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"The Millikan Experiment" - a laboratory exercise.

PROBLEM - In 1909, Robert Millikan, using new apparatus and $q^{+} = m\ g\ d/V$, attempted to measure the charge of an electron. Is electric charge quantized, that is, is there a certain minimum value or quantum of electric charge? Is there one quantum (one value) for each electron? He sprayed oil droplets from a nozzle and found that they had different amounts of + charge. He assumed that the different amounts of + charge on the different droplets resulted from different numbers of electrons being scraped off while passing through the nozzle. If he measured the different amounts of + charge on a large number of droplets, he thought he might discover a pattern that would reveal a simple relationship between charge and the number of electrons scraped off. When reduced to its simplest form, the relationship would reveal the charge on a single electron and show all other charges as simple multiples (1,2,3...) of the minimum value. Electric charge would be quantized. Millikan tried to measure very small amounts of charge to narrow his study down to the minimum value that he sought. The very difficult process took seven years to gather enough data to reach his final, correct conclusions.

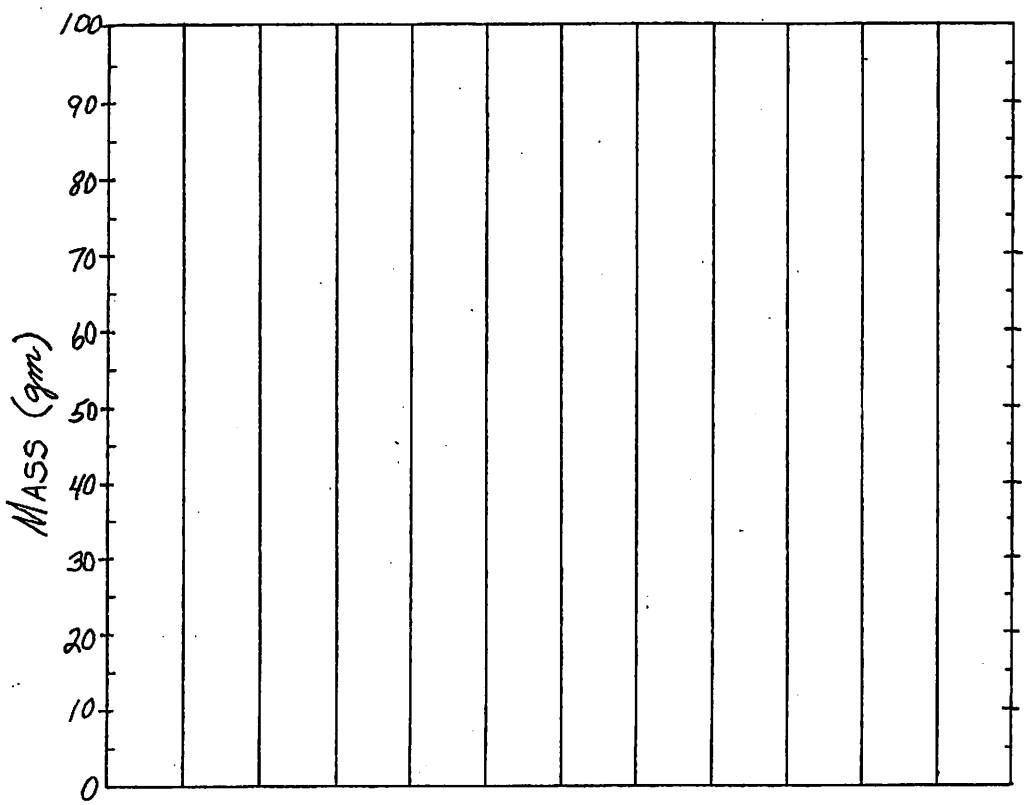
We can simulate his thinking and discovery with a mechanical analogy. We will attempt to find a "quantum" (minimum value) of mass much as he attempted to find a "quantum" (minimum value) of electric charge.

MATERIALS - 35-mm film cans, "stuff", triple-beam balance

PROCEDURE - (a) Carefully measure the mass of each can and record in the table. (b) Plot the data, in ascending order, as a histogram. (c) Study the histogram and its plateaus and determine the "quantum" (minimum value) of mass in this exercise. (d) How many "quantums" (+ charges?) exist in each can? Label the histogram with parentheses. (e) If the can's mass is a little greater than one "quantum", how many "quantums" really exist in each can? Label histogram. (f) Open a can and check.

OBSERVATIONS - data table and histogram

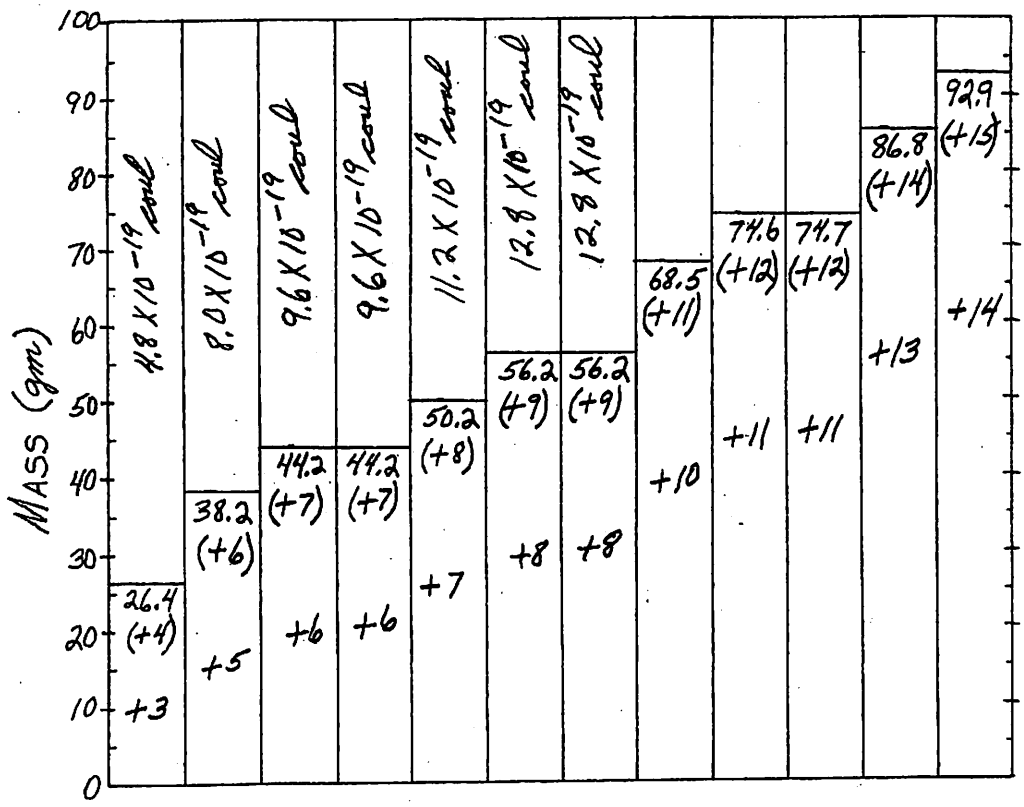
Can #	Mass (gm)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	



CONCLUSIONS -

Here is a sample or example using actual data from prepared cans of washers.

Can #	Mass (gm)
1	56.2
2	44.2
3	68.5
4	56.2
5	26.4
6	38.2
7	92.9
8	74.6
9	50.2
10	44.2
11	86.8
12	74.7



CONCLUSIONS - can = 7.1 gm

6.0 gm/washer

5 lb box of 3/8" washers