Problem 3: (30 pts.) A grindstone (a uniform disk) of mass 80 kg and radius 0.4 m is initially at rest. A 20 Watt motor is used to accelerate the wheel for 7 seconds. (Assume constant angular acceleration.)

a. (15 pts.) What is the angular velocity of the wheel after 7s? (Ignore friction.)

b. (15 pts.) A bug is sitting on the disk at a distance of 0.3m from the center. What total linear distance (in meters) will the bug travel during those 7 seconds?

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$E_i + W_{other} = E_f$

$0 + \left(20 \frac{J}{s}\right) \times 7s = E_f = 140\ J$

Then note $E_f = \frac{1}{2} I \omega_f^2$

$I = \frac{1}{2} MR^2 = \frac{1}{2}(80\ kg)(0.4m)^2 = 6.4\ kg\,m^2$

$E_f = 140\ J = \frac{1}{2} I \omega_f^2$

$\omega_f = \sqrt{\frac{2E_f}{I}} = \sqrt{\frac{2(140\ J)}{6.4\ kg\,m^2}} = \boxed{6.61\ rad/s}$

b. (15 pts.) A bug is sitting on the disk at a distance of 0.3m from the center. What total linear distance (in meters) will the bug travel during those 7 seconds?

$\omega_f^2 = \omega_0^2 + 2\alpha(\Delta\theta)$, $\omega_0 = 0$

$\Delta\theta = \frac{\omega_f^2}{2\alpha}$. what is α? assuming constant angular acceleration, $\omega_f = \alpha t$, where $t = 7s$, so $\alpha = \omega_f / t$

$\Delta\theta = \frac{1}{2} \frac{\omega_f^2}{\omega_f / t} = \frac{1}{2} \omega_f t = \frac{1}{2}(6.61\ rad/s)(7s) = 23.15\ rad$

$\Delta s = r\,\Delta\theta = (0.3m)(23.15\ rad) = \boxed{6.95\ m}$