# 2024 A1

**ROTATING BODIES**

**L1:** To determine the total number of revolutions, multiply the revolutions per minute by the number of minutes in an hour, hours in a day, and total number of days. To find the appropriate RPM, work backwards from 1,500,000 revolutions dividing by the number of days, hours in a day, and minutes in an hour.

$$\omega = 10\frac{rev}{min} \rightarrow \left(10\frac{rev}{min}\right) * \left(60\frac{min}{hour}\right) * \left(24\frac{hour}{day}\right) * (90\ days) = \mathbf{1,296,000\ revolutions}$$

$$\frac{1{,}500{,}000\ revolutions}{(90\ days)\left(24\frac{hour}{day}\right)\left(60\frac{min}{hour}\right)} = \mathbf{11.574\ \frac{rev}{min}}$$

**L2:** To determine the future position of the blade you will need to know its initial position, its average or final velocity, and the time elapsed. To find the average velocity you can take the average of the initial and final velocity. Final velocity is found by adding the initial velocity with the constant acceleration, times the time elapsed. Because wind turbines rotate clockwise, using a radian circle, set the velocity and acceleration as negative values. To find final position, add the initial position to the distance travelled. Distance travelled is defined as the average velocity multiplied by the time elapsed. Once the final position in radians is found, convert to degrees, and find the equivalent position between 0 and 360°.

$$\omega_{final} = \omega_{initial} + (\alpha * \Delta t) \rightarrow \omega_{final} = -4\frac{rad}{sec} + \left(-0.10\frac{rad}{sec^2} * 30\text{sec}\right) = -7\frac{rad}{sec}$$

$$\omega_{average} = \frac{\omega_{final} - \omega_{initial}}{2} + \omega_{initial} \rightarrow \omega_{average} = \frac{(-7 - -4)\frac{rad}{sec}}{2} + -4\frac{rad}{sec} = -5.5\frac{rad}{sec}$$

$$\theta_{final} = \theta_{initial} + (\omega_0 * \Delta t) + \left(\frac{\alpha t^2}{2}\right) \rightarrow \theta_{final} = \frac{\pi}{4} + \left(-4.0\frac{rad}{sec} * 30sec\right) + (0.1\frac{rad}{sec} * 30^2 sec)/2 = -164.215\text{ radians}$$

$$\theta_{radians} * \frac{180}{\pi} = \theta_{degrees} \rightarrow -164.215 * \frac{180}{\pi} = -9408.8°$$

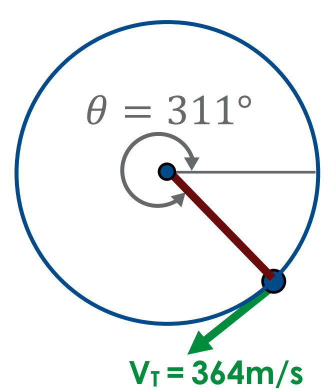
$$\frac{-9408.8}{360} = -26.135 \rightarrow round\ to\ 27\ revolutions \rightarrow -9408.8° + (360° * 27) = 311.17°$$

The blade's linear velocity direction is found by subtracting 90° from the final position because it is rotating clockwise, and rotating objects have linear velocities tangent to the radius of rotation.

$$Linear\ Velocity\ Direction = 311.17° - 90° = 221.17°$$

To find the final linear velocity, multiply the radius of rotation times the final rotational velocity.

$$V = r * \omega \rightarrow V = (52\ meters) * \left(7\frac{rad}{sec}\right) = 364\frac{m}{s}$$




**Final Answers:**

**Final Angular Velocity: -7 rad/sec**
**Final Position: 311.17°**
**Linear Velocity: 364 $\frac{m}{s}$ at 221.17°**