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Another Angle on Perspective

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Fermi Questions

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Another angle on perspective

You are standing in the middle of a straight path of width W (the edges of which are parallel), looking along the midline. (It's a lot less dangerous than standing in the middle of train tracks, but the principle still applies there as well.) The horizontal distance along the path to any point on the midline is y. Perspective, of course, makes the edges (and shadows here) appear to converge to a point (the apex angle, A).

Question 1:

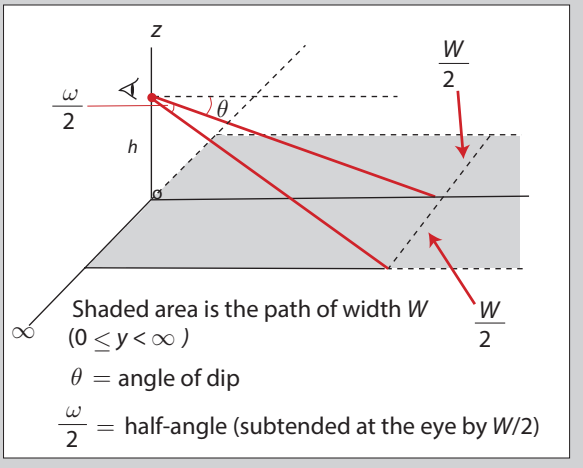
How does A depend on W, and the height h of your eyes above the ground, as your "angle of dip" (θ) approaches zero (i.e., y approaches infinity)? Under these circumstances, $A(\theta)$ is defined as the derivative $d\omega/d\theta$, where $\omega(\theta)$ is the angle subtended at your eye by the path width W.

Specifically, show using elementary geometry that

$$\omega(\theta) \approx 2\tan^{-1}\frac{\mu\theta}{2},$$

for small values of θ, where $\mu = W/h$ and $\tan\theta = h/y$.

In the US, the standard railroad gauge is 4 ft and 8.5 in. (~1.4 m).



(a) What is A (in degrees of arc) for a tall adult whose eyes are 1.8 m above the ground?

(b) What is A for an 8-yr-old whose eyes are 1.3 m above the ground?

(c) What is A for a mouse scurrying along the midline?

Question 2:

(i) Answer Question 1 parts (a) and (b) for the path in the first photograph for $W \approx 2.5$ m.

(ii) Answer Question 1(a) for the trellis above the observer, with $W^+ \approx 3$ m, $h^+ \approx 1.5$ m.

Look for the answers online at tpt.aapt.org under "Browse," at the very end of the current issue.

Fermi Questions *are brief questions with answers and back-of-the-envelope estimation techniques. To submit ideas, please email John Adam (jadam@odu.edu).*

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