# ROTATIONAL MOTION

## PROBLEMS

1. A particle moves in a circle 1.50 m in radius. Through what angle in radians does it rotate if it moves through an arc length of 2.50 m? What is this angle in degrees?

2. A grinding wheel, initially at rest, is rotated with constant angular acceleration $\alpha = 5.0$ rad/s$^2$ for 8.0 s. The wheel is then brought to rest, with uniform negative acceleration, in 10 rev. Determine the negative angular acceleration required and the time needed to bring the wheel to rest.

3. A centrifuge in a medical laboratory is rotating at an angular speed of 3600 rev/min. When switched off, it rotates 50.0 times before coming to rest. Find the constant angular deceleration of the centrifuge.

4. An airliner arrives at the terminal, and the engines are shut off. The rotor of one of the engines has an initial clockwise angular velocity of 2000 rad/s. The engine's rotation slows with an angular acceleration of magnitude 80.0 rad/s$^2$. (a)Determine the angular velocity after 10.0 s. (b) How long does it take the rotor to come to rest?

5. A race car travels in a circular track of radius 200 m. If the car moves with a constant speed of 80 m/s, find (a) its angular velocity and (b) its tangential acceleration.

6. The race car of Problem 5 increases its speed at a constant linear acceleration from 80 m/s to 95 m/s in 10 s. (a) Find the constant angular acceleration and (b) the angle the car moves through in this time.

7. A tire 0.500 m in radius rotates at a constant rate of 200 revolutions per minute. Find the speed and acceleration of a small stone lodged in the tread of the tire (on its outer edge).

8. The driver of a car traveling at 30.0 m/s applies the brakes and undergoes a constant negative acceleration of 2.00 m/s$^2$. How many revolutions does each tire make before the car comes to a stop, assuming that the car does not skid and that the tires have radii of 0.300 m?

9. Young David experimented with slings before tackling Goliath. He found that he could develop an angular speed of 8.0 rev/s in a sling 0.60 m long. If he increased the length to 0.90 m, he could revolve the sling only six times per second. (a) Which angular speed gives the greater linear speed? (b) What is the centripetal acceleration at 8.0 rev/s? (c) What is the centripetal acceleration at 6.0 rev/s?

10. The downward motion of an elevator is controlled by a cable that unwinds from a cylinder of radius 0.20 m. What is he angular velocity of the cylinder when the downward speed of the elevator is 1.2 m/s?

11. A 60.0-cm diameter wheel rotates with a constant angular acceleration of 4.00 rad/s$^2$. It starts from rest at $t = 0$, and a chalk line drawn to a point, $P$, on the rim of the wheel makes an angle of 57.3° with the horizontal at this time. At $t = 2.00$ s, find (a) the angular speed of the wheel, (b) the linear velocity and tangential acceleration of $P$, and (c) the position of $P$.

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Answers: $1. \theta = 95.7°$     $2. t = 3.1$ s          $3. \alpha = -2.26 \times 10^2$ rad/s$^2$          $4.$(a) $\omega = 1200$ rad/s  (b) $t = 25$ s
$5.$(a) $\omega = 0.40$ rad/s       (b) $a_t = 0$   $6.$ (a) $\alpha = 7.5 \times 10^{-3}$ rad/s$^2$     (b) $\theta = 4.4$ rad          $7. v = 10.5$ m/s          $a_c = 218$ m/s$^2$

$8. \theta = 119$ rev  $9.$(a) greater linear speed with larger sling.          (b) $a_c = 1.5 \times 10^3$ m/s$^2$·          (c) $a_c = 1.3 \times 10^3$ m/s$^2$.
$10. \omega = 6.0$ rad/s $11.$     (a) $\omega = 8.00$ rad/s  (b) $a_t = 1.20$ m/s$^2$     (c) $\theta = 516°$