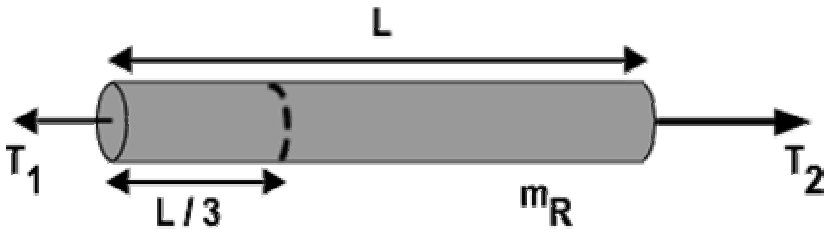
Question 1

In the 17th century, Otto von Guricke fitted two hollow bronze hemispheres together and removed the air from the resulting sphere. Two eight-horse teams could not pull the halves apart even though the hemispheres fell apart when air was re-admitted. Suppose von Guricke had tied both teams of horses to one side and bolted the other side to a heavy tree trunk. In this case, how would the force on the hemispheres compare to the original case?

A. One quarter the force of the original case.
B. One half the force of the original case.
C. Equal to the force of the original case.
D. Twice the force of the original case. **RIGHT ANSWER**
E. Four times the force of the original case.

Question 2

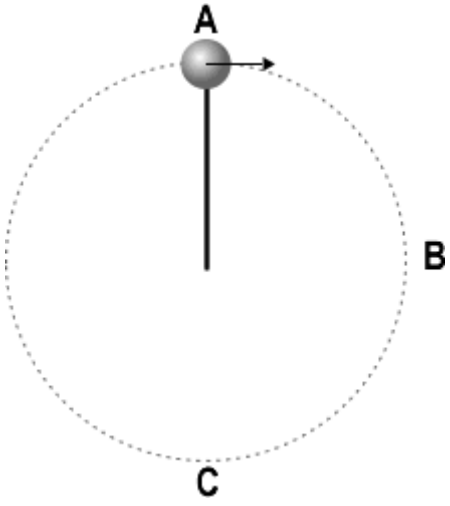
A uniform rope of mass $\mathbf{m_R}$ and length **L** has 2 forces pulling it in opposite directions: $\mathbf{T_2}$ and $\mathbf{T_1}$, as shown. Assume the magnitude of $\mathbf{T_2}$ is greater than the magnitude of $\mathbf{T_1}$. Assume the sag of the rope is negligible. What is the tension in the rope at a distance **L/3** from the left side?



A. 0
B. $\mathbf{T_2 - T_1}$
C. $\mathbf{(T_2 - T_1) / 3}$
D. 1/3 ($\mathbf{T_2}$ + 2 $\mathbf{T_1}$) **RIGHT ANSWER**
E. 3 ($\mathbf{T_2}$ + $\mathbf{T_1}$)

Question 3

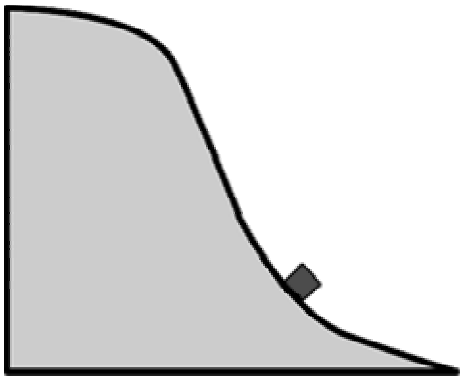
A massive ball on a massless string is moving in a *vertical* circle as shown. Air resistance is negligible. Three points **A**, **B** and **C** on the circle are shown. At which of the three points is the magnitude of the tangential acceleration of the ball, a_T, the largest?



A. A
B. B **RIGHT ANSWER**
C. C
D. The tangential acceleration has the same non-zero magnitude at all 3 points.
E. The tangential acceleration is zero at all 3 points.

F. **Question 4**

A cart slides without friction down a track as shown. As the cart slides beyond the point shown, what happens to its acceleration in the direction of motion and its speed?



