Physics 10154 - Exam #4a

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 5.0 kg sphere with a radius of 3.5 cm rolls without slipping down a 2.0 meter ramp. The sphere starts from rest and the ramp makes an angle of 15° with respect to the horizontal. How many seconds does it take for the sphere to reach the bottom of the ramp?

$h = 2.0 \sin 15^\circ = 0.5176\ m$

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

$W_{grav} = mgh$

$\Delta K = \left(\frac{1}{2}mv^2 + \frac{1}{2}Iw^2\right) - (0)$

$= \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{2}{5}mR^2\right)\left(\frac{v^2}{R^2}\right)$

$= \frac{1}{2}mv^2 + \frac{2}{10}mv^2 = \frac{7}{10}mv^2$

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

$v = \sqrt{\frac{10}{7}gh} = 2.69\ m/s$

$\Delta s = 2.0$

$v_0 = 0$

$v = 2.69$

$a = ?$

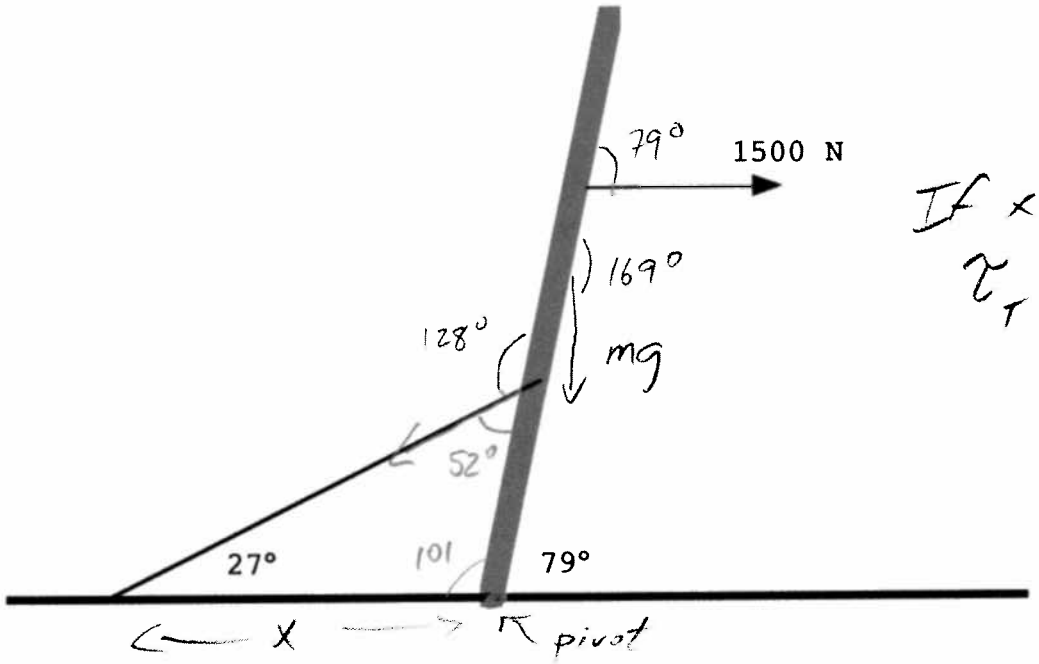
$t = ?$

$\Delta s = \frac{1}{2}(v + v_0)t$

$2.0 = \frac{1}{2}(2.69)t$

$\boxed{t = 1.5\ s}$

2. (30 pts) A 120-meter tall uniform radio tower of mass 1200 kg is supported by a cable anchored to a point 45 meters from the base of the tower as shown below. A 1500 Newton force exerted by a strong wind on the tower is horizontal and centered on a point 85 meters above the ground. The tower leans, making an angle of 79° with the horizontal as shown below. What is the tension in the cable?



If $x = 45$,

$\tau_T = F_T (45 \sin 27)$

$\Sigma\tau = \tau_T + \tau_W + \tau_{App}$

$\tau_T = +(45) F_T \sin 128° = 35.46 F_T$

$\tau_W = -(60)(1200)(9.8)\sin 169° = -134,600$

$\tau_{App} = -(85)(1500)\sin 79° = -125,200$

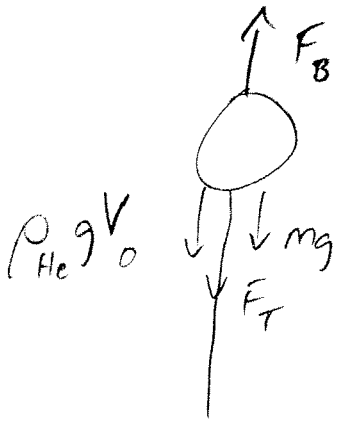
$35.46 F_T - 134600 - 125200 = 0$

could be 87 depending on how problem is read.

$F_T = \frac{259,800}{35.46} = \boxed{7300\ N}$

3. (40 pts) Air has a density of 1.29 kg/m^3. A balloon with a mass of 15.0 grams is filled with helium at a density of 0.181 kg/m^3. The balloon has a radius of 45.0 cm. The balloon is attached to a vertical string and in equilibrium. What is the tenion in the string?

$$V_{obj} = \frac{4}{3}\pi R^3 = 0.382\ m^3$$



$$\Sigma F_y = \rho_{Air} g V_0 - F_T - mg - \rho_{He} g V_0$$

$$= (1.29)(9.8)(.382) - F_T - (.015)(9.8) - (.181)(9.8)(.382)$$

$$= 4.83 - F_T - 0.15 - 0.68$$

$$F_T = 4.83 - 0.15 - 0.68$$

$$= \boxed{4.0\ N}$$