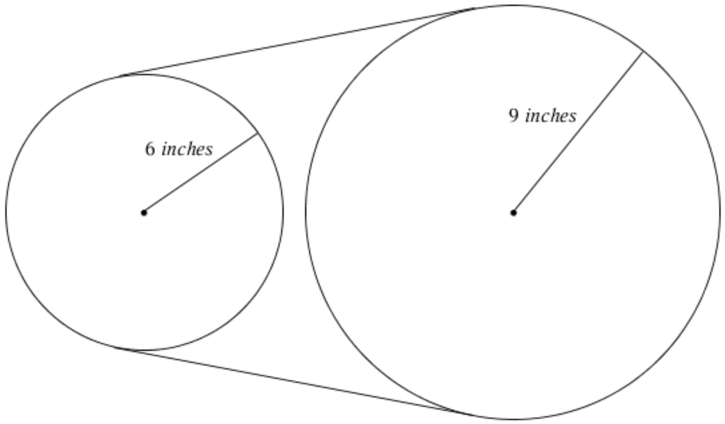
Problem 1

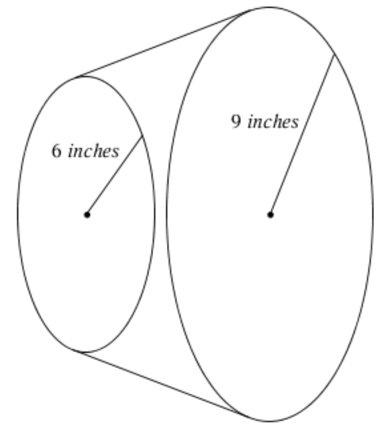


Suppose that you have a pulley system set up and your smaller pulley, 6 inches radius, is moving at 150 revolutions per minute. This smaller pulley is connected by a belt to a larger pulley that has a radius of 9 inches.

1. Determine the angular speed of the smaller pulley

2. Determine the angular speed of the larger pulley

3. Determine the revolution per minute of the larger pulley.



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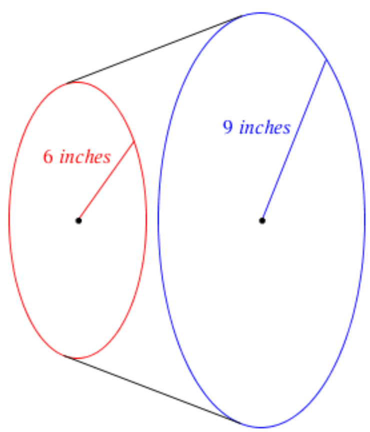
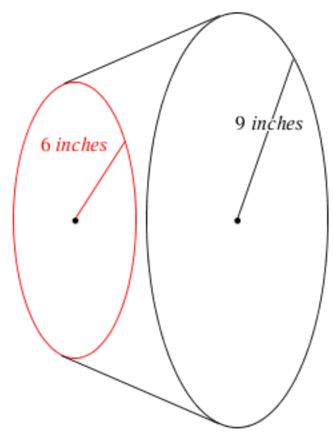




The red circle has 150 revolutions per minute

This means that we can determine the number of radians and therefore how far the belt/ chain on the pulley is moved by these revolutions

150 revolutions implies that the circle rotates a total radians

recall radians =(# of revolutions)$\left(\frac{2\cdot\pi\ radians}{revolutions}\right)$

$=150\cdot 2\cdot\pi$

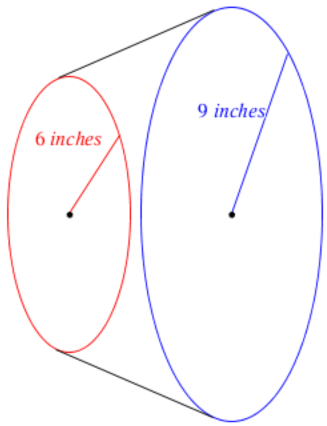
$=300\cdot\pi\cdot radians$

So θ of red circle (small pulley) $=300\cdot\pi\cdot radians$

Now we now that the total distance traveled by the belt/chain is equal to the arc length of the red circle

arc length $=\theta\cdot radius$

$=(300\cdot\pi)\cdot(6\cdot inches)=1800\cdot\pi\cdot inches$



The red circle has 150 revolutions per minute

arc length related to red circle $= \theta \cdot radius$

$= (300 \cdot \pi) \cdot (6 \cdot inches) = 1800 \cdot \pi \cdot inches$

Now we can find 1) how many times the large pulley is rotated and 2) how far the belt has traveled under the rotations of small pulley

arc length of blue circle $= \theta \cdot radius$

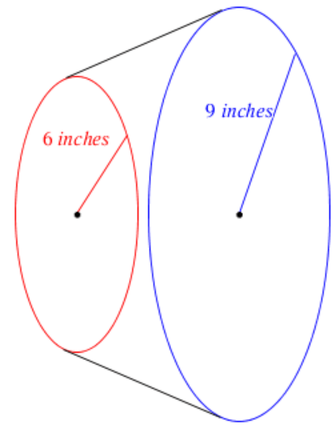
$1800 \cdot \pi \cdot inches = (\theta)(9 \cdot inches)$

