1. The sun exerts a force on a drop of water of mass *m* on earth. The drop is somewhere along the line between the centers of earth and the sun. The distance of the drop from the sun is $R_{es} + r$. The drop is on your kitchen table. The force exerted by the sun on the drop is

$$F_{sun} = -(GM_s m {R_{es}}^{-2})(1 - 2\left(\frac{r}{R_{es}}\right)).$$

   a. (3 pts.) What are the other forces on the drop?

   b. (3 pts.) Explain in what way the drop accelerates.

   c. (3 pts.) Calculate the value for the acceleration. Pick out the force that causes the acceleration.

2. Asteroid A is in the 1:3 resonance of Jupiter, and asteroid B is in the 11:30 resonance.

   a. (3 pts.) Asteroid A and Jupiter are close at point x. The very next time when they are close, where are they? Where are they at subsequent close approaches? How many orbits of Jupiter are needed for the positions to repeat?

   b. (3 pts.) How many orbits of Jupiter are needed for the positions to repeat for asteroid B?

   c. (3 pts.) Explain why Asteroid A cannot survive and Asteroid B can survive.

3. Suppose you are looking for asteroids at midnight. You point the telescope along the meridian toward the ecliptic. If you cannot remember Kepler's 3rd Law, read about it in the textbook. Useful conversions: $\pi \times 10^7$ s/yr; 2×10^5 arcsec/radian.

   a. (3 pts.) In 1 minute, how much does Earth move? (It takes the least amount of work to express your answer in AU.)

   b. (3 pts.) In 1 minute, how much does an asteroid with an orbital radius of 2.2 AU move?

   c. (3 pts.) You take two pictures a minute apart. With respect to the stars, how much does the asteroid move? Express your answer in arcsec. (A movement of 1 arcsec is easy to detect.)

   d. (3 pts.) Explain how you can find the distance of any newly discovered asteroid in your pictures.

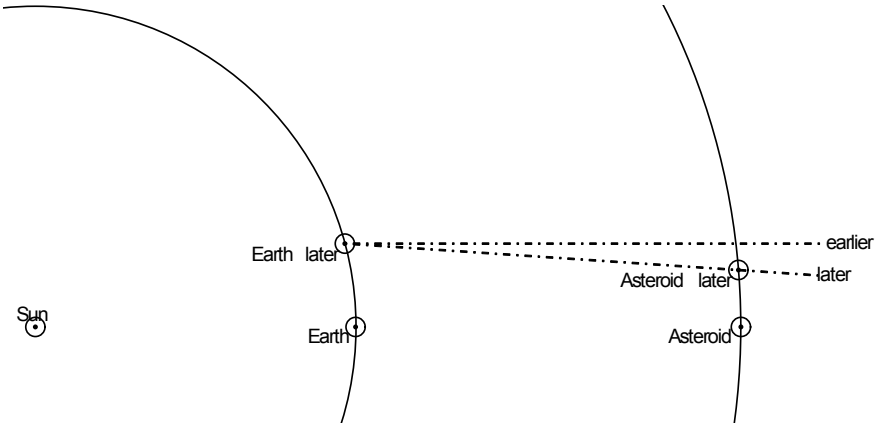

Figure 1 Earth and asteroid at two times. The dashed lines show the directions of the asteroid as viewed from earth at two times.