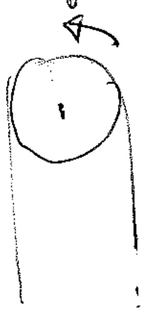
$W_0 = 3.4 \frac{rev}{s} \xrightarrow{t=1.3s} W = 5.5 \frac{rev}{s}$



i) $\alpha = ?$

ii) $\Delta\theta = ?$

40. **ORGANIZE AND PLAN** We have the initial and final angular velocity and the time, so Equation 8.8 will be needed to find the angular acceleration. For the second part, we can use either Equation 8.9 or 8.10 to find $\Delta\theta = \theta - \theta_0$.

Known: $\omega_0 = 3.40$ rev/s, $\omega = 5.50$ rev/s, $t = 1.30$ s.

SOLVE (a) Let's first convert the angular velocities into rad/s:

$$\omega_0 = 3.40\ \cancel{\text{rev}}/\text{s}\left[\frac{2\pi\ \text{rad}}{1\ \text{rev}}\right] = 21.4\ \text{rad/s}$$

$$\omega = 5.50\ \cancel{\text{rev}}/\text{s}\left[\frac{2\pi\ \text{rad}}{1\ \text{rev}}\right] = 34.6\ \text{rad/s}$$

in 3 sec

Plugging these values into Equation 8.8:

$$\alpha = \frac{\omega - \omega_0}{t} = \frac{34.6\ \text{rad/s} - 21.4\ \text{rad/s}}{1.30\ \text{s}} = 10.2\ \text{rad/s}^2$$

(b) We will use Equation 8.10 (but 8.9 could be used as well):

$$\Delta\theta = \frac{\omega^2 - \omega_0^2}{2\alpha} = \frac{(34.6\ \text{rad/s})^2 - (21.4\ \text{rad/s})^2}{2(10.2\ \text{rad/s}^2)} = 36.2\ \text{rad}$$

$w^2 - w_0^2 = 2\alpha \cdot \Delta\theta$

QUIZ 3 **NAME:**

A POTTER'S WHEEL STARTING WITH ANGULAR VELOCITY OF 2.4 RAD/S ACCELERATES IN 2.0 S TO 3.6 RAD/S, WITH CONSTANT ACCELERATION.

DURING THIS TIME THE WHELL TURNS AT AN ANGLE OF (?):

SOLVE We'll want to use Equation 8.9 to find the anglular displacement, but first we need to find the angular acceleration (Equation 8.6):

$$\alpha = \frac{\Delta\omega}{\Delta t} = \frac{(3.6 \text{ rad/s} - 2.4 \text{ rev/s})}{2.0 \text{ s}} = 0.60 \text{ rad/s}^2$$

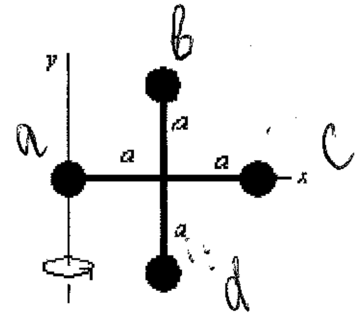
Plugging this into Equation 8.9:

$$\Delta\theta = \omega_0 t + \tfrac{1}{2}\alpha t^2 = (2.4 \text{ rad/s})(2.0 \text{ s}) + \tfrac{1}{2}(0.60 \text{ rad/s}^2)(2.0 \text{ s})^2 = 6.0 \text{ rad}$$

$$I = \sum m_i r_i^2$$

Calculating the Rotational Inertia

43. Four identical particles, each with mass m, are arranged in the x, y plane as shown. They are connected by light sticks to form a rigid body. If $m = 2.0$ kg and $a = 1.0$ m, the rotational inertia of this array about the y-axis is:



1) $4.0\ \mathrm{kg \cdot m^2}$
2) $12\ \mathrm{kg \cdot m^2}$
3) $9.6\ \mathrm{kg \cdot m^2}$
4) $4.8\ \mathrm{kg \cdot m^2}$

$$I = \sum m_i r_i^2$$

$$= \underbrace{(2\,\mathrm{kg})(1.0\,\mathrm{m})^2}_{b} + \underbrace{(2.0\,\mathrm{kg})(1.0\,\mathrm{m})^2}_{d} + \underbrace{(2.0\,\mathrm{kg})(2\,\mathrm{m})^2}_{c}$$

$$= 2 + 2 + 8 = 12\,[\mathrm{kg \cdot m^2}]$$

Ans: 2

$I = \frac{2}{5} M_E R^2$ Earth

$I = ?$

$K_{rot} = ?$

54. ORGANIZE AND PLAN Looking at Table 8.4, the rotational inertia for a uniform solid ball is: $I = \frac{2}{5}MR^2$. The values for the Earth's mass and radius can be found in Appendix E.

Known: $M = 5.97 \times 10^{24}$ kg, $R = 6.38 \times 10^6$ m.

SOLVE Plugging in the given values:

$$I = \tfrac{2}{5}(5.97 \times 10^{24} \text{ kg})(6.38 \times 10^6 \text{ m})^2 = 9.72 \times 10^{37} \text{ kg m}^2$$

REFLECT Measurements of the Earth's actual rotational inertia are slightly smaller (approximately 8×10^{37} kg m^2). The discrepancy is because the Earth is denser near its center. This gives it a lower rotational inertia than for a uniform sphere.

55. ORGANIZE AND PLAN The rotational kinetic energy is stated in Equation 8.15: $K = \frac{1}{2}I\omega^2$. We have the rotational inertia, so we only need the angular velocity of the Earth in rad/s. Let's use Equation 8.5 with the period of 24 hours in a day.

Known: $I = 9.72 \times 10^{37}$ kg m^2, $T = 24$ h.

SOLVE First, finding the angular velocity:

$$\omega = \frac{2\pi}{T} = \frac{2\pi}{24 \text{ h}}\left[\frac{1 \text{ h}}{60 \cdot 60 \text{ s}}\right] = 7.27 \times 10^{-5} \text{ rad/s}$$

This is the same answer we got in Problem 15. Plugging this into Equation 8.15:

$$K = \tfrac{1}{2}I\omega^2 = \tfrac{1}{2}(9.72 \times 10^{37} \text{ kg m}^2)(7.27 \times 10^{-5} \text{ rad/s})^2 = 2.56 \times 10^{29} \text{ J}$$

Notice we have cancelled radians from the equation because it is dimensionless. And we have used the fact that:

$$1 \text{ J} = 1 \text{ kg m}^2/\text{s}^2.$$

REFLECT This is a lot of energy, but we expect as much from an entire planet.