$1800 \cdot \pi \cdot inches = 9 \cdot \theta \ inches$

$\frac{1800 \cdot \pi \cdot inches}{9 \cdot \theta \cdot inches} = \frac{9 \cdot \theta \ inches}{9 \cdot inches}$

$\theta = 200 \cdot \pi$ radians

revolutions $= \frac{\theta}{2 \cdot \pi} = \frac{200 \cdot \pi}{2 \cdot \pi} =$ 100 revolutions



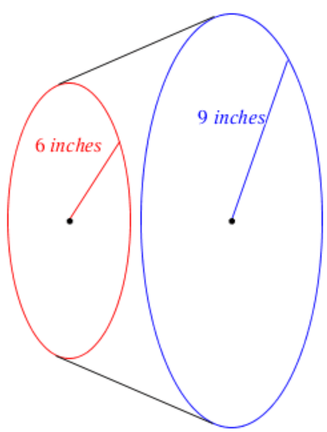
The red circle has 150 revolutions per minute

θ of red pulley $= 300 \cdot \pi$ radians

θ of blue pulley $= 200 \cdot \pi$ radians

Linear Speed of red circle $= \frac{(300 \cdot \pi) \cdot 6 \cdot inches}{minute} = \frac{1800 \cdot \pi \cdot inches}{minute}$

Linear Speed of blue circle $= \frac{(200 \cdot \pi) \cdot 6 \cdot inches}{minute} = \frac{1800 \cdot \pi \cdot inches}{minute}$



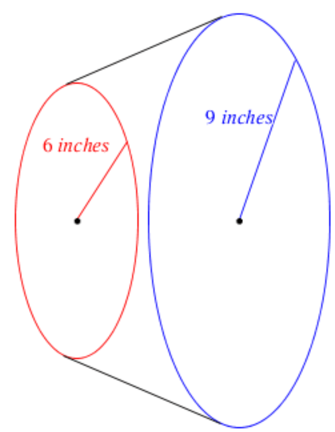
The red circle has 150 revolutions per minute

θ of red pulley $= 300 \cdot \pi$ radians

θ of blue pulley $= 200 \cdot \pi$ radians

Angular Speed of red circle $= \frac{(300 \cdot \pi) \ radians}{minute} = \frac{300 \cdot \pi \ radians}{minute}$

Angular Speed of blue circle $= \frac{(200 \cdot \pi) \ radians}{minute} = \frac{200 \cdot \pi \ radians}{minute}$



The red circle has 150 revolutions per minute

θ of red pulley $= 300 \cdot \pi$ radians

θ of blue pulley $= 200 \cdot \pi$ radians

Number of revolutions of red circle $= \frac{300 \cdot \pi}{2pi}$

$= 150$ revolutions

Number of revolutions of blue circle $= \frac{200 \cdot \pi}{2pi}$

$= 100$ revolutions

Problem 2

#96

2 inch pulley

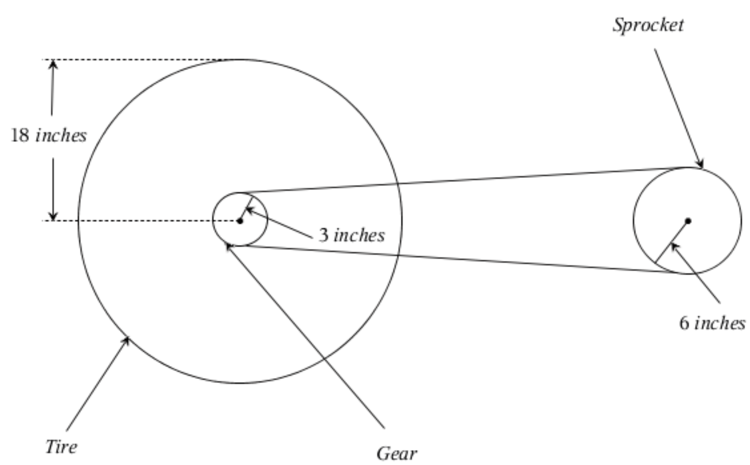
$$1700 \cdot rev \cdot \frac{2 \cdot \pi \cdot radians}{1 \cdot rev} = 3400 \cdot \pi \ radians$$

