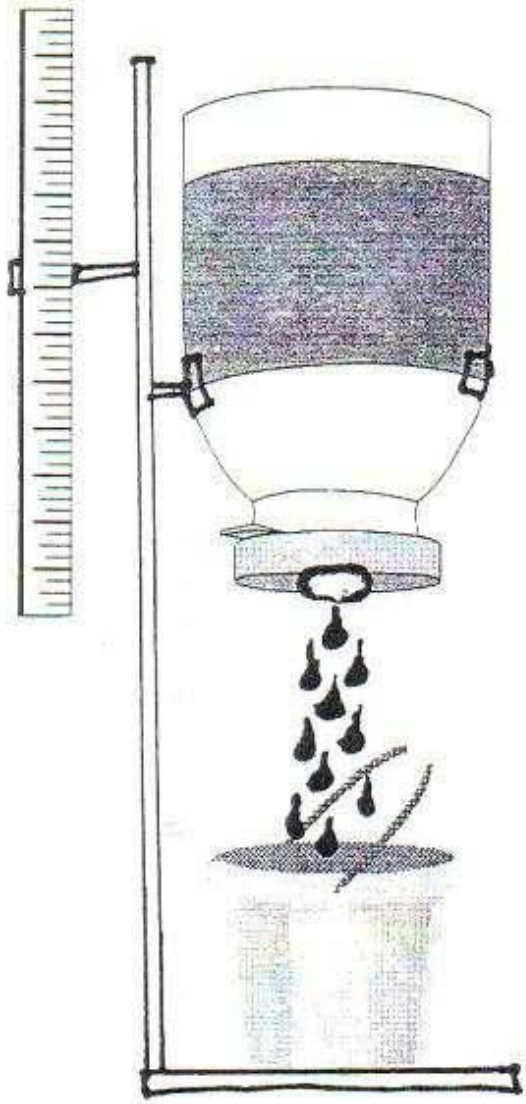
ANALYSIS OF AN EXPERIMENT



PHYSICS Experiment

Analysis of an Experiment Lab

The presentation and analysis of experimental results is an essential part of physics. In Table 1 are the results of an experiment. You are asked to present and analyze these results in a form which will enable you to predict the outcome of similar experiments.

The experiment was an investigation of the time it takes water to pour out of a can through a hole in the bottle. As you would expect, this time depends on the size of the hole and the amount of water in the can.

To find the dependence on the size of the hole, four large cylindrical containers of water of the same size were emptied through relatively small circular openings of different diameters. To find the dependence on the amount of water, the same containers were filled to different heights.

Each measurement was repeated several time, and the averages of the times (in seconds) that each container took to empty have been entered in the table. A stop watch operated by a human hand cannot be trusted to measure less than a tenth of a second. The last digit in each time entry in the table may be in error by one unit either way. Therefore, the relative (or fractional) error is large for shorter times than for longer times.

Table 1 Times to Empty (s)

Diameter of hole(cm)	Height of Water (cm)				
	30	10	4	1	
1.5	73	43.5	26.7	13.5	Times to empty (s)
2	41.2	23.7	15	7.2	
3	18.4	10.5	6.8	3.7	
5	6.8	3.9	2.2	1.5	

All the information we shall use in the table, but a graphical presentation will enable us to make predictions and will greatly facilitate the discovery of mathematical relationships.

First, plot the time versus the area of the opening ($A_{circle} = \pi r^2$) for a constant height, say 30.0 cm. From the graph shape, determine the algebraic relationship between the time and area of the hole. This will involve transforming the data and plotting it and obtaining the linear trend line. What do you find? Was you conjecture right? Use the trend-line equation to express the functional relationship between time and diameter.

Next we would like to know if this relationship holds for the other heights tested. On the same graph plot the other height data sets. What do you observe? On the basis of your data, what can you say about the functional relationship between time and diameter?

Now investigate the dependence of time on height when the diameter of the opening stays fixed. Take the case of d = 1.5 cm, which is the first row. Make a plot in which height is the independent variable. Is this a linear relationship? If not, transform the data so that you take the square root of the height of water.

Using the information you have gained relating time diameter and height of the water, find a single expression for time of flow as a function of both height and diameter. Calculate time for a height of 20.0 cm with a diameter of 4.00 cm. How does this time compare with you graph? Which do you think is more reliable?