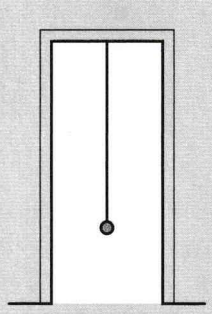
A ***pendulum*** is a suspended weight that swings freely.
One hundred years ago, the best clocks used pendulums to keep time.
In this project, we will explore several properties of pendulums that make them excellent timekeepers.

Complete this project with the help of an adult.

Step 1: Make a pendulum.
You will need: tape, thin string (dental floss works great), a small weight (like a C battery), a stopwatch, and a tall person.

1. Cut a string between 100 and 200 centimeters in length.
2. Tape one end of the string to the small weight.
3. Tape the other end of the string to the top of an open doorway. This is where the tall person comes in handy.



Step 2: Explore.
Your goal is to time the swings of pendulums of different lengths.

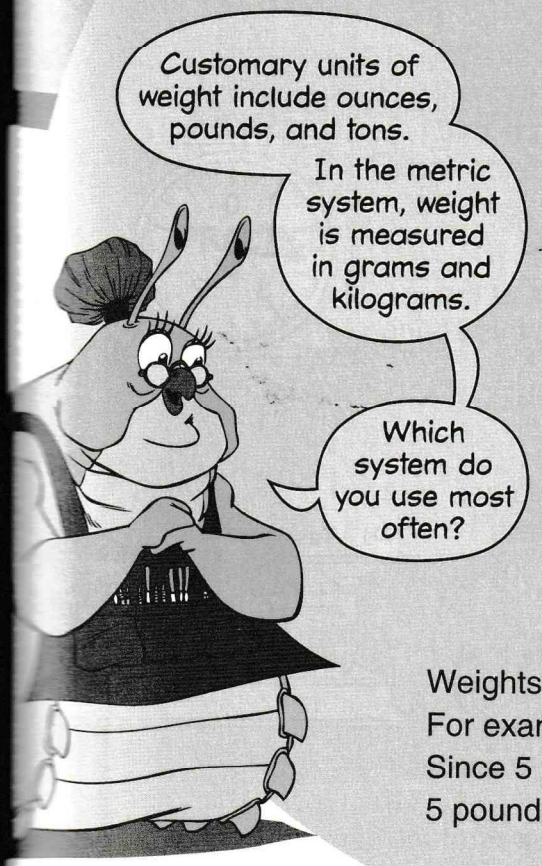
1. Measure the length of your pendulum in centimeters. The length of your pendulum is the distance from the top of the string to the middle of the weight at the end.
2. Use a stopwatch to measure your pendulum's period. The ***period*** is the time your pendulum takes to make one full (out-and-back) swing.
3. Change the length of your pendulum. Repeat steps 1 and 2 for pendulums of several different lengths. Create a table like the one below to record your results. We filled in one entry for you.

Length (cm)	Period (seconds)
140	2.37

Step 3: Answer the following questions based on your experiments.

1. Does pulling the pendulum farther back change its period?
2. Does changing the length of the pendulum change its period?
3. What is the length in centimeters of a pendulum that has a period of 2 seconds?

Answers are in the solutions section after Problem 33.



Customary Unit	Conversion
ounce (oz)	
pound (lb)	1 lb = 16 oz
ton	1 ton = 2,000 lb

A large chicken egg weighs about 2 ounces.

Metric Unit	Conversion
gram (g)	
kilogram (kg)	1 kg = 1,000 g

A nickel weighs exactly 5 grams.

Weights are often listed as mixed measures.
For example, 5 pounds 7 ounces equals 87 ounces.
Since 5 pounds equals $5 \times 16 = 80$ ounces,
5 pounds 7 ounces equals $80 + 7 = 87$ ounces.

PRACTICE | Use the information above to help you solve each problem below.

