Oscillation and Rotation Review questions

1. A spring stretches by 0.015 m when a 1.75 kg object is suspended from its end. If its frequency of vibration is *f* = 3.0 Hz, what is the period of the motion? Through what distance does the mass move in 12.0 seconds? What is the spring constant of the spring?
2. An oscillating block-spring system has a mechanical energy of 1.00 J, an amplitude of 10.0 cm, and a maximum speed of 1.20 m/s. Find the spring constant, the mass of the block, and the frequency of oscillation.
3. A 0.45 kg mass is attached to a spring with a force constant of 26.0 N/m and released from rest a distance of 3.25 cm from the equilibrium position of the spring. (a) What is the period of the mass? (b) Use conservation of energy to find the speed of the mass when it is halfway to the equilibrium position. (c) What is the maximum speed of the mass?
4. Our sun is 2.3 x 104 light years from the center of our Milky Way galaxy and is moving roughly in a circle around that center at a speed of 250 km/s. How long does it take the Sun to make one revolution about the galactic center? B) How many revolutions has the Sun completed since it was formed about 4.5 x 109 years ago. (Hint: a light year is the distance that light can travel in one year at 3 x 108 m/s.)
5. A pulley wheel that is 8.0 cm in diameter has a 5.6 m long cord wrapped around its periphery. Starting from rest, the wheel is given a constant angular acceleration of 1.5 rad/s2. a) Through what angle must the wheel turn for the cord to unwind? b) How long does the unwinding take?
6. A flywheel of radius 2.83 cm is accelerated from rest at 14.2 rad/s2 until its angular speed is 2760 rev/min. a) What is the tangential acceleration of a point on the rim of the flywheel? b) Through what distance does a point on the rim move during the acceleration?
7. A communications satellite is a solid cylinder with a mass of 1210 kg, a diameter 1.21 m, and a length of 1.75 m. Prior to launching from the shuttle cargo bay, it is set spinning at 1.52 rev/s about the cylinder axis. Calculate the satellite’s a) moment of inertia about the rotation axis and b) the rotational kinetic energy.
8. A small 0.75 kg ball is attached to one end of a 1.25 m long massless rod, and the other end of the rod is hung from a pivot. When the resulting pendulum is 30° from the vertical, what is the magnitude of the torque about the pivot?
9. Two blocks with a mass of 2.50 kg are suspended from the ends of a rigid weightless rod of 1.00 m length. If a fulcrum is placed 20.0 cm from one end, find the initial acceleration of the blocks when they begin to move.
10. A uniform sphere rolls down an incline. a) What must be the incline angle if the linear acceleration of the center of the sphere is to be 0.10g? b) For this angle, what would be the acceleration of a frictionless block sliding down the incline?
11. Suppose that the Sun runs out of nuclear fuel and suddenly collapses to form a white dwarf star, with a diameter equal to that of the Earth. Assuming no mass loss, what would then be the Sun’s new rotation period, which currently is about 25 days for one rotation? (mass of sun = 1.99 x 1030 kg; radius of Earth = 6.37 x 106m, radius of Sun = 6.96 x 108m)
12. A hemispherical sign 1.0 m in diameter and of uniform mass density is supported by two strings as shown. What is the tension in each string if the sign has a mass of 65.0 kg?
13. Challenge Bonus equilibrium question: Sir Lost-a-Lot dons his armor and sets out from the castle on his trusty steed in his quest to rescue fair damsels from dragons. Unfortunately his aide lowered the drawbridge too far and finally stopped it 20.0° below the horizontal. Sir Lost-a-lot and his steed stop when their combined center of mass is 1.0 m from the end of the bridge. The bridge is 8.0 m long and has a mass of 2 000 kg; the lift cable is attached to the bridge 5.0 m from the castle end and to a point 12.0 m above the bridge. Sir Lost's mass combined with his armor and steed is 1 000 kg.

(a) Determine the tension in the cable and

(b) the horizontal and vertical force components acting on the bridge at the castle end.