

Physics 3 Quiz 6 (Sample Version) 4Aug03
(HW 15 Due Mon 4Aug, but not to be turned in for a grade)

Consider an ordinary clock with a smoothly moving sweep second hand of mass $m=50$ grams and length $L=25$ cm. I prescribe a coordinate system with origin where the axis of rotation of the hands passes through the clock face, x-axis passing through the three, and y-axis passing through the twelve.

- Where does the z-axis point? (Remember that $\mathbf{i} \times \mathbf{j} = \mathbf{k}$...)
 - To the left.
 - Clockwise.
 - Out of the clock face.
 - Into the clock face.
- What is the angular velocity (vector...) of the pointer on the second hand?
 - $1.05 \times 10^{-1} \mathbf{i} \text{ sec}^{-1}$
 - $-1.05 \times 10^{-1} \mathbf{j} \text{ sec}^{-1}$
 - $-1.05 \times 10^{-1} \mathbf{k} \text{ sec}^{-1}$
 - $1.05 \times 10^{-1} \text{ rad/sec}$
- What is the magnitude of the angular velocity of a point on the second hand 12.5 cm from the axis (half the length of the second hand)?
 - $0.524 \times 10^{-1} \text{ rad/sec}$
 - $1.05 \times 10^{-1} \text{ rad/sec}$
 - $2.09 \times 10^{-1} \text{ rad/sec}$
 - Not enough information to compute.
- What is the angular acceleration (vector...) of the second hand?
 - Zero
 - $-1.05 \times 10^{-1} \text{ rad/sec}^2$
 - $0.524 \times 10^{-1} \text{ rad/sec}^2$
 - Need the moment of inertia of a rod rotating about one end to compute.
- A fly of mass $m_f = 0.5$ g lands on the pointer of the second hand. As the hand passes the three, what is the magnitude of the torque exerted by the fly on the axle rotating the second hand?
 - $-m_f g$
 - $(m_f/m)g$
 - $-mL$
 - $m_f L$
- What is the direction of the torque vector due to the fly (still passing the three)?
 - Clockwise
 - Counterclockwise
 - Out of the face of the clock
 - Into the face of the clock

7. When the second hand is passing through the 4:00 position (or the 20 second position, if you prefer), what is the torque due to the fly? (Note that you do not actually need a calculator to solve this problem...)

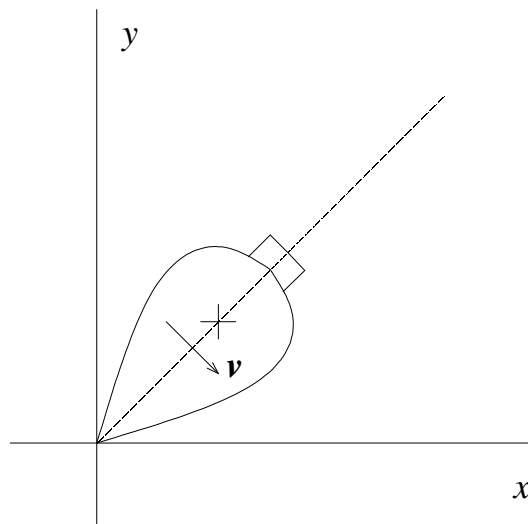
- a. $1.06 \times 10^{-3} \text{ k N-m}$
- b. $-1.06 \times 10^{-3} \text{ k N-m}$
- c. $6.13 \times 10^{-4} \text{ k N-m}$
- d. $-6.13 \times 10^{-4} \text{ k N-m}$

8 The fly flies away. But he later crawls into the gears of the clock and by a miraculous chain of events causes the second hand to go its normal speed until it passes the twelve, and then slow down uniformly to half its normal speed by the time it reaches the six. What direction is the angular acceleration vector α of the second hand?

- a. Down (i.e. $-\mathbf{j}$)
- b. Clockwise
- c. Counterclockwise
- d. Out of the clock face

9. Derive an expression for the magnitude of the angular acceleration vector. Call the normal angular speed ω_0 . (No, I wouldn't ask you this on the quiz, but solving this problem is a good way to think about how angle represents position in a rotating system, and how to apply the kinematic principles we studied for straight-line motion to rotational motion.)

Consider a child's toy top as shown in the diagram. The top has a mass m and its center of mass is shown by the cross. The top spins about the axis indicated by the dotted line in a direction such that a spot on the visible surface moves in the direction indicated by the arrow, and with a speed v . The top has a moment of inertia I .



10. Draw the angular velocity vector and label it ω . (For all the subsequent questions asking you to draw vectors, I'm looking for proper placement and direction, not length.)
11. Draw the angular momentum vector L .
12. There is an external force acting on the top. Draw a vector representing it and label it appropriately.
13. This force produces a torque N on the top. Draw a radius vector r from the axis of rotation *for this torque* to the point of application of the force.
14. Using appropriate symbology, indicate this torque on diagram. Label it.
15. What is the magnitude of the angular acceleration α of the top?
- 0
 - N/I
 - $I\omega$
 - mr^2
16. How does the angular acceleration α affect the motion of the top?
- Increases ω
 - Decreases ω
 - Causes the top to fall (topple).
 - Causes the CM to move into the page.