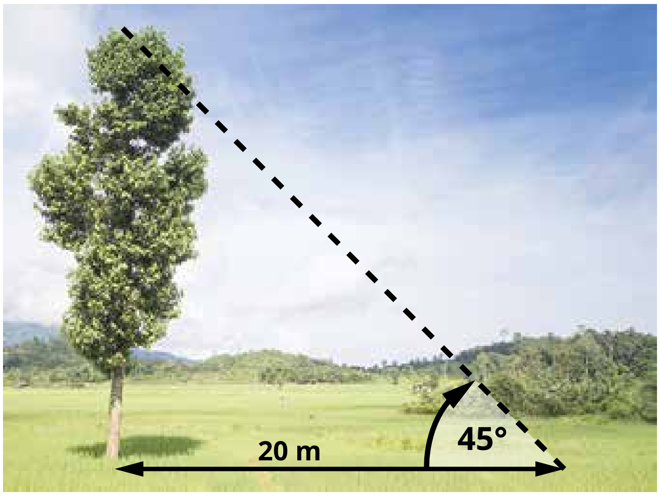
This same idea of indirect measurement is used to measure the distance to the closer stars. A very long base line is needed so astronomers use the diameter of the earth's orbit. They measure the angle to a star and six months later measure it again. From these measurements, the star/earth distance can be determined.



| Indirect Measurement of the Distance to a Star

Complete these activities.

A line of sight to the top of a tree meets the ground 20 meters from the trunk at an angle of 45°.



1.65 How tall is the tree?

____

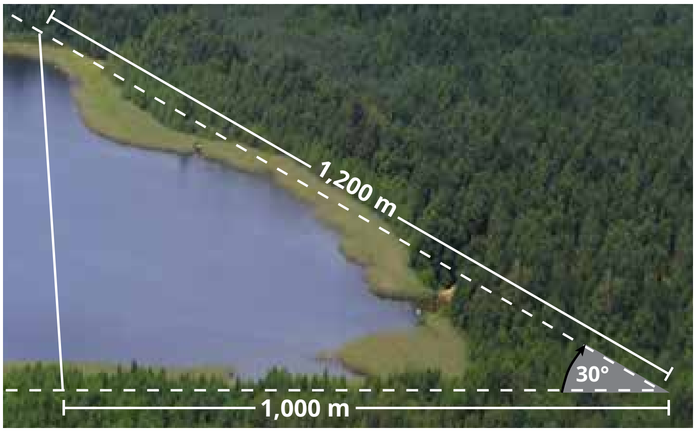
1.66 If you do not have a protractor or a draftsman's triangle, how could you construct a 45° angle?

____

1.67 How could you construct a 22¾° angle? _______________________

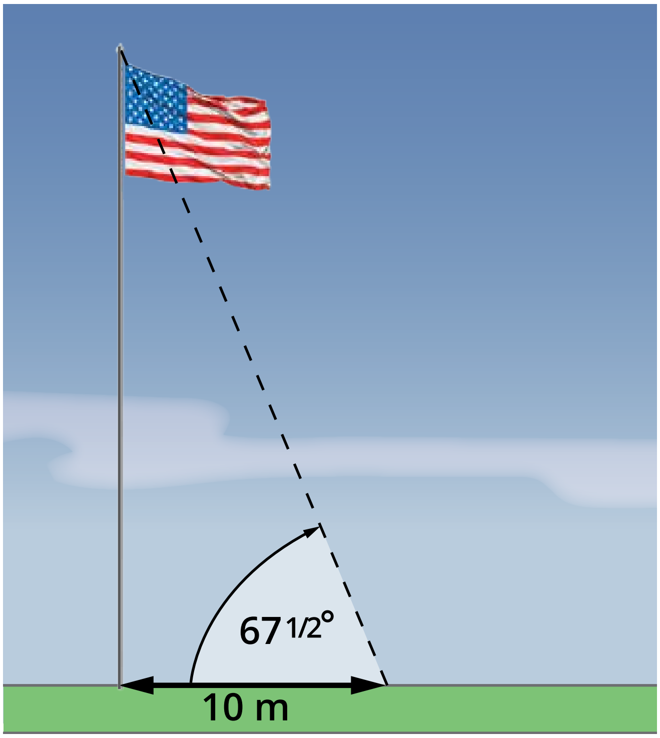
1.68 Two straight roads intersect at one end of a lake. The roads form an angle of 30° with each other. The widest part of the lake is 1,000 m from the intersection along one road and 1,200 m from the intersection along the other road. Make a new scale drawing similar to the sample of this problem.

How wide is the lake? ____________



1.69 A flagpole casts a shadow 10 m long. An imaginary line from the end of the shadow to the top of the pole forms an angle of 67½° with the ground. How tall is the flagpole?

____



TEACHER CHECK ____________ initials ____________ date

Review the material in this section in preparation for the Self Test. The Self Test will check your mastery of this particular section. The items missed on this Self Test will indicate specific areas where restudy is needed for mastery.

SELF TEST 1

Write the letter of the correct choice (each answer, 2 points).

1.01 The cubit was known as early as _______ .
a. 1750 b. 1400 c. AD 1 d. 2500 BC

1.02 The metric system was devised by _______ .
a. Sophocles b. Moses c. the Romans d. the French

1.03 The system of measurements that includes the foot, yard, and mile is the _______ system.
a. English b. French c. metric d. electric

1.04 A mile contains _______ feet.
a. 63,360 b. 5,280 c. 1,492 d. 1,000

1.05 In the United States the metric system is most commonly used by ________ .
a. auto mechanics b. grocers c. scientists d. bus drivers

Make these conversions (each answer, 3 points).

1.06 10 cm = ___________________ mm

1.07 100 cm = ___________________ m

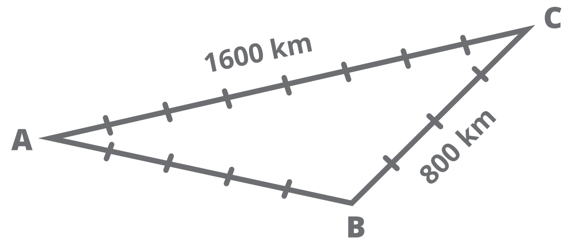
1.08 25 m = ___________________ cm

1.09 73 m = ___________________ mm

1.010 147 mm = ___________________ m

Calculate these distances (each answer, 5 points).

1.011 Use the scale drawing to find the actual distance AB.



1.012 Use a scale drawing to find the height of a tree if it casts a shadow 30 m and the line from the top of the tree to the top of the shadow forms an angle of 45° with the ground.

Complete these sentences (each answer, 3 points).

1.013 Measuring the distance to a planet would probably require the use of ______________________ (direct, indirect) measurement.

1.014 The system of mathematics used for, among other things, surveying and indirect measurements is ______________________ .

1.015 The term that means 1,000 meters is ______________________ .

1.016 The metric system is based on multiples of the number ____________________________ .

1.017 The fundamental unit of length in the metric system is the _____________ .

1.018 An educated guess of a distance is a(n) ______________________ .

42/53 **SCORE** ____________ **TEACHER** ____________ ____________
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