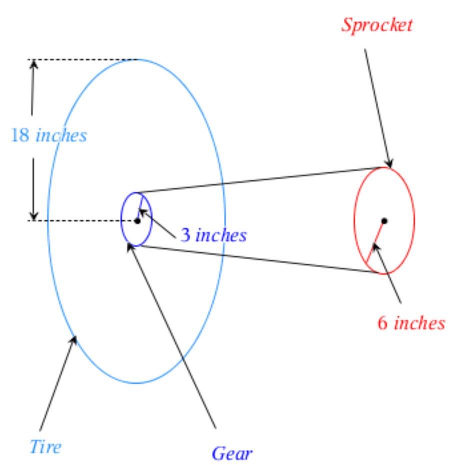
4 inch pulley

$$\frac{3400 \cdot \pi}{4 \cdot \pi} \blacktriangleright 850 \text{ rev}$$

$$850 \cdot rev \cdot \frac{2 \cdot \pi \cdot radians}{1 \cdot rev} = 1700 \cdot \pi \ radians$$

Problem 3

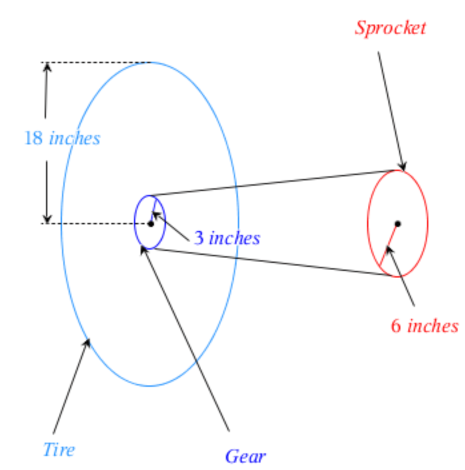




You have a bicycle that has a sprocket with a radius of 6 inches, a gear radius of 3 inches, and a tire radius of 18 inches.

4. Determine the speed of the bicycle in feet per second if the person riding the bike is pedaling at a rate of 2 revolutions per second.

5. Determine the speed of the bicycle in miles per hour if the person riding the bike is pedaling at a rate of 2 revolutions per second.



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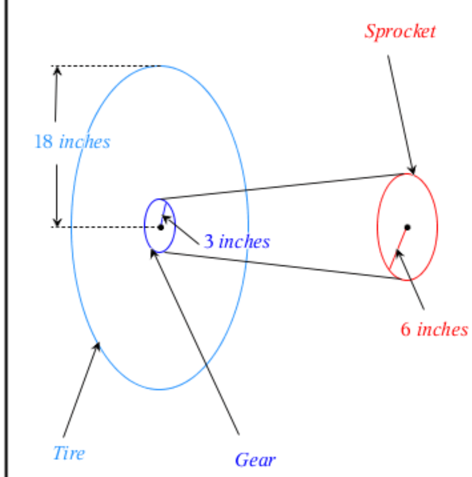


The person riding the bike is pedaling at a rate of 2 revolutions per second.

This means that the sprocket has

$\theta = 2 \cdot revolutions \cdot \dfrac{2 \cdot \pi \cdot radians}{1 \cdot revolutions}$

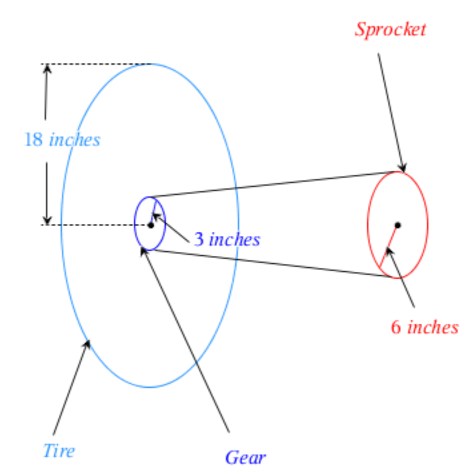
$= 4 \cdot \pi$ radians

This also means that the arc length of the sprocket is

$s = (4\pi)(6) = 24\,\pi\ inches$

This means that in 1 second the sprocket moves the chain $24\,\pi\ inches$

This chain in turn moves the gear $24\,\pi\ inches$



The person riding the bike is pedaling at a rate of 2 revolutions per second.

