

Introduction to radiometry - Mathieu Hébert

1h30 – No document permitted

Exercise 1

A lamp emits a flux of 0.3 W. Assuming that its spectral flux is uniform in the spectral band 432-437 nm and zero in the rest of the spectrum, what is the spectral flux in the spectral emission band? Using the table of $V(\lambda)$ in appendix, what is the visual flux emitted by this lamp? (*don't forget to specify the units*).

Exercise 2

N photons of wavelength 500 nm form a flux F .
How many photons of wavelength 700 nm form the same flux?

Problem: balance weight lamp.



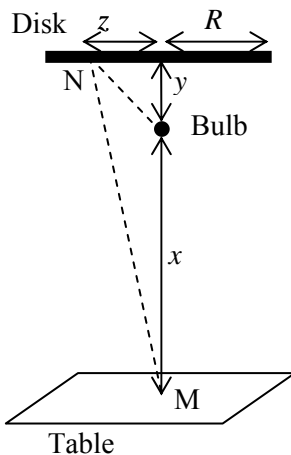
Balance weight lamps were frequently used in the past by dressmakers to adjust the illuminance from a light bulb on their work. The light bulb is assumed to be an isotropic point source, of electrical power P . Its radiating efficiency is q (in %), and its luminous efficacy is α (in lm/W).

As shown on the picture, the bulb is topped by a white glass disk aiming at reflecting more light towards the table. We assume that this disk is a Lambertian reflector of radius R and reflectance ρ . The distance between the bulb and the center of the white glass disk is y .

For all questions below, give the analytical formula and the corresponding units.

1. What is the energetic flux F_e emitted by the bulb?
2. What is the visual flux F_v emitted by the bulb?
3. What is the visual intensity emitted by the bulb in a given direction?
4. In absence of disk, what is the irradiance E on the table at point M below the bulb at a distance x from the bulb? How does the irradiance E vary when the lamp-to-table distance x is doubled?
5. What is the solid angle subtended by the disk from the bulb?
6. What is therefore the total flux received by the disk? and the total flux reflected by the disk?
7. Is the irradiance on the disk uniform over its whole area?
8. Consider a point N on the disk at a distance z from its center. What is the irradiance at this point?
9. Which radiance flows between N and the point M on the table?
10. What is the total irradiance in M by considering the direct illumination from the bulb and the total light reflected by the disk?

NB: Question 10 may contain integrals.



Appendix

λ (nm) CIE 1951 $V(\lambda)$

| | |
|-----|------------|
| 380 | 5.890e-004 |
| 385 | 1.108e-003 |
| 390 | 2.209e-003 |
| 395 | 4.530e-003 |
| 400 | 9.290e-003 |
| 405 | 1.852e-002 |
| 410 | 3.484e-002 |
| 415 | 6.040e-002 |
| 420 | 9.660e-002 |
| 425 | 1.436e-001 |
| 430 | 1.998e-001 |
| 435 | 2.625e-001 |
| 440 | 3.281e-001 |
| 445 | 3.931e-001 |
| 450 | 4.550e-001 |
| 455 | 5.130e-001 |
| 460 | 5.670e-001 |
| 465 | 6.200e-001 |
| 470 | 6.760e-001 |
| 475 | 7.340e-001 |
| 480 | 7.930e-001 |
| 485 | 8.510e-001 |
| 490 | 9.040e-001 |
| 495 | 9.490e-001 |
| 500 | 9.820e-001 |
| 505 | 9.980e-001 |
| 510 | 9.970e-001 |
| 515 | 9.750e-001 |
| 520 | 9.350e-001 |
| 525 | 8.800e-001 |
| 530 | 8.110e-001 |
| 535 | 7.330e-001 |
| 540 | 6.500e-001 |
| 545 | 5.640e-001 |
| 550 | 4.810e-001 |
| 555 | 4.020e-001 |
| 560 | 3.288e-001 |
| 565 | 2.639e-001 |
| 570 | 2.076e-001 |
| 575 | 1.602e-001 |
| 580 | 1.212e-001 |

λ (nm) CIE 1951 $V(\lambda)$ (continued)

| | |
|-----|------------|
| 585 | 8.990e-002 |
| 590 | 6.550e-002 |
| 595 | 4.690e-002 |
| 600 | 3.315e-002 |
| 605 | 2.312e-002 |
| 610 | 1.593e-002 |
| 615 | 1.088e-002 |
| 620 | 7.370e-003 |
| 625 | 4.970e-003 |
| 630 | 3.335e-003 |
| 635 | 2.235e-003 |
| 640 | 1.497e-003 |
| 645 | 1.005e-003 |
| 650 | 6.770e-004 |
| 655 | 4.590e-004 |
| 660 | 3.129e-004 |
| 665 | 2.146e-004 |
| 670 | 1.480e-004 |
| 675 | 1.026e-004 |
| 680 | 7.150e-005 |
| 685 | 5.010e-005 |
| 690 | 3.533e-005 |
| 695 | 2.501e-005 |
| 700 | 1.780e-005 |
| 705 | 1.273e-005 |
| 710 | 9.140e-006 |
| 715 | 6.600e-006 |
| 720 | 4.780e-006 |
| 725 | 3.482e-006 |
| 730 | 2.546e-006 |
| 735 | 1.870e-006 |
| 740 | 1.379e-006 |
| 745 | 1.022e-006 |
| 750 | 7.600e-007 |
| 755 | 5.670e-007 |
| 760 | 4.250e-007 |
| 765 | 3.196e-007 |
| 770 | 2.413e-007 |
| 775 | 1.829e-007 |
| 780 | 1.390e-007 |