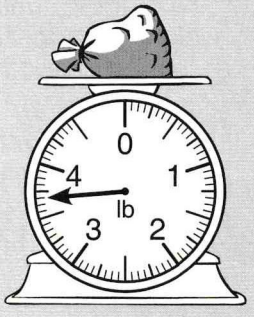
34. How many grams are there in four kilograms? **34.** _____

35. When Alex was born, he weighed 3 pounds 9 ounces. What was Alex's birth weight in ounces? **35.** _____

36. At the Academy Steak House, you can order a 50-ounce steak. It comes with a 14-ounce baked potato. How many ***pounds*** does the whole meal weigh? **36.** _____

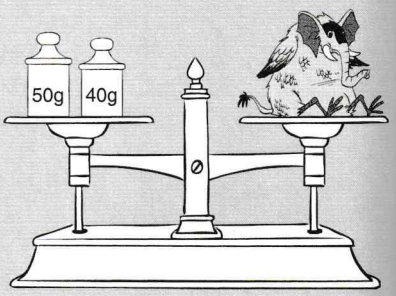
37. ★ Lizzie has five textbooks. Each book weighs 1 lb 5 oz. What is the total weight of Lizzie's books in pounds and ounces? **37.** _____lb _____oz
When a weight is given in pounds and ounces, the number of ounces must always be less than 16.

A ***spring scale*** uses a spring that is stretched or compressed. On the spring scale to the right, the weight is displayed in pounds and ounces. The numbered tick marks on the scale indicate pounds. The tick marks between the numbered tick marks indicate ounces.



The arrow on this spring scale points at the 11th tick mark past 3, so the sack on this spring scale weighs 3 lb 11 oz.

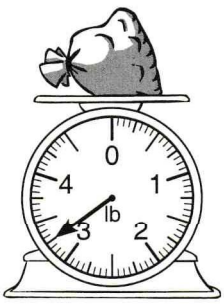
A ***balance scale*** compares weights. The object you are weighing is placed on one side of the scale. Objects of known weight are placed on the other side until the two sides are level.



When the two sides are level, we say that the scale is balanced, meaning the weight on each side is the same. The elefinch on this balance scale weighs 50+40 = 90 grams.

PRACTICE | Write the weight displayed on each scale below in the units listed.

38.



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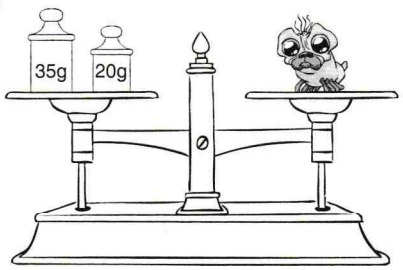
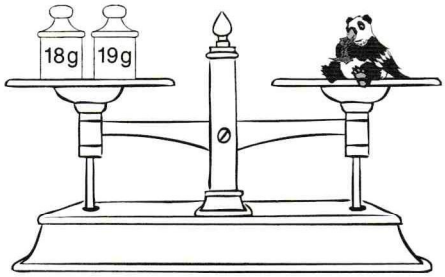


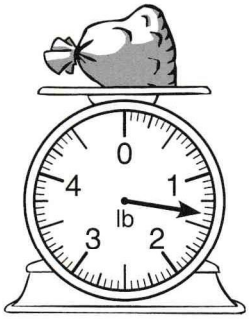
38. _____lb _____oz

39. _____g

40.



41.



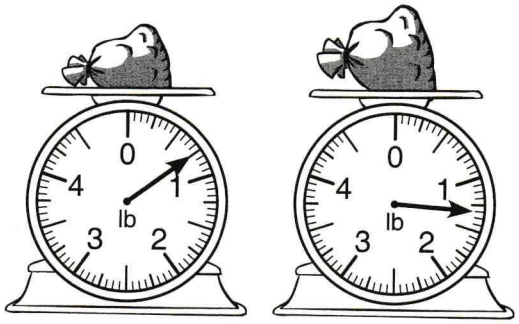
40. _____g

41. _____lb _____oz

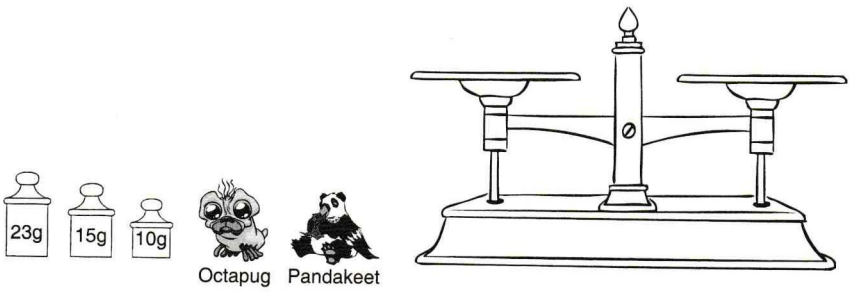
PRACTICE

42. What is the combined weight in pounds and ounces of the two sacks of coins on the scales below?

42. _____lb _____oz

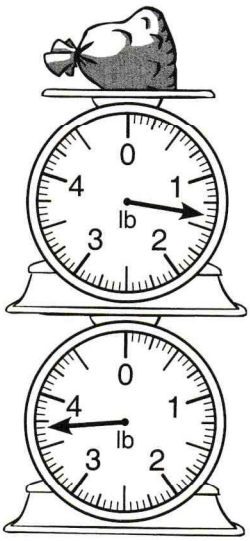


43. ★ Use your answers from the previous page for the weight of the octapug and the pandakeet. How can all five items below be placed on the scale so that the scale is balanced?

