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Problem 44.43 (RHK)

A photographer stands 44.5 m *from a rail road track, the line of vision being perpendicular to the tracks. A train passes at* 135 km/h *and the photographer takes a picture. Using a camera with focal length* 3.6 cm, *we have to find the maximum exposure time so that the blurring of the image on the film does not exceed* 0.75 mm.

Solution:

As the photographer stands at a distance of 44.5 m from the railroad track, the image will be at the focal plane of the lens. Therefore, the image distance will be the focal length, which is 3.6 cm.

The line of sight of the photographer is perpendicular to the train. Let the shutter time for the exposure be t s. The train which is moving at 135 km/h will have travelled a distance of D m in t s. We want to adjust the maximum exposure time so that the blurring of the image on the film does not exceed 0.75 mm.

We use the result that the magnitude of the lateral magnification is given by

$$|m| = \left|\frac{i}{o}\right| = \frac{3.6\times10^{-2}}{44.5} = 8.0\times10^{-2}.$$

Therefore, D can be determined from the requirement that the size of the image is 0.75 mm. We find

$$D = \frac{0.75\times10^{-3}}{8.0\times10^{-2}}\ \text{m} = 0.93\ \text{m}.$$

As the train is moving at 135 km/h the maximum exposure time will therefore be

$$t = \frac{0.93}{135\times10^{3}/60\times60}\ \text{s} = 25\ \text{ms}.$$