Student Workbook $.30

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HUNTINGTON II Simulation Program — CHARGE

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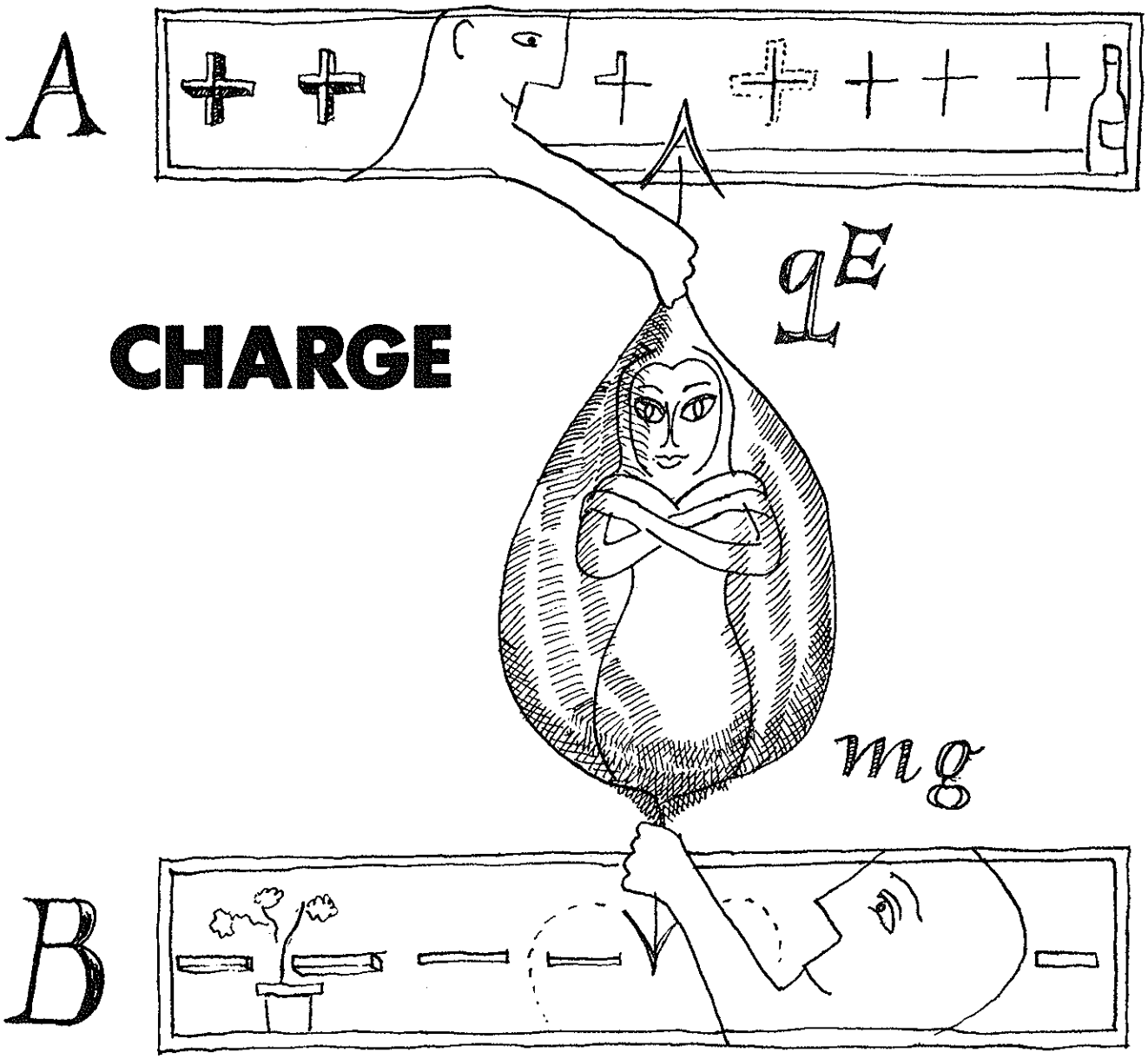


