1. A turntable rotates 33.3 rpm. Find the speed and period of an object on the turntable 9.00 cm from the center. Repeat for an object 18.0 cm from the center.

2. A car moves with uniform speed counterclockwise around a circular track and completes 1.00 revolution in 24.0 seconds. The car's position is 10$\underline{0}$ m , 90.0° from the center at $t = 0.00$ s. (a) Find the car's speed. (b) Find the distance the car travels in 60.0 s. (c) Determine the displacement during the interval from $t = 0.00$ s to $t = 60.0$ s.

3. Find the speed of a person standing on the surface of the Earth at the equator. (a) Find the speed of the person relative to the Earth's axis. (b) Find the speed of the Earth's axis relative to the Sun. (c) Find the speed of the person relative to the Sun. Helpful info:
orbital radius = 149.6 Gm, Earth radius = 6378 km
(Optional challenge – adjust for your latitude!)

4. Find the frequency and period of rotation for the wheel of a car traveling at 25 m/s given its diameter is 65 cm. Hint: relative to the axle of the wheel, the tread of the tire is moving at 25 m/s in the opposite direction of the car.

5. A 1500 kg car travels clockwise at a speed of 10.0 m/s around a curve with radius 80.0 m. For the point on the curve that is farthest to the east find: velocity, acceleration, and net force.

6. An object of mass 37.0 g moves in a circle with radius 0.400 m. Measure the time to complete 10 revolutions and then determine the following: (a) Find the speed. (b) Find the centripetal acceleration. (c) Find the centripetal force. (d) Identify the centripetal force(s) on the object.

7. Use a force sensor and gyro to measure the motion of a rubber stopper moving in a circle at various speeds. Use Graphical Analysis to create a graph of force vs. speed squared. Apply an appropriate curve fit – does this support the concept $a = v^2/r$? Use a coefficient of the equation to determine the mass of the stopper and compare.

8. A mass of 25<u>0</u> g is tied to the end of a string and slung counterclockwise in a horizontal circle of radius 70.0 cm. The tension in the string is 40.0 N. Ignore the effect of gravity. For the northern most point in the circle find: acceleration and velocity.

9. A fan cart is placed on a horizontal track that can be spun in a circle. Measure the period and radius at which the cart remains at rest relative to the track. Calculate the centripetal acceleration. Measure the acceleration of the fan cart on the stationary track and compare.

10. A toy hovercraft is acted upon by a certain force and moves in a circular path. Predict the period of its motion given measurements of its mass, radius, and the force.

11. A small wooden block is placed on a revolving platter at a distance of 15.0 cm. Given the static coefficient of friction is 0.40, determine the maximum number of rpm the block can undergo without sliding off the platter.

12. A mass is attached to one end of a string and the other end is fixed to a support. The mass is then twirled in a horizontal circle so that the string traces out the shape of a cone. (This is called a conical pendulum.) Predict the period of such an arrangement based on measurements of the length of the string and the radius of the circular path.

13. As a test of a car's cornering ability it is driven around a circular track with radius 75.0 m at increasing speeds until it skids off the track. If the minimum period possible is 19.5 s, what is the car's maximum centripetal acceleration? (Sometimes called "lateral acceleration".)

14. (a) Given the skidpad results for a certain car, determine its maximum speed on the test track.
(b) Use the car's mass to determine the maximum amount of friction as the car corners.
(c) Determine the static coefficient of friction. (What assumption must be made?)
(d) Determine the maximum speed for the same car traveling around the FHS parking lots, which have radii: 3<u>0</u> m, 57 m, and 78 m.

15. A car with velocity 30.0 m/s, 90.0° goes around a curve with radius 1720 m and attains a new velocity of 30.0 m/s, 95.0°. (a) Determine the time for this change in direction to occur. (b) Determine the acceleration, including direction, halfway through the curve.

