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Instruction Sheet for the PASCO Model TD-8555

STEFAN-BOLTZMAN LAMP

Introduction

The Stefan-Boltzmann Lamp is a high temperature source of thermal radiation. It can be used with a radiation detector, such as PASCO's Model TD-8553 Radiation Sensor, to investigate the Stefan-Boltzmann Law:

$$R_{rad} = \sigma T^4;$$

where R_{rad} is the power per unit area radiated by an object, and T is its temperature. This law can also be investigated using a low temperature source such as PASCO's Model TD-8554 Thermal Radiation Cube. However, the high temperature of the Stefan-Boltzmann Lamp simplifies the analysis because the fourth power of the ambient temperature is negligibly small compared to the fourth power of the high temperature of the lamp filament.

When properly oriented, the filament of the Stefan-Boltzmann Lamp provides a good approximation to a point source of thermal radiation. It therefore works well for investigations into the inverse square law.

Measuring the Filament Temperature

By adjusting the power into the lamp (13 Volts Maximum, between 2 and 3 A or approximately 36 Watts), filament temperatures up to approximately 3,000 °C can be obtained. The filament temperature is determined by carefully measuring the voltage and current into the lamp. The voltage divided by the current gives the resistance of the filament.

For small temperature changes, the temperature of the tungsten filament can be calculated using α, the temperature coefficient of resistivity for the filament:

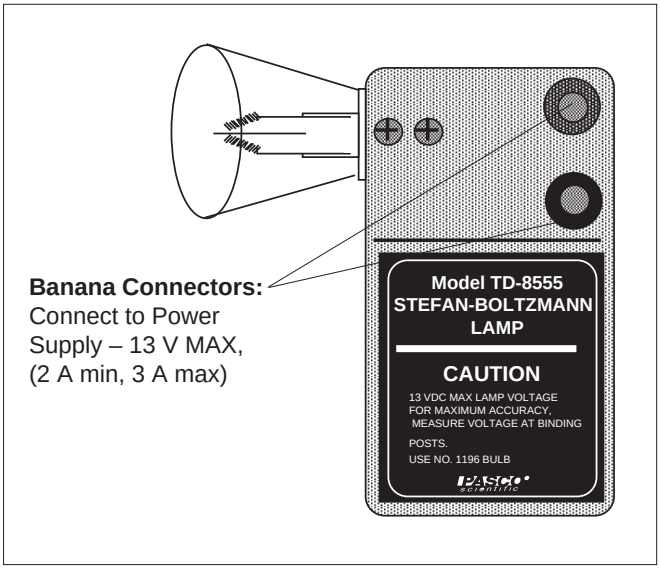
$$T = \frac{R - R_{ref}}{\alpha R_{ref}} + T_{ref}$$

where,

T = Temperature
R = Resistance at temperature T
T_{ref} = Reference temperature (usually room temp.)
R_{ref} = Resistance at temperature T_{ref}
α = Temperature coefficient of resistivity for the filament

Recommended Equipment

AC/DC LV Power Supply SF-9584 or equivalent capable of 13 V @ 3 A max.



For large temperature differences, however, α is not constant and the above equation is not accurate.

For large temperature differences, therefore, determine the temperature of the tungsten filament as follows:

1. Accurately measure the resistance (R_{ref}) of the tungsten filament at room temperature (about 300 °K). Accuracy is important here. A small error in R_{ref} will result in a large error in your result for the filament temperature.
2. When the filament is hot, measure the voltage and current into the filament and divide the voltage by the current to measure the resistance (R_T).
3. Divide R_T by R_{ref} to obtain the relative resistance (R_T/R_{ref}).
4. Using your measured value for the relative resistivity of the filament at temperature T, use Table 2 on the following page, or the associated graph, to determine the temperature of the filament.

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Important: The voltage into the lamp should **NEVER exceed 13 V.** Higher voltages will burn out the filament.

Replacement Bulb: Use GE Lamp No. 1196, available at most auto parts stores. When replacing the bulb, solder the leads to minimize resistance.

Note: Complete instructions for the Stefan-Boltzmann and inverse square law experiments can be found in the Instruction Manual and Experiment Guide for the PASCO scientific Thermal Radiation System (PASCO Part NO. 012-02845).

