

## Homework Solutions "Rotational Kinematics"

1) A grindstone, from a gristmill, rotates at constant angular acceleration  $\alpha=0.35 \text{ rad/s}^2$ . At time  $t=0$ , it has an angular velocity of  $\omega_0 = -4.6 \text{ rad/s}$  and a reference line on it is horizontal, at the angular position  $\theta_0 = 0$ .

a. At what time after  $t=0$  is the reference line at the position  $\theta = 5.0 \text{ rev}$ ?

First convert  $\theta_f \dots \theta_f = (5.0 \text{ rev}) \left( \frac{2\pi \text{ rad}}{1 \text{ rev}} \right) = 31.4 \text{ rad}$

Then using the kinematic equation  $\theta_f = \frac{1}{2} \alpha t^2 + \omega_0 t + \theta_0$

plug in the given values...  $0 = \frac{1}{2} \left( 0.35 \frac{\text{rad}}{\text{s}} \right) t^2 + \left( -4.6 \frac{\text{rad}}{\text{s}} \right) t - (31.4 \text{ rad})$

Now use the quadratic equation to solve for  $t \dots$

$$t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{4.6 \pm \sqrt{(-4.6)^2 - (4)(0.175)(-31.4)}}{(2)(0.175)} \Rightarrow \boxed{+ = 31.7\text{s}} \ \& \ - = -5.6\text{s}$$

Check on spreadsheet.

b. Describe the grindstone's rotation between  $t=0$  and  $t=40\text{s}$ .

It slows down, stops momentarily at  $t=13\text{s}$ , then reverses direction.  
See spreadsheet and graphs.

c. At what time  $t$  does the grindstone momentarily stop?

$$\omega_f = \alpha t + \omega_0$$

$$0 = \alpha t + \omega_0 \Rightarrow \frac{-\omega_0}{\alpha} = t = \frac{-\left(-4.6 \frac{\text{rad}}{\text{s}}\right)}{0.35 \frac{\text{rad}}{\text{s}^2}} = 13\text{s}$$