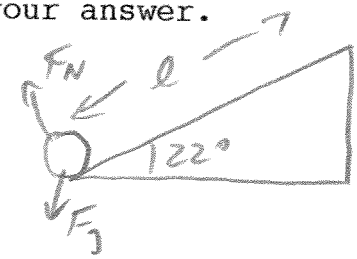
Physics 10154 - Exam #4b

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 thin metallic ring with a radius of 4.5 cm is given an initial linear speed of 5.5 m/s (rolling without slipping) at the base of a ramp inclined 22° above the horizontal. (a) How far up the ramp does the ring travel before stopping? Also, (b) If a sphere were rolled up the ramp with the same initial speed, would it roll a greater distance, a smaller distance or the same distance? Justify your answer.



$h = \ell \cos 22°$

$W_N + W_{grav} = \Delta K$

$0 - mgh = 0 - K_i$

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

$-mgh = -\frac{1}{2}mv^2 - \frac{1}{2}(MR^2)\left(\frac{v^2}{R^2}\right)$

$-mgh = -\frac{1}{2}mv^2 - \frac{1}{2}mv^2$

$gh = v^2$

$h = \frac{v^2}{g} = \frac{(5.5)^2}{9.8} = 3.1\,m$

$\ell = \frac{h}{\sin 22°} = \boxed{8.2\,m}$

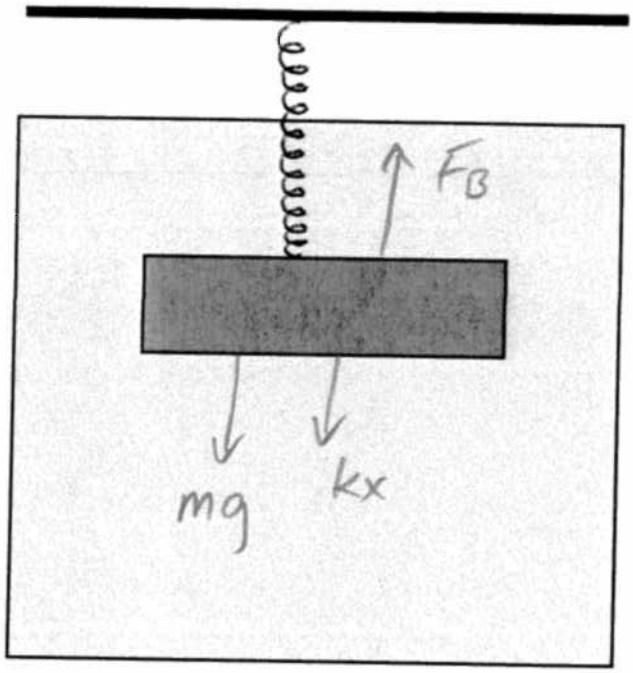
b) Ring $KE = \frac{1}{2}mv^2 + \frac{1}{2}mv^2 = mv^2$

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

$= \frac{1}{2}mv^2 + \frac{1}{5}mv^2 = \frac{7}{10}mv^2$

Sphere has less KE, so rolls $\boxed{\text{smaller distance}}$

2. (30 pts) A 7.5 kg block of wood is immersed in a closed vat of water. The wooden block has a density of 570 kg/m^3. A vertically oriented spring (k = 860 N/m) connects the top of the wooden block with the lid of the container. The spring is compressed some distance x in order to keep the wood completely submerged. Find x.



$$\rho_{wood} = \frac{M_{wood}}{V_{wood}}$$

$$V_{wood} = \frac{M_{wood}}{\rho_{wood}}$$

$$= \frac{7.5}{570}$$

$$= .01316\ m^3$$

$$\Sigma F_y = F_B - mg - kx = 0$$

$$\rho_f g V_f - m_{wood} g - kx = 0$$

$$\rho_f g V_{wood} - m_{wood} g - kx = 0$$

$$(1000)(9.8)(.01316) - (7.5)(9.8) - 860x = 0$$

$$128.95 - 73.50 - 860x = 0$$

$$55.45 = 860x$$

$$x = .064\ m$$

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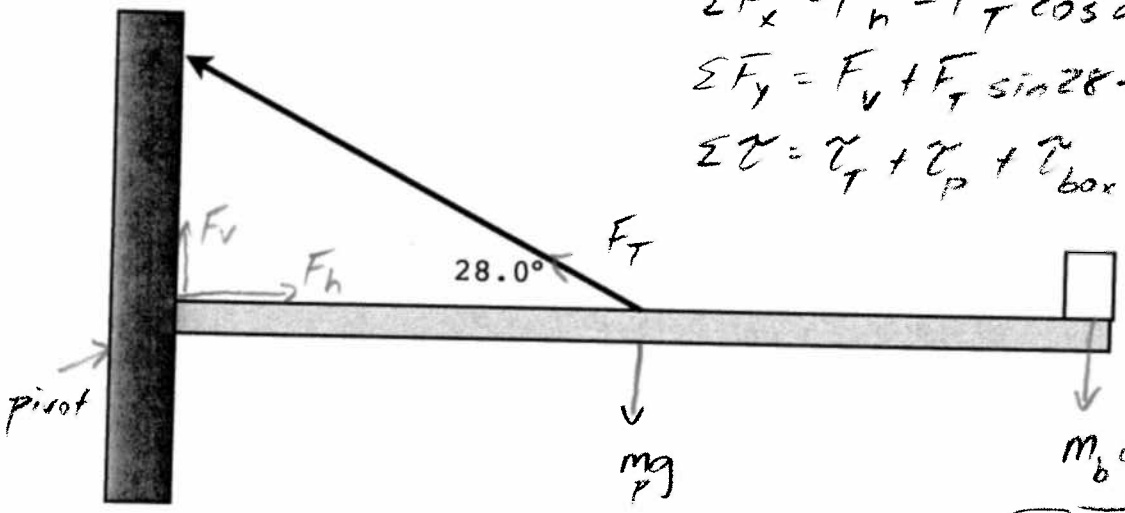
3. (40 pts) A thin, uniform, horizontal platform has an unknown length and a mass of 13.5 kg. On the left end, the platform is attached to the wall. On the right end of the platform, a box of unknown mass is placed. A rope provides a tension of 982 N pulling at the center of the platform. Find (a) the mass of the box, (b) the horizontal component and (c) the vertical component of the reaction force exerted by the wall on the platform.

$\Sigma F_x = F_h - F_T \cos 28° = 0$

$\Sigma F_y = F_v + F_T \sin 28 - m_p g - m_b g = 0$

$\Sigma \tau = \tau_T + \tau_p + \tau_{box} = 0$



$\Sigma F_x: F_h - 982 \cos 28° = 0 \Rightarrow \boxed{F_h = 867\ N}$

$\Sigma F_y: F_v + 982 \sin 28° - (13.5)(9.8) - m_b(9.8) = 0$

$\tau_T = +\frac{\ell}{2} F_T \sin 152°$

$\tau_p = -\frac{\ell}{2}(13.5)(9.8)\sin 90°$

$\tau_{box} = -\ell (m_b)(9.8)\sin 90°$

$+\frac{\ell}{2}(982)\sin 152° - \frac{\ell}{2}(13.5)(9.8) - \ell(m_b)(9.8) = 0$

$230.5 - 66.2 - 9.8 m_{box} = 0$

$164.3 = 9.8 m_{box}$

$\boxed{m_{box} = 16.8\ kg}$

$F_v = -982 \sin 28° + (13.5)(9.8) + 16.8)(9.8)$

$F_v = -461 + 132.3 + 164.6$

$F_v = -164$

$\boxed{F_v = 164\ N, -y}$