4. A mass $m = 0.10$ kg is in uniform circular motion, radius $R = 1.0$ m and angular speed $\omega_i = 5.0$ 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.

Hanging mass provides tension in the string to account for uniform ⊙ motion centripetal accel $\omega^2 R$

$$\Rightarrow Mg = m\omega^2 R \Rightarrow M = \frac{m\omega^2 R}{g}$$

$$= \frac{(0.1\text{ kg})(5\text{ rad/s})^2(1.0\text{ m})}{(10\text{ m/s}^2)} = 0.25\text{ kg}$$

B. (5 pts) A small additional mass ΔM is added to M, and these masses drop a distance h = 1 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. L about hole in center of table is conserved – no torque about this point. If "i" and "f" refer init and final, then

$$L = m v_i R_i = m v_f R_f$$

$$m\omega_i R_i^2 = m\omega_f R_f^2$$

$$\Rightarrow \omega_f = \omega_i \left(\frac{R_i}{R_f}\right)^2 = \omega_i \left(\frac{R_i}{R_i - h}\right)^2 = \omega_i \underbrace{\left(\frac{100\text{ cm}}{99\text{ cm}}\right)^2}_{\simeq 1.02}$$

$$= 5(1.02) = 5.1\text{ rad/s}$$