

**Atmospheric Sciences 336, Fall 2007**  
**Problem Set 6**  
**Due Wednesday, Nov 14**

**Problem 1** *When gravity is more than just  $g$*

Since the earth is not exactly spherical, the radius of the earth at the equator is larger than the radius at the pole. Suppose that the equatorial radius is given by  $a_e = 6378$  km while the polar radius is  $a_p = 6356$  km. And let the angular frequency of the earth be given by  $\Omega = 7.292 \times 10^{-5} \text{ s}^{-1}$ . If your weight were measured at both the equator and the pole, how much smaller would it be at the equator? (Express your answer as a percentage difference.)

**Problem 2** *Coriolis in the commode*

Consider the approximately circular motion of water as it circles a bathtub drain at a latitude of  $43^\circ\text{N}$ . Suppose that the radius of the circular motion is roughly  $0.25$  m and that the water completes a full circuit around the drain in roughly  $4$  s. What is the ratio of the acceleration to the Coriolis force for this motion? Does Coriolis play an important role in the dynamics?

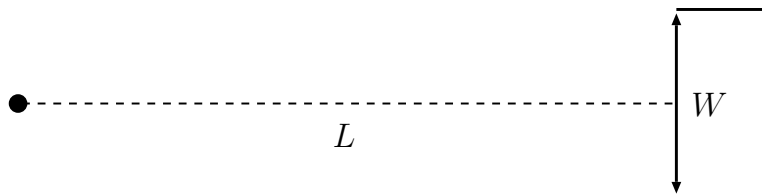
**Problem 3** *He shoots....really slowly....and misses!*

Suppose a hockey puck is placed a distance of  $L = 20$  m from the center of the goalmouth as illustrated below. Let the full width of the goal be  $W = 2$  m. We'll assume that (i) the ice is frictionless and (ii) the puck stays in contact with the ice so that all forces in the vertical are balanced. The acceleration of the puck is then given by

$$\frac{du}{dt} = fv \quad \text{and} \quad \frac{dv}{dt} = -fu$$

where  $f = 2\Omega \sin \phi$  is the Coriolis parameter. Take the latitude to be  $\phi = 43^\circ\text{N}$ .

Suppose that the initial velocity of the puck (immediately after being struck) is  $U_0$  in the  $x$  direction. What is the minimum  $U_0$  needed to hit the goal?



[*Hint:* Assume that the total deflection of the puck in the  $y$  direction is small (less than  $1$  m anyway) so that the  $v$  component of velocity is always much smaller than  $u$ . Then it's probably safe to assume that the  $fv$  term in the momentum equations must be pretty small—small enough to be neglected.]