

Mass, Volume, Density

Mass-

Although mass and weight are not the same, most scales on Earth have been calibrated so that they take the effects of Earth's gravity into account. This means that you are actually measuring mass, not weight, on the scale.

Measure the mass of a penny as accurately as possible. What is its mass?

Do you think that all pennies have the same mass?

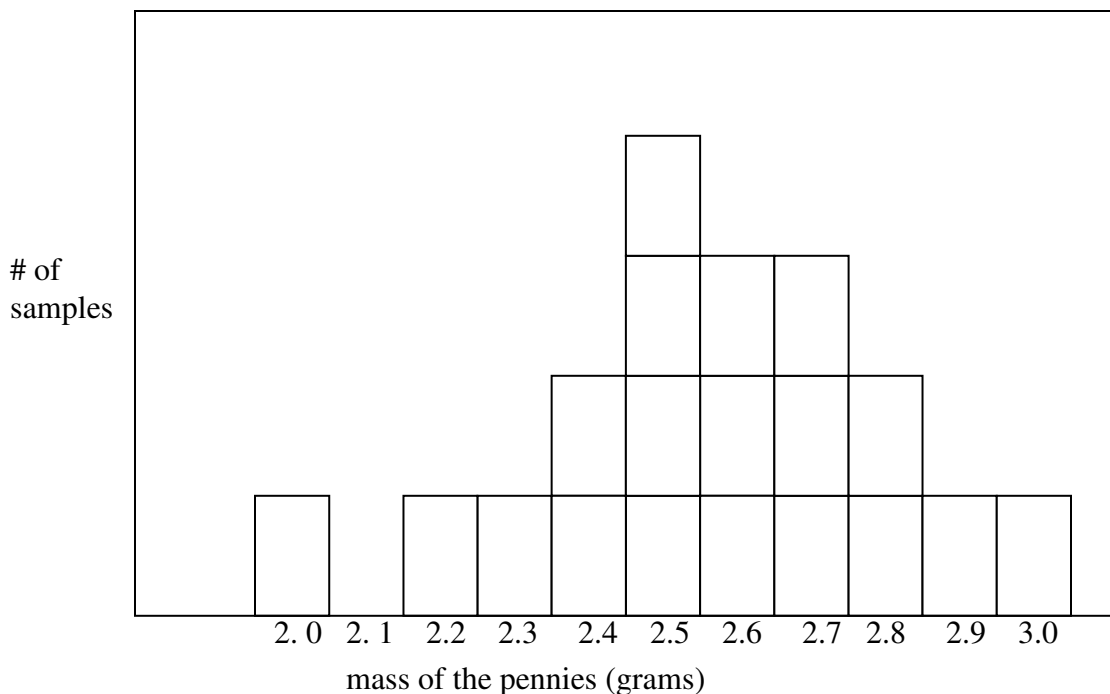
You can test your hypothesis by measuring the mass of many different pennies. Measure the mass of each of the 25 pennies you are given, and record your data on the table below.

Sample #	mass (grams)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	

Are all of the masses the same? Does this support your hypothesis?
Assuming that your pennies were not all identical in weight, how would you describe the variation within your penny population?

This type of descriptive challenge is common in science – trying to describe the variation within a population. You have seen how difficult it can be to describe in words. An easier, and more accurate way of depicting the variation is to show the data in a graph. When you only have one variable (mass, in this case), the most common type of graph is a histogram.

Construct a histogram of your data plotting vertical bars showing the number of samples with a given mass (shown on your horizontal axis.) Be careful to use consistent spacing on both the vertical and horizontal scale – you don't get to leave out a value just because no individual penny measured at that mass! (example of 2.1 grams below)



As you can see, the graph gives good visual representation of your data. However, it is often not convenient or possible to include a graph when discussing data.

