Motivation:
Bohr’s theory of the atom was in part based on the fact that the emission spectrum of atoms is discrete. It was also known that atomic vapors absorbed radiation only at discrete wave lengths. In 1914, Franck and Hertz observed that the transfer of energy to atoms by inelastic electron scattering exhibits a discrete spectrum provided that the atom is not ionized.

References:
- *Experiments in Modern Physics*, by Melissinos pp. 8-18

Procedure
Using the circuit diagram on the next page as a guide connect wires from the Franck-Hertz control apparatus to the Franck-Hertz oven/tube assembly and the Pasco interface box.

Tips and Precautions:
1. Before plugging in the oven, insert the thermometer into the hole at the top of the oven. The “immersion line” should be about 1 cm inside the oven.
2. Set the thermostat control on the side of the oven at “4” before plugging in the oven. You will have to raise it after the heater cycles off but, if you start it higher, the temperature may overshoot to an unsafe level. The first time the heater shuts off, you can start increasing the thermostat setting while watching the thermometer closely. Continuing adjusting until the temperature is centered at about 180°C (it will probably cycle plus and minus 5° or so around this temperature.) The required thermostat setting is approximately 6\(\frac{1}{2}\).
3. NEVER ALLOW THE TEMPERATURE TO EXCEED 195°C.
4. The actual accelerating voltage (between the cathode and the screen electrode) appears at the “Monitor” terminals. You can measure this voltage with a digital voltmeter (with both sides floating from ground) to calibrate the X-axis on the recorder or plots from the Pasco interface system. The voltage at the recorder output comes from a differential amplifier so that it can be referenced to ground. It is about \(\frac{5}{70}\) of the actual accelerating potential.

In your lab book you should:
1. Provide a sketch of the Franck-Hertz tube and a circuit diagram for this experiment. The diagram in this handout may be included in your data book.
2. Obtain several sets of data (graphs) using the Pasco software. Independently, compute a mean of the voltage difference between the peaks (excitation curve). The instructor will discuss several methods of obtaining the peak positions.
3. Once you obtain curve using the built in ammeter you should then perform the same measurement using the Keithley 610 electrometers which provide much better sensitivity. The output plugs are located on the back of the instrument.

4. For some intermediate value of the acceleration voltage, plot the potential distribution in the Franck-Hertz tube. For this same value of the acceleration voltage, plot the kinetic energy of an electron which makes No (zero), one, two, etc. collisions. (Note: the graphs in Melissinos are incorrect for your tube.)

Questions (to be answered in your notebook)

1. What wavelength of light would be emitted in the electronic transition which de-excites the Hg atom?
2. Why is the spacing to the first peak different than the spacing between successive peaks?
3. Why is the oven necessary?