Homework 1

Due **September 3 by 11:59pm via Canvas upload**
Please show all work, writing solutions/explanations clearly, or no credit will be given. You are encouraged to work together, but everyone must turn in independent solutions; do not copy from others or from any other sources.

1. When viewed from Salt Lake City, Polaris lies roughly 49.3° from the zenith.
   (a) What is the latitude of Salt Lake City?
   (b) From SLC, what is the altitude of the South Celestial Pole?
   (c) From SLC, what is the minimum declination that a circumpolar star can have?

   Draw a diagram showing the angles or relationships used to find your answers.

2. Imagine you have been deployed to a future Moon base for a year-long mission. When gazing back at the Earth on occasion, which of the following properties of the Earth will change, and which will barely change, if at all? Explain your answers.
   - Right ascension
   - Declination
   - Altitude
   - Azimuth
   - Phase
   - Visible landforms

   Note that while the horizon coordinate system applies to your position on the Moon, the equatorial coordinate system can be shared by observers either on Earth or the Moon.

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Star	Right Ascension (α)	Declination (δ)
Alkaid	207.0°	+49.3°
Mizar	201.0°	+54.9°
Alioth	193.5°	+56.0°
Megrez	183.8°	+57.0°
Phecda	178.5°	+53.7°
Merak	165.5°	+56.4°
Dubhe	166.0°	+61.8°

3. The above table shows the right ascension and declination coordinates for the 7 brightest stars in the Big Dipper (Ursa Major).
   (a) What is the minimum latitude at which all of the Big Dipper stars in the table are circumpolar?
   (b) For what range of latitudes are none of these Big Dipper stars ever above the horizon?

4. Describe two ways in which our descendents, 10,000 years in the future, will see a different night sky than we see today.

5. Cosmic strings are hypothetical ∼1-dimensional topological defects in space-time that may have formed in the early universe. In the novel *Tides of Light* by Gregory Benford (also a physicist), an advanced alien civilization uses a cosmic string to bore a hole through the center of a planet to mine heavy metals in its core. The main character is tossed down the shaft through the planet and calculates how long the journey will take him, which is given as this equation in the 1989 paperback edition:

$$\text{time} = \left[\frac{\pi}{2} - \tan^{-1}\frac{v}{R\sqrt{\frac{4\pi}{3}G\rho}}\right]\frac{3}{4\pi G\rho}\,, \tag{1}$$

   where v is his initial velocity, R is the radius of the planet, G is the gravitational constant, and ρ is the planet's average density. Why won't this equation provide a correct estimate for the travel time through the planet? (HINT: You do not have to work through any physics.)