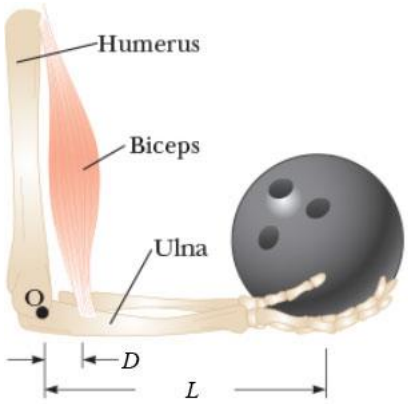
Name: _____

# PHYS 1110-02 Exam 3

You may use an 8.5"×11" note sheet written on both sides and a calculator. Please write your answers in the boxes provided. Show your work outside the boxes. If you need to change the answer you wrote in a box, erase it completely and write your intended answer. This is easiest if you write in pencil. You have 110 minutes.

1. The biceps muscle powers flexion of the elbow joint. It attaches to the ulna bone of the forearm at a distance $D = 4.80$ centimeters from O, the elbow's pivot point. Because of the width of the biceps muscle, the force it applies to the ulna is vertically upward.

   Preparing to roll a 6.00-kg bowling ball down the lane, a bowler holds the ball in his hand, a horizontal distance $L = 34.0$ centimeters from O. The ulna is horizontal, parallel to the floor, while the humerus bone is vertical. The mass of the bowler's forearm and hand is 3.00 kg, and its center of gravity is $C = 12.0$ centimeters from O.




   A. What is the magnitude of the torque about O caused by the weight of the bowling ball?

   B. What is the direction of the torque about O caused by the weight of the bowling ball?

      ○ a. Clockwise, negative, into the page.

      ○ b. Counterclockwise, positive, out of the page.

      ○ c. The torque is zero, so it has no direction.

   C. What is the magnitude of the torque about O caused by the weight of the forearm?

D. What is the direction of the torque about O caused by the weight of the forearm?

○ a. Clockwise, negative, into the page.

○ b. Counterclockwise, positive, out of the page.

○ c. The torque is zero, so it has no direction.

E. What is the magnitude of the torque about O caused by the biceps muscle?

F. What is the direction of the torque about O caused by the biceps muscle?

○ a. Clockwise, negative, into the page.

○ b. Counterclockwise, positive, out of the page.

○ c. The torque is zero, so it has no direction.

G. What is the magnitude of the tension in the biceps muscle?

H. What is the magnitude of the torque about O caused by the humerus?

I. What is the direction of the torque about O caused by the humerus?

○ a. Clockwise, negative, into the page.

○ b. Counterclockwise, positive, out of the page.

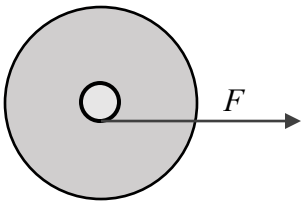
○ c. The torque is zero, so it has no direction.

J. What is the magnitude of the force exerted on the elbow joint by the humerus?

K. What is the direction of the force exerted on the elbow joint by the humerus?

○ a. Downward ○ b. Upward ○ c. The force is zero, so it has no direction.

2. A pulley of radius 0.025 m is fixed to the axle of a cylinder with a moment of inertia of 0.0400 kg·m$^2$. A string wound around the pulley is pulled away from the cylinder with a tension $F$ of 3.00 newtons. What is the angular acceleration of the cylinder?




3. A 55-kilogram platform diver jumps from a diving board and tucks into a ball. In his ball shape, he spins at the rate of 5.00 radians per second. Before reaching the water, he extends his body straight out.

A. What is his moment of inertia when he is in the ball shape? Approximate him as a uniform sphere with a radius of 0.25 meters.

B. What is his moment of inertia when he is extended? Approximate him as a thin rod with a length of 1.70 meters.

C. What is his angular momentum when he is in the ball shape?

D. What is his angular momentum when he is extended?

E. What is his angular velocity when he is extended?

F. What is his rotational kinetic energy when he is in the ball shape?

4. A 0.400-kg weight hanging on a spring oscillates up and down with an amplitude of 0.085 meters and a period of 0.80 seconds.

   A. What is the spring constant (stiffness) of the spring?

   B. What is the total energy of the system of the weight and spring?

   C. What is the maximum speed of the weight?

5. A piano wire with a "speaking length" (length of the vibrating segment) of 0.665 meters has a length density of $6.2\times10^{-3}$ kilograms per meter and is under a tension of 750 newtons.

   A. What is the propagation speed of a transverse wave in this piano wire?

   B. The transverse standing wave in this wire with the lowest frequency has a distance between nodes of 0.665 meters. What is the wavelength of this standing wave?

   C. What is the frequency of the lowest-frequency transverse standing wave in this wire?

   D. What is the wavelength of the next-highest standing wave in this wire?

   E. What is the frequency of the next-highest standing wave in this wire?

6. To tune an orchestra, an oboe plays a "Concert A" at 440 Hz (1 Hz = 1 cycle per second). A violinist plays an "A" and observes that it creates beats with a frequency of 4.0 Hz. The violinist adjusts the string to slightly higher tension and observes that the beat frequency increases to 4.5 Hz. What was the frequency of the violin's note that gave beats at 4.0 Hz?

7. Room 133 in the Classroom Building has good acoustics, so that when I stand in the right place I can hear everyone in the theatre seats. More specifically, if a student sitting in the room speaks at a conversational loudness, I hear their voice at 60 decibels.

   A. What is the intensity, in watts per square meter, of the sound I hear at 60 decibels?

   B. If 80 students in their seats are all talking at conversational loudness, what is the intensity, in watts per square meter, of the sound that I hear?

   C. If 80 students in their seats are all talking at conversational loudness, what is the decibel level of the sound that I hear?

8. Out in open air, where sound is neither absorbed nor reflected, a person speaking at conversational loudness is heard at 60 decibels at a distance of 1.00 meter. What is the sound power, in watts, of their voice?

9. Branlee has perfect pitch, and can identify the frequency of sounds she hears. While driving in her car at 5.0 meters per second, she hears the sound of a fire engine's horn from behind her at a frequency of 125 Hz. The horn creates its sound at 120 Hz, and the speed of sound in air is 342 meters per second.

   A. Is the fire truck standing still, is it traveling in the same direction as Branlee's car, or is it traveling away from Branlee's car?

      ○ a. Standing still ○ b. Same direction ○ c. Traveling away

   B. What is the speed of the fire truck?

10. A simple pendulum with a mass of 9.00 kg has a period of 8.0 seconds. What is the pendulum's length?

11. The Moon, which has a mass of $7.35 \times 10^{22}$ kg, kilograms, most strongly interacts gravitationally with the Earth and the Sun. $G = 6.672 \times 10^{-11} \frac{\text{N}\cdot\text{m}^2}{\text{kg}^2}$

A. The Sun has a mass of $1.99 \times 10^{30}$ kilograms and is, on average, a distance of $1.50 \times 10^{11}$ meters from the Moon. What is the force of the gravitational interaction between the Moon and the Sun?

B. The Earth has a mass of $5.976 \times 10^{24}$ kilograms and is, on average, a distance of $3.82 \times 10^{8}$ meters from the moon. What is the force of the gravitational interaction between the Moon and the Earth?