4. A mass \( m = 0.10 \text{ kg} \) is in uniform circular motion, radius \( R = 1.0 \text{ m} \) and angular speed \( \omega_i = 5.0 \text{ rad/s} \), on a horizontal air table (no friction). It can do this because it is attached to a string that passes through a hole in the table located in the middle of the circular path and to which a mass \( M \) is attached below the table, hanging from the end of the string.

A. (5 pts) What is the value of \( M \)?

(a) 0.050 kg.
(b) 2.5 kg.
**(c) 0.25 kg.
(d) 0.50 kg.

\[
\text{Hanging mass provides tension in the string to account for uniform \( \omega \) motion centrifugal accel \( \omega^2 R \)}
\]
\[
\Rightarrow \quad M g = m \omega^2 R \Rightarrow M = \frac{m \omega^2 R}{g}
\]
\[
= \frac{(0.1 \text{ kg})(5 \text{ rad/s})^2(1.0 \text{ m})}{(10 \text{ m/s}^2)} = 0.25 \text{ kg}
\]

B. (5 pts) A small additional mass \( AM \) is added to \( M \), and these masses drop a distance \( h = 1 \text{ cm} \) before the system comes to a new equilibrium, uniform circular motion with a different radius and angular speed. What is the new angular speed?

(a) 5.00 rad/s.
**(b) 5.10 rad/s.
(c) 5.25 rad/s.
(d) 4.90 rad/s.

Angular mom. about hole in center of table is conserved - no torque about this point. If \( i \) and \( f \) refer init and final, then

\[
L_{i} = \sum \text{mom.} R_{i} = \sum \text{mom.} R_{f}
\]
\[
mw_i R_i^2 = mw_f R_f^2
\]
\[
\Rightarrow \quad \omega_f = \omega_i \left( \frac{R_i}{R_f} \right)^2 = \omega_i \left( \frac{R_i}{R_i-h} \right)^2 = \omega_i \left( \frac{100 \text{ cm}}{99 \text{ cm}} \right)^2 = 1.02
\]
\[
= 5(1.02) = 5.1 \text{ rad/s}
\]