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# Planck's Constant Measuring Instrument

# P/N: SS20802

# User's Manual

## The Purpose of this Instrument

This device can be used to experimentally derive Planck's constant by demonstrating the photoelectric effect of visible light.

## How It Works

The energy of an electromagnetic wave (in this case visible light) is absorbed by a vacuum phototube causing it to emit electrons. This device will measure the induced current allowing the user to determine Planck's constant.

## Configuration

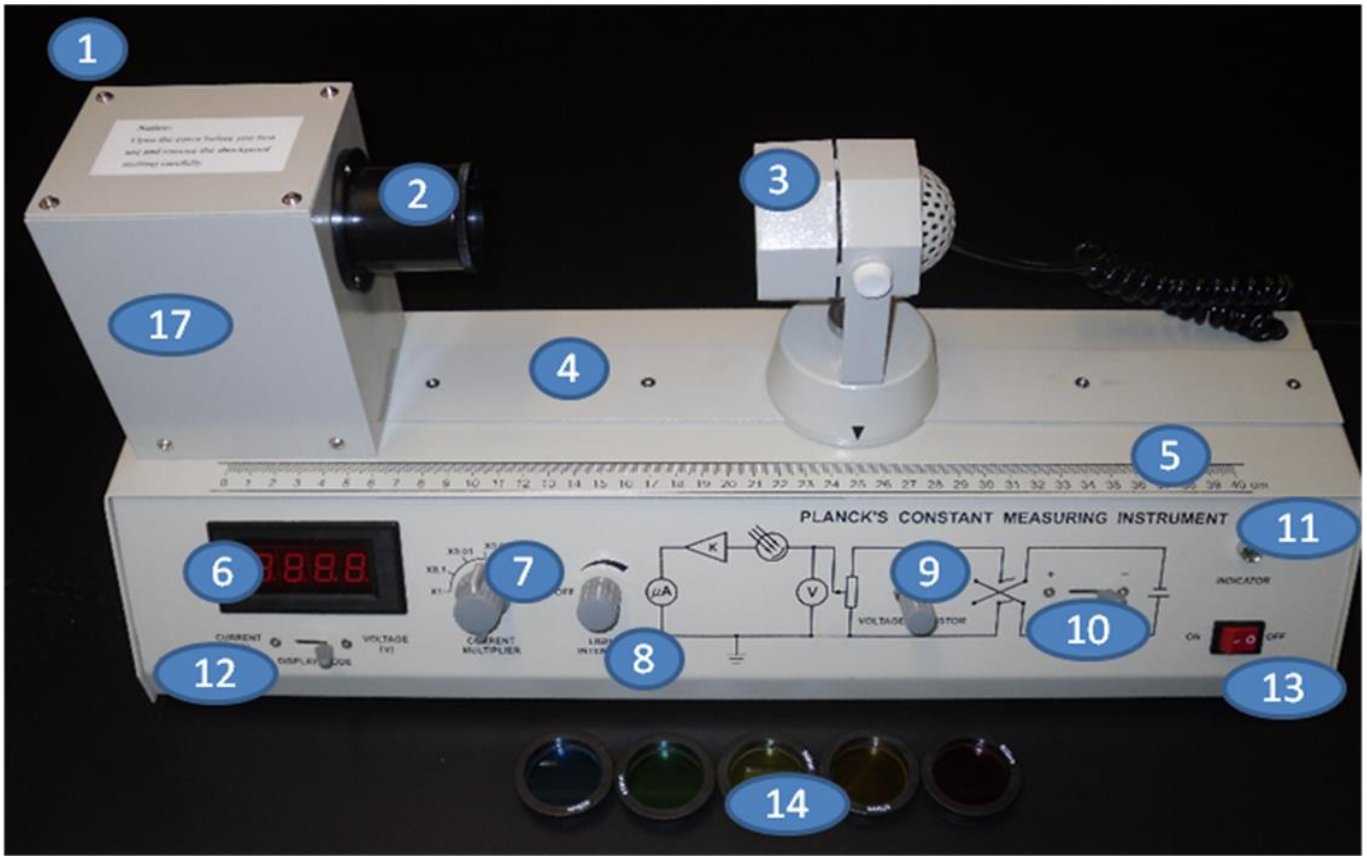
The instrument contains a light source (12 V/35 W halogen tungsten lamp), a dark-box which contains a vacuum phototube (sensitive component), a DC amplifier, and five color filters.

| Color of Filter | Wavelength(λ) |
|---|---|
| Red | 635nm. |
| Orange | 570nm. |
| Yellow | 540nm. |
| Green | 500nm. |
| Blue | 460nm. |

## The Accuracy of this Device

- The dark current is less than 0.003 μA.
- The power supply is 110±11 V / 50±1 Hz.
- The error of the accelerate voltage is less than ±2%.
- Planck's constant is found to vary less than ±15% of accepted value ($h=6.62619\times10^{34}$ Js).