A. Both decrease.
B. The speed decreases, but the acceleration increases.
C. Both remain constant.
D. The speed increases, but the acceleration decreases. **RIGHT ANSWER**
E. Both increase.

Question 5

A disc of radius 2R rotates about a fixed axis. A point at a distance R/2 from the axis has an angular speed of ω. What is the angular speed of a point a distance R from the axis of rotation?

A. ω/4
B. 2 ω
C. ω/2
D. ω **RIGHT ANSWER**
E. 4ω

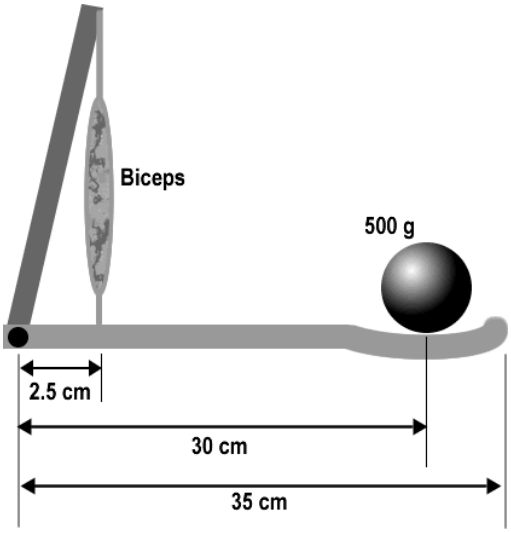
Question 6

Two cylinders are rotating about their axes. One cylinder is hollow, the other is solid. They have the same mass, radius, length, and are rotating with the same angular speed. Which cylinder has the higher rotational kinetic energy?

A. The hollow cylinder. **RIGHT ANSWER**
B. The solid cylinder.
C. They have the same rotational kinetic energy.
D. There is insufficient information given to answer this question.

Question 7

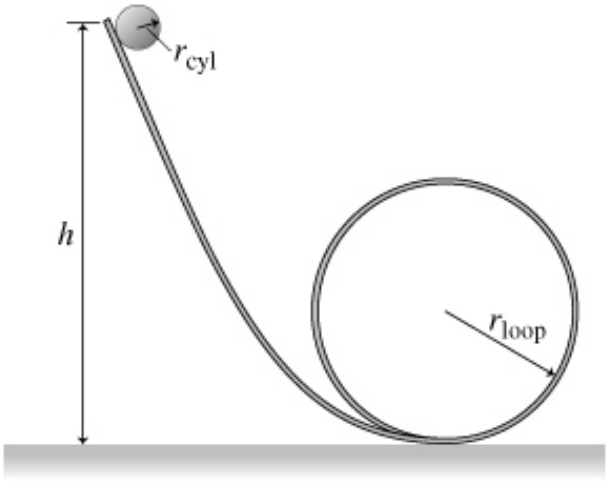
A forearm and hand can be modeled as a 1.2 kg uniform "beam" that is 35 cm long, pivots at the elbow and is supported by the biceps muscle. The biceps is connected to the forearm 2.5 cm from the elbow. The hand is supporting a 500 g ball that is 30 cm from the elbow, and the forearm is horizontal and the biceps is vertical, as shown. The arm is stationary. Assume that g is 9.8 m/s^2. What is the magnitude of the force, in N, that the biceps exerts on the forearm?



A. 670
B. 14
C. 59
D. 220
E. 140 **RIGHT ANSWER**

Question 8

A cylinder of radius r_{cyl} is released from rest and rolled from a height h large enough that it "loops the loop," that is, rolls around the track with a loop of radius r_{loop} without losing contact with the track.



When the cylinder rolls the friction is sufficient that it rolls without slipping. The radius r_{cyl} of the cylinder is much smaller than the radius of the loop r_{loop}.

Compared to an object that does not roll, but instead slides without friction, should a rolling object be released from the same, a greater, or a lesser height in order just barely to complete the loop the loop?

A. The rolling object should be released from a greater height. **RIGHT ANSWER**
B. The rolling object should be released from a lesser height.
C. The rolling object should be released from exactly the same height.
D. The answer depends on the moment of inertia of the rolling object.
E. None of the above.