1) A comet with a sidereal period of 125 years moves in a highly elliptical orbit about the Sun. At perihelion, the comet comes very close to the Sun’s surface.
   a) What is the comet’s average distance from the Sun?
   b) What is the farthest it can get from the Sun?

2) A certain asteroid is 2.0 AU from the Sun at perihelion and 6.0 AU from the Sun at aphelion.
   a) Find the semimajor axis of the asteroid’s orbit.
   b) Find the sidereal period of the orbit.

3) A comet orbits the Sun with a sidereal period of 64.0 years.
   a) Find the semimajor axis of the orbit.
   b) At aphelion, the comet is 31.5 AU from the Sun. How far is it from the Sun at perihelion?
4) Suppose a newly discovered asteroid is in a circular orbit with a synodic period of 1.25 years. The asteroid lies between the orbits of Mars and Jupiter. (see “Box 4-1” of your textbook for help with this question)
   a) Find the sidereal period of the orbit.

   b) Find the distance from the asteroid to the Sun.

5) **Force & Acceleration:**
   a) How much force do you have to exert on a 3-kg brick to give it an acceleration of 2 m/s^2?

   b) If you double this force, what is the brick’s acceleration? Explain.

6) The mass of the Moon is $7.35 \times 10^{22}$ kg, while that of the Earth is $5.98 \times 10^{24}$ kg. The average distance from the center of the Moon to the center of the Earth is 384,400 km.
   a) What is the size of the gravitational force that the Earth exerts on the Moon?

   b) What is the size of the gravitational force that the Moon exerts on the Earth?
7) **Gravity:**
   a) Suppose that the Earth were moved to a distance of 3.0 AU from the Sun. How much stronger or weaker would the Sun’s gravitational pull be on the Earth? Explain.

   b) How far would you have to go from Earth to be completely beyond the pull of its gravity? Explain.

   c) Suppose that you traveled to a planet with 4 times the mass and 4 times the diameter of the Earth. Would you weigh more or less on that planet than on Earth, and if so, by what factor?

   d) The mass of Saturn is approximately 100 times that of Earth, and the semimajor axis of Saturn’s orbit is approximately 10 AU. To this approximation, how does the gravitational force that the Sun exerts on Saturn compare to the gravitational force that the Sun exerts on the Earth (numerically)?

   e) On Earth, a 50-kg astronaut weighs 490 newtons. What would she weigh if she landed on Jupiter’s moon Callisto?

   f) Calculate the escape velocity from the surface of Mars’ moon Phobos (mass = $1.1 \times 10^{16}$ kg, radius = 12 km).
8) A satellite is said to be in *geosynchronous orbit* if it appears always to remain over the exact same spot on Earth.
   a) What is the period of this orbit?

   b) At what distance from the center of the Earth must such a satellite be placed in orbit?

   c) Explain why the orbit must be in the plane of the Earth’s equator.

9) Energy:
   a) Metabolizing a candy bar releases about $10^6$ joules of energy. How fast must the candy bar travel to have the same $10^6$ joules in the form of kinetic energy? (assume the candy bar’s mass is 0.2 kg)

   b) Suppose that, through the horrific act of a powerful, angry creature, all the mass in your body was suddenly converted into energy according to the formula $E = mc^2$. How much energy would be produced? (for comparison, the energy released by a 1-megaton H-bomb is $5 \times 10^{13}$ joules)
10) **Light:**
   a) Approximately how many times around the Earth could a beam of light travel in one second?

   b) How long does it take light to travel from the Sun to the Earth, a distance of $1.50 \times 10^8$ km?

   c) A cellular phone is actually a radio transmitter and receiver. You receive an incoming call in the form of a radio wave of frequency 880.65 MHz. What is the wavelength (in meters) of this wave?

   d) A light source emits infrared radiation at a wavelength of 1150 nm. What is the frequency of this radiation?

   e) Your normal body temperature is 98.6°F (310 K). What kind of radiation do you predominantly emit, and at what wavelength (in nm)?

11) The observing cage in which an astronomer sits at the prime focus of the 5-m telescope on Palomar Mountain is about 1 m in diameter. Calculate what fraction of the incoming starlight is blocked by the cage.
12) Suppose your Newtonian reflector has an objective mirror 20 cm (8 in) in diameter with a focal length of 2 m.
   a) What magnification do you get with an eyepiece of focal length 9 mm?
   b) …of 20 mm?
   c) … of 55 mm?
   d) What is the telescope’s *diffraction-limited angular resolution* when used with orange light of wavelength 600 nm? (see page 129 of your textbook for help)

13) The four largest moons of Jupiter are roughly the same size as our Moon and are about 628 million (6.28 x 10^8) kilometers from Earth at opposition.
   a) What is the size in kilometers of the smallest surface features that the Hubble Space Telescope (resolution of 0.1 arcsec) can detect?
   b) What is the size in kilometers of the smallest surface features that can be seen on our Moon with the unaided human eye (resolution of 1 arcmin)?