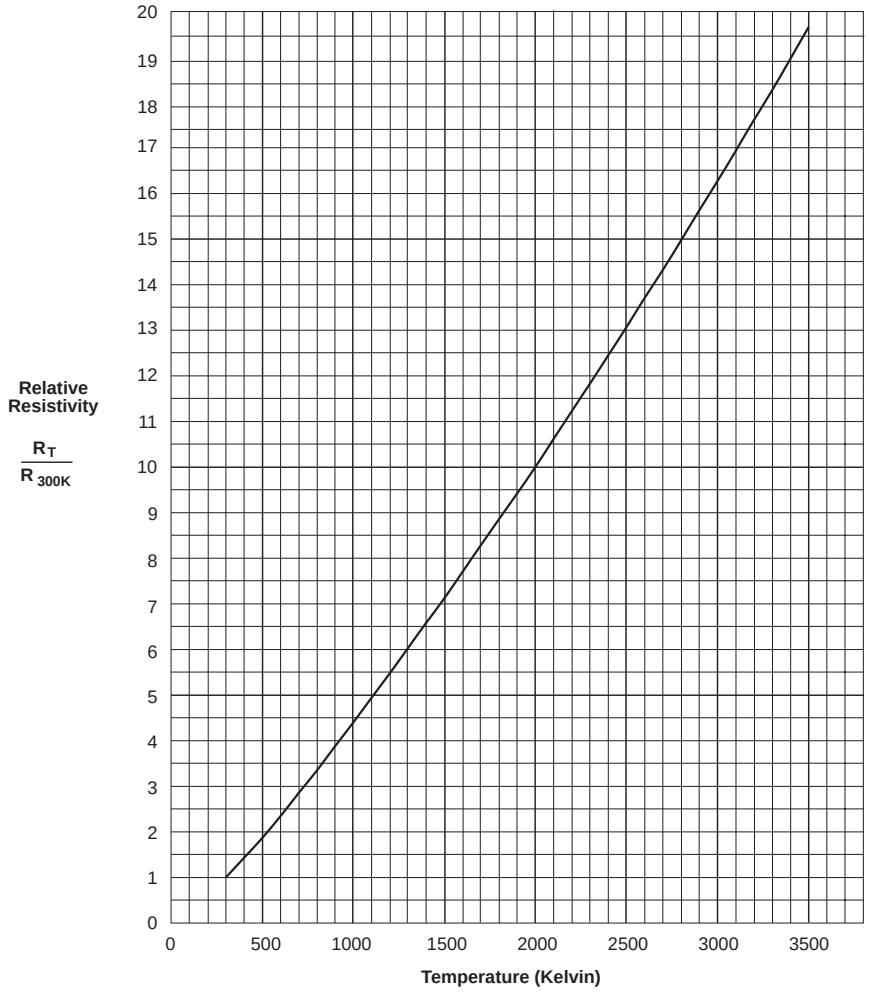
Limited Warranty

PASCO scientific warrants this product to be free from defects in materials and workmanship for a period of one year from the date of shipment to the customer. PASCO will repair or replace, at its option, any part of the product which is deemed to be defective in material or workmanship. This warranty does not cover damage to the product caused by abuse or improper use. Determination of whether a product failure is the result of a manufacturing defect or improper use by the customer shall be made solely by PASCO scientific. Responsibility for the return of equipment for warranty repair belongs to the customer. Equipment must be properly packed to prevent damage and shipped postage or freight prepaid. (Damage caused by improper packing of the equipment for return shipment will not be covered by the warranty.) Shipping costs for returning the equipment, after repair, will be paid by PASCO scientific.

Temperature and Resistivity for Tungsten

R/R_{300K}	Temp °K	Resistivity μΩ cm	R/R_{300K}	Temp °K	Resistivity μΩ cm	R/R_{300K}	Temp °K	Resistivity μΩ cm	R/R_{300K}	Temp °K	Resistivity μΩ cm
1.0	300	5.65	5.48	1200	30.98	10.63	2100	60.06	16.29	3000	92.04
1.43	400	8.06	6.03	1300	34.08	11.24	2200	63.48	16.95	3100	95.76
1.87	500	10.56	6.58	1400	37.19	11.84	2300	66.91	17.62	3200	99.54
2.34	600	13.23	7.14	1500	40.36	12.46	2400	70.39	18.28	3300	103.3
2.85	700	16.09	7.71	1600	43.55	13.08	2500	73.91	18.97	3400	107.2
3.36	800	19.00	8.28	1700	46.78	13.72	2600	77.49	19.66	3500	111.1
3.88	900	21.94	8.86	1800	50.05	14.34	2700	81.04	26.35	3600	115.0
4.41	1000	24.93	9.44	1900	53.35	14.99	2800	84.70			
4.95	1100	27.94	10.03	2000	56.67	15.63	2900	88.33			

Temperature versus Resistivity for Tungsten



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