1. A sinusoidal gravity wave travels in the +z direction. The frequency is 1 kHz, and the distance change is 10^{-12}.

   (a) (3 pts.) Write metrics for the two independent, linearly polarized, gravity waves.

   (b) (3 pt.) Change one of the metrics so that it represents the same gravity wave but is algebraically different.

   (c) (3 pts.) There are 16 possible terms in the metric for a gravity wave. Why are there only two independent polarizations?

2. Let the metric for a gravitational wave be

$$ds^2 = -dt^2 + dx^2 + dy^2 + [1 + f(t - z)]dz^2 - f(t - z)dtdz,$$

   where $f(t-z)$ is an arbitrary function of $(t-z)$. At a given time t_0, $f(t_0-z)$ is nearly constant over the size of your gravity wave detector. Hint: This metric is not the same as the metric that we introduced in class on April 5, and the property that the coordinates of a mass are unchanged is untrue here.

   (a) (1 pt.) In which direction is the wave moving?

   (b) (7 pts.) Compute the distance between two parts of your gravity-wave detector at $(0, 0, 0, 0)$ and $(0, 0, 0, 1)$ with and without the wave.

   (c) (2 pts.) Explain why this wave is unphysical.

3. Consider the Römer, Einstein, and Shapiro time delays, equations 8–10 in Taylor, J, and Weisberg, J, 1989, ApJ, 345, 434. (There is a link on the syllabus.)

   (a) (6 pts.) Explain each time delay at a level appropriate for your little sister, who is enrolled in PHY183.

   (b) (6 pts.) For the binary pulsar 1913+16, estimate the magnitude of each time delay for the radio waves passing in the pulsar system and in the solar system. Your estimate need only be good to a factor of 10.