Answer on Question 56958, Physics, Mechanics, Relativity

Question:

At $t = 0s$ a flywheel is rotating at 25 rpm. A motor gives it a constant acceleration of $0.5\, rad/s^2$ until it reaches 70 rpm. The motor is then disconnected. How many revolutions are completed at $t = 21s$?

Solution:

Let's first find the time that flywheel needs to reach 70 rpm:

$$\omega_f = \omega_i + \alpha t,$$

here, ω_f is the final angular velocity, ω_i is the initial angular velocity, α is the angular acceleration, t is the time.

From this formula we can find the time that flywheel needs to reach 70 rpm:

$$t = \frac{\omega_f - \omega_i}{\alpha} = \frac{\left(70\frac{rev}{min}\right)\cdot\left(2\pi\frac{rad}{1rev}\right)\cdot\left(\frac{1min}{60s}\right) - \left(25\frac{rev}{min}\right)\cdot\left(2\pi\frac{rad}{1rev}\right)\cdot\left(\frac{1min}{60s}\right)}{0.5\frac{rad}{s^2}}$$
$$= \frac{7.33\frac{rad}{s} - 2.62\frac{rad}{s}}{0.5\frac{rad}{s^2}} = \frac{4.71\frac{rad}{s}}{0.5\frac{rad}{s^2}} = 9.42s.$$

Let's find the angular displacement of the flywheel during acceleration:

$$\theta = \theta_0 + \omega_i t + \frac{1}{2}\alpha t^2,$$

here, θ_0 is initial angular displacement, ω_i is the initial angular velocity, α is the angular acceleration, t is the time.

From this formula we can find the angular displacement of the flywheel during acceleration:

$$\theta = \theta_0 + \omega_i t + \frac{1}{2}\alpha t^2 = 0rad + 2.62\frac{rad}{s}\cdot 9.42s + \frac{1}{2}\cdot 0.5\frac{rad}{s^2}\cdot(9.42s)^2 =$$
$$= 24.68rad + 22.18rad = 46.86rad.$$

Then, we can find the angular displacement of the flywheel when the motor is disconnected and the flywheel is coasting (for time $t = 21s - 9.42s = 11.58s$):

$$\theta = \theta_0 + \omega_f t = 46.86rad + 7.33\frac{rad}{s} \cdot 11.58s = 46.86rad + 84.88rad =$$

$$= 131.74rad.$$

Finally, we can find how many revolutions are completed:

$$R = \frac{\theta}{2\pi} = \frac{131.74rad}{2\pi} = 21rev.$$

Answer:

$R = 21rev.$