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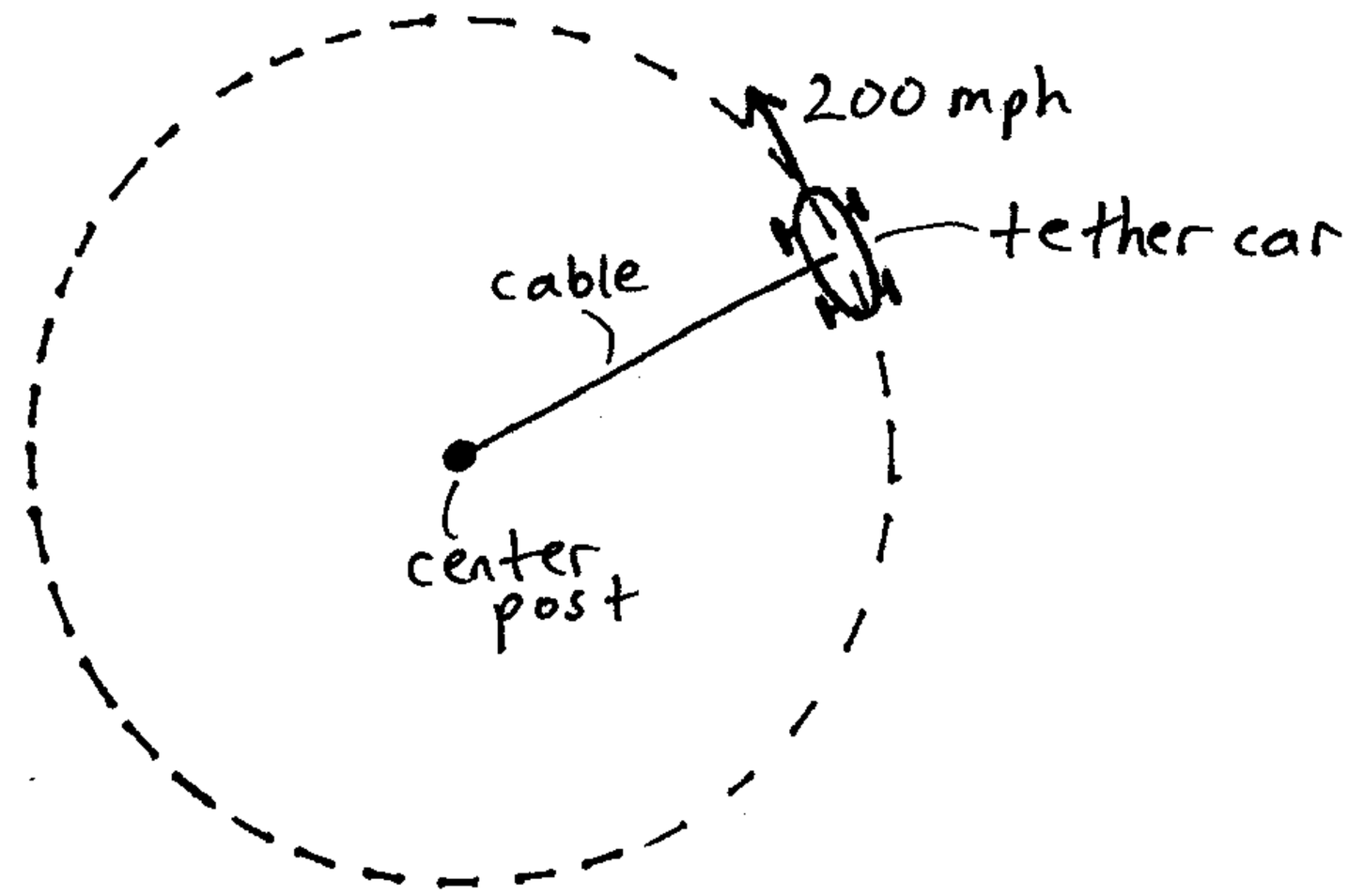
This is a problem involving uniform circular motion.



A tether car is going around a track at a speed of 200 mph. To prevent the car from going off the track it is tethered to a center post with a cable. The diameter of the track is 21.3 m, and the wheel diameter of the car is 5 cm.

(a) What is the acceleration of the car?

(b) How fast do the car wheels rotate, in revolutions per minute?

(c) Looking at the car from above, how fast does it go around the track, in revolutions per minute?

Solution:

(a) Use the centripetal acceleration equation:

$$a = \frac{v^2}{r}$$

$a = ?$ (magnitude of centripetal acceleration)

$$v = 200\,\frac{\text{miles}}{\text{hour}} \times \frac{1609.3\text{ m}}{1\text{ mile}} \times \frac{1\text{ hour}}{3600\text{ sec}} = 89.4\text{ m/s}$$

(speed of the car, which is the magnitude of its velocity)

$$r = \frac{\text{diameter}}{2} = \frac{21.3\text{ m}}{2} = 10.65\text{ m}$$

(radius of curve)

Substitute:

$$a = \frac{(89.4)^2}{10.65} = 750.5\text{ m/s}^2 \text{ (answer)}$$

(b) The circumference of the track is: $2\pi(10.65) = 66.916\text{m}$

The circumference of the wheels is:

$$2\pi\left(\frac{0.05}{2}\right) = 0.1571\text{m}$$

Therefore, when the car goes around the track once, the wheels rotate:

$$\frac{66.916\text{m}}{0.1571\text{m}} = 426 \text{ times}$$

In one minute, the car travels a distance:

$$89.4\text{ m/s} \times 60\text{s} = 5364\text{ m}$$

- Therefore, the number of times that the wheels rotate in one minute is:

$$\frac{5364m}{0.1571m} = 34,150 \text{ (answer)}$$

(c) In one minute, the number of times that the car goes around the track is:

$$\frac{34,150}{426} = 80 \text{ (answer)}$$