Sprocket Information

θ of sprocket= $4 \cdot \pi$ radians

s of sprocket $= (4\pi)(6) = 24\,\pi\ inches$

Gear Information

s of gear is $24\,\pi\ inches$

radius of gear = 3 inches

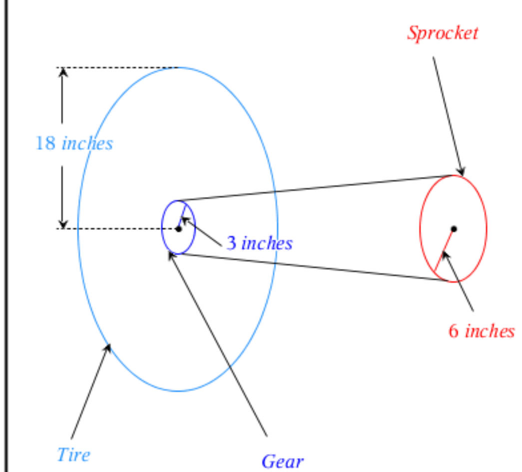
We can find θ of the gear

(which is also the θ of the tire)

$24\,\pi\ inches = 3\ inches \cdot \theta\ radians$

$\dfrac{24\,\pi\ inches}{3\ inches} = \dfrac{3\ inches \cdot \theta\ radians}{3\ inches}$

$\theta = 8\,\pi$ radians



The person riding the bike is pedaling at a rate of 2 revolutions per second.

Sprocket Information

θ of sprocket= $4 \cdot \pi$ radians

s of sprocket $= (4\pi)(6) = 24\,\pi\ inches$

Gear Information

s of gear is $24\,\pi\ inches$

θ of gear=$8\,\pi$ radians

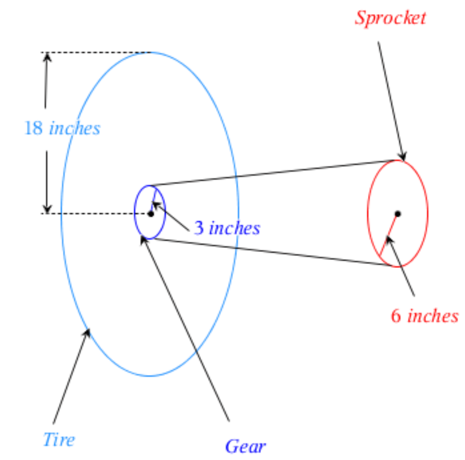
Tire Information

θ of tire=$8\,\pi$ radians

s of tire =($8 \cdot \pi$ radians)(18 inches)

=$144 \cdot \pi$ inches

This means that the linear speed of the tire is $\dfrac{144\pi\ inches}{1\ second}$



4. Determine the speed of the bicycle in feet per second if the person riding the bike is pedaling at a rate of 2 revolutions per second.

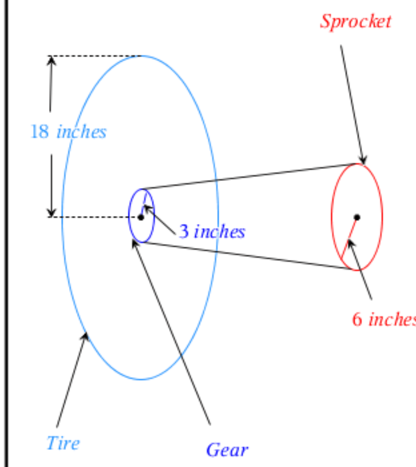
We know the linear speed of the tire is

$$\frac{144\pi \text{ inches}}{1 \text{ second}}$$

We just need to convert to linear speed in feet per second

$$\frac{144\pi \text{ inches}}{1 \text{ second}} \cdot \frac{1 \text{ foot}}{12 \text{ inches}}$$

$$\frac{12\pi \text{ feet}}{1 \text{ second}}$$



5. Determine the speed of the bicycle in miles per hour if the person riding the bike is pedaling at a rate of 2 revolutions per second.

We know the linear speed of the tire is

$$\frac{144\pi \text{ inches}}{1 \text{ second}}$$

or

$$\frac{12\pi \text{ feet}}{1 \text{ second}}$$

We need to convert to miles per hour

$$\frac{12\pi \text{ feet}}{1 \text{ second}} \cdot \frac{3600 \text{ seconds}}{1 \text{ hour}} = \frac{43200 \cdot \pi \cdot \text{feet}}{1 \cdot \text{hour}}$$

$$\frac{43200 \cdot \pi \cdot \text{feet}}{1 \cdot \text{hour}} \cdot \frac{1 \text{mile}}{5280 \text{ feet}} = \frac{43200 \cdot \pi}{5280} \text{ mph}$$

$$= \frac{90 \cdot \pi}{11} \text{ mph} \approx 25.7039 \text{ mph}$$