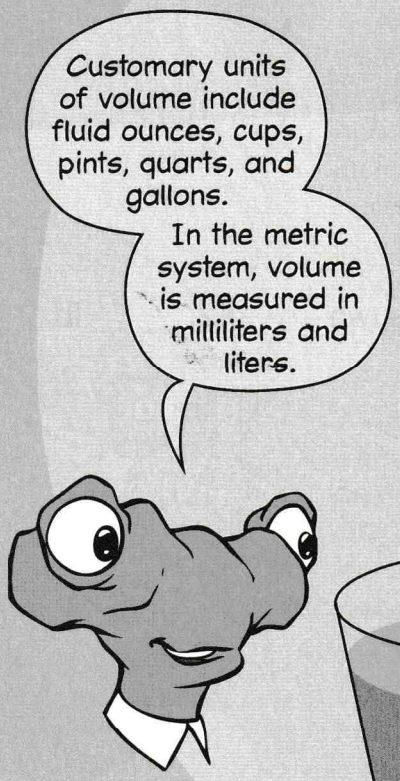


44. ★ What is the weight of one scale?

44. _____lb _____oz

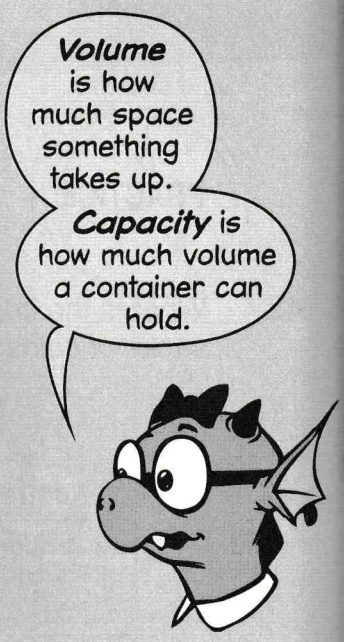


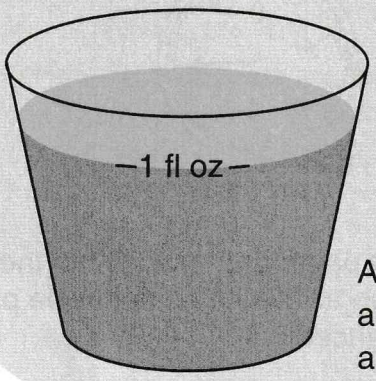
Units of Volume and Capacity

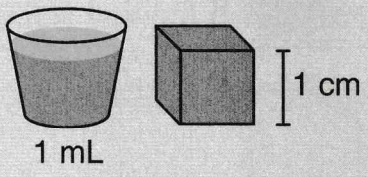


Customary Unit	Conversion
fluid ounce (fl oz)	
cup (c)	1 c = 8 fl oz
pint (pt)	1 pt = 2 c
quart (qt)	1 qt = 2 pt
gallon (gal)	1 gal = 4 qt

Metric Unit	Conversion
milliliter (mL)	
liter (L)	1 L = 1,000 mL







A milliliter is a very small amount, equal to the volume of a cube that has 1 cm edges.

PRACTICE

45. How many fluid ounces are in a pint? A quart? A gallon?

1 pt = _____ fl oz

1 qt = _____ fl oz

1 gal = _____ fl oz

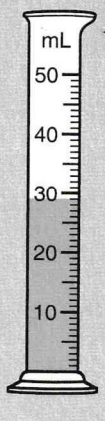
46. How many milliliters are there in two and a half liters? **46.** _____

47. How many fluid ounces are in a half-gallon plus a half-pint? **47.** _____

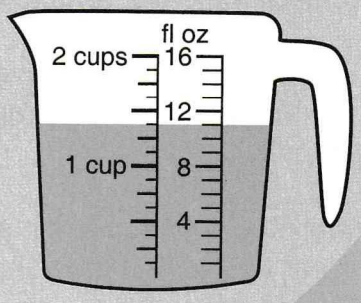
48. A glass of milk holds 10 fluid ounces. How many ***pints*** of milk will it take to fill 8 of these glasses? **48.** _____

EXAMPLE

What is the volume of water in each container below?



