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# Standard Procedure SP 0011-1:2005

## Methods of determining the density of materials - Part 1: Determining the density of regular-shaped objects

### 1 Scope

This procedure is adapted from BS EN ISO 845:1995 Cellular plastics and rubbers – Determination of apparent density.

It can be used to determine the real density of any non-porous, regular-shaped object, or the apparent density of any hollow or porous, regular-shaped object.

### 2 Definitions

#### *density*

the mass per unit volume of a uniform material

#### *apparent density*

the overall density of a hollow or porous object. It is calculated from the total mass of the object, including trapped air or gases, divided by the total volume determined from its external dimensions.

### 3 Principle

The object is weighed to determine its mass, and its dimensions measured to calculate its volume, using the appropriate formula. Dividing the mass by the volume gives the density of the object.

### 4 Apparatus

- balance that can measure mass to the nearest 0.01 g
- ruler with millimetre graduations

### 5 Test Specimens

The test specimens must have a regular shape. The procedure below gives formulae for cuboids (rectangular blocks) and cylinders. However, any regular-shaped object may be used, provided you know a formula to calculate its volume from its dimensions.

Test specimens should be as large as possible, but small enough to fit on your chosen balance.

At least three specimens of each material should be tested.

### 6 Procedure

- Place the test specimen in the centre of the balance pan. Record its mass to the nearest 0.01 g.
- Measure the test specimen's dimensions, in centimetres to the nearest 0.1 cm.
  - (a) If it is cuboid, measure its height, width and length.
  - (b) If it is cylindrical, measure its length and diameter. Halve the diameter to calculate the radius.
  - (c) For other regular shapes, measure the dimensions needed for the formula you are using to calculate the volume.

### 7 Expression of Results

Calculate the volume  $V$  of the specimen in cubic centimetres ( $\text{cm}^3$ ).

#### **For a cuboid use the formula:**

$$V = h \times w \times l$$

where

$h$ ,  $w$  and  $l$  are the height, width and length, in centimetres

#### **For a cylinder use the formula:**

$$V = \pi \times r^2 \times l$$

where

$\pi$  is 3.1416

$r$  is the radius of the cross-section, in centimetres

$l$  is the length of the cylinder, in centimetres

**Calculate the density  $\rho$  of the specimen in grams per cubic centimetre ( $\text{g cm}^{-3}$ ) using the formula:**

$$\rho = m/V$$

where

$m$  is the mass, in grams

$V$  is the volume in cubic centimetres

Note:

- Density in kilograms per cubic metre ( $\text{kg m}^{-3}$ ) = 1000 x density in grams per cubic centimetre ( $\text{g cm}^{-3}$ )
- $\rho$  is the Greek letter rho, pronounced “roh”.

## 8 Test Report

Your test report should include:

- (a) reference to this standard procedure;
- (b) the density of each test specimen in both  $\text{g cm}^{-3}$  and  $\text{kg m}^{-3}$ ;
- (c) the average density of each material (calculated by adding the densities of all test specimens of that material and dividing the total by the number of specimens of that material tested);
- (d) whether the real or apparent density was determined.