Franck-Hertz Apparatus

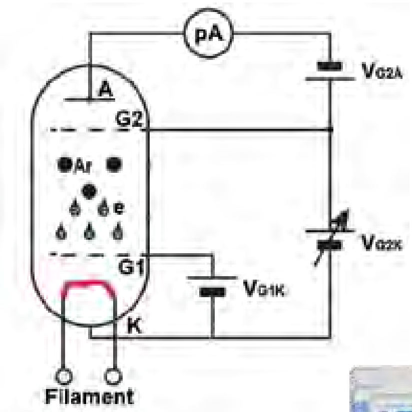
SE-9639

See complete experiment on page 389.

- Uses argon gas, so no heating is required
- Digital displays for stand-alone use
- Can be used with the 850 Interface and PASCO Capstone

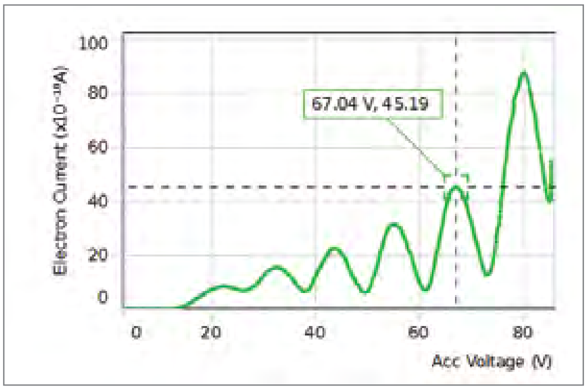
Introduction

As early as 1914, James Franck and Gustav Hertz discovered in the course of their investigations an energy loss in distinct steps for electrons passing through mercury vapor and a corresponding emission at the ultraviolet line (λ= 254 nm) of mercury. They performed this experiment that has become one of the classic demonstrations of the quantization of atomic energy levels. They were awarded the Nobel Prize for this work in 1925.



This diagram shows the internal structure of the Franck-Hertz tube and the wiring diagram.

The system can be used stand-alone or with the 850 Interface and PASCO Capstone. Each power supply and the current amplifier can be connected to 850 analog ports so Capstone can record the data.



The advantage of using Capstone is that students are able to get many more data points compared to manually taking readings from the digital readouts. The peaks and troughs are easily measured using the coordinate tool.

How It Works

Electrons are accelerated by applying a known potential between two grids inside the argon tube. When an electron has sufficient kinetic energy to excite one of argon's outer orbital electrons and has an inelastic collision with an argon atom, the electron loses a specific amount of kinetic energy. This loss of electron kinetic energy causes a decrease in the electron current in the argon tube. Within a very short time, the excited argon electron will fall from the excited state back into the ground state level, emitting energy in the form of photons.

As the accelerating voltage is increased, the electrons undergo multiple collisions and the excitation energy of the argon atom can be determined by the differences between the accelerating voltages that cause a decrease in the current. Planck's Constant can be determined.

Specifications

Filling Gas: argon
Filament Voltage: ≤6.3 VDC
Accelerating Voltage: ≤100 VDC
Wave Crest (or Trough) Number: 6
Argon Tube Life Span: ≤3000 hrs

Power supply and current amplifier specs: See page 253.

Franck-Hertz System (SE-9639) includes:

- Franck-Hertz Tube Enclosure with Argon Tube (SE-9650)
- Tunable DC (Constant Voltage) Power Supply I (SE-6615)
- Tunable DC (Constant Voltage) Power Supply II (SE-9644)
- DC Current Amplifier (SE-6621)
- Red and Black Patch Cords

Order Information

Franck-Hertz System SE-9639
Power supplies & amplifier can be purchased separately. See page 253.
If you already have power supplies, you will need:
Franck-Hertz Tube Enclosure with Argon Tube SE-9650
Replacement Parts:
Franck-Hertz Argon Tube SE-9645

Photoelectric Effect

EX-5549A

Designed for use with either of the following:
- 850 Universal Interface
- 550 Universal Interface

Concepts:
- Connects to the 850 Universal Interface for data collection in PASCO Capstone
- Find Planck's Constant to within 5%
- Verify that stopping voltage is independent of intensity
- Find characteristics of the photodiode

The Photoelectric Effect System is used to perform the photoelectric experiment, determining Planck's Constant to within 5%. This apparatus uses the conventional method of determining Planck's Constant. The metal plate in the photodiode is illuminated with various frequencies of light, selected from a mercury lamp using filters. The voltage is then adjusted to stop the photoelectric current. The stopping voltage is plotted vs. the frequency, and Planck's Constant is determined from the slope of the graph.

