We can relate the angular velocity ω to the frequency of rotation, f. The **frequency** is the number of complete revolutions (rev) per second, as we saw in Chapter 5. One revolution (of a wheel, say) corresponds to an angle of 2π radians, and thus $1\text{ rev/s} = 2\pi\text{ rad/s}$. Hence, in general, the frequency f is related to the angular velocity ω by

Frequency

$$f = \frac{\omega}{2\pi}$$

or

$$\omega = 2\pi f. \tag{8–7}$$

The unit for frequency, revolutions per second (rev/s), is given the special name the hertz (Hz). That is

$$1\text{ Hz} = 1\text{ rev/s}.$$

Note that "revolution" is not really a unit, so we can also write $1\text{ Hz} = 1\text{ s}^{-1}$.

The time required for one complete revolution is called the **period** T, and it is related to the frequency by

Period

$$T = \frac{1}{f}. \tag{8–8}$$

If a particle rotates at a frequency of three revolutions per second, then the period of each revolution is $\frac{1}{3}$ s.

EXERCISE A In Example 8–4, we found that the carousel, after 8.0 s, rotates at an angular velocity $\omega = 0.48\text{ rad/s}$, and continues to do so after $t = 8.0\text{ s}$ because the acceleration ceased. What are the frequency and period of the carousel?

PHYSICS APPLIED

Hard drive and bit speed

EXAMPLE 8–5 **Hard drive.** The platter of the hard drive of a computer rotates at 7200 rpm (revolutions per minute = rev/min). (*a*) What is the angular velocity of the platter? (*b*) If the reading head of the drive is located 3.00 cm from the rotation axis, what is the linear speed of the point on the platter just below it? (*c*) If a single bit requires 0.50 μm of length along the direction of motion, how many bits per second can the writing head write when it is 3.00 cm from the axis?

APPROACH We use the given frequency f to find the angular velocity ω of the platter and then the linear speed of a point on the platter ($v = r\omega$). The bit rate is found by dividing the linear speed by the length of one bit (v = distance/time).

SOLUTION (*a*) First we find the frequency in rev/s, given $f = 7200\text{ rev/min}$:

$$f = \frac{(7200\text{ rev/min})}{(60\text{ s/min})} = 120\text{ rev/s} = 120\text{ Hz}.$$

Then the angular velocity is

$$\omega = 2\pi f = 754\text{ rad/s}.$$

(*b*) The linear speed of a point 3.00 cm out from the axis is given by Eq. 8–4:

$$v = r\omega = \left(3.00 \times 10^{-2}\text{ m}\right)(754\text{ rad/s}) = 22.6\text{ m/s}.$$

(*c*) Each bit requires 0.50×10^{-6} m, so at a speed of 22.6 m/s, the number of bits passing the head per second is

$$\frac{22.6\text{ m/s}}{0.50 \times 10^{-6}\text{ m/bit}} = 45 \times 10^{6}\text{ bits per second},$$

or 45 megabits/s (Mbps).