ANGULAR KINEMATICS PRACTICE

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

A) $\omega = \frac{\theta}{t} = \frac{1.7}{.15} = 11.33 \frac{rad}{s}$

B. $V = R\omega$ $\quad V = .35(11.33) = 3.96 \, m/s$

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.

$\omega = 900 RPM = \frac{900 rev}{60 s} \times 2\pi = 94.24 \, rad/s$ $\quad 2 min \times 60 = 120 s$

A. $\omega = \omega_0 + \alpha t$ $\quad (\omega_0 = 0)$

$94.24 = 0 + \alpha(120)$ $\quad \frac{94.24}{120} = \alpha = .785 \, rad/s^2$

B. $a = R\alpha = .5(.785)$ $\quad a = .3925 \, m/s^2$

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

$\omega = \frac{8590 rev}{60 s} \times 2\pi = 899.5 \frac{rad}{s}$ $\quad (\omega_0 = 0)$

$\omega = \omega_0 + \alpha t$

$899.5 = 0 + 450(t)$

$t = 1.998 \, s$

4. A rotating machine has an initial angular speed (ω_0) of 1.6 rad/s accelerates uniformly at a rate (α) of 0.5 rad/s^2 for 5.0 seconds (t). A) What is its angular displacement (θ) during this time? B) How many revolutions is this?

A) $\Delta\theta = \omega_0 t + \frac{1}{2}\alpha t^2$

$= 1.6(5) + \frac{1}{2}(.5)(5^2)$

$\Delta\theta = 14.25 rad$

B. $\frac{14.25 rad}{(2\pi)} = 2.26 \, rev$

5. A DJ speeds up a turntable uniformly from 33.3 rpm (ω_0) to 45 rpm (ω). In doing so, the turntable goes through 4 revolutions (θ). What is the angular acceleration (α) of the table? $\quad \omega^2 = \omega_0^2 = 2\alpha\theta$

$\omega_0 = \frac{33.3 rev}{60} \times 2\pi = 3.48 \, rad/s$

$\omega = \frac{45 rev}{60} \times 2\pi \quad 4.712 \, rad/s$

$\theta = 4 rev \times 2\pi = 25.13 \, rad$

$4.712^2 - 3.48^2 = 2\alpha(25.13)$

$\alpha = .20 \frac{rad}{s^2}$

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

$\frac{250 rev}{60} \times 2\pi = 26.17 \frac{rad}{s}$ $\quad (\omega_0)$

$\frac{150 rev}{60 s} \times 2\pi = 15.70 \, rad/s$ $\quad (\omega)$

$\omega = \omega_0 + \alpha t$ $\quad (t = 4.2)$

$15.70 = 26.17 + \alpha(4.2)$

$-10.47 = \alpha 4.2$

$\alpha = -2.49$

$\omega^2 - \omega_0^2 = 2\theta\alpha$

$15.70^2 - 26.17^2 = 2\theta(-2.49)$

$\theta = 88.02 = 14.01 \, rev$

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?

$15in \times \frac{2.54cm}{1in} = 38.1cm \Rightarrow .381m$

$V = R\omega$

$24.6 = .381\omega$

$\omega = 64.57\ rad/s$

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.

$V=0 \quad V=2 \quad \omega_0 = 0 \quad r = .05m$

$2 = .05\omega$

$\omega = 40\ rad/s$

$C = 2\pi r$

$C = 2\pi(.05)$

$C = .314m$

$\frac{1.0m}{.314} = 3.183\ rev \times 2\pi = 20\ rad$

$40^2 - 0^2 = 2(20)\alpha$

$\alpha = 40\ rad/s^2$

9. A soccer ball is rolling at 15r/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.

$\omega_0 \quad \omega = 0 \quad d \quad t$

$C = 2\pi(.1) = .628$

$\frac{25m}{.628} = 39.8 \times 2\pi = 250\ rad$

$0^2 - 15^2 = 2(250)\alpha$

$\alpha = -.45\ rad/s^2$

$\omega = \omega_0 + \alpha t$

$0 = 15 + (-.45)t$

$t = 33.3s$

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.

$t \quad \omega = 0 \quad \omega_0 \quad \theta$

$r = \frac{10in}{2} \times \frac{2.54}{1in} = 12.7cm = .127m$

$\omega = \omega_0 + \alpha t$

$0 = 10 + \alpha(4.5)$

$\alpha = -2.22\ rad/s^2$

$\Delta\theta = 10(4.5) + \frac{1}{2}(-2.22)(4.5^2)$

$\Delta\theta = 22.52\ rad$

$V = R\omega \qquad V = .127(10) = 1.27\ m/s$

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?

$\omega_0 = 0 \quad \alpha \quad t$

$r = \frac{2.5}{2} = 1.25cm = .0125m$

$\omega = \omega_0 + \alpha t$

$\omega = 0 + 1.0(25)$

$\omega = 25\ rad/s$

$V = R\omega$

$v = .0125(25) = .3125\ m/s$

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