45 Eureka!

Purpose

To explore the displacement method of finding volumes of irregularly shaped objects and to relate their masses to their volumes.

Required Equipment/Supplies

two 35-mm film canisters (prepared by the teacher): one of which is filled with lead shot, and the other with a bolt just large enough to cause the canister to sink when placed in water
triple-beam balance
string
graduated cylinder
water
masking tape
5 steel bolts of different size
irregularly shaped piece of scrap iron
1000-mL beaker

Activity

Discussion

The volume of a block is easy to compute. Simply measure its length, width, and height. Then, multiply length times width times height. But how would you go about computing the volume of an irregularly shaped object such as a bolt or rock? One way is by the displacement method. Submerge the object in water, and measure the volume of water displaced, or moved elsewhere. This volume is also the volume of the object. Go two steps further and (1) measure the mass of the object; (2) divide the mass by the volume. The result is an important property of the object—its *density*.

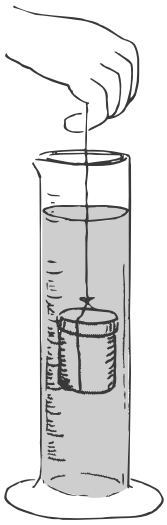

Fig. A

Part A

Procedure

Find the mass of each canister.

Step 1: Your teacher has prepared two film canisters for you. Each canister should have a piece of string attached to it. Use a triple-beam balance to find the mass of each one.

mass of lighter canister = _____

mass of heavier canister = _____

Observe rise in water level.

Step 2: Place a strip of masking tape vertically at the water level of a graduated cylinder about 2/3 full of water. Mark the water level on the tape. Submerge the lighter canister in the water, as shown in Figure A. Observe the rise in water level. Mark the new water level on the tape. Remove the canister.

Predict rise in water level.

Step 3: Predict what you think the rise in the water level for the heavier canister will be when it is submerged. Do you think it will be less than, the same as, or greater than the rise in water level for the lighter canister?

prediction: _____

Observe rise in water level.

Step 4: Test your prediction by submerging the heavier canister. Write down your findings.

findings: _____

Analysis

1. How do the amounts of water displaced by each canister compare?

_____

_____

_____

2. Does the amount of water displaced by a submerged canister depend on the mass of the canister? On the volume of the canister?

_____

_____

Part B

Procedure

Measure mass and volume of bolts.

Step 5: Measure the masses of five different-sized bolts and then measure their volumes using the displacement method. Record your data in Data Table A.

BOLT NUMBER	MASS (g)	VOLUME (mL)	_____ (g/mL OR g/cm³)
1			
2			
3			
4			
5			

Data Table A

Step 6: For each bolt, divide its mass by its volume and enter the results in the last column of Data Table A.

Analysis

3. How do the ratios of mass to volume compare for each of the bolts?

4. Would you expect the ratio of mass to volume to be the same for bolts of different metals?

5. What name is given to the ratio of mass to volume? (Fill this name in at the top of the last column in Data Table A.)

Part C

Going Further

Pretend that you are living in ancient Greece during the time of Archimedes. The king has commissioned a new crown to be made of pure gold. The king is worried that the goldsmith may have cheated him by replacing some of the gold with less precious metals. You are asked to devise a way to tell, without damaging the crown, whether the king was cheated or not.

Unfortunately, your school cannot supply you with an actual gold crown for this activity. A less valuable piece of scrap iron will simulate the crown.

Write down your procedure and any measurements you make.