Name:_____ Class:_____ Date:_____

Circular Motion and Gravitation

# Problem B

## CENTRIPETAL FORCE

### PROBLEM

The royal antelope of western Africa has an average mass of only 3.2 kg. Suppose this antelope runs in a circle with a radius of 30.0 m. If a force of 8.8 N maintains this circular motion, what is the antelope's tangential speed?

### SOLUTION

**Given:** $m = 3.2\ \text{kg}$
$r = 30.0\ \text{m}$
$F_c = 8.8\ \text{N}$

**Unknown:** $v_t = ?$

Use the equation for centripetal force, and rearrange it to solve for tangential speed.

$$F_c = \frac{mv_t^2}{r}$$

$$v_t = \sqrt{\frac{F_c r}{m}} = \sqrt{\frac{(8.8\ \text{N})(30.0\ \text{m})}{3.2\ \text{kg}}} = \sqrt{82\frac{\text{m}^2}{\text{s}^2}}$$

$$v_t = 9.1\ \text{m/s}$$

### ADDITIONAL PRACTICE

1. **Gregg Reid of Atlanta, Georgia, built a motorcycle that is over 4.5 m long and has a mass of 235 kg. The force that holds Reid and his motorcycle in a circular path with a radius of 25.0 m is 1850 N. What is Reid's tangential speed? Assume Reid's mass is 72 kg.**

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?**

$F_T = F_c + F_g$

3. In 1994, Mata Jagdamba of India had very long hair. It was 4.23 m long. Suppose Mata conducted experiments with her hair. First, she determined that one hair strand could support a mass of 25 g. She then attached a smaller mass to the same hair strand and swung it in the horizontal plane. If the strand broke when the tangential speed of the mass reached 8.1 m/s, how large was the mass?

4. **Pat Kinch used a racing cycle to travel 75.57 km/h. Suppose Kinch moved at this speed around a circular track. If the combined mass of Kinch and the cycle was 92.0 kg and the average centripetal force was 12.8 N, what was the radius of the track?**

**5. 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.**