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Radiometry and Photometry study

In many applications, we need to know how many Watt/m^2 or Joule/sec/m^2 are equal to one Lux or one Foot Candle. This technical note is intended to help you understand a little more about the definitions and units involved with RADIOMETRY and PHOTOMETRY before attempting any conversion.

RADIOMETRY. In radiometry we are concerned with measuring electromagnetic energy regardless of whether we can *see* such energy. Radiometric terms apply anywhere in the electromagnetic spectrum.

PHOTOMETRY. In contrast, photometry is restricted to that portion of the electromagnetic spectrum that is perceived by the human eye as visible light. Photometric terms apply to the visible part of the spectrum only.

ILLUMINANCE. Illuminance is a photometric term and is defined as the luminous power per unit area incident on a surface. It is measured in units of Lumen/m^2 or Lux.

IRRADIANCE. Irradiance is the equivalence of illuminance in the radiometric terminology. It is measured in units of Watt/m^2 or Joule/sec/m^2.

If we want to convert radiometric values into photometric values, and vice versa, we have to take into account the relative visibility of the light of the particular wavelength involved. The ratio of any photometric unit to its radiometric equivalent is known as luminous efficacy, $K(\lambda)$. The maximum value of the luminous efficacy occurs at a wavelenght of about 555 nm and has a value of 673 Lumen/Watt. Luminous efficiency, $V(\lambda)$, is the ratio of the luminous efficacy at a given wavelength to the value of the luminous efficacy (673 Lumen/Watt) at the wavelength of about 555 nm. Accordingly,

$$V(l) = K(l)/673.$$

Tabulated values for $V(\lambda)$ are given in TABLE I. For convenience, the number of Lux for one Watt/m^2 are listed in column three and the number of Watt/m^2 for every Lux are list in the fourth column. For example, the luminous efficacy at 600 nm is 0.631; thus, one Watt/m^2 of monochromatic light illuminance at that wavelength equals 424.663 Lux. If the source is not monochromatic, integration is needed.

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TABLE I

Wavelength (nm)	Luminous Efficiency	1 Watt/m^2 = ? Lux	1 Lux = ? Watt/m^2
380	0.00004	000.02692	37.14710253
390	0.00012	000.08076	12.38236751
400	0.00040	000.26920	03.71471025
410	0.00120	000.80760	01.23823675
420	0.00400	002.69200	00.37147103
430	0.00116	000.78068	01.28093457
440	0.02300	015.47900	00.06460366
450	0.03800	025.57400	00.03910221
460	0.06000	040.38000	00.02476474
470	0.09100	061.24300	00.01632840
480	0.13900	093.54700	00.01068981
490	0.20800	139.98400	00.00714367
500	0.32300	217.37900	00.00460026
510	0.50300	338.51900	00.00295404
520	0.71000	477.83000	00.00209279
530	0.86200	580.12600	00.00172376
540	0.95400	642.04200	00.00155753
550	0.99500	669.63500	00.00149335
560	0.99500	669.63500	00.00149335
570	0.95200	640.69600	00.00156080
580	0.87000	585.51000	00.00170791
590	0.75700	509.46100	00.00196286
600	0.63100	424.66300	00.00235481
610	0.38100	256.41300	00.00389996
630	0.26500	178.34500	00.00560711
640	0.17500	117.77500	00.00849077
650	0.10700	072.01100	00.01388677
660	0.06100	041.05300	00.02435876
670	0.03200	021.53600	00.04643388
680	0.01700	011.44100	00.08740495
690	0.00820	005.51860	00.18120538
700	0.00410	002.75930	00.36241076
710	0.00210	001.41330	00.70756386
720	0.00105	000.70665	01.41512772
730	0.00052	000.34996	02.85746943
740	0.00025	000.16825	05.94353640
750	0.00012	000.08076	12.38236751
760	0.00006	000.04038	24.76473502
770	...	...	...