

www.unitedsci.com

3. Specifications	
Voltages supplied to the Franck- Hertz tube. U_{G1K} U_{G2A} (rejecting voltage) U_{G2K} point- measure observe U_H (filament voltage, AC) Sawtooth scan for oscilloscope Parameters of the sawtooth signal: Scanning Voltage at tul Scanning Frequency Scanning output amplit	$\begin{array}{llllllllllllllllllllllllllllllllllll$
Low-current Measuring ranges: Number of observable peaks in spectrum: Point-by-point measurement Automatic observation on oscilloscope	10 ⁻⁹ ~ 10 ⁻⁶ A in 4 steps >5 >2
Operating conditions Ambient temperature Relative humidity Operating power Preheating time Continuous operating time Rated input power Dimensions	-10 ~ 40°C ≤85% (at 40°C) 110VAC ± 10%, 60Hz ≤5 min 8 hours ≤15W 400mm X 230mm X 130mm (l x w x h)
4.Operating Principle	
describes the symbols of each electrode and relations between their voltages. $A(5) \qquad \qquad$	
Figure 2 A voltage of about 1.5V is added between the first grid (G1) and the cathode (K) to eliminate the scattering effect of the space charge at the cathode. When the filament is heated, the electrons emitted by the cathode oxide are accelerated in the electric field between the second grid (G2) and the cathode, obtaining increased energy. But at the beginning, because of a low voltage between the second grid and	
	SUPPLIES, INC. 847-336-7556 www.unitedsci.com

cathode, the electron energy is low. Thus the energy exchanged is small even when the electrons collide with a gas atom. So initially, the plate current I_A formed by electrons penetrating the second grid will increase as U_{G2K} is increased. (left segment in Figure 3)



Figure 3

When U_{G2K} reaches the first excitation potential of the argon atom, electrons collide with argon atoms near the second grid in an inelastic collision, and transfer the total energy obtained in the accelerating field to the argon atoms, exciting them from the ground state to the first excitation state. But after transferring all their energy to argon atoms, the electrons can't overcome the reverse field between G2 and the anode. They are drawn back to the second grid, even if some of them have penetrated it. So the plate current I_A decreases noticeably. Then, with a further increase of U_{G2K} , the electron energy also increases. There is now enough energy left after a collision with an argon atom to overcome the reverse field and reach the anode plate A once more. At this stage, the current I_A begins to increase again, until U_{G2K} reaches twice the argon atom's first excitation potential. Electrons between G2 and K can now lose energy twice and electrons undergoing second inelastic collisions cannot reach the anode, so the current decreases as before.

We can plot the amplitude curve of I_A vs. U_{G2K} to obtain a spectrum of the transitions. The voltage difference between two consecutive valley points (or peak points) is the first excitation potential of the argon atom. This experiment illustrates the fact that the slow electrons in Franck-Hertz tube collide with argon atoms, exciting the atoms from a lower energy level to a higher level. By measuring the argon's first excitation potential (13.1V), we can verify that the energy absorbed and transmitted is discrete, not continuous.

5. Operation

- 1. **Without** the argon tube in place, set up the voltages: Switch on the power. The indicator will light.
- Turn the "Manual-Auto" switch to "Manual", rotate the scan knob counter-clockwise to minimum, turn "Filament Voltage Selector" to 3.5V, and set the "Current Multiplier" to 10⁻⁷.
- 3. Turn the "Voltage Selector" switch to 1.3 ~ 5V, and rotate the 1.3 ~ 5V adjustment knob until the voltmeter reads 1.5V to set $U_{G1K} = 1.5V$.
- 4. Turn "Voltage Selector" switch to 1.3 \sim 15V, and rotate 1.3 \sim 55V adjustment knob

WUNITED SCIENTIFIC SUPPLIES, INC.

until the voltmeter reads 7.5V to set U_{G2A} = 7.5V (rejecting voltage).

5. Turn "Voltage Selector" switch to 0 ~ 100V, and rotate 0 ~ 100V adjustment knob until the voltmeter reads 0V to set U_{G2k} =7.5V(accelerating voltage).

When you have finished steps 2 through 5, with $U_H=3.5V$ (Filament voltage), $U_{G1K} = 1.5V$ (the voltage between the first grid and cathode), $U_{G2A} = 7.5V$ (The voltage between the second grid and anode) you are ready to do the experiment These are suggested voltages for the experiment. You can also do the experiment using the parameters marked on the argon tube.

- 6. Now turn off the power, remove the tube cover on the right side of the instrument, place the Franck-Hertz tube in lamp socket, replace the cover and turn on the power The indicator will light. Preheat the tube 3 minutes before making measurements.
- 7. Rotate " 0 ~ 100V" adjustment knob slowly while observing the ammeter and voltmeter readings. As U_{G2K} (accelerating voltage) increases, the ammeter readings pass through periodic peaks and valleys. Record corresponding pairs of voltage and current values. Plot the I_A vs. U_{G2A} curve.
- **8.** Turn the "Manual-Auto" switch to "Auto", and connect the instrument's Y, ground, and X output sockets to the corresponding Y, ground, and X input sockets of an oscilloscope. Set the oscilloscope to X-Y mode and switch on the power of oscilloscope. Adjust the Y and X positions to make the scan baseline lie at the bottom of the screen, and adjust the X Gain to make scan baseline 10 grids. Rotate the scanning knob of the Franck-Hertz apparatus and observe the waveform on the oscilloscope screen. Adjust the "Y gain" and "X gain" of the oscilloscope to make the waveform clear and Y amplitude convenient. Rotate scanning potentiometer clockwise to end, set the maximum scan voltage to 50V, measure the horizontal distance of two consecutive crests (count the grids). Multiply the distance by 5V/grid, to obtain the value of the argon atom's first excitation potential.

6. Caution

During the experiment, pay attention to the output current indicator when the voltage is over 60V. If the ammeter's reading increases suddenly, decrease the accelerating voltage at once to avoid the damage to the tube.

If you want to change the value of U_{G1K} , U_{G2A} and U_H during the experiment, rotate the "0 ~ 100V" adjust knob counter-clockwise to end, before making the changes.

The filament voltage of this instrument is 3V, 3.5V, 4V, 4.5V, 5V, 5.5V, 6.3V. You can perform the experiment with these filament voltages. If distortion occurs on the top of the waveform, that means that the anode output current is too large and is causing the amplifier to saturate. The filament voltage should be decreased.

7. Packing List

Franck-Hertz Apparatus Argon Tube Power cord Oscilloscope hookup wires Operating instructions 1 each 1 each 1 each 1 set of 3 1 each