Related topics

Luminous flux, quantity of light, luminous intensity, illuminance, luminance.

Principle and task

The luminous intensity emitted by a punctual source is determined as a function of distance.

Equipment

Lux meter, hand-held	07137.00	1
Luxmeter probe	12107.01	1
Optical profile bench l = 60 cm	08283.00	1
Base f. opt. profile-bench, adjust.	08284.00	2
Slide mount f. opt. pr.-bench, h 30 mm	08286.01	1
Slide mount f. opt. pr.-bench, h 80 mm	08286.02	1
Lamp holder E 14, on stem	06175.00	1
Filament lamp 6V/5A, E14	06158.00	1
Universal clamp	37715.00	1
Power supply 0-12V DC/6V, 12V AC	13505.93	1

Problems

1. The luminous intensity emitted by a punctual source is determined as a function of distance from the source.
2. The photometric law of distance is verified by plotting illuminance as a function of the reciprocal value of the square of the distance.

Set-up and procedure

The experimental set-up is shown in Fig. 1. It must be assured that the axis of the lamp filament (slide mount h = 30mm) coincides with the axis of the optical bench. The luxmeter probe (slide mount h = 80mm) must be at the same height. The luxmeter must be calibrated before actually carrying out measurements. Possible background luminance must be determined with the lamp switched off and must be taken into account during evaluation. Small distances are best determined using a ruler, larger distances are determined by means of the scale on the optical bench.
The lamp is connected to the fixed 6V alternating current output of the power supply.

Theory and evaluation

A punctual light source of luminous intensity I (Candela/cd) emits a light flux Φ (Lumen/lm) throughout a solid angle ω. Luminous intensity in a solid angle element $d\omega$ amounts to:

$$I = d\Phi / d\omega \quad [\,cd\,] \tag{1}$$

For luminous sources extended in space (also such which emit no light by themselves, but which are reflecting), luminance B is given by:

$$B = dI/dA \quad [\,cd/cm^2\,] \tag{2}$$

Fig. 1: Experimental set-up: Photometric law of distance.

If an area dA* is illuminated by a luminous flux dΦ, illuminance E (Lux/lx) is:

$$E = d\Phi \,/\, dA^* \;\; [\,lx\,] \qquad (3)$$

Fig. 2 gives a schematic representation of the illumination of a surface element dA* through a punctual light source P. The luminous intensity of the source is I and its distance from the surface element is r, the perpendicular to the surface element points in the direction of the connecting line with the light source.
The illuminance E is given by:

$$E = d\Phi \,/\, dA^* = \frac{d\Phi \,/\, d\omega}{d\omega \,/\, dA^*} \qquad (4)$$

With $d\omega = dA^* / r^2$ and (1) one obtains: $E = I/r^2$ (5)

Equation (5) describes the photometric law of distance. According to this, the illuminance E of a surface decreases proportionally to the square of distance r for constant luminous intensity I.

In Fig. 3, the measurement values of illuminance E are plotted as a function of the reciprocal values of the square of distance r. The photometric law of distance is verified by the linearity of the primary graph.

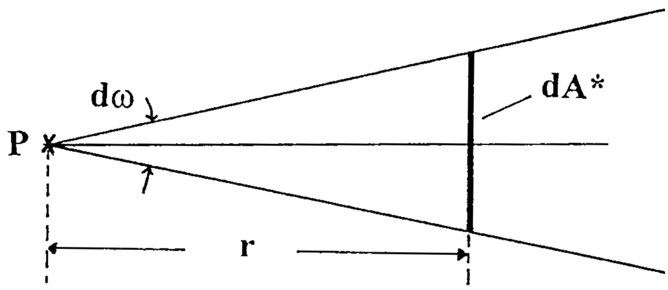

Fig. 2: Schematic determination of the photometric law of distance.

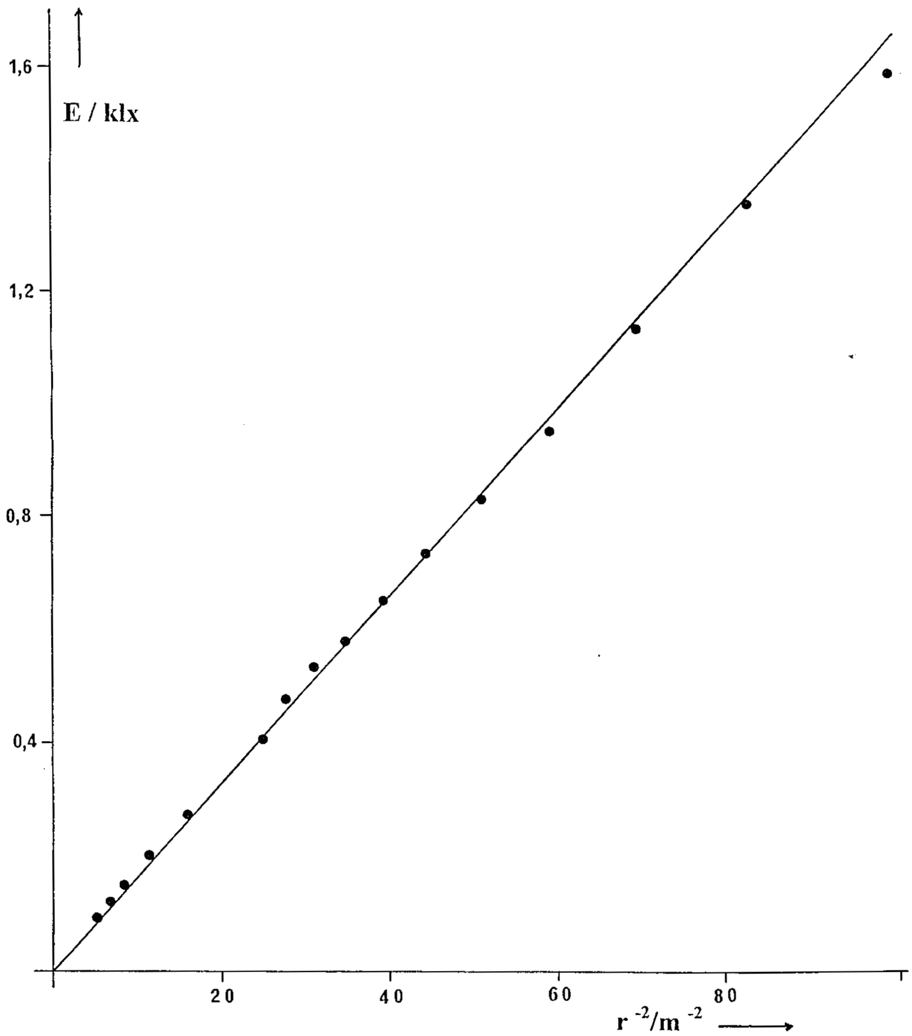

Fig. 3: Illuminance as a function of the reciprocal values of the square of the distances.