Experiment 1a. Density

It may look small but it is massive because of its density.

Objective:

To determine the density of an irregular solid.

Apparatus:

An irregular solid, a balance, a graduated cylinder.

Theory:

$$\text{Density, } \rho = \frac{\text{mass}}{\text{volume}}$$

Procedure:

1. Find the least count of the balance. The least count of an instrument is the smallest value of the physical quantity that can be accurately measured with that instrument. For example, on a meter stick, one centimeter is divided into ten equal parts (millimeters). Thus the least count of a meter stick is 0.1 cm.
2. Take two readings of the mass of the solid.
3. Find the least count of the graduated cylinder.
4. Pour some water into the graduated cylinder and take the reading of the water level. Remember that the lowest point of the meniscus is read if the meniscus is concave.
5. Gently lower the irregular solid by means of the thread into the graduated cylinder and read the position of the water level again.
6. Take one more set of readings by changing the quantity of water in the graduated cylinder.

Use cgs units in this experiment.

The cgs unit of volume is cubic cm (cm^3). 1 mL (milliliter) = 1 cm^3.

Record the observations with appropriate units.

Experiment 1b. Scattering

Ever wondered how the 'size' of an atom is estimated!

Objective:

To determine the diameter of a marble by scattering method.

Apparatus:

Two wooden boards (one with nails), marbles, a meter stick.

Theory:

Let a marble A (Fig. 1) of radius r approach another marble T of the same radius. The marble A will hit the marble T if the path of its center lies between the points G and H. It is evident from the figure that GH = 4r = 2D, where D is the diameter of each marble. Thus each target marble presents a 'collision cross-section' of 2D. Now if n marbles are arranged on the target board J, the total collision cross-section presented by n target marbles is 2Dn. Further, if w is the width of the target board, then the probability of a collision is given by

$$P = \frac{2Dn}{w}. \qquad (1)$$

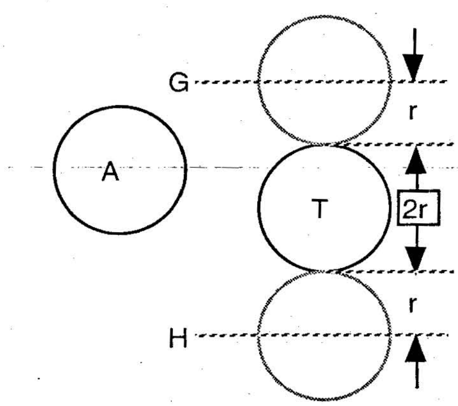

Fig. 1

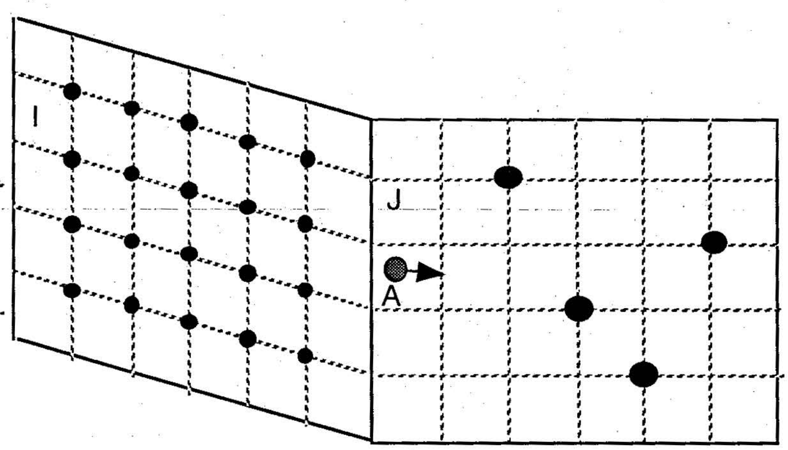

Fig. 2

To determine the collision probability, a number of target marbles are arranged on the target plane J (Fig. 2) such that no two marbles are on the same line. A marble A is rolled down a number of times from different points near the top of the inclined plane I. The inclined plane has a number of nails to randomize the motion of the marble being rolled down. If the marble A hits any target marble, the trial is counted as one with a hit. Now if s is the total number of trials and h is the number of trials with a hit, then the collision probability is given by

$$P = \frac{h}{s}. \qquad (2)$$

By equating the right hand sides of Eqs. (1) and (2), we get

$$\frac{2Dn}{w} = \frac{h}{s}.$$

$$\text{Or } D = \frac{hw}{2sn} \qquad (3)$$

Procedure:

1. Arrange 8 target marbles on the target board. Marbles should be placed at the points of intersections of the lines on the board. No two marbles should be placed on the same line on the board.
2. Let a marble roll down the plane I. If this marble hits one or more target marbles, count this trial as one with a hit. Repeat the procedure 100 times, releasing the marble from different points at the top of the inclined plane I.
3. Measure the width (w) of the target board.
4. Measure the length of a string of 10 marbles, arranged in a straight line along a meter stick and thus find the diameter of a single marble.
5. This procedure is followed by each team of 2 students of the class. The data of all the teams is accumulated and used by each student.

