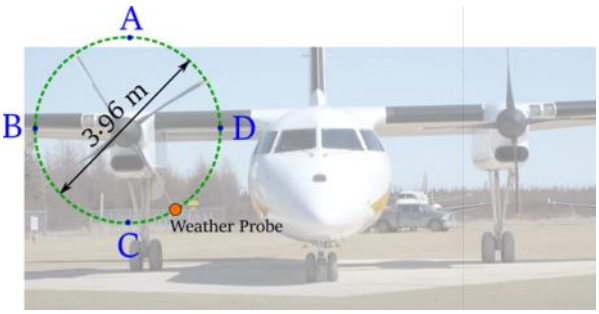
Quiz 1

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.

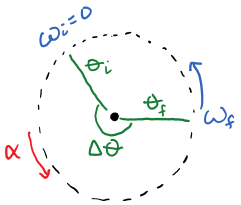


(a) Benny wishes to launch the weather probe completely vertical into the air. At what point (A, B, C, or D) should Benny activate the release mechanism which detaches the probe from the propeller? Explain your reasoning using words, diagrams, mathematical arguments, etc.

(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

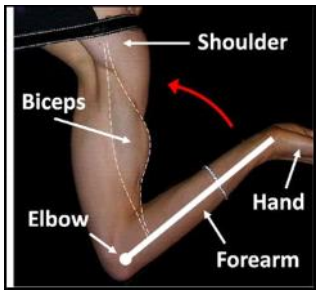
Problem Orientation	Solution Exploration	Solution Execution	Solution Evaluation
+1 pt - physical representation +1 pt - known and unknown quantities	+2 pts - relevant equations (0.5 pts each)	~~ ***part (a)*** ~~ 0.5 pts - correct answer 0.5 pts - reasoning ~~ ***part (b)*** ~~ 1 pt - conversion 0.5 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

Quiz 2

Tuesday, January 19, 2021 11:39 AM

The biceps brachii (commonly known as biceps) muscles are responsible for bending your arm at the elbow. They move your forearm towards your shoulder (the red arrow shows this motion, also known as adduction). See diagram at right. Your biceps muscles attach to your forearm a few cm away from your elbow.

(a) Using relevant physical concepts we have discussed this term, explain why the biceps muscles do not attach directly to the elbow, but instead attach to the forearm a few centimeters away from the elbow. Use words, diagrams, graphs, etc!

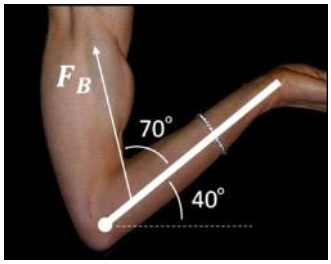


$\Sigma \tau = I\alpha$, $\tau = r \times F$, where r is the lever arm, which is displacement from axis of rotation to location of force.

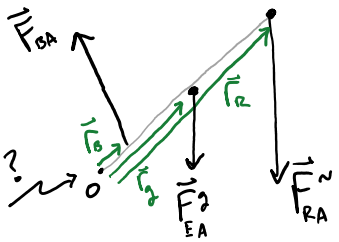
if $r = 0$, $\tau = 0$

if $\tau_{Bicep} = 0$, you can't rotate arm

(b) While lifting a rock, Elle Beau's biceps make an angle of 70 degrees with her forearm, and her forearm makes an angle of 40 degrees with the horizontal as shown to the right. The distance from Elle's elbow to her hand is 26.7 cm, and her biceps attach to her forearm 3.4 cm away from her elbow. Elle's forearm has a mass of 1.46 kg, and a center of mass midway between her elbow and her hand. If she is holding the 5 kg rock stationary in her hand, how much force are her biceps exerting on her forearm? (assume no other muscles are exerting forces)



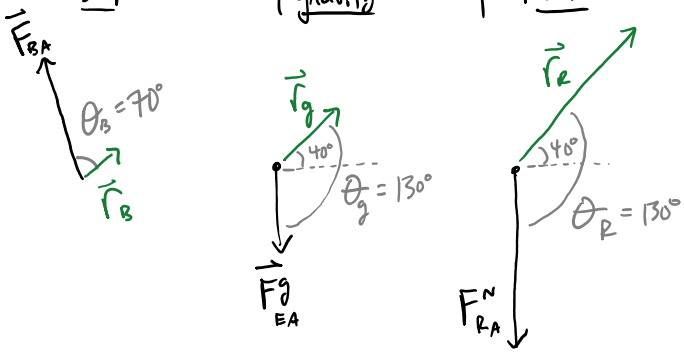
e-FBD (Arm)



$\vec{F}$ elbow

Torque Cross Product Vector operations

Bicep | gravity | Rock



$\Sigma \tau_O = I_O \alpha_O^{\circ} \Rightarrow \tau_B + (-\tau_g) + (-\tau_R) = 0$

$|\vec{r}_B||\vec{F}_{BA}|\sin\theta_B - |\vec{r}_g||\vec{F}^g_{EA}|\sin\theta_g - |\vec{r}_R||\vec{F}^N_{RA}|\sin\theta_R = 0$, $F^g_{EA} = M_A g$, $F^N_{RA} = M_R g$

$$\therefore \quad |\vec{F}_{BA}| = \frac{|\vec{r}_g||\vec{F}_{EA}|\sin\theta_g + |\vec{r}_R||\vec{F}^N_{RA}|\sin\theta_R}{|\vec{r}_B|\sin\theta_B} = \boxed{359\ N}$$

Rubric
(a) 1.5 pts
(b)

Problem Orientation	Solution Exploration	Solution Execution	Solution Evaluation
1.5 pts - eFBD 1.5 pts - vector operations 1 pt - 2nd law torque eq. 0.5 pt - torque = r x F =r*F*sin(theta) eq. 0.5 pts - F_g = mg	0.5 pts - F_R = mg	1.0 pts - sign of torques 1.5 pts - application of 2nd law	0.5 pts - Correct answer and units