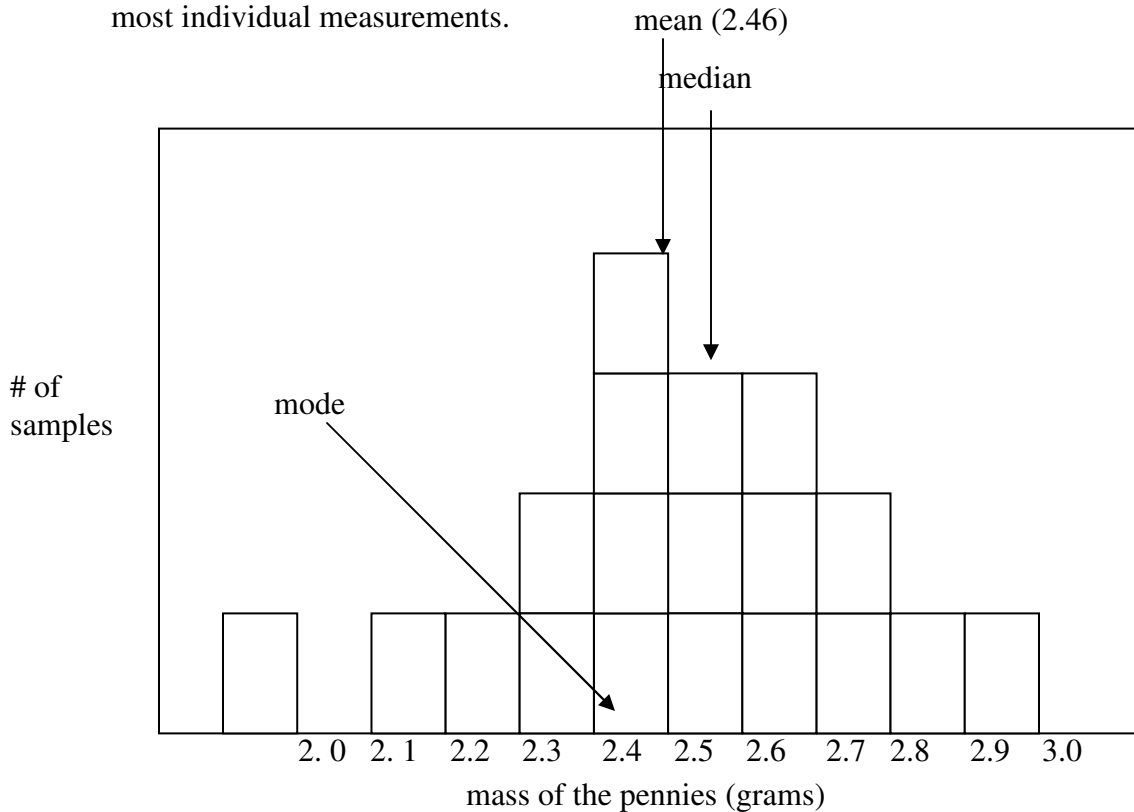
Fortunately, scientists (and statisticians) have devised a few common ways of describing variation within a population. You have probably heard some of these terms used in news reports. We will calculate three of the most common of them: mean, median and mode.

mean- this is basically the same thing as the “average”. It is calculated by adding all of the individual values and then dividing by the number of samples.

$$\text{mean} = \frac{\sum \text{masses}}{\# \text{ of samples}}$$

median – this is the ‘middle’ value. There are an equal number of measurements larger than this value and an equal number of measurements smaller than this value. It is calculated by dividing the total number of samples by 2 and counting up (or down) to find the sample in that position.

mode – the most common value. You just have to figure out which value has the most individual measurements.



These 3 values work well for the type of “normal” distribution shown above where all of the data are clustered around a central, most common value. They do not as accurately describe widely dispersed or asymmetrical data.

Why do you think that many economists talk about median family income rather than mean family income?

Plot your penny data on a histogram and calculate the mean, median, and mode for your data. (show your work) Do these numbers adequately describe your data?

What is the volume of a penny? It is harder to measure the volume of something very small like a penny. Try using the technique from above. Did it work well?

Could you accurately measure the amount of water displacement?

If not, how could you alter your measuring technique to determine the mean volume of a penny?

What is the mean volume of a penny?

(hint – try measuring them all at once)

Density-

Density describes the ‘heaviness’ of an object; whether an object is heavier than expected for its size (high density) or lighter than expected (low density).

Of the 3 samples you measured above, which do you think will have the highest density?

Which do you think will have the lowest density?

Once you know the mass of an object and its volume, the density is easy to calculate.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Density is usually written as gm/cm^3
(1 ml = 1 cm^3)

Calculate the density of your 3 samples, using the mean volume value calculated on the previous page.

Sample	Volume	Mass	Density