

## Assignment 6

1. A person stands at the equator of Mars.
  - a) What is the person's velocity due to the rotation of the Earth?
  - b) What is the centripetal acceleration and how does this compare to gravity?
2. Estimate the angular momentum and energy of the following:
  - a) the rotating Mars.
  - b) the motion of Mars orbiting around the Sun
3. Estimate the moment of inertia of a nitrogen molecule.
4. A car wheel has a mass of 80 kg which can be viewed as contained only on the rim which has a radius of 25 cm. The car travels at 120 km/hr.
  - a) What is the angular momentum of the wheel?
  - b) What is the rotational energy of the wheel?
  - c) What torque must be applied if the wheel is braked to a halt in 10 seconds?
5. A cylinder of uniform mass  $M$  and radius  $R$  rolls down an inclined ramp beginning at a height of 4 meters.
  - a) What is the final velocity of the cylinder?
  - b) Repeat the problem if the cylinder is hollow. (neglect the mass in the ends of the can)
6. Explain why a twirling skater speeds up if they bring their arms closer to their body.
7. A scientist proposes construction of a space elevator by using a steel wire to raise a mass from the Earth's surface to a satellite 1000 km above the Earth's surface. Assume the steel wire has a diameter of 1 mm.
  - a) What is the mass of the wire?
  - b) Estimate the extension of the wire due to its weight. Assume that all parts of the wire experience the same acceleration of gravity as at the surface of the Earth.
  - c) Is this realistic?
8. Greenland Icecap
  - a) Estimate the rise in sea level if the Greenland ice cap fully melts.
  - b) How much does your answer change if you also consider the melting of ice in the waters surrounding Greenland?

9. A cube having volume  $100 \text{ cm}^3$  floats in water.
- If 70% of the cube is submerged, what is its density?
  - The cube is next placed in an unknown liquid and 90% of it is submerged. What is the density of the liquid?
10. A water tank has a small hole near its bottom at a depth  $h$  from the top surface. What is the speed of the stream of water emerging from the hole?
11. Gas Pressure
- Estimate the density of air at sea level and a temperature of  $20^\circ\text{C}$ .
  - Consider a nitrogen molecule travelling at the speed of sound that bounces perpendicularly off the wall of a chamber. Assume its speed is not changed while its direction is reversed. What momentum is transferred to the wall?
  - Estimating the number of collisions per  $\text{m}^2$  per second with the wall by multiplying the half the particle density times the speed. (The factor half takes into account that the molecules move randomly and only half have a velocity component toward the wall.)
  - Estimate the gas pressure.