Submitted to the internet by Dr. Ching-yeh Hu, Biology Department, William Patterson University, 300 Pompton Rd., Wayne, NJ 07470, 973-720-2439, chu@frontier.wilpaterson.edu Permission was given by Dr. Hu to publish this here.

Coping With the Problem of Light Measurement

Unfortunately our understanding of practical lighting with electrical sources has been hindered by the multitude of ways of expressing visible radiation for plants. The lighting engineers and manufacturers of equipment use illumination units e.g. footcandle, lumen, or lux (or klx) since the majority of their activities deal with lighting installation for humans whose eyes "see" visible light differently from plants. Photobiologists in Europe and, to a minor extent, in the U.S. have expressed light in absolute energy units (watts per square meter, microwatts per square centimeter).

Since the work of McCree and the development of the quantum sensor which senses and quantifies visible or photosynthetically active radiation from 400-700 nanometers (PAR), most plant physiologists, photobiologists, horticulturists, and agronomists have accepted the unit, microeinstein of PAR, to measure radiation for plant growth (photosynthesis).

Although it is desirable to have a moderate understanding of the meaning of all these units of light measurement, it is by no means essential in order to design an adequate system for either research or commercial use. It may be difficult to get a system layout without the help of an illuminating engineer who can supply a computer array of optimum spacing and mounting height of a particular luminaire. These layouts are, at present, always expressed in footcandles or lumens since their prime use is in industrial or commercial lighting.

The approximate conversion factors given below will help to convert absolute energy units or irradiance units (PAR) as recommended by the plant scientist into illuminance or photometric values (lu.x or fc). (Data from McCree)

Light Conversion Factors

Source	Radiometric	PAR	Photometric	
	W m^{-2}	µE $m^{-2}s^{-1}$	fc	lux
HP Sodium (400 W)	1	5	33.5	360
		1	6.7	72.3
			1	10.8
Metal Halide (400 W)	1	4.6	29.6	319
		1	6.5	69.5
			1	10.8
Mercury (400 W)	1	4.7	30.8	332
		1	6.5	70.0
			1	10.8
CW Fluorescent (215 W)	1	4.6	34.2	367
		1	7.44	80.0
			1	10.8

To convert from either W m^{-2} or µE $m^{-2}s^{-1}$ to photometric units, multiply by the appropriate factor.

Please route questions to:Dr. Ching-yeh Hu, Biology Department, William Patterson University, 300 Pompton Rd., Wayne, NJ 07470, 973-720-2439, chu@frontier.wilpaterson.edu