A Minolta T-1 light meter is shown to the left of this text. This meter measures illuminance, which is the term for describing the amount of light that is falling upon or striking a region or an object. This is different from luminance, which is the light which is reflected from some object or the light which is emitted from some object, like a car's headlight or tail light. We see by luminance and contrast; without illuminance, there is no light to reflect back to the viewer. If an object is not self-luminescent, we can't see it when there is no illuminance, and we have a hard time discerning it when there is illuminance but there is little or no contrast between the object of interest and other parts of or objects in the visual environment. As an example, even in a brightly lit room, it would be hard to find a white dot placed on a white wall, but, even in a dimly lit room, it would be very easy to see a black dot on a white wall or a white dot on a black wall. If either dot were a glowing bulb, however, we could observe and discern it quickly, regardless of the ambient illuminance and the contrast in color.

To provide a basis for understanding the quantification of illuminance, a few definitions are necessary. **Luminous flux** is a term for the time rate of flow of light. A physical analogy to luminous flux is the water which flows from a sprinkler in operation. The common unit of measurement of luminous flux is the **lumen.** The illuminance on a surface is the density of the luminous flux which is striking it. A physical analogy to illuminance would be the rate of water spread by a sprinkler in terms of gallons per square feet (or liters per square meter in the SI system). The usual units of illuminance are lumens per square foot (American system) or lumens per square meter (SI system). One lumen per square foot is called one **foot-candle**; one lumen per square meter is called one **lux**. One foot-candle is approximately the same illuminance level as 11 lux, because there are 10.8 square feet in a square meter. The characterization and quantification of various properties and quantities of light involve concepts which seem quite abstract to those who don't work with such details.

To put illuminance numbers in some perspective, places where people read are commonly lighted to levels of 20 to 100 foot-candles (220 to 1100 lux). Fine machine work may require illumination of 500 foot-candles (5500 lux) or more. At sunset, ambient illuminance is generally near 30 foot-candles; at the end of civil twilight, the ambient illuminance from sunlight has usually fallen to a level of 0.3 foot-candle. We all know what sunrise and sunset mean; the United States Naval Observatory, the entity in the United States with the authority to describe times of sunrise, sunset, and descriptions of movements of other celestial bodies, has also specified periods after sunset or before sunrise. **Civil twilight** is a period of time after sunset/before sunrise which is nominally 30 minutes long. **Nautical twilight** refers to the next 30 minutes or so after sunset/before sunrise. **Astronomical twilight** refers to the next period of roughly 30 minutes after sunset/before sunrise. The length of each described zone of twilight will vary depending on season and on location. After the end of astronomical twilight at night/before the beginning of astronomical twilight in the morning, it is simply dark o'clock: Ambient illuminance levels from the effects of sunlight do not vary during the period between the end of astronomical twilight at night and the beginning of astronomical twilight in the morning.

Another celestial body which the USNO tracks and reports on is the moon—its position, phase, and moonrise and moonset times. Although a full moon may be an illumination benefit to a pedestrian, the illuminance from a full moon generally has no visual benefit to drivers of motor vehicles driving by headlights at night. Also, when considering the possible effects of moonlight, it is necessary to consider whether the moon is above or below the horizon. If the moon has set, a full moon is the same illuminance condition as a new moon—i.e., none.

Another factor affecting illuminance levels at night is cloud cover. In rural areas, cloud cover can reduce the already feeble ambient illuminance available at a given location at night. In areas near cities, however, the light pollution from those cities will be reflected from clouds if they are present, increasing the ambient illuminance at night, possibly even doubling it.

The human eye is capable of seeing over a very wide range of luminance levels. In light of sufficient intensity, we can see fine details, and in color. In very dim light, we can no longer see details, and, if the illuminance level is low enough, we won't see in color, but we can see to move around and discern shapes. But the human eye cannot see all objects at all times: When the eyes are accustomed to seeing by bright light, objects in darkness which don't have their own source of luminance will not be observed. When the eyes are accustomed to seeing by dim light, a rapid change to a region of bright light can produce an unpleasant reaction. If you have ever been to a matinee movie and left the theater while it was still daylight outside, you have experienced that sensation. It takes time to adjust to a large change in illuminance.

I have written all of this to address the topic of night-time pedestrian conspicuity. In a relatively dark environment, pedestrians can move and see well enough to travel to their destination or otherwise move about. Drivers of motor vehicles have headlights to illuminate some of the path in front of them. But the visual environments of the pedestrian and the driver are radically different. Because the pedestrian's eyes have (usually) adapted to a dimly-lit environment, he is able to see dimly-lit objects as well as objects with a large amount of luminance, like headlights of motor vehicles, and lack of contrast is usually not a condition which creates significant limitations. To the driver of a motor-vehicle operating at night with headlights, however, his eyes have adapted to a much higher level of luminance, mostly because of the light from headlights but also because of the light from the instrument panel and interior accessories. In regions directly illuminated by headlights, the driver can typically see details well and in color; in regions not directly illuminated by headlights, however, that driver is usually incapable of observing objects which do not provide luminance of some type. Retroreflective objects are specifically engineered to direct a large amount of whatever light strikes them back toward the source(s). Pedestrians and bicyclists often have their own electrically powered sources of luminance. A pedestrian or other object which is directly under a street light may be quite visible to drivers before their headlight beam is illuminating it; beware, if you are not directly under a street light or very close to its most brightly lit region, you are likely to be inconspicuous to motorists. A pedestrian who is wearing dark clothing with no retroreflective or self luminous attachments will generally not be observed by a driver unless and until that pedestrian is into or very near the vehicle's path. Pedestrians can usually see very well at night, and many believe that the drivers of motor vehicles can see them as well as they can see the motor vehicles. Not so! And therein lies the reason why there are so many pedestrian impacts by motor vehicles at night, after which the motorist will say something like, "I didn't see him until it was too late to avoid hitting him," or "I didn't know what I had hit until I stopped and got out of my car."

Numerous experiments, including some in which I participated, have repeatedly demonstrated two important factors in night driving: motorists do not see nearly as well by the light from their headlights as they believe, and pedestrians believe they are as visible to motorists as the motor vehicles are to them. Two wrongs make for pedestrian impacts at night, and pedestrians never win that contest. But they often want to blame the motorists for not seeing them when they were "in plain sight."

There is a different visibility problem also related to contrast but in the daytime. You have probably all experienced the difficulty when driving into a bright sun on a cloudless day. When the sun is directly above some object ahead of you, you generally cannot perceive that object until you are quite close to it. As a pedestrian, that's almost never a problem, except for the discomfort. As a motorist, however, traveling at highway speed, you may be closing on an object stopped in the road ahead at a rate of 90 feet per second or more; with the sun directly over or otherwise near the location of that object but not blocked by it, you may not be able to see it in time to avoid colliding with it. This situation is called **veiling luminance.** What is commonly called glare can be a problem, caused by light or images reflecting off a surface and possibly creating a veiling image on the inside of your windshield. Wearing glasses with polarized lenses will eliminate most of those "glare" problems, but sunglasses, polarized or not, have little effect in defeating veiling luminance.

The illuminance meter is very useful when evaluating a site where a pedestrian impact has occurred at night. The level of ambient illuminance in the region where the impact occurred can be a critical factor in evaluating how likely it is for a motorist to see a pedestrian. Clothing worn by a struck pedestrian is always an important element of a reconstruction. Please call if you have need of night conspicuity evaluations or whenever you have need of any of the other motor-vehicle-related services I offer.

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