Circular Motion and Gravitation

ADDITIONAL PRACTICE A

Givens	*Solutions*
1. $v_t = 0.17$ m/s $a_c = 0.29$ m/s^2	$r = \frac{v_t^2}{a_c} = \frac{(0.17 \text{ m/s})^2}{0.29 \text{ m/s}^2} = \boxed{0.10 \text{ m}}$
2. $v_t = 465$ m/s $a_c = 3.4 \times 10^{-2}$ m/s^2	$r = \frac{v_t^2}{a_c} = \frac{(465 \text{ m/s})^2}{3.4 \times 10^{-2} \text{ m/s}^2} = \boxed{6.4 \times 10^6 \text{ m}}$
3. $r = \frac{58.4 \text{ cm}}{2} = 29.2$ cm $a_c = 8.50 \times 10^{-2}$ m/s^2	$v_t = \sqrt{ra_c} = \sqrt{(29.2 \times 10^{-2} \text{ m})(8.50 \times 10^{-2} \text{ m/s}^2}$ $v_t = \boxed{0.158 \text{ m/s}}$
4. $r = \frac{12 \text{ cm}}{2} = 6.0$ cm $a_c = 0.28$ m/s^2	$v_t = \sqrt{ra_c} = \sqrt{(6.0 \times 10^{-2} \text{ m})(0.28 \text{ m/s}^2)} = \boxed{0.13 \text{ m/s}}$
5. $v_t = 7.85$ m/s $r = 20.0$ m	$a_c = \frac{v_t^2}{r} = \frac{(7.85 \text{ m/s})^2}{20.0 \text{ m}} = \boxed{3.08 \text{ m/s}^2}$
6. $\Delta t = 1.000$ h $\Delta s = 47.112$ km $r = 6.37 \times 10^3$ km	$a_c = \frac{v_t^2}{r} = \frac{\left(\frac{\Delta s}{\Delta t}\right)^2}{r} = \frac{\Delta s^2}{r\Delta t^2}$ $a_c = \frac{(47\,112 \text{ m})^2}{(6.37 \times 10^6 \text{ m})[(1.000 \text{ h})(3600 \text{ s/h})]^2} = \boxed{2.69 \times 10^{-5} \text{ m/s}^2}$

Circular Motion and Gravitation

Problem A

CENTRIPETAL ACCELERATION

PROBLEM

Calculate the orbital radius of the Earth, if its tangential speed is 29.7 km/s and the centripetal acceleration acting on Earth is 5.9×10^{-3} m/s^2.

SOLUTION

Given: $v_t = 29.7$ km/s $a_c = 5.9 \times 10^{-3}$ m/s^2

Unknown: $r = ?$

Use the centripetal acceleration equation written in terms of tangential speed. Rearrange the equation to solve for r.

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

$$r = \frac{v_t^2}{a_c} = \frac{(29.7 \times 10^3 \text{ m/s})^2}{5.9 \times 10^{-3} \text{ m/s}^2} = 1.5 \times 10^{11} \text{ m} = 1.5 \times 10^8 \text{ km}$$

ADDITIONAL PRACTICE

1. The largest salami in the world, made in Norway, was more than 20 m long. If a hungry mouse ran around the salami's circumference with a tangential speed of 0.17 m/s, the centripetal acceleration of the mouse was 0.29 m/s^2. What was the radius of the salami?
2. An astronomer at the equator measures the Doppler shift of sunlight at sunset. From this, she calculates that Earth's tangential velocity at the equator is 465 m/s. The centripetal acceleration at the equator is 3.41×10^{-2} m/s^2. Use this data to calculate Earth's radius.
3. In 1994, Susan Williams of California blew a bubble-gum bubble with a diameter of 58.4 cm. If this bubble were rigid and the centripetal acceleration of the equatorial points of the bubble were 8.50×10^{-2} m/s^2, what would the tangential speed of those points be?
4. An ostrich lays the largest bird egg. A typical diameter for an ostrich egg at its widest part is 12 cm. Suppose an egg of this size rolls down a slope so that the centripetal acceleration of the shell at its widest part is 0.28 m/s^2. What is the tangential speed of that part of the shell?
5. A waterwheel built in Hamah, Syria, has a radius of 20.0 m. If the tangential velocity at the wheel's edge is 7.85 m/s, what is the centripetal acceleration of the wheel?
6. In 1995, Cathy Marsal of France cycled 47.112 km in 1.000 hour. Calculate the magnitude of the centripetal acceleration of Marsal with respect to Earth's center. Neglect Earth's rotation, and use 6.37×10^3 km as Earth's radius.