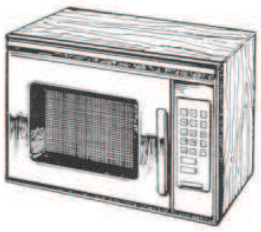
Unit 11, Worksheet 3. Several more practice problems dealing with circular motion

Note: for my calculations using π, I use 3.14159. Your answers may be a bit different depending upon your value for pi and rounding.



1. Many microwave ovens rotate the food as it cooks it. Let's say we have a microwave oven with a rotating plate of 15 cm (0.15 cm) radius. The angular acceleration (α) of this rotating plate has been measured at 0.87 rad/s^2. This is the angular acceleration needed to bring the plate from rest to its operational rotational velocity (ω_f). The plate takes 0.5 seconds to reach this ω_f. Once it reaches this ω_f, the plate moves at a constant angular velocity.

(a) What is the angle (θ) the plate moves through in both radians and rotations as it starts from rest and reaches its operational angular velocity? (answer = 0.11 rad or 0.017 rotation)

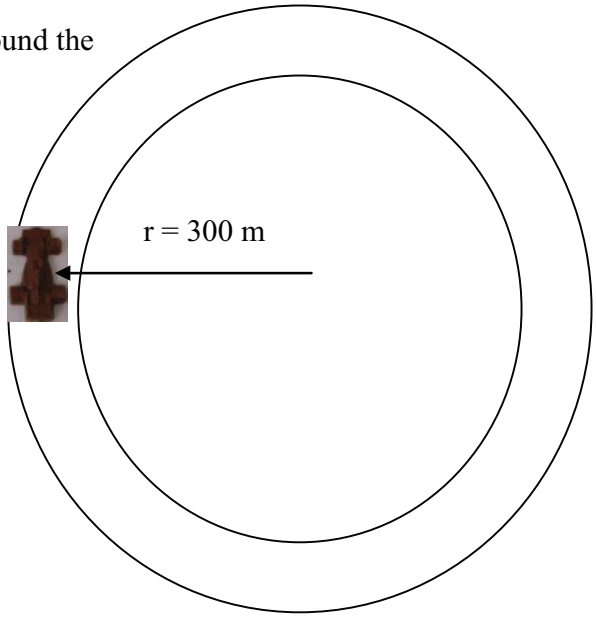
(b) What is the operational angular velocity in radians per second? (answer = 0.44 rad/s).

(c) What would is the tangential velocity (v_t) of a point on the outer edge of the plate? (note: there is an easy way to get the answer and a more difficult way). answer = 0.065 or 0.066m/s).

(d) When the microwave is turned off, the rotating plate makes half of a revolution before stopping. What is the angular acceleration needed to stop the plate given the operational angular velocity of 0.44 rad/s found in part b? (answer = -0.031 rad/s^2)

2. A race car is on a circular track with a radius of 0.30 km (300 m). The driver accelerates from rest with a constant angular acceleration (α) of 4.5 x 10^{-3} rad/s^2. The driver constantly accelerates as he drives one lap around the track.

(a) How long does it take for the driver to make one lap around the track? (answer = 53 seconds)



(b) What is the driver's angular velocity (ω_f) as he finishes this first lap? Answer in rad/s and degrees/sec (answer 0.23 or 0.24 rad/s or around 13-14 degrees per sec)

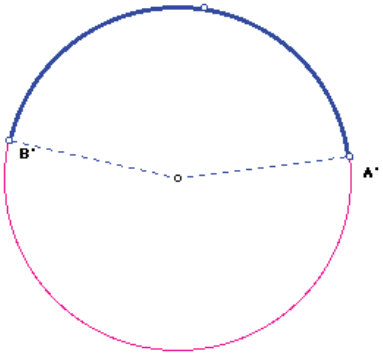
3. The blades of a circular fan running at low speed turn at 250 rpm. When the fan is switched to high speed, the rotation rate increases to 350 rpm. This change of the rotation rate occurs uniformly and takes 5.75 seconds. Remember to convert rpm to rad/s.

(a) What is the angular acceleration (α) needed to go from low to high speed? (answer = 1.82 rad/s^2)

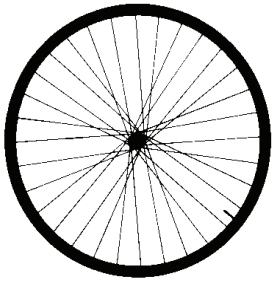
(b) How many rotations do the fan blades go through while the fan is accelerating? (answer = 28.8 rotations)

Physics (worksheet 4, full solutions at the back…)
More practice with rotational questions
Your answers may vary a bit depending upon rounding of pi.

1. While riding on a merry-go-round, a child travels through an arc length of 11.5 m. If the merry-go-round has a radius of 4 m, through what angle (theta) does the child travel? Give the angle in radians, degrees, and rotations. *(answers: 2.875 radians, 164.7 degrees, and 0.46 rotations)*

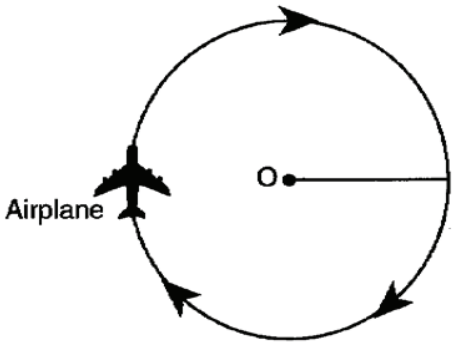


2. A beetle sits stuck in the tread atop a bicycle wheel with a radius of 0.375 m. Assuming the wheel turns counterclockwise, what is the angular displacement of the beetle before it is squashed under the wheel? What arc length does the beetle travel through before it is squashed? *(answers: pi or 3.14 radians, arc length = 1.178 m*)



3. A car tire rotates at a constant angular velocity of 3.5 rotations during a time interval of 0.75 s. What is the angular speed of the tire in radians per sec, degrees per sec, and rotations per minute? *(answers = 29.3 radians/sec, 1681 degrees per second, and 280 rotations per minute)*

4. A girl ties a toy airplane to the end of a string and swings it around her head in a horizontal circle with a constant angular velocity of 21 rpm. (a) what is this rotational velocity in radians per second? (b) What would be angular displacement (θ) in radians and degrees if she continued to spin the plane at this constant angular velocity for 10 seconds? *(answers: 2.2 radians/second, 22 radians, 1260 or 1261 degrees)*



5. A figure skater begins spinning counterclockwise at an angular speed of 4.0π rad/s. During a 3.0 sec interval, she slowly pulls her arms inward and finally spins at 8.0π rad/s. (a) What is her average angular acceleration during this time interval? (b) How many rotations did she spin in this time interval as she accelerated her spin? *[answers: a) 4.2 rads/s^2 and b) 9 rotations]*

6. You go out on some nice afternoon after school and play with your RC car. You have it moving so that the wheels are moving with an initial angular velocity of 10.8 radians/sec. You accelerate the car with your remote control at a rate of 22.4 radians/sec^2 (this is α). After 3 complete rotations (this is a θ but you'll need to convert this to radians) of the car's wheels you stop the angular acceleration. (a) What is the wheel's final angular velocity in radians per sec? (b) How long (in seconds) did this acceleration take? *(answers: 31 radians/sec and 0.9 seconds)*