PHSX 222L **Millikan Oil Drop** **Name:**_____

Object: 1) Repeat Millikan's famous oil drop experiment to determine the charge e on the electron (and that it is quantized). 2) Find out how hard physics experiments can be.

Theory: Millikan's oil drop experiment is one of the classic physics experiments of the past century; it is also one of the hardest to duplicate in a student laboratory. For his work on this and the photoelectric effect Millikan received the Nobel prize in 1923 (though his graduate student, Harvey Fletcher, deserves more of the credit than is widely known).

Small drops of oil are injected into the space between two horizonal metal plates. They normally begin to fall due to gravity, but if a potential difference is applied to the plates the electric field can exert a force on the drops if they carry a net charge; by controlling the voltage between the plates the experimenter can make the drops move up or down and control their speed.

For example, if the voltage is adjusted to bring the drop of mass m and charge q to rest (so the electrical force just balances the gravitational force), then

$$F_g = F_e \quad (1)$$

$$mg = (V/d)q \quad (2)$$

where d is the distance between the plates and V is the potential difference between them. Then we can solve for q in terms of quantities that can be ascertained:

$$q = mgd/V. \quad (3)$$

Of course Millikan and Fletcher did not know the mass of their oil drops beforehand, so some figuring using Stokes' Law was necessary.

Pre-lab: Before you come to lab, watch *The Mechanical Universe* video (episode 12) about the Millikan Oil Drop experiment and read the accompanying section from *The Mechanical Universe* textbook. Also read the *Physics Today* article entitled "My Work with Millikan on the Oil-Drop Experiment" by Harvey Fletcher. The readings can be found on the class website.

Procedure:

1. Run the experiment as a computer simulation on a DOS computer. See the instructions that came with the software. The software has three versions of the experiment ranging from simple to hard (the hard version is almost as hard as the real original experiment). You will have time for only one version. Take and analyze data as if it were real data, and compute e, the charge on the electron. Use a spreadsheet to tabulate and analyze your data. Compare your value of e with the accepted value of $e = 1.602177 \times 10^{-19}$ C. Especially note the quantization of your data (by plotting it in a histogram).

2. Try the experiment on the real apparatus. At least try to see the oil drops (they are extremely small points of light).