The concept that the stopping voltage does not change with light intensity is tested using the various apertures that change the light intensity by partially blocking the light.

Use the 850 Universal Interface and PASCO Capstone to collect and analyze data.

Both the picoammeter and the power supply for the stopping voltage have sensor ports on the front that connect to the analog sensor ports of the 850 Universal Interface. PASCO Capstone automatically recognizes these instruments and can read the current and the voltage. During the experiment, each time a different filter is applied, the user clicks "Keep in PASCO Capstone and the value of the stopping voltage for that frequency is recorded and automatically graphed vs. frequency.

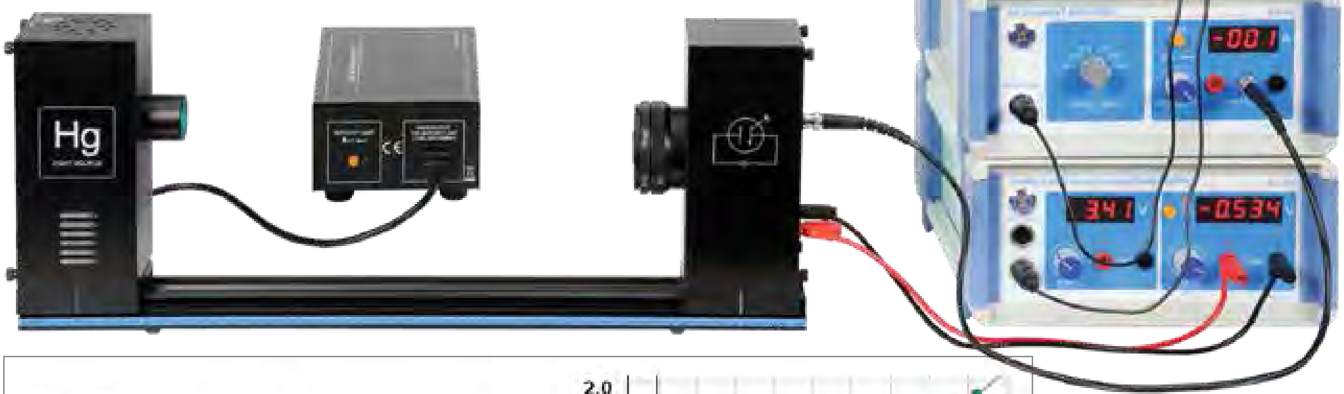
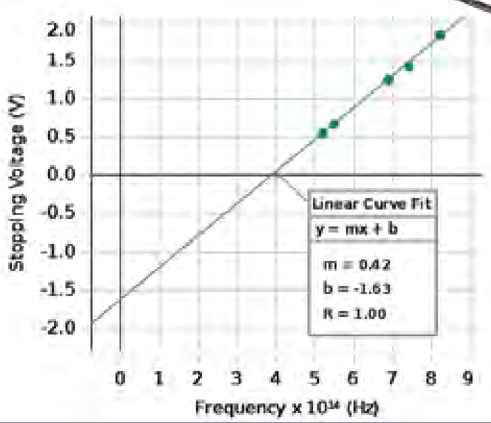



Table I: Photoelectric Effect with 4 mm Aperture

	Run #1	Run #1
	Frequency x 10^{14} (Hz)	Stopping Voltage (V)
1	8.214	1.835
2	7.408	1.428
3	6.879	1.248
4	5.490	0.671
5	5.196	0.551



For the typical sample data shown, the graph of Stopping Voltage vs. Frequency gives a slope of 4.2 x 10^{-15} V·s. This results in a value for Planck's Constant of 6.7 x 10^{-34} J·s, which is 1.3% above the accepted value. Graph generated using PASCO Capstone software.

Experiment Includes

• Photoelectric Effect Apparatus	SE-6614
• DC Current Amplifier	SE-6621
• Tunable DC Power Supply	SE-6615
• Cables for 850 Interface	

Download This Experiment

The FREE experiment files include instructions in Microsoft Word®, PASCO Capstone workbook files with sample data, and graphics. Download these experiments at **www.pasco.com/CapstoneExperiments**.

Order Information

Photoelectric Effect..EX-5549A

Required:

550 or 850 Universal Interface ....pp. 28-30

PASCO Capstone Software...pp. 72-75