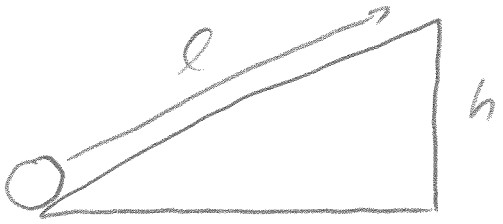
Physics 10154 - Exam #4a C

Partial credit will be given provided you show all work and are solving parts of the problem correctly. Points will be deducted if you don't show your work (or if some parts are incorrect) even if you get the right answer. Clearly indicate your answer with a circle or box and remember to include correct units and significant figures.

1. (30 pts) A sphere rolls without slipping up a 27° inclined plane with an initial linear speed of 6.4 m/s. How far up the ramp does the sphere travel before stopping?



$$\Sigma W_F = W_{grav} = \Delta K$$

$$-mgh = 0 - \left(\tfrac{1}{2}mv^2 + \tfrac{1}{2}I\omega^2\right)$$

$$mgh = \tfrac{1}{2}mv^2 + \tfrac{1}{2}\left(\tfrac{2}{5}MR^2\right)\left(\tfrac{v^2}{R^2}\right)$$

$$mgh = \tfrac{1}{2}mv^2 + \tfrac{1}{5}mv^2$$

$$mgh = \tfrac{7}{10}mv^2$$

$$h = \frac{7v^2}{10g} = 2.926\,m$$

$$h = \ell \sin 27^\circ$$

$$\ell = \frac{h}{\sin 27^\circ} = 6.4\,m$$

2. (35 pts) A 65 kg woman stands on a 370 kg turntable, both rotating with an initial angular speed of 0.45 rev/sec. The woman is initially 1.0 meters from the center of the turntable, and she moves to the edge of the turntable, 1.7 meters from the center. (a) What is the final angular speed of the turntable? (b) If the woman's applied force is the only force doing work in this problem, how much work does she do?

$$I_{1i}\omega_{1i} + I_{2i}\omega_{2i} = I_{1f}\omega_{1f} + I_{2f}\omega_{2f}$$

a) Woman & turntable move together

so $\omega_{1i} = \omega_{2i} = \omega_i$, $\omega_{1f} = \omega_{2f} = \omega_f$

Also turntable I_2 is constant

$$(I_{1i} + I_2)\omega_i = (I_{1f} + I_2)\omega_f$$

$I_{1i} = (65)(1)^2 = 65$

$I_{1f} = (65)(1.7)^2 = 187.85$

$I_2 = \frac{1}{2}(370)(1.7)^2 = 534.65$

$\omega_i = 0.45\ \text{rev/sec} = 2.827\ \text{rad/s}$

$$(65 + 534.65)(2.827) = (187.85 + 534.65)\omega_f$$

$\omega_f = 2.35\ \text{rad/s}$ or $2.3\ \text{rad/s}$

b) $\Sigma W_F = W_{App} = \Delta K$

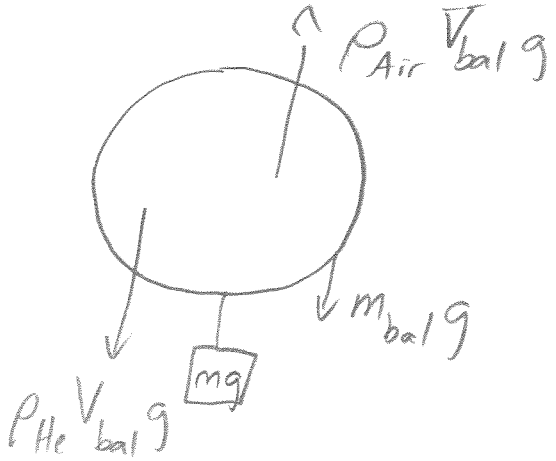
$= \frac{1}{2}(I_{1f} + I_2)\omega_f^2 - \frac{1}{2}(I_{1i} + I_2)\omega_i^2$

$= \frac{1}{2}(187.85 + 534.65)(2.35)^2 - \frac{1}{2}(65 + 534.65)(2.827)^2$

$= 1989.36 - 2396.2 = -410\ \text{J}$

3. (35 pts) A spherical balloon has a mass of 45 grams (the material of the ballon only) and, when filled with Helium, a radius of 52 cm. The density of Helium in the balloon is 0.181 kg/m^3. The density of air surrounding the balloon is 1.29 kg/m^3. How much additional weight can the balloon support without moving toward the ground if it is initially at rest?

The volume of a sphere is $\frac{4}{3}\pi R^3$



$$V_{bal} = \frac{4}{3}\pi (.52)^3$$

$$= 0.589\ m^3$$

$$\Sigma F_y : \rho_{Air} V_{bal} g - \rho_{He} V_{bal} g - m_{bal} g - mg = 0$$

$$(1.29)(.589)(9.8) - (.181)(.589)(9.8) - (.045)(9.8) - m(9.8) = 0$$

$$7.446 - 1.045 - 0.441 - 9.8m = 0$$

$$9.8m = 5.96$$

$$m = 0.61\ kg$$