# Advanced Kepler's Laws w/ Newton's Laws of Gravitation

**Solve the following problems**

1. (Walker, p. 379, #26) Phobos, one of the moons of Mars, orbits at a distance of 9378 km from the center of the red planet. What is the period of Phobos?

2. (Walker, p. 379, #27) The largest moon in the solar system is Ganymede, a moon of Jupiter. Ganymede orbits at a distance of $1.07 \times 10^9$ m from the center of Jupiter with a period of about $6.18 \times 10^5$ s. Using this information, find the mass of Jupiter.

3. (Walker, p. 379, #29) A typical GPS (Global Positioning System) satellite orbits at an altitude of $2.0 \times 10^7$ m. Find **(a)** the orbital period, and **(b)** the orbital speed of such a satellite.

4. (Walker, p. 378, #30) Two satellites orbit the Earth, with satellite 1 at a greater altitude than satellite 2. **(a)** Which satellite has the greater orbital speed? Explain. **(b)** Calculate the orbital speed of a satellite that orbits at an altitude of one Earth radius above the surface of the Earth. **(c)** Calculate the orbital speed of a satellite that orbits at an altitude of two Earth radii above the surface of the Earth.

5. (Walker, p. 378, #33) Centauri A and Centauri B are binary stars with a separation of $3.45 \times 10^{12}$ m and an orbital period of $2.52 \times 10^{9}$ s. Assuming the two stars are equally massive (which is approximately the case), determine their mass. Find the speed of Centauri A and Centauri B, using the information provided.

6. (Walker, p. 378, #23) On Apollo missions to the Moon, the command module orbited at an altitude of 110 km above the lunar surface. How long did it take for the command module to complete one orbit?

7. (Walker, p. 378, #24) Find the orbital speed of a satellite in a circular orbit 1700 km above the surface of the Earth.

8. (Serway, p. 251, #2) At what distance above Earth would a satellite have a period of 125 min?

9. (Serway, p. 253, #5) Find the orbital speed and period of Earth's moon. The average distance between the centers of Earth and of the moon is $3.84 \times 10^{8}$ m.

10. (Serway, p. 264, #27) What would be the orbital speed and period of a satellite in orbit $1.44 \times 10^8$ m above Earth?

11. (Serway, p. 264, #28) A satellite with an orbital period of exactly 24.0 h is always positioned over the same spot on Earth. This is known as a geosynchronous orbit. Television, communication, and weather satellites use geosynchronous orbits. At what distance would a satellite have to orbit Earth in order to have a geosynchronous orbit?

12. (Serway, p. 264, #29) The distance between the centers of a small moon and a planet in our solar system is 2.0 × 108 m. If the moon's orbital period is $5.0 \times 10^4$ s, what is the planet?

13. (Giancoli, p. 142, # 56) Our Sun rotates about the center of the Galaxy $\left(M_G \approx 4\times10^{41}\ \text{kg}\right)$ at a distance of about $3\times10^4$ light-years $\left(1\,\text{ly} = 3\times10^8\ \text{m/s}\times3.16\times10^7\ \text{s/y}\times1\,y\right)$. What is the period of our orbital motion about the center of the Galaxy?