

assigned March 15, 2006

due March 20, 2006

HOMEWORK #4

Photometry

Questions

- a. Write the symbols of the four major photometric quantities and their units, and draw lines between them all. For each line, write the relation lying between the two quantities involved.
- b. What are the properties of a lambertian surface ?
- c. How can you determine the number of lumens in a Watt ?
- d. A radiometer with a 3 cm^2 sensor measures a flux of 300 mW of natural light. Assuming the luminous efficacy of daylight to be of about 110 lm/W (i.e. the ratio of luminous and energy fluxes), what is the (luminous) illuminance at that moment ?
- e. The respective contribution of the different heat transfer modes occurring for a double glazing comprising two clear glass panes separated by air is analyzed. One finds out that 30% of the total heat transfer is due to conduction, 6% to convection and 64% to radiation. To improve its insulating properties, what would you suggest between creating vacuum between the glass panes and adding a selective coating that would reduce the radiation by a factor 8 ?

Problems

1. You want to check whether a ceiling light fixture will be adequate to illuminate your desk. Its intensity distribution (in Cd) is given by the continuous line on this graph. The ceiling height is 2.60 m and your desk is at 80 cm from the floor. The center of the desk is not directly below the source, but shifted by $2'$ to the right.

What is the illuminance at the center of the desk ? Is this an appropriate value ?

What flux would be absorbed by a black sheet of paper (letter size, reflection coefficient = 10%) if you placed it at the center of your desk ?

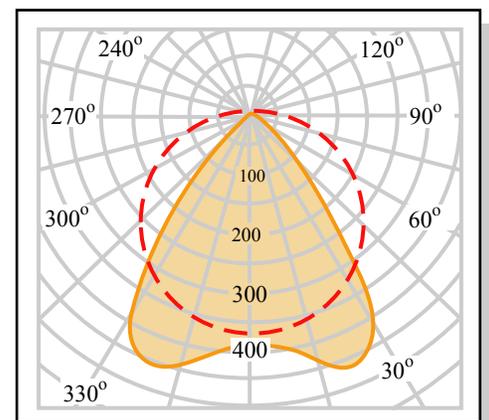


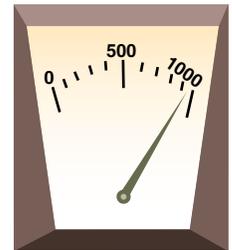
Image by MIT OCW.

2. In one of the exhibition halls of the Kimbell Art Museum, located in Fortworth (Texas) and designed by Louis Kahn in 1972, you are taking measurements under the zenithal opening as well as under one of the halogen sources; you dispose of a luxmeter and a radiometer.

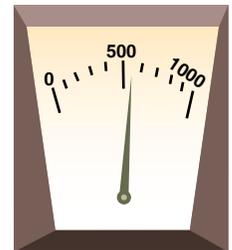
On your luxmeter, you get the following reading in klux under the zenithal opening.



Exactly 2m below the halogen source (considered a point source) and holding your luxmeter horizontally, you get the following reading, in lux (only due to artificial light):



Now taking your radiometer, you check the radiance in W/m^2 under the zenithal opening and get the following reading:



Finally, because of annoying visitors, you cannot get exactly below the halogen source anymore with your radiometer and therefore decide to hold it horizontally at the same height as before (2m below the halogen source's position) but at 45° off the vertical from the source. The reading you get is the following, in W/m^2 :

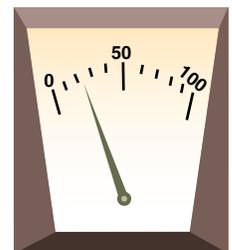


Image by MIT OCW.

What luminous efficacy do you deduce from your measurements for natural light, and what is its unit ?

What luminous efficacy do you deduce from your measurements for the halogen source ?

Reading assignment from Textbook

"Introduction to Architectural Science" by Szokolay: § 2.1

Additional readings relevant to lecture topics:

"IESNA Lighting Handbook" (9th Ed.): pp. 2-1 to 2-3 + pp. 3-1 to 3-5 + pp. 3-9 to 3-14 + pp. 4-1 to 4-6