PRACTICE A

Centripetal Acceleration

1. A rope attaches a tire to an overhanging tree limb. A girl swinging on the tire has a centripetal acceleration of 3.0 m/s^2. If the length of the rope is 2.1 m, what is the girl's tangential speed?

2. As a young boy swings a yo-yo parallel to the ground and above his head, the yo-yo has a centripetal acceleration of 250 m/s^2. If the yo-yo's string is 0.50 m long, what is the yo-yo's tangential speed?

3. A dog sits 1.5 m from the center of a merry-go-round. The merry-go-round is set in motion, and the dog's tangential speed is 1.5 m/s. What is the dog's centripetal acceleration?

4. A race car moving along a circular track has a centripetal acceleration of 15.4 m/s^2. If the car has a tangential speed of 30.0 m/s, what is the distance between the car and the center of the track?

Tangential acceleration is due to a change in speed

You have seen that centripetal acceleration results from a change in direction. In circular motion, an acceleration due to a change in speed is called *tangential acceleration.* To understand the difference between centripetal and tangential acceleration, consider a car traveling in a circular track. Because the car is moving in a circle, the car has a centripetal component of acceleration. If the car's speed changes, the car also has a tangential component of acceleration.

Figure 3
When a ball is whirled in a circle, it is acted on by a force directed toward the center of the ball's circular path.

CENTRIPETAL FORCE

Consider a ball of mass m that is tied to a string of length r and that is being whirled in a horizontal circular path, as shown in **Figure 3.** Assume that the ball moves with constant speed. Because the velocity vector, **v,** continuously changes direction during the motion, the ball experiences a centripetal acceleration that is directed toward the center of motion. As seen earlier, the magnitude of this acceleration is given by the following equation:

$$a_c = \frac{v_t^2}{r}$$

The inertia of the ball tends to maintain the ball's motion in a straight path. However, the string exerts a force that overcomes this tendency. The forces acting on the ball are gravitational force and the force exerted by the string, as shown in **Figure 4(a)** on the next page. The force exerted by the