Principles of Astrophysics and Cosmology
Problem Set 10

JC-28) **2D Being on the Surface of a Sphere - Part I**

Suppose you are a two-dimensional being, living on the surface of a sphere with radius R. An object of width $ds << R$ is a distance r from you (remember, all distance are measured on the surface of the sphere). What angular width $d\theta$ will your measure for the object? Explain the behavior of $d\theta$ *as* $r \rightarrow \pi R$.

JC-29) **2D Being on the Surface of a Sphere - Part II**

Suppose you are *still* a two-dimensional being, living on the same sphere of radius R. Show that if you draw a circle of radius r, the circle's circumference will be

$$C = 2\pi R \sin\left(\frac{r}{R}\right)$$

Idealize the Earth as a perfect sphere if radius $R = 6371$ km. If you could measure distances with an error of ± 1 meter, how large a circle would you have to draw on the Earth's surface to convince yourself that the Earth is spherical rather than flat?

JC-30) **Fun with Triangles on Surfaces of Constant Curvature**

Consider an equilateral triangle, with sides of length L, drawn on a two-dimensional surface of constant curvature.

a) Can you draw an equilateral triangle of arbitrarily large area A on a surface with $k = +1$ and radius of curvature R? If not, what is the maximum possible value of A?
b) Can you draw an equilateral triangle of arbitrarily large area A on a surface with $k = 0$? If not, what is the maximum possible value of A?
c) Can you draw an equilateral triangle of arbitrarily large area A on a surface with $k = -1$? If not, what is the maximum possible value of A?