Needham, VDGAF, Chapter 3, Exercise 12, p. 27.
Palmer, December 27, 2021, 4:50 pm PST

Photo 1

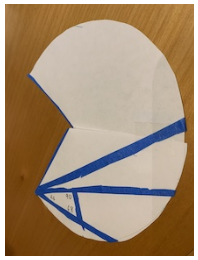

Photo 2

12. Zero Curvature.

(i) Roll up a piece of paper into a cone, and tape it so that it does not unfurl. Start to create a long geodesic segment originating at a point on the rim, but try to guess its form before you stick your strip down onto the surface. Starting at the same point on the rim, repeat this construction, launching new geodesics in different directions.

See photo 1.

(ii) Next, construct a geodesic triangle and use a protractor to verify that $\varepsilon = 0$. (This is true of all geodesic triangles on the surface, proving that $\mathcal{K} = 0$.)

See photo 2. From page 8, ε = (angle sum of triangle) - π. The angles 26, 68, and 90, measured with a protractor, are converted to radians: .42, 1.13, and 1.6.

$$\varepsilon = \{ .45 + 1.19 + 1.57\} - \pi \simeq 0.07 \text{ radians}$$

This is a remainder of less than .1, so it is about a 2 percent error on π, which is close to zero error given the crudeness of the method.

(iii) Finally, cut the cone (along a generator) and press the paper flat again, and observe the Euclidean form of your tape construction.

See photo 2