The graduated cylinder on the left is marked with milliliters. It contains **29 mL** of water.

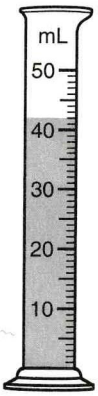


This measuring cup is marked in cups and fluid ounces. It contains **11 fl oz** of water. This can also be written as a mixed measure. Since 1 cup equals 8 ounces, 11 fluid ounces is 3 fluid ounces more than 1 cup. So, 11 oz = **1 cup 3 oz**.

PRACTICE

Write the volume of the water in each measuring cup or graduated cylinder below. Use the units listed.

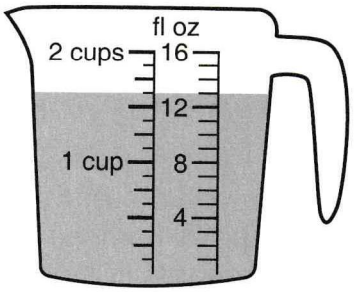
49.



_____mL

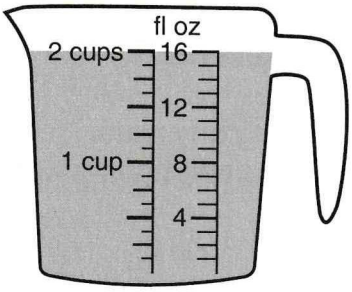
50.

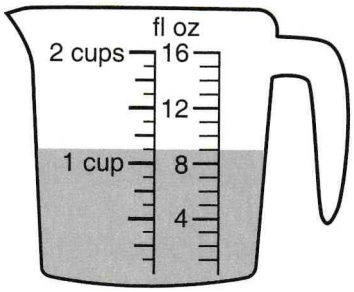
___ cup ___ fl oz

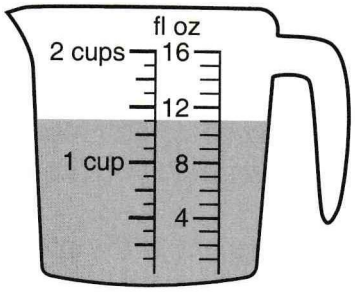


51. If the liquid in the three measuring cups below is used to fill as many 5-fluid-ounce jars as possible, how many fluid ounces of water will be left over?

51. _____







Project: Eureka!

Archimedes was a Greek mathematician who lived more than 2,000 years ago.

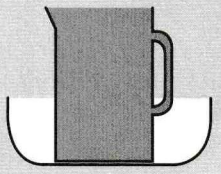
There is a famous story of one of Archimedes's earliest discoveries. Archimedes needed to find the volume of a crown. One day, while taking a bath, Archimedes noticed that as he sunk his body into the water, the water level in the tub would rise. Archimedes realized that the change in the level of the water in the tub could be used to determine the volume of an object.

Upon making this discovery, Archimedes leaped from the tub without remembering to put his clothes on and ran through the streets shouting "Eureka!" which means "I've found it!"

While no one knows for sure if the *story* is real, Archimedes's discovery gives us a great way to find the volume of an object.

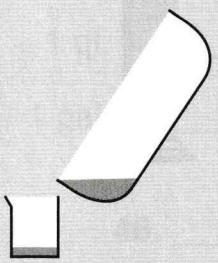
Goal: Find the volume of several objects.
You will need a measuring cup, a pitcher, a large bowl, and several objects that fit in the pitcher (examples are given below).

Step 1: Setup.
Fill a pitcher until it overflows.
Place the full pitcher inside a large empty bowl.



Step 2: Sink something.
Place a waterproof object into the pitcher so that it is completely under water. The object will cause some of the water in the pitcher to spill out into the bowl.

Step 3: Measure the volume of the spilled water.
Pour the water that spilled from the pitcher into a measuring cup or graduated cylinder. The volume of the spilled water is equal to the volume of the object!



Step 4: Try some other objects!
A coffee mug, a flip-flop, a softball, an action figure, your hand, your dad's hand, etc. Waterproof items only, please.

Step 5: Answer the following questions based on your experiments.
1. How can you measure the volume of an object that floats?
2. How could you measure the volume of an object without spilling any water?
3. How could you measure the volume of your entire body without spilling any water?

Answers are in the solutions section after Problem 51.