16. In a classroom demonstration the instructor swings a cup of water (upside down) over his head. Assuming the radius of the cup's path is 4$\underline{0}$ cm, what is the minimum speed at the top of the path that will prevent the water from falling out of the cup?

17. A space station shaped like a huge wheel has diameter 100.0 m. In order to produce "artificial gravity" at the rim, the wheel must be rotated about its center. Determine the number of revolutions per minute required to simulate Earth's gravity.

18. Two boxcars sit on a railroad track. Boxcar B has mass 3.00×10^5 kg and its center is 25.0 m, 0.0° from the center of boxcar A, which has a mass of 4.50×10^5 kg. (a) Determine the acceleration of each boxcar assuming there is no friction. (b) What is the minimum coefficient of static friction in order to prevent either car from moving?

19. A 125-kg astronaut is on a spacewalk outside the space shuttle (mass 79000 kg). Suppose the astronaut is at rest at a position 11.0 m from the center of mass of the shuttle. Estimate the amount of time for the astronaut to be pulled 1.0 meter by the gravity of the shuttle.

20. Determine the mass of the Earth given that it pulls a 0.500 kg object with 4.90 N of force.

21. A certain person weighs $80\underline{0}$ N on Earth. What would the force of gravity be on this person in orbit 1500 km above the Earth's surface? Is he weightless?

22. On July 4, 1997, the Pathfinder spacecraft landed on Mars (mass 6.42×10^{23} kg and radius 3394 km). After drifting down on a parachute, it was released from rest at 20.0 m above the surface. The Pathfinder delivered to Mars the robotic rover Sojourner with mass 11.5 kg.
(a) Find the impact speed of the spacecraft hitting the surface. (b) Find the weight of Sojourner on the surface of Mars and on the surface of Earth.

23. At what distance from the center of the Earth would an object freefall at 9.78 m/s^2? At what altitude is this? (This basically tells us the “limit” of the value g = 9.80 m/s^2.)

24. Determine the value of g at the surface of a solar system body of your choice.

25. Select a satellite from the J-Track database and based on its altitude determine its speed and period.

26. The spacecraft Mars Global Surveyor orbits Mars at an altitude of 35$\underline{0}$ km. (a) In order to achieve this orbit what speed was required of it? (b) What is its period of revolution?

27. Use the circular orbit of one of Jupiter's moons to determine the mass of the planet:

Io:	$r = 421.8$ Mm	$T = 1.76$ d
Europa:	$r = 671.1$ Mm	$T = 3.52$ d
Ganymede:	$r = 1.070$ Gm	$T = 7.16$ d
Callisto:	$r = 1.883$ Gm	$T = 16.7$ d

28. An announcer on TV states that the space shuttle is orbiting at 17500 mph (7820 m/s). Determine the altitude and period of its orbit, assuming it to be circular.

29. A GPS satellite is designed to have a period of 11 hours 58 minutes. What must be its orbital radius?

30. A block of 2.00 kg is attached to the free end of a certain steel spring with constant 72.0 N/m, which hangs from the ceiling. (a) Determine the period with which the mass bobs up and down. (b) What amount of mass added to or subtracted from the block would result in a doubling of this period?

31. The weight of a 475 N kid compresses the spring in a pogo stick by 10.0 cm when the kid is at rest atop it. (a) Determine the frequency of the kid bouncing atop the pogo stick, assuming it does not come off the ground. (b) A different kid on the same pogo stick bounces with frequency 2.00 Hz – what is the weight of this kid?

32. After freefalling from a bridge a bungee jumper of mass 68 kg is left bouncing up and down with period 3.0 s and amplitude 1.5 m. (a) Determine the spring constant of the bungee, assuming it follows Hooke's Law. (b) What is the maximum rate of acceleration as the person bounces?

33. Determine the period of a pendulum of length: (a) 0.15 m and (b) 0.60 m.

34. Use the length of a pendulum and a graph of its position vs. time to determine the gravitational field strength in this location.