STUDENT WORKBOOK

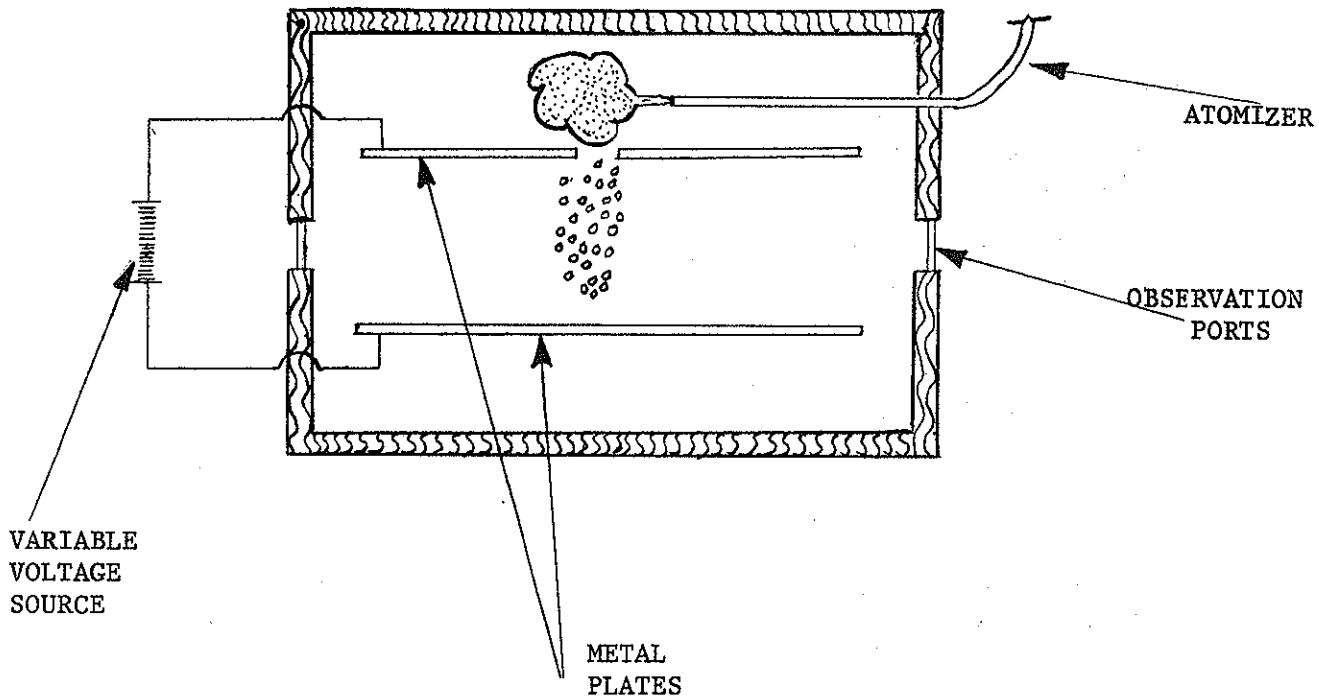
HUNTINGTON TWO COMPUTER PROJECT

1 September 1971

The work of the Huntington Two Computer Project is partially supported by the National Science Foundation, Grant GW-5883.

CHARGE

CHARGE is a simulation of an actual experiment that can be done in the laboratory to determine the charge on an electron. The apparatus looks like this:



Two parallel metal plates are connected to a variable voltage source and placed in a box to protect them from air currents. The upper plate has a hole in its center. Tiny latex spheres suspended in water are sprayed from an atomizer above the hole. The water quickly evaporates and a few of the spheres drift down through the hole into the region between the two plates. A light source illuminates the inside of the box so that the spheres can be seen from outside the box with a telescope placed at the glass window. During the spraying, many of the spheres become charged through friction. When a voltage is applied across the plates, the resulting electric field pulls some of the charged spheres upward. If the voltage is properly adjusted, the weight of one of the latex spheres can be balanced by the upward electric force, causing the sphere to be held stationary in the air. When the sphere is stopped, the only forces acting on it are the downward gravitational force $-mg$ and the upward electric force cE. (m is the mass of the sphere, g is the acceleration of gravity, c is the charge on the sphere, and E is the electric field between the plates.) Since the sphere is obviously not accelerating, the total force must be zero, or

$$mg = cE$$

In this experiment, everything in this equation is known except c, so that c can be calculated from

$$c = mg/E \ .$$

Luckily, most of the spheres pick up only a few units of charge, so that c is usually a small integer times the basic unit of charge, the charge on a single electron. By measuring the charge on several spheres, stopping them one at a time, the basic unit of charge can be calculated from the difference between the charges on individual spheres.

At the beginning of each run, the computer calculates and prints out the velocities of four latex spheres that are drifting downward at their terminal velocities in the absence of an electric field (V=0). (A negative velocity indicates a sphere moving downward.) A voltage can be applied to the plates by typing in a number between +1000 and -1000. A positive voltage exerts an upward force on a negatively charged sphere (the most popular kind). The computer will then calculate and print the velocity of the four spheres under the combined force due to gravity and the voltage on the plates. The voltage can be adjusted until one of the four spheres is stopped.

When one of the spheres is stopped, the charge on that sphere can be calculated by multiplying the mass of the sphere by the acceleration of gravity and dividing by the electric field that just stopped the sphere:

$$c = mg/E \ .$$

(If V is the voltage across the plates and they are separated by a distance D, the electric field E is E=V/D.) Since it is eager to help, the computer, if asked, will do this calculation for you.

Measure enough spheres so that you have a variety of charges and use these charges to find the value of the smallest unit of charge that can land on or leave one of the tiny spheres.

Summary of Computer Instruction

In CHARGE the computer will request a new voltage or an option change by printing our " V = X? ", where X is the old voltage. After the question mark, you may either type in a new voltage between -1000 and +1000 volts, type in the old voltage again, or enter one of the following code numbers for an option to be performed.

2000 - to request calculation of charge for a drop with velocity = 0

3000 - to request a new batch of drops

4000 - to end the program.

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