

Circular Motion Practice Problems

Show the initial equation(s) and all work clearly on a separate sheet.
Box the final answer. Staple your work to the back of this sheet.

Angular Displacement

2. 6 rad
- Mercury, the planet closest to the sun, has an orbital radius of 5.8×10^7 km. Find the angular displacement of Mercury as it travels through an arc length equal to the radius of Earth's orbit around the sun (1.5×10^8 km).

Tangential Speed

- 5.11 m/s
- 3.0 x 10⁶ s
- In about 45 minutes, Nicholas Mason inflated a weather balloon to a diameter of 2.44 m using only lung power. If a fly were to make exactly 8.00 revolutions around the inflated balloon in 12.0 seconds, what would the fly's tangential speed be?
 - Earth's average tangential speed around the sun is about 29.7 km/s. If Earth's average orbital radius is 1.5×10^8 km, how long does it take Earth to sweep through an angle of 0.60 rad?

Tangential Acceleration

- 6 m/s²
- 22 m/s²
- In 1988, Stu Cohen made his kite perform 2911 figure eights in just 1 hour. If the kite makes a circular loop with a radius of 1.5 m and has an angular acceleration of 0.4 radians per seconds squared, what is its tangential acceleration?
 - To "crack" a whip requires making its tip move at a supersonic speed. Kris King of Ohio achieved this with a whip 56.24 m long. If the tip of this whip moved in a circle and its angular speed increased from 6.00 rad/s to 6.30 rad/s in 0.60 s, what would be the tip's tangential acceleration?

Angular Kinematics

- 5500 s
- 3.0 x 10⁻⁶ rad/s²
- 0.0407 rad/s²
- Tal Burt of Israel rode a bicycle around the world in 77 days! If Burt could have ridden along the equator, his average angular speed would have been 9.0×10^{-7} rad/s. Now consider an object moving with this angular speed. How long would it take the object to reach an angular speed of 5.0×10^{-6} rad/s if its angular acceleration were 7.5×10^{-10} rad/s²?
 - One of the largest scientific devices in the world is the particle accelerator at Fermilab, in Batavia, Illinois. The accelerator consists of a giant ring with a radius of 1.0 km. Suppose a maintenance engineer drives around the accelerator, starting at an angular speed of 5.0×10^{-3} rad/s and accelerates at a constant rate until one trip is completed in 14.0 min. Find the engineer's angular acceleration.
 - In 1987, a giant hanging basket of flowers with a mass of 4000 kg and a radius of 3.00 m was constructed. Suppose this basket is placed on the ground and an admiring spectator runs around it to see every detail again and again. At first the spectator's angular speed is 0.820 rad/s, but he steadily decreases his speed so that it is 0.360 rad/s by the time he has traveled 20.0 m around the basket. Find the spectator's angular displacement and angular acceleration.

Centripetal Acceleration

- 3 m/s²
- The largest Salami in the world, made in Norway, was more than 20 m long and had a diameter of about 20.0 cm. If a hungry mouse runs around a the salami at a constant speed and completes the circle in 2.5 s, how large is the centripetal acceleration acting on the mouse?

Newton's Second Law for Rotating Object

10) The giant sequoia General Sherman in California has a mass of about 2.00×10^6 kg, making it the most massive tree in the world. It's height of 83.0 m is also impressive. Imagine if Imagine a uniform bar with the same mass and length as General Sherman. If the bar is rotated about an axis that is perpendicular and passes through the bar's midpoint, how large a torque would provide and angular acceleration of 0.040 rad/s^2 ? (Assume the bar is thin. Hints: First, find the bar's moment of inertia. Then, use Newton's 2nd Law for Rotating Objects.)

$4.6 \times 10^7 \text{ Nm}$

11. The largest Ferris wheel currently in existence is in Yokohama, Japan. The wheel has a radius of 50.0 m and a mass of 1.200×10^6 kg. If a torque of 1.0×10^9 Nm is needed to turn the wheel from a state of rest, what would be the wheel's angular speed in 3.0 s? Treat the wheel as a thin hoop.

1.0 rad/s

12. In 1990, a cherry pie with a radius of 3.0 m and a mass of 17×10^3 kg was baked in Canada. Suppose the pie is placed on a light rotating platform attached to a motor. IF this motor brings the angular speed of the pie from rest to 3.6 rad/s in 12s, what is the torque the motor must apply to the pie? Assume the mass of the platform is negligible and the pie is a uniformly solid disk.

$2.3 \times 10^3 \text{ Nm}$

Conservation of Mechanical Energy

13. In 1990, Eddy McDonald of Canada completed 8437 loops with a yo-yo in an hour, setting a world record. Assume that the yo-yo he used has a moment of inertia of $7.50 \times 10^{-5} \text{ kgm}^2$ and a mass of 6.00×10^{-2} kg. If the yo-yo descends from a height of 6.00×10^{-1} m, down a vertical string and has a linear speed of 1.80 m/s by the time it reaches the bottom of the string, what is its angular speed? 82.6 rad/s

$82.6 \frac{\text{rad}}{\text{s}}$

14. A potato with a record breaking mass of 3.5 kg was grown in 1994. Suppose a child sees this potato and decides to pretend it is a soccer ball. The child kicks the potato so that it rolls without slipping with a speed of 5.4 m/s . The potato rolls up a slope with a 30.0° incline. Assuming that the potato can be approximated as a uniform, solid sphere with a radius of 7.0 cm, what is the distance along the slope that the potato rolls before coming to a stop?

4.2 m

$\omega = \frac{\Delta \theta}{\Delta t}$

$v_t = r \omega$

$\Delta e = \omega_0 t + \frac{1}{2} \alpha t^2$

$a_t = r \alpha$

$\omega_f^2 - \omega_0^2 = 2 \alpha \Delta e$

$\Delta \theta = \frac{\Delta s}{r}$

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

$K E_{\text{rot}} = \frac{1}{2} I \omega^2$

$\alpha = \frac{\Delta \omega}{\Delta t}$

$\tau = I \alpha$

