72. (a) Constant angular acceleration kinematics can be used to compute the angular acceleration $\alpha$. If $\omega_0$ is the initial angular velocity and $t$ is the time to come to rest, then

$$0 = \omega_0 + \alpha t \implies \alpha = -\frac{\omega_0}{t}$$

which yields $-39/32 = -1.2$ rev/s or (multiplying by $2\pi$) $-7.66\,\mathrm{rad/s^2}$ for the value of $\alpha$.

(b) We use $\tau = I\alpha$, where $\tau$ is the torque and $I$ is the rotational inertia. The contribution of the rod to $I$ is $M\ell^2/12$ (Table 11-2(e)), where $M$ is its mass and $\ell$ is its length. The contribution of each ball is $m(\ell/2)^2$, where $m$ is the mass of a ball. The total rotational inertia is

$$I = \frac{M\ell^2}{12} + 2\frac{m\ell^2}{4} = \frac{(6.40\,\mathrm{kg})(1.20\,\mathrm{m})^2}{12} + \frac{(1.06\,\mathrm{kg})(1.20\,\mathrm{m})^2}{2}$$

which yields $I = 1.53\ \mathrm{kg\cdot m^2}$. The torque, therefore, is

$$\tau = \left(1.53\,\mathrm{kg}\cdot\mathrm{m}^2\right)\left(-7.66\,\mathrm{rad/s^2}\right) = -11.7\ \mathrm{N\cdot m}\ .$$

(c) Since the system comes to rest the mechanical energy that is converted to thermal energy is simply the initial kinetic energy

$$K_i = \frac{1}{2}I\omega_0^2 = \frac{1}{2}\left(1.53\,\mathrm{kg}\cdot\mathrm{m}^2\right)\left((2\pi)(39)\,\mathrm{rad/s}\right)^2 = 4.59\times10^4\ \mathrm{J}\ .$$

(d) We apply Eq. 11-13:

$$\theta = \omega_0 t + \frac{1}{2}\alpha t^2 = \left((2\pi)(39)\,\mathrm{rad/s}\right)(32.0\,\mathrm{s}) + \frac{1}{2}\left(-7.66\,\mathrm{rad/s^2}\right)(32.0\,\mathrm{s})^2$$

which yields 3920 rad or (dividing by $2\pi$) 624 rev for the value of angular displacement $\theta$.

(e) Only the mechanical energy that is converted to thermal energy can still be computed without additional information. It is $4.59\times10^4$ J no matter how $\tau$ varies with time, as long as the system comes to rest.