Figure 1 Planck's Constant Measuring Instrument




1. The cover of the receiving dark-box
2. Drawtube
3. Light source
4. Guide (used to change the distance of the light source from the phototube)
5. Scale (measures the distance of the light source from the center of the phototube)
6. Digital meter (displays the voltage and Photocurrent)
7. Current multiplier
8. Light intensity adjuster
9. Accelerate voltage adjuster
10. Voltage direction switch
11. Power indicator
12. Display mode switch (used to change display from voltage to photocurrent)
13. Power switch
14. Color filters (can be inserted in the drawtube to change the wavelength of the light)
15. Vacuum phototube
16. Focus lens
17. Dark-box (houses the vacuum phototube)

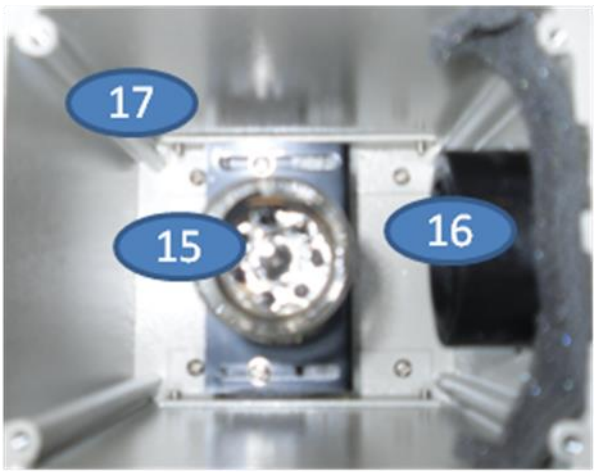



Figure 2
Inside the dark-box

## Calibration

Loosen the screws on the cover of the dark-box and remove the plate. Increase the voltage to ±15 V and turn on the light. The light should shine on the middle area of the phototube's cathode plate adjust the direction of the light to create the greatest current possible while other conditions remain unchanged. Then replace the cover and tighten the screws.

## Experiment Procedures: Finding the Relationship between Photocurrent and Light Intensity

Turn on the instrument and allow it to heat for five minutes. Then insert the red filter into the drawtube, position the light source in the 25 cm position, set the current multiplier to '×1' or '×0.1' and current direction to '+'. Now gradually adjust the accelerate voltage to increase the photocurrent to saturation. Record the voltage and the photocurrent, using the display mode switch to change from voltage to current. Change the distance (r) between the light source and the vacuum phototube by sliding the light source along the guide. Record the photocurrent for several values of r. Plot the relationship between photocurrent and the distance r.

Cover the drawtube with your hand, and the photocurrent will drop to zero almost instantaneously. When you remove your hand the photocurrent will be restored just as quickly; this should not take more than $10^{-9}$s, demonstrating that there is very little delay with the photoelectric effect.

## Experiment Procedures: Measuring Planck's Constant

Turn on the instrument and allow it to heat for five minutes. Then insert the red color filter into the drawtube, turn light intensity up to high, set the current multiplier to '×0.001' and change current direction to '-'. Adjust the accelerate voltage until the photocurrent is zero, switch the display mode to view the voltage and record the voltage. Repeat this process for each of the filters, recording the voltage value for each wavelength. Plotting the energy vs. light frequency will give the value of Planck's constant.

## Maintenance

The instrument should be operated in a dry, temperature controlled (0 to 40°C), indoor area to prevent corrosion. For the most accurate results prevent stray light from entering the dark-box directly. When experiments are complete, insert the black cover into the drawtube to protect the vacuum phototube. The phototube may need to be replaced if sensitivity is reduced by age.

Store the instrument in a dust and moisture proof place. If dust accumulates on the phototube, collection mirror, or color filters they should be cleaned with a miscible liquid, such as alcohol, and absorbent cotton.