

# Film speeds and characteristic curves

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Film speed is defined arithmetically as

$$S = \frac{0.8}{H_m} \quad (1)$$

where  $H_m$  is the exposure in lux-seconds that produces a density of 0.1 above film base + fog density at a specific contrast. The key point here is that you can calculate the minimum usable density produced on the negative for a given film's speed. For ISO 125,  $H_m = 0.0065$  lux-s.

The relationship between proper exposure and lighting conditions

$$\frac{A^2}{t} = \frac{LS}{K} \quad (2)$$

where  $A$  is the f/stop,  $t$  is the shutter speed in seconds,  $L$  is the scene luminance, and  $K$  is the meter calibration constant for reflected light, commonly 12.5. We know that the sunny-16 exposure for ISO 125 film is  $\frac{1}{125}$  s at f/16. We can use equation 2 to calculate the luminance of the scene to be  $L = 3200$  lux. There is an equivalent equation for equation 2 for incident meters

$$\frac{A^2}{t} = \frac{ES}{C} \quad (3)$$

where  $E$  is the illuminance and  $C$  is the incident meter calibration constant, usually 250–350 depending on the design of the meter.

The exposure at the film plan is

$$H = \frac{qLt}{A^2} \quad (4)$$

where  $H$  is exposure in lux-seconds.  $q$  is usually set to 0.65 and is derived from

$$q = \frac{\pi}{4} T v(\theta) \cos^4 \theta \quad (5)$$

with  $T = 0.9$  being the transmittance of the lens,  $v(\theta) = 0.98$  the vignetting factor, and  $\theta = 10^\circ$  the angle relative to the axis of the lens.

So, using our scene luminance of  $L = 3200$  lux and equation 4 we can calculate the exposure in lux-seconds at the film plane for our 18% gray that sunny-16 or our meter gives us.

$$H = \frac{0.65 \cdot 3200 \cdot \frac{1}{125}}{16^2} = 0.065 \quad (6)$$

The  $x$ -axis of a characteristic curve for film is given in units of  $\log_{10}(H)$ . So for our ISO 125 film, the minimum density is at  $\log_{10}(0.0065) = -2.19$  and the metered 18% gray is at  $\log_{10}(0.065) = -1.19$ , or  $1 \log_{10}(H)$  unit higher. Every 0.3 change in  $\log_{10}(H)$  is the equivalent of 1 stop, so a 1.0 change in  $\log_{10}(H)$  is  $3\frac{1}{3}$  stops. So, you get a hair more than 3 stops below your metered value and about 6–7 above your metered value for a film like Plus-X.

So, the take home message is that the metered point is 10 times higher than the density defined by the film speed in equation 1, which is equivalent to moving 1 unit to the right on the  $\log_{10}(H)$  axis.

This information was collected from the internet, mostly the Wikipedia entries for “Exposure Values” and “Film Speed.”