Key

ANGULAR KINEMATICS PRACTICE

1. A tire rotates at a constant 1.7 radians every 0.15 s. A) What is the tire's angular velocity? B) If the tire has a diameter of 70 cm, what is the linear speed of the car?

$\omega = \frac{\theta}{t} = \frac{1.7}{0.15} = 11.3 \text{ rad/s}$

$v = r\omega = (.35)(11.3) = 3.96 \text{ m/s}$

2. A flywheel speeds up uniformly from rest to 900 rpm in 2 minutes. A) Find the angular acceleration. B) Find the tangential acceleration of the rim if the flywheel has a 0.5 m radius.

$\frac{(900)(2\pi)}{60} = 94.2 \text{ rad/s}$ $\quad \alpha = \frac{\Delta\omega}{t} = \frac{94.2 - 0}{120} = .785 \text{ rad/s}^2$

$a_{tan} = r\alpha = (.5)(.785) = .393 \text{ m/s}^2$

3. A CD player spins at 8590 rpm. If it starts from rest and has an acceleration of 450 r/s^2, how long does it take to reach full speed?

$\frac{(8590)(2\pi)}{60} = 900 \text{ rad/s}$ $\quad \alpha = \frac{\Delta\omega}{t}$ $\quad t = \frac{\Delta\omega}{\alpha}$

$t = \frac{900 - 0}{450} = 2 \text{ sec}$

4. A rotating machine has an initial angular speed of 1.6 rad/s accelerates uniformly at a rate of 0.5 rad/s^2 for 5.0 seconds. A) What is its angular displacement during this time? B) How many revolutions is this?

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2 = (1.6)(5.0) + \frac{1}{2}(.5)(5.0)^2 = 14.25 \text{ rad}$

$\text{rev} = \frac{\theta}{2\pi} = \frac{14.25}{2\pi} = 2.3 \text{ rev}$

5. A DJ speeds up a turntable uniformly from 33.3 rpm to 45 rpm. In doing so, the turntable goes through 4 revolutions. What is the angular acceleration of the table?

$\frac{(33.3)(2\pi)}{60} = 3.49 \text{ rad/s}$ $\quad \frac{(45)(2\pi)}{60} = 4.71 \text{ rad/s}$ $\quad (4)(2\pi) = 25.1 \text{ rad}$

$\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$ $\quad \alpha = \frac{\omega^2 - \omega_0^2}{2\Delta\theta} = \frac{4.71^2 - 3.49^2}{2(25.1)} = .199 \text{ rad/s}^2$

6. A flywheel slows from 250 rpm to 150 rpm in 4.2 seconds. How many revolutions occur during this time?

$\frac{(250)(2\pi)}{60} = 26.2 \text{ rad/s}$ $\quad \frac{(150)(2\pi)}{60} = 15.7 \text{ rad/s}$

$\theta = \left(\frac{\omega_0 + \omega}{2}\right)t = \left(\frac{26.2 + 15.7}{2}\right)4.2 = 88.0 \text{ rad}$

$\frac{88.0}{2\pi} = 14 \text{ rev}$

7. You are driving your car at 55 mph (24.6 m/s). Your car has 15-inch radius tires (1 inch = 2.54 cm). What is the angular speed of the tires?

$\frac{15 \text{ in}}{1} \frac{2.54 \text{ cm}}{1 \text{ in}} = 38.1 \text{ cm}$

$\omega = \frac{v}{r} = \frac{24.6}{.381} = 64.6 \text{ rad/s}$

8. A ball rolls down a 1.0-meter long incline from rest to 2.0 m/s. The ball has a 5.0 cm radius. Find the angular acceleration of the ball.

$v^2 = v_0^2 + 2a\Delta x \qquad a = \frac{v^2 - v_0^2}{2\Delta x} = \frac{(2.0)^2 - 0}{2(1)} = 2 \text{ m/s}^2$

$\alpha = \frac{a}{r} = \frac{2}{.05} = 40 \text{ rad/s}^2$

9. A soccer ball is rolling at 15rad/s. It stops rolling after traveling 25.0 m. Calculate the time it was rolling. Also find its angular acceleration. The ball has 20 cm diameter.

Ball has $C = 2\pi(.10) = .628 \text{ m/rev} \qquad \frac{25.0}{.628} = 39.9 \text{ rev} \qquad (39.9)(2\pi) = 250 \text{ rad}$

$\alpha = \frac{\omega^2 - \omega_0^2}{2\theta} = \frac{0^2 - (15)^2}{2(250)} = -.45 \text{ rad/s}^2 \qquad \omega = \omega_0 + \alpha t \qquad t = \frac{\omega - \omega_0}{\alpha}$

$t = \frac{0 - 15}{-.45} = 33.3 \text{ sec}$

10. A basketball is spun on a player's finger. The ball starts with a rotational speed of 10 r/s and stops in 4.5 seconds. Find the angle through which the ball rotated. Find the initial linear speed of the edge of the ball if the diameter is 10 inches.

$\omega = \omega_0 + \alpha t \qquad \alpha = \frac{\omega - \omega_0}{t} = \frac{0 - 10}{4.5} = -2.22 \text{ rad/s}^2$

$\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2 = (10)(4.5) + \frac{1}{2}(-2.22)(4.5^2) = 22.5 \text{ rad}$

$\frac{10 \text{ in}}{1} \frac{2.54 \text{ cm}}{1 \text{ in}} \frac{1 \text{ m}}{100 \text{ cm}} = \frac{.254}{2} \qquad r = .127 \text{ m} \qquad v = \omega r = (10)(.127) = 1.27 \text{ m/s}$

11. A spool of thread is mounted on a spindle so that when the thread is pulled, the spool rotates. The spool starts at rest. The thread is pulled so that the spool has an angular acceleration of 1.0r/s^2. The spool is 2.5 cm in diameter. What linear speed is required to maintain this acceleration after 25.0 second?

$\omega = \omega_0 + \alpha t = 0 + (1.0)(25.0) = 25.0 \text{ rad/s}$

$v = \omega r = (25.0)(.0125) = .313 \text{ m/s}$

ANSWERS: 1. 11.3 r/s, 4.0 m/s 2. 0.79 r/s^2, 0.39 m/s^2 3. 2.0 s
4. 14.3 rad, 2.3 rev 5. 0.2 r/s^2 6. 14. Rev 7. 64.7 r/s
8. 40r/s^2 9. 33.3s, -0.5r/s^2 10. 22.5 r, 1.25 m/s 11. 0.31 m/s