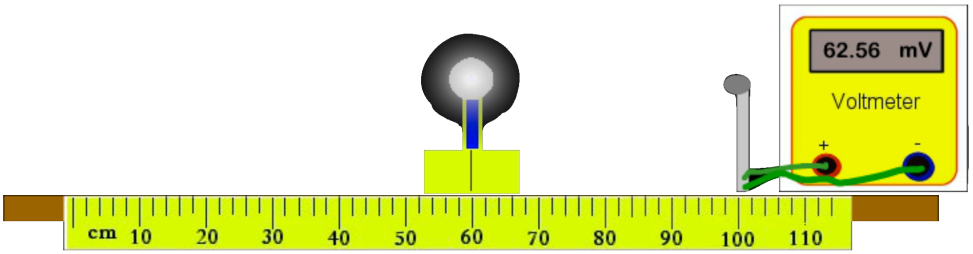
Particles and Waves

The inverse Square Law

1) A physics student set up the following experiment in a dark room. A small light source considered to be a point source of light was slid along a ruler. A voltmeter attached to a photodiode gives voltage readings which are directly proportional to the irradiance from the light source.



The student collected the following data.

Distance from light source / cm	20	40	60	80	100
Voltage / V	250	62.5	28.0	15.7	10.0

Use all the data in the table to find a relationship between the distance d from the light source and the voltage V.

2) In the following practice problems use the inverse square law to determine the quantity asked for.

a)
The irradiance at a distance of 40.0 cm from a point source of light is 50 Wm^{-2}
Calculate the irradiance at a distance of 80.0 cm from the point source of light.

[12.5 Wm^{-2}]

b)
The irradiance at a distance of 12.0 cm from a point source of light is measured to be 256 Wm^{-2}.
Calculate the irradiance at a distance of 3.0 cm away from the point source of light.

[4 096 Wm^{-2}]

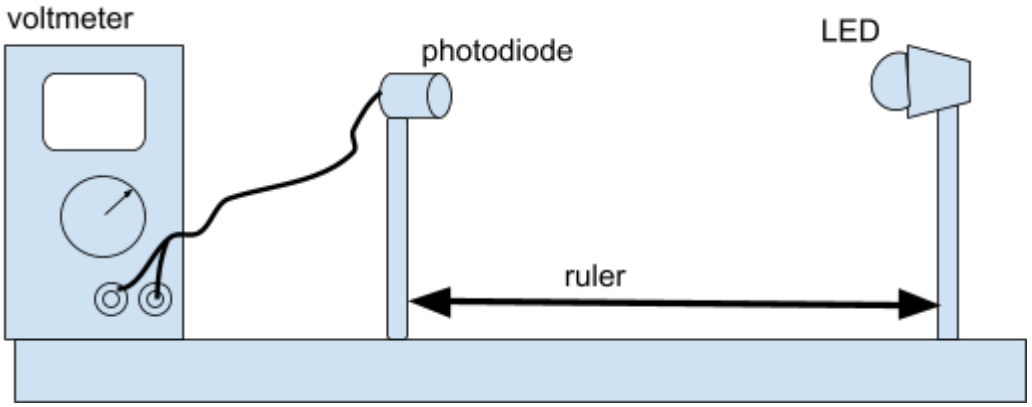
c)
The irradiance from a point source of light is found to be 90 Wm^{-2} at a distance of 30 cm from the light source. Calculate the distance from the light source that gives an irradiance of 22.5 Wm^{-2}

[60 cm]

d)
The irradiance from a point source of light is 64 Wm^{-2} at a distance of 36 cm. Calculate the distance from the light source that gives an irradiance of 256 Wm^{-2}

[18 cm]

3) An experiment is set up to determine the relationship between the irradiance and distance from an LED.



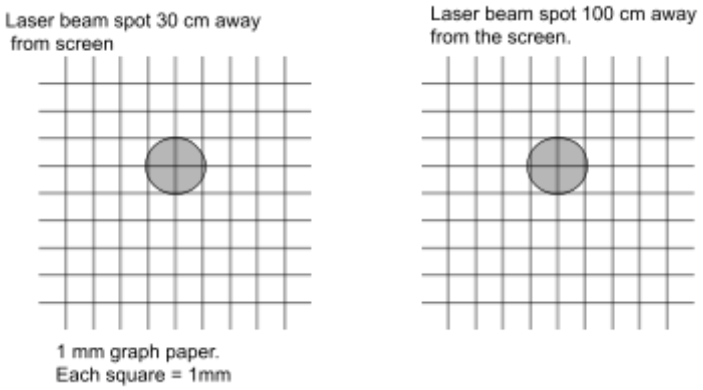
A student took the following readings. The irradiance is directly proportional to the reading on the voltmeter.

distance/ cm	3	4	5	6	7	8	9	10
irradiance/ units of volts	4.10	2.83	2.07	1.58	1.26	1.01	0.84	0.10

Use the above data to plot a graph of $1/d^2$ against the irradiance.

Explain why the student concludes that the LED is not a point source of light.

4) An experiment was carried out to determine how the irradiance of a laser beam changed over distance.
The beam of the laser was directed towards a screen. When the laser was moved further away the diameter of the beam spot did not change.



a) Explain why the irradiance of the laser beam remains constant.
b) The irradiance is measured to be 1,600 Wm^{-2}
Determine then power of the laser.

Answers

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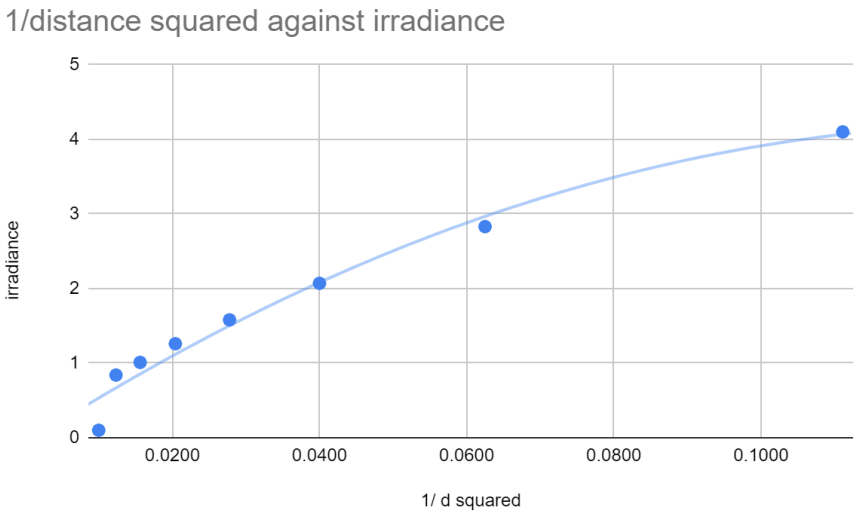
3) The chart obtained from the data



It is not showing that $I \propto 1/d^2$ So is not a point source of light

4) The laser has a power of 5 mW.