Use cgs units in this experiment.

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Record the observations with appropriate units.

Experiment 1b. Scattering

Ever wondered how the 'size' of an atom is estimated!

Objective:

To determine the diameter of a marble by scattering method.

Apparatus:

Two wooden boards (one with nails), marbles, a meter stick.

Theory:

Let a marble A (Fig. 1) of radius r approach another marble T of the same radius. The marble A will hit the marble T if the path of its center lies between the points G and H. It is evident from the figure that GH = 4r = 2D, where D is the diameter of each marble. Thus each target marble presents a 'collision cross-section' of 2D. Now if n marbles are arranged on the target board J, the total collision cross-section presented by n target marbles is 2Dn. Further, if w is the width of the target board, then the probability of a collision is given by

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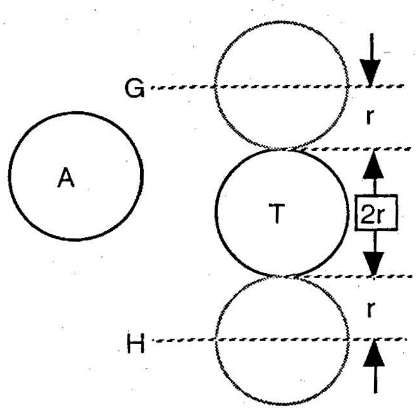
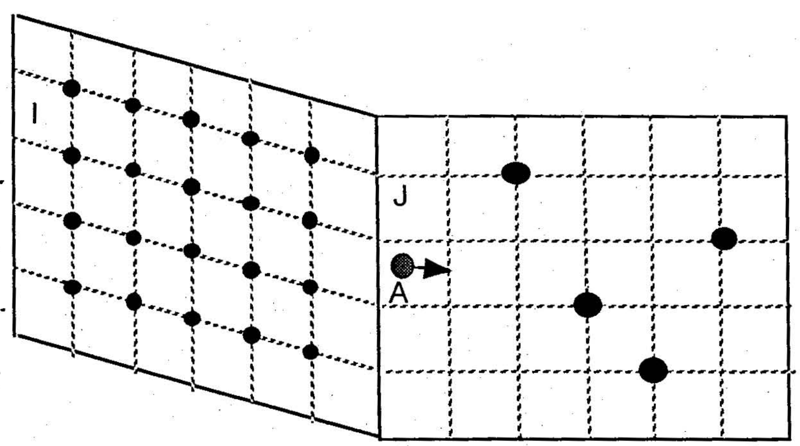


Fig. 1



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Use cgs units in this experiment.

Experiment No. 1

Name:	Marks:
Partner:	Remarks:
Section:	
Date Submitted:	

Title:

Objective:

Theory/Formulas:

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Data Sheet

a. Determination of the density of an irregular solid:

Least count of the balance =

Mass of the irregular solid:

Reading 1 =

Reading 2 =

Least count of the graduated cylinder =

No.	Initial reading of water level	Final reading of water level	Volume

Calculations:

Average mass of the solid =

Average volume of the solid =

$$\text{Density of the solid} = \frac{\text{Mass}}{\text{Volume}} =$$

Standard value of the density of the solid =

Percent error in the experimental value of density =

Probable errors:

Probable error in the mass of the solid = least count of the balance =

Probable error in the volume of the solid

= least count of the graduated cylinder[1] =

Probable percent error in the mass of the solid =

Probable percent error in the volume of the solid =

Probable percent error in the density of the solid

= probable percent error in mass + probable percent error in volume

=

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1 In fact, the probable error in volume = sum of the probable errors in the initial and final readings of water level.

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b. Determination of diameter of a marble:

Width of the board, w = ; Number of target marbles, n =

Team No.	1	2	3	4	5	6	7	8	9	10
No. of trials with hits										
Total No. of trials										

Length of the string of 10 marbles, L =

Calculations:

Total number of trials for all the teams, s =

Total number of trials for all the teams with hits, h =

$$D = \frac{hw}{2sn}$$

Total number of trials for team numbers 3 and 6, s_1 =

Total number of trials for team numbers 3 and 6 with hits, h_1 =

$$D_1 = \frac{h_1 w}{2s_1 n}$$

Diameter of one marble (from direct measurement), $D_t = \frac{L}{10} =$

Taking D_t as the standard value,

Percent error in D =

Percent error in D_1 =

Questions

1. What is the main source of error in the determination of density?

2. Do the results by using a larger sample demonstrate the advantage of having a larger sample in the scattering experiment? Explain.