



1.2 Indirect Measurement

READ


Have you ever wondered how scientists and engineers measure large quantities like the mass of an iceberg, the volume of a lake, or the distance across a river? Obviously, balances, graduated cylinders, and measuring tapes could not do the job! Very large (or very small) quantities are calculated through a process called indirect measurement. This skill sheet will give you an opportunity to try indirect measurement for yourself.

EXAMPLE

- The length of a tree's shadow is 4.25 meters and the length of a meter stick's shadow is 1.25 meters. Using these two values and the length of the meter stick, how tall is the tree?

<p>Looking for The height of a tree.</p>	<p>Solution</p> $\frac{1.00 \text{ m}}{1.25 \text{ m}} = \frac{\text{height of tree}}{4.25 \text{ m}}$ $4.25 \text{ m} \times \frac{1.00 \text{ m}}{1.25 \text{ m}} = \frac{\text{height of tree}}{4.25 \text{ m}} \times 4.25 \text{ m}$ $3.40 \text{ m} = \text{height of tree}$ <p>The height of the tree is 3.40 meters.</p>
<p>Given Tree's shadow = 4.25 m Meter's stick's shadow = 1.25 m Height of meter stick = 1 m</p>	
<p>Relationships There is a direct relationship between the height of objects and the length of their shadows.</p> $\frac{\text{height of meter stick}}{\text{length of meter stick shadow}} = \frac{\text{height of object}}{\text{length of object shadow}}$	

- At the science museum, 12 first graders stand on a giant scale to measure their mass. The combined mass of the 12 first graders is 262 kilograms. What is the average mass of a first grader in this group?

<p>Looking for The average mass of a first grader.</p>	<p>Solution</p> $\frac{262 \text{ kilograms}}{12} = 21.8 \text{ kilograms}$ <p>The average mass of a first grader in this group is 21.8 kilograms.</p>
<p>Given Total mass of 12 first graders = 262 kilograms</p>	
<p>Relationships To get the average mass of one first grader, divide the total mass by 12.</p> $\frac{262 \text{ kilograms}}{12}$	

PRACTICE

- You go to another forest and measure the shadow of a tree to be 6 meters long. The shadow of your meter stick is 2 meters long. How tall is the tree?
- The height of a flagpole is 8.50 meters. If the length of the meter stick shadow is 1.50 meters, what is the length of the flagpole's shadow?



3. While touring a city, you see a skyscraper and wonder how tall it is. You see that it is clearly divided into floors. You estimate that each floor is 20. feet high. You count that the skyscraper has 112 floors.
 - a. Approximately how tall is this skyscraper in feet?
 - b. Approximately how tall is the skyscraper in meters? (One foot is about 0.3 meter.)
4. There are 10 apples in a one-kilogram bag of apples. What is the average mass of each apple in the bag? Give your answer in units of kilograms and grams.
5. If you place one staple on an electronic balance, the balance still reads 0.00 grams. However, if you place 210 staples on the balance, it reads 6.80 grams. What is the mass of one staple?
6. A stack of 55 business cards is 1.85 cm tall. Use this information to determine the thickness of one business card.
7. A stack of eight compact disks is 1.0 centimeter high. What is the thickness of one compact disk (CD) in centimeters? What is the thickness of one CD in millimeters?
8. A quarter is 2.4 millimeters thick. How tall are the following stacks of quarters?
 - a. A stack worth 50 cents
 - b. A stack worth \$1
 - c. A stack worth \$5
 - d. A stack worth \$1,000
(Give your answer in millimeters and meters.)
9. Yvonne has gained a reputation for her delicious cheesecakes. She takes orders for 10 cheesecakes and spends 8.5 hours on one Saturday baking them all. She earns \$120 from selling these cheesecakes.
 - a. What is the average length of time to make one cheesecake? Give your answer in minutes.
 - b. What does Yvonne charge for each cheesecake?
 - c. How much money is Yvonne earning per hour for her work?
10. A sculptor wants to create a statue. She goes to a quarry to buy a block of marble. She finds a chip of marble on the ground. The volume of the chip is 15.3 cm^3 . The mass of the chip is 41.3 grams. The sculptor purchases a block of marble 30.0-by-40.0-by-100.0 cm. Use a proportion to find the mass of her block of marble.
11. The instructions on a bottle of eye drops say to place three drops in each eye, using the dropper. How could you find the volume of one of these drops? Write a procedure for finding the volume of a drop that includes using a glass of water, a 10.0-mL graduated cylinder, and the dropper.
12. A student wants to use indirect measurement to find the thickness of a sheet of newspaper. In a 50-centimeter tall recycling bin, she finds 50 sheets of newspaper. Each sheet in the bin is folded in fourths. Design a procedure for the student to use that would allow her to measure the thickness of one sheet of newspaper with little experimental error. The student has a meter stick and a calculator.

