PRACTICE

Perform each conversion.

1. 45 yards = 1620 inches

$45\text{ yd}\left(\frac{3\text{ ft}}{1\text{ yd}}\right)\left(\frac{12\text{ in}}{1\text{ ft}}\right) = 1620\text{ in}$

2. 1.5 km = 150000 cm

$1.5\text{ km}\left(\frac{1000\text{ m}}{1\text{ km}}\right)\left(\frac{100\text{ cm}}{1\text{ m}}\right) = 150000\text{ cm}$

3. 28 m/sec = 100.8 km/hr

$\frac{28\text{ m}}{1\text{ sec}}\left(\frac{1\text{ km}}{1000\text{ m}}\right)\left(\frac{60\text{ sec}}{1\text{ min}}\right)\left(\frac{60\text{ min}}{1\text{ hr}}\right)$

100.8 km/hr

4. 30 rev/min = 60π rad/min

$\frac{30\text{ rev}}{1\text{ min}}\left(\frac{2\pi\text{ rad}}{1\text{ rev}}\right) = \frac{60\pi\text{ rad}}{1\text{ min}}$

5. 120 rev/hr = 2 rev/min

$\frac{120\text{ rev}}{1\text{ hr}}\left(\frac{1\text{ hr}}{60\text{ min}}\right) = \frac{120\text{ rev}}{60\text{ min}}$

6. 30 mi/hr = 44 ft/sec

$\frac{30\text{ mi}}{1\text{ hr}}\left(\frac{5280\text{ ft}}{1\text{ mi}}\right)\left(\frac{1\text{ hr}}{60\text{ min}}\right)\left(\frac{1\text{ min}}{60\text{ sec}}\right) = \frac{158400\text{ ft}}{3600\text{ sec}}$

A windmill for generating electricity has a blade that is 30 feet long. Depending on the wind, it rotates at various velocities. In each case, find the angular velocity in rad/sec for the tip of the blade.

7. 500 rev/sec

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

$\omega = \frac{500 \cdot 2\pi}{1\text{ sec}}$

$\omega = 1000\pi\text{ rad/sec}$

8. 11,000 rev/hr

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

$\omega = \frac{11{,}000 \cdot 2\pi}{1\text{ hr}}$

$\omega = \frac{22{,}000\pi}{60\text{ min}} \cdot \frac{1\text{ min}}{60\text{ sec}} = \frac{22000\pi}{3600\text{ sec}}$

$\omega = \frac{55\pi}{9}\text{ rad/sec}$

9. 50,000 rev/day

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

$\omega = \frac{50{,}000 \cdot 2\pi}{1\text{ day}}$

$\omega = \frac{100{,}000\pi}{24\text{ hr}} \cdot \frac{1\text{ hr}}{60\text{ min}} \cdot \frac{1\text{ min}}{60\text{ sec}} = \frac{100{,}000\pi}{86{,}400\text{ sec}}$

$\omega = \frac{125\pi}{108}\text{ rad/sec}$

A common speed for an electric motor is 3450 revolutions per minute. Saw blades of various diameters can be attached. Determine the linear velocity in mi/hr for a point on the edge of a blade given the diameter.

10. 6 in

$\omega = \frac{\theta}{t} = \frac{3450 \cdot 2\pi}{1\text{ min}}$

$\omega = 6900\pi\text{ rad/min}$

$v = \omega r$

$v = 6900\pi(3)$

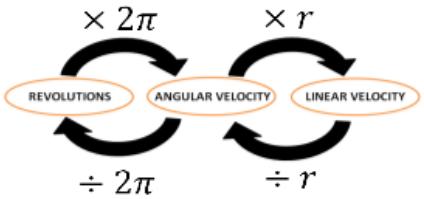
$v = \frac{20700\pi\text{ in}}{1\text{ min}}\left(\frac{1\text{ ft}}{12\text{ in}}\right)\left(\frac{1\text{ mile}}{5280\text{ ft}}\right)\left(\frac{60\text{ min}}{1\text{ hr}}\right)$

$v = 61.58\text{ mi/hr}$

11. 1.2 feet

Using shortcut!

$3450(2\pi)(0.6) = 4140\pi\text{ ft/min}$



$\frac{4140\pi\text{ ft}}{\text{min}}\left(\frac{1\text{ mi}}{5280\text{ ft}}\right)\left(\frac{60\text{ min}}{1\text{ hr}}\right)$

$v = 147.8\text{ mph}$

12. 1 yard

$\omega = \frac{\theta}{t} = \frac{3450 \cdot 2\pi}{1\text{ min}}$

$\omega = 6900\pi\text{ rad/min}$

$v = \omega r$

$v = 6900\pi(0.5)$

$v = \frac{3450\pi\text{ yds}}{1\text{ min}}\left(\frac{3\text{ ft}}{1\text{ yd}}\right)\left(\frac{1\text{ mile}}{5280\text{ ft}}\right)\left(\frac{60\text{ min}}{1\text{ hr}}\right)$

$v = 369.5\text{ mph}$

13. **A circular blade with a 12-inch diameter spins at a rate of 1800 rpm (revolutions per minute).**

a. What is the blade's angular velocity in radians per minute?

