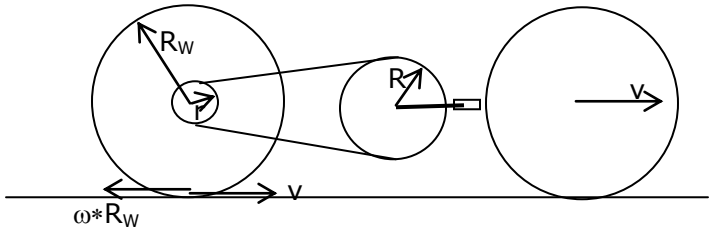
Q- The drive train of a bicycle has wheels 67.3 cm in diameter and pedal cranks 17.5 cm long. The cyclist pedals at a steady cadence of 76.0 rev/min. The chain engages with a front sprocket 15.2 cm in diameter and a rear sprocket 7.00 cm in diameter. (a) Calculate the speed of a link of the chain relative to the bicycle frame. (b) Calculate the angular speed of the bicycle wheels. (c) Calculate the speed of the bicycle relative to the road.

(a)



When a body rotates or a particle moves on a circular path the angular velocity □, linear speed v and the radius r are related as

$v = \omega * r$

Here the angular velocity of the pedals and the front sprocket is the same and given by

$$\omega_F = 76.0 rev/\min = 76.0 * \frac{2\pi}{60} = 7.958 \text{ rad/s}$$

Hence the speed of a point on the circumference of the front sprocket or that of the chain will be

$$v = \omega_F * R = 7.958 * \frac{15.2}{2} = 60.481 \text{ cm/s}$$

Hence the speed of the chain link relative to the frame is **60.5 cm/s**.

(b)

As the chain is moving with speed v relative to the frame, any point on the rim of the rear sprocket will have the same speed and hence its angular velocity or the angular velocity of the rear (and so that of front) wheel is given by

$$\omega_R = \frac{v}{r} = \frac{60.5 cm/s}{(7.0/2) cm} = 17.28 \text{ rad/sec}$$

And hence angular velocity of the wheels will be **17.3 rad/s**.

(c)

When a wheel rolls on a surface without sliding, the point of contact with the surface comes to an instantaneous rest. This happens because the forward speed of the wheel with the bicycle v, is equal in magnitude to the backward speed of the point due to rotation of the wheel and hence resultant velocity of the point of contact will be zero at that time.
So the velocity of the bicycle is given by

$$v_B = \omega_R * R_W = 17.3 * (67.3/2) = 582.1 \text{ cm/s} = \textbf{5.82 m/s.}$$