611-2002 (30-095) Density of Solid Cylinders Set

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Description: Use this set to determine the specific gravity of a material by graphical methods. Fifteen individual determinations of specific gravity per material can be made. These results are plotted on a graph, the slope of which is the specific gravity of the material.

Warranty and Parts:
We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear.

How to Teach with Density of Solids Cylinder Set:
Concepts Taught: Density; Specific Gravity; Buoyancy
Curriculum Fit: Grades 6-8 and up.

Additional Materials Needed:

- 1,000 mL beaker
- Balance capable of reading up to two decimal places of one gram
- Frictionless double pulley system
- Set of standard masses including 1 g and 2 g masses with weight hanger
- Stand and clamp

Experiment #1 Density of Solids – Archimedes' Principle
Procedure:

1. Fill the 1,000 mL beaker about 2/3 full with distilled water and set aside.
2. Using the balance, find the exact mass (g) of each of the four given masses per material (e.g., 1/8, 1/4, 1/2, and 1" for aluminum) and record in Table 1 below.
3. Find the mass (g) of the sturdy weight hanger and record below.
   Mass sturdy weight hanger = _____ (g)

Table 1. Actual Values of Masses in the Set of "Given" Masses

Material	Size (inches)	Size (mm)	Mass (g)
Aluminum	1/8	3	
Aluminum	1/4	6.3	
Aluminum	1/2	12.7	
Aluminum	1	25.4	
Copper	1/8	3	
Copper	1/4	6.3	
Copper	1/2	12.7	
Copper	1	25.4	
Delrin (black)	1/8	3	
Delrin (black)	1/4	6.3	
Delrin (black)	1/2	12.7	
Delrin (black)	1	25.4	
Bronze	1/8	3	
Bronze	1/4	6.3	
Bronze	1/2	12.7	
Bronze	1	25.4	
Brass	1/8	3	
Brass	1/4	6.3	
Brass	1/2	12.7	
Brass	1	25.4	
PTFE (white)	1/8	3	
PTFE (white)	1/4	6.3	
PTFE (white)	1/2	12.7	
PTFE (white)	1	25.4	
PVC (gray)	1/8	3	
PVC (gray)	1/4	6.3	
PVC (gray)	1/2	12.7	
PVC (gray)	1	25.4	
Stainless steel	1/8	3	
Stainless steel	1/4	6.3	
Stainless steel	1/2	12.7	
Stainless steel	1	25.4	

4. Photocopy Table 2 seven times. Label each copy with the appropriate material (e.g., aluminum, copper, delrin (black), bronze, brass, PTFE (white), PVC (gray) and stainless steel). You'll use the table shown below for one of the eight materials. The data for the other seven materials will be recorded on the photocopied pages.

   Values of m and m' from Experiment for _____.

   There will be a total of eight tables.

5. Place the smallest given mass per material (e.g., 1/8" aluminum) on the sturdy weight hanger and find its total mass using the balance. Record this value in Table 2 in the column for m.

   Table 2. Values of m and m' from Experiment for _____

Mass Selection	m (g)	m' (g)	Mass Selection	m (g)	m' (g)
mass #1 (1/8")			mass # 2 + 4 (1/4" + 1")		
mass #2 (1/4")			mass # 3 + 4 (1/2" + 1")		
mass #3 (1/2")			mass # 1 + 2 + 3 (1/8" + 1/4" + 1/2")		
mass #4 (1")			mass # 1 + 2 + 4 (1/8" + 1/4" + 1")		
mass # 1 + 2 (1/8" + 1/4")			mass # 1 + 3 + 4 (1/8" + 1/2" + 1")		
mass # 1 + 3 (1/8" + 1/2")			mass # 2 + 3 + 4 (1/4" + 1/2" + 1")		
mass # 1 + 4 (1/8" + 1")			mass # 1 + 2 + 3 + 4 (1/8" + 1/4" + 1/2" + 1")		
mass # 2 + 3 (1/4" + 1/2")					

6. Attach the mass from step 5. to one side of the frictionless double pulley system and let it sink in the water in the beaker. It should sit on the bottom of the beaker. The cord will pass over the two pulleys.
7. Attach the standard mass holder to the other end of the cord and place enough standard masses on the weight pan such that the mass in the beaker is just about lifted from the bottom of the beaker. The mass in the beaker should not fall back to the bottom nor continue to rise.

   Note: The smallest available standard mass is a one gram mass. If you find that adding a one gram mass to the weight pan causes the mass in the beaker to rise up, while not adding the mass to the weight pan causes the mass in the beaker to sink, then it means that you need a fractional mass (e.g., 1/2 gram). In the absence of such masses, we shall approximate the correct mass to be half way between the two masses. For example, if 20 g causes the given mass to move downward and 21 g causes it to move upward, then the correct mass will be approximated to 20.5 g. This value should be recorded in Table 2.

8. Disconnect the "standard mass and weight pan" assembly from the cord and find its mass using the balance. This is the m' value. Record in Table 2.
9. Place mass #2 on the sturdy weight hanger. Repeat steps 5, 6 and 7.
10. Continue with the rest of the masses and their combinations as shown in Table 2.
11. When all the trials have been completed, be sure to wipe the masses dry. Dispose of the distilled water and disassemble the double pulley apparatus.
12. Calculations and Graph
    a. From Table 2, plot m' values on the y-axis and m values on the x-axis. You'll have a total of eight different graphs (i.e., one for each material).
    b. Draw a best fit straight line using a computer (if available).
    c. Find the slope of the best fit straight line. If the graph is plotted on a computer, the computer will print the slope. Make sure it is given with at least four significant decimal places.
    d. Using the equation shown below, solve for the specific gravity (SG) of each material.

$$\text{slope} = 1 - \frac{1}{SGsolid}$$

SG_{solid} = specific gravity of material

13. Record values for SG of each material in Table 3 below.

Table 3. Specific Gravity

Material	Specific Gravity (SG)
Aluminum	
Copper	
Delrin (black)	
Bronze	
Brass	
PTFE (white)	
PVC (gray)	
Stainless steel	

14. Write your conclusions from the experiment (i.e., which material has the largest SG and which has the smallest) and as a class discuss the results.

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