$\omega = \frac{\theta}{t}$ $\quad \omega = \frac{1800 \cdot 2\pi}{1 \text{ min}} = 3600\pi$ rad/min

b. Find the linear velocity (in inches per minute) of one of the teeth on the edge of the blade.

$v = \omega r$ $\quad v = 3600\pi(6) = 21{,}600\pi$ in/min

c. Convert the linear velocity into feet per second.

$\frac{21{,}600\pi \text{ in}}{1 \text{ min}} \cdot \frac{1 \text{ ft}}{12 \text{ in}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} = 30\pi$ ft/sec

14. **Vinyl record albums are 11 inches in diameter and spin at a rate of 33 rpm.**

a. What is a record's angular velocity in radians per minute?

$\omega = \frac{\theta}{t}$ $\quad \omega = \frac{33 \cdot 2\pi}{1 \text{ min}} = 66\pi$ rad/min

b. How fast (in inches per minute) would a record move under a needle placed on the records edge?

$v = \omega r$ $\quad v = 66\pi(5.5) = 363\pi$ in/min

c. Convert this linear velocity to feet per second.

$\frac{363\pi \text{ in}}{1 \text{ min}} \cdot \frac{1 \text{ ft}}{12 \text{ in}} \cdot \frac{1 \text{ min}}{60 \text{ sec}} = 1.58$ ft/sec

15. **With his arms fully extended, a baseball player swings a bat. Using his shoulder as the center of rotation, the bat moves through 120° in only 0.2 seconds.** $120^\circ = \frac{120^\circ}{360^\circ} = \frac{1}{3}$ rev

a. What is the angular velocity of the batter's swing in radians per second?

$\omega = \frac{\theta}{t}$ $\quad \omega = \frac{\frac{1}{3} \cdot 2\pi}{0.2 \text{ sec}} = \frac{10}{3}\pi$ rad/sec

b. As he swings the bat, the player hits a baseball. Suppose the ball leaves the bat at a distance of 40 inches from the player's shoulder. How fast (in miles per hour) would the ball be moving?

$v = \omega r$ $\quad v = \frac{10}{3}\pi(40) = \frac{400}{3}\pi$ in/sec $\approx \frac{418.88 \text{ in}}{1 \text{ sec}} \cdot \frac{1 \text{ ft}}{12 \text{ in}} \cdot \frac{1 \text{ mi}}{5280 \text{ ft}} \cdot \frac{60 \text{ sec}}{1 \text{ min}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} = 23.8$ mi/hr

c. During a second time at bat, the player hits another ball, which leaves the bat a distance of 43 inches from the player's shoulder. How fast (in miles per hour) would this ball be moving?

$v = \frac{10}{3}\pi(43) = \frac{430}{3}\pi$ in/sec $\approx \frac{450.29 \text{ in}}{1 \text{ sec}} \cdot \frac{1 \text{ ft}}{12 \text{ in}} \cdot \frac{1 \text{ mi}}{5280 \text{ ft}} \cdot \frac{60 \text{ sec}}{1 \text{ min}} \cdot \frac{60 \text{ min}}{1 \text{ hr}} = 25.58$ mi/hr

Skillz Review Simplify the following.

1. $\frac{\frac{1}{2}}{\frac{5}{4}}$ $\quad \frac{1}{2} \cdot \frac{4}{5} = \frac{4}{10} = \frac{2}{5}$

2. $\frac{\frac{1}{4}}{\frac{\sqrt{2}}{2}}$ $\quad \frac{1}{4} \cdot \frac{2}{\sqrt{2}} = \frac{2}{4\sqrt{2}} = \frac{1}{2\sqrt{2}}$

$\frac{1}{2\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{\sqrt{2}}{2\sqrt{4}} = \frac{\sqrt{2}}{2 \cdot 2} = \frac{\sqrt{2}}{4}$

3. $\frac{5}{\left(\frac{\sqrt{3}}{2}\right)}$ $\quad \frac{5}{1} \cdot \frac{2}{\sqrt{3}} = \frac{10}{\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}} = \frac{10\sqrt{3}}{3}$

4. $\frac{\left(\frac{\sqrt{3}}{2}\right)}{\sqrt{2}}$

$\frac{\sqrt{3}}{2} \cdot \frac{1}{\sqrt{2}} = \frac{\sqrt{3}}{2\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{\sqrt{6}}{2 \cdot 2} = \frac{\sqrt{6}}{4}$