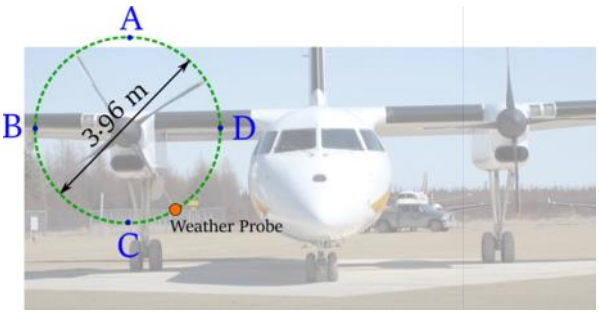
Quiz 1

Wednesday, January 13, 2021 1:17 PM

After a successful weather probe launch at Penn State University, Benny was contracted to launch a 0.25 kg weather probe by Embry-Riddle Aeronautical University. In the spirit of aviation, Benny designed a device that attaches to the tip of the propeller of a Dash-8 airplane which is 3.96 meters in diameter . The weather probe is attached to the tip of the propeller that starts from rest and spins counter-clockwise to an idle speed of 660 RPM in 30 seconds. While spinning at a constant 660 RPM, Benny is able to activate a release mechanism that detaches the weather probe from the propeller. At all times the plane's brakes are activated so the center of mass of the plane is at rest.

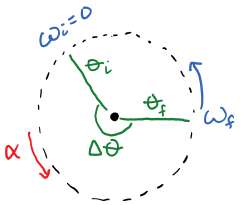


(a) Benny wishes to launch the weather probe completely vertical into the air. At what point (A, B, C, or D) should Benny activate the release mechanism which detaches the probe from the propeller? Explain your reasoning using words, diagrams, mathematical arguments, etc.

(b) What speed, in m/s, is the probe moving the moment it is released from the propeller?

(c) What is the average angular acceleration of the propeller between 0 and 30 seconds?

(d) Through how much distance, in meters, does the tip of the propeller travel between 0 and 30 seconds?



(a) Point D, Velocity is tangent to circle & that is where $\vec{V}$ is vertically upward

(b) $|\vec{V}_f| = V_t = \omega_f r$, $\omega_f = \frac{660\,\text{rev}}{\text{min}} \left| \frac{1\,\text{min}}{60\,\text{s}} \right| \frac{2\pi\,\text{rad}}{1\,\text{rev}} = 22\pi\,\frac{\text{rad}}{\text{s}}$

$|\vec{V}_f| = 136.8\,\text{m/s}$

(c) eq(ii), $\omega_f = \cancel{\omega_i^{\,0}} + \bar{\alpha}\Delta t \Rightarrow \bar{\alpha} = \frac{\omega_f}{\Delta t} = 2.30\,\frac{\text{rad}}{\text{s}^2}$

(d) eq(i), $\Delta\theta = \cancel{\omega_i^{\,0}}\Delta t + \frac{1}{2}\alpha\Delta t^2 \Rightarrow \Delta\theta = 1036.7\,\text{rad}$

$s = \Delta\theta r = 2053\,\text{m}$

K
$\omega_i = 0$
$\Delta t = 30\text{s}$
$\omega_f = 660\,\text{RPM}$
$r = \frac{3.96}{2}\,\text{m}$

Uk
α
$\Delta\theta$

equations

(i) $\Delta\theta = \omega_i \Delta t + \frac{1}{2}\alpha\Delta t^2$

(ii) $\omega_f = \omega_i + \alpha\Delta t$

(iii) $\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta$

(iv) $s = \Delta\theta r$

(v) $V_t = \omega r$

Rubric

Problem Orientation	Solution Exploration	Solution Execution	Solution Evaluation
+1 pt - physical representation +1 pt - known and unknown quantities	+2 pts - relevant equations (0.5 pts each)	~~ ***part (a)*** ~~ 0.5 pts - correct answer 0.5 pts - reasoning ~~ ***part (b)*** ~~ 1 pt - conversion 0.5 pt - application 0.5 pt - answer and units ~~ ***part (c)*** ~~ 0.5 pt - application 0.5 pt - answer and units ~~ ***part (d)*** ~~ 1.5 pt - application 0.5 pt - answer and units	Not requested