NAME _____ DATE _____ CLASS _____

Circular Motion and Gravitation

Problem A

CENTRIPETAL ACCELERATION

PROBLEM

The most violent part of a hurricane is at the edge of the hurricane's eye. This region, called the *eyewall,* can have winds with speeds of more than 300 km/h. Suppose winds in a hurricane's eyewall have a tangential speed of 82.2 m/s. If the eyewall is 25 km from the center of the hurricane, what is the magnitude of the centripetal acceleration of particles in the eyewall?

SOLUTION

Given: $v_t = 82.2$ m/s

$r = 25$ km

Unknown: $a_c = ?$

Use the centripetal acceleration equation for a_c in terms of v_t and r.

$$a_c = \frac{v_t^2}{r} = \frac{(82.2 \text{ m/s})^2}{25 \times 10^3 \text{ m}}$$

$$a_c = \boxed{0.27 \text{ m/s}^2}$$

ADDITIONAL PRACTICE

1. Because of the conditions that give rise to them, tornadoes do not have the widespread destructive effects of hurricanes. Nevertheless, the winds encountered in some tornadoes are even greater than those at the eyewall of a hurricane. Suppose a small pebble is swept up in a tornado. The pebble is 3.81 m from the center of the tornado and has a tangential speed equal to that of the surrounding wind: 124 m/s. What is the magnitude of the centripetal acceleration of the pebble?

2. A type of pinball machine uses a spinning rubber disk to deflect the ball. Suppose this disk has a radius of 6.50 cm, and the disk is horizontal so that gravity does not also affect the ball's motion. Calculate the magnitude of the ball's centripetal acceleration when the ball has a tangential speed of 1.95 m/s at the outer edge of the disk.

3. A customer sits in a revolving restaurant 11 m from the center. If the customer's tangential speed is 1.92×10^{-2} m/s, how large a centripetal acceleration does the customer experience?

4. NASA uses large centrifuges to study the effects of large forces on astronauts prior to their going into space. A subject in the 20-G centrifuge, which has a radius of 8.9 m, can have a centripetal acceleration as large as $20.0g$, where g equals 9.81 m/s^2. What is the tangential speed of the subject?

5. A rotating furnace has been developed recently to give a rough parabolic curve to molten glass. This makes the manufacture of very large telescope mirrors easier and more economical than ever before. The largest mirror made in this furnace to date has a radius of 4.2 m. While in the furnace, the centripetal acceleration of the molten glass for this mirror was 2.13 m/s^2. What was the tangential speed at the edge of the molten glass?

6. For several decades the idea of an orbiting space colony has been discussed. The colony would consist of a large hollow cylinder that rotates at a constant angular speed. Colonists would live on the inner wall of the cylinder, where centripetal acceleration would simulate free-fall acceleration at Earth's surface. If the structure has an inner radius of 150 m, what would the tangential speed of a colonist standing on the cylinder's inner wall be?

7. The Indianapolis Motor Speedway has four banked curves, each of which forms a quarter of a circle. Suppose a race car speeds along one of these curves with a constant tangential speed of 75.0 m/s. Neglecting the effects due to the banking of the curve, the centripetal acceleration on the car is 22.0 m/s^2. What is the radius of the curve?

8. A quarter placed on a turntable has a centripetal acceleration of 2.0 m/s^2 and a tangential speed of 0.57 m/s. How far is the quarter from the center of the turntable?

9. A model electric train moves along a circular track. The train has a tangential speed of 0.35 m/s and has a centripetal acceleration of 0.29 m/s^2. What is the radius of the track?

10. A roller-coaster has a loop-the-loop in which the centripetal acceleration on the cars and passengers just equals 9.81 m/s^2. If the tangential speed of the roller-coaster cars is 15.7 m/s, what is the radius of the loop-the-loop?