Topic: Relating linear and angular velocity

Question: If a wheel of diameter 21 inches is rotating at a rate of 0.543π radians per second, what is the linear velocity v of a point on the outside edge of the wheel?

Answer choices:

A $v = 1.49$ ft/sec

B $v = 2.98$ ft/sec

C $v = 17.9$ ft/sec

D $v = 3.66$ ft/sec

Solution: A

The radius is half the diameter, so

$$r = \frac{21.0}{2} = 10.5 \text{ inches}$$

Use the formula relating linear velocity to angular velocity, and substitute the values we know.

$$v = r\omega$$

$$v = (10.5 \text{ in})\left(\frac{0.543\pi}{\text{sec}}\right)$$

Multiply by a conversion factor to change inches into feet.

$$v = (10.5 \text{ in})\left(\frac{1 \text{ ft}}{12 \text{ in}}\right)\left(\frac{0.543\pi}{\text{sec}}\right)$$

$$v = \frac{10.5(0.543)}{12}\pi \text{ ft/sec}$$

$$v \approx 0.475\pi \text{ ft/sec}$$

$$v \approx 1.49 \text{ ft/sec}$$

Topic: Relating linear and angular velocity

Question: Determine the linear velocity in inches per minute of the tips of the $13''$ blades of a ceiling fan, if the blades are rotating at 52 revolutions per minute.

Answer choices:

A 431 in/min

B $1,352$ in/min

C 676 in/min

D $4,247$ in/min

Solution: D

First we need to convert the angular velocity from revolutions per minute to radians per minute.

$$\omega = \left(52\ \frac{\text{rev}}{\text{min}}\right)\left(\frac{2\pi\ \text{rad}}{1\ \text{rev}}\right)$$

$$\omega \approx 104\pi \text{ radians per minute}$$

Now we can find the linear speed.

$$v = r\omega$$

$$v \approx (13\ \text{in})\left(\frac{104\pi}{\text{min}}\right)$$

$$v \approx 13(104\pi) \text{ inches per minute}$$

$$v \approx 4{,}247 \text{ inches per minute}$$

Topic: Relating linear and angular velocity

Question: The wheels of a car have a diameter of 2.5 ft and are rotating at 4 revolutions per second. How fast is the car moving in miles per hour? Hint: There are $5,280$ feet in 1 mile.

Answer choices:

A 21.4 mi/hr

B 6.82 mi/hr

C 42.8 mi/hr

D 3.4 mi/hr

Solution: A

First we need to convert the angular velocity from revolutions per second to radians per second.

$$\omega = \left(4\ \frac{\text{rev}}{\text{sec}}\right)\left(\frac{2\pi\ \text{rad}}{1\ \text{rev}}\right)$$

$\omega \approx 8\pi$ radians per second

Because the diameter of the blade is 2.5 ft, its radius is 1.25 ft, so linear velocity is

$$v = r\omega$$

$$v = (1.25\ \text{ft})\left(\frac{8\pi}{\text{sec}}\right)$$

Multiply by a conversion factor to change feet into miles and seconds into hours.

$$v = (1.25\ \text{ft})\left(\frac{1\ \text{mi}}{5{,}280\ \text{ft}}\right)\left(\frac{8\pi}{\text{sec}}\right)\left(\frac{3{,}600\ \text{sec}}{\text{hr}}\right)$$

$$v = \frac{1.25(8)(3600)}{5280}\pi\ \text{mi/hr}$$

$$v \approx 6.82\pi\ \text{mi/hr}$$

$$v \approx 21.4\ \text{mi/hr}$$