

## Honors Physics – Ch 7 Practice Problems

1. An astronomer at the equator measures the Doppler shift of sunlight at sunset. From this, she calculates that Earth's tangential velocity at the equator is 465 m/s. The centripetal acceleration at the equator is  $3.41 \times 10^{-2} \text{ m/s}^2$ . Use this data to calculate Earth's radius.
2. With an average mass of only 30.0 g, the mouse lemur of Madagascar is the smallest primate on Earth. Suppose this lemur swings on a light vine with a length of 2.4 m, so that the tension in the vine at the bottom point of the swing is 0.393 N. What is the lemur's tangential speed at that point?
3. In 1992, a team of 12 athletes from Great Britain and Canada rappelled 446 m down the CN Tower in Toronto, Canada. Suppose an athlete with a mass of 75.0 kg, having reached the ground, took a joyful swing on the 446 m-long rope. If the speed of the athlete at the bottom point of the swing was 12 m/s, what was the centripetal force? What was the tension in the rope? Neglect the rope's mass.
4. The passenger liners *Carnival Destiny* and *Grand Princess*, built recently, have a mass of about  $1.0 \times 10^8 \text{ kg}$  each. How far apart must these two ships be to exert a gravitational attraction of  $1.0 \times 10^{-3} \text{ N}$  on each other?
5. Jupiter, the largest planet in the solar system, has a mass 318 times that of Earth and a volume that is 1323 times greater than Earth's. Calculate the magnitude of the gravitational force exerted on a 50.0 kg mass on Jupiter's surface.
6. The period of Mars' rotation is 24 hours, 37 minutes, and 23 seconds. At what altitude above Mars would a "Mars-stationary" satellite orbit?
7. V404 Cygni is a dark object orbited by a star in the constellation Cygnus. Many astronomers believe the object is a black hole. Suppose the star's orbit has a mean radius of  $2.30 \times 10^{10} \text{ m}$  and a period of 6.47 days. What is the mass of the black hole? How many times larger is the mass of the black hole than the mass of the sun?
8. A meterstick of negligible mass is fixed horizontally at its 100.0 cm mark. Imagine this meterstick used as a display for some fruits and vegetables with record-breaking masses. A lemon with a mass of 3.9 kg hangs from the 70.0 cm mark, and a cucumber with a mass of 9.1 kg hangs from the  $x$  cm mark. What is the value of  $x$  if the net torque acting on the meterstick is 56.0 N·m in the counterclockwise direction?
9. A catapult, a device used to hurl heavy objects such as large stones, consists of a long wooden beam that is mounted so that one end of it pivots freely in a vertical arc. The other end of the beam consists of a large hollowed bowl in which projectiles are placed. Suppose a catapult provides an angular acceleration of  $50.0 \text{ rad/s}^2$  to a  $5.00 \times 10^2 \text{ kg}$  boulder. This can be achieved if the net torque acting on the catapult beam, which is 5.00 m long, is  $6.25 \times 10^5 \text{ N}\cdot\text{m}$ .
  - a. If the catapult is pulled back so that the beam makes an angle of  $10.0^\circ$  with the horizontal, what is the magnitude of the torque produced by the  $5.00 \times 10^2 \text{ kg}$  boulder?
  - b. If the force that accelerates the beam and boulder acts perpendicularly on the beam 4.00 m from the pivot, how large must that force be to produce a net torque of  $6.25 \times 10^5 \text{ N}\cdot\text{m}$ ?