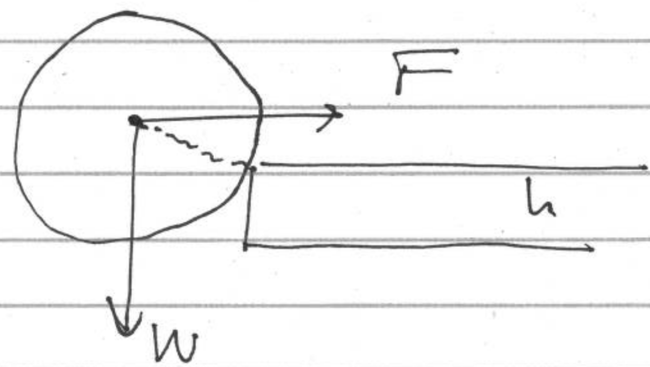
BICYCLE WHEEL



BALANCE TORQUES

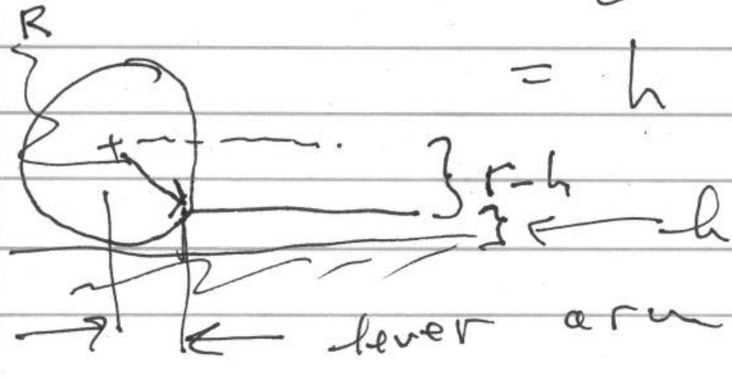
τ_F = TORQUE DUE TO F = $F\underbrace{(r-h)}_{\text{lever arm}}$

τ_W = TORQUE DUE TO WHEEL WEIGHT

= $W \cdot$ (lever arm)

FROM GEOMETRY OF SITUATION.

lever arm = $\left[r^2 - (r-h)^2\right]^{1/2}$



BICYCLE WHEEL.

$$\tau_p = \tau_w$$

$$F(r-h) = w\,h$$

$$F = w\left(\frac{h}{r-h}\right)$$

$$F = 25\left(\frac{0.12}{0.34-0.12}\right) \quad N$$

$$\boxed{F = 13.6 \text{ N}}$$

BEACH BALL

(a) $F_N = F_B - m_B g$

$F_B = \rho_w \frac{4}{3}\pi R^3 * g$

$F_B = 6.54 \times 10^{2}$ N

F_{B} (BALL) $= 0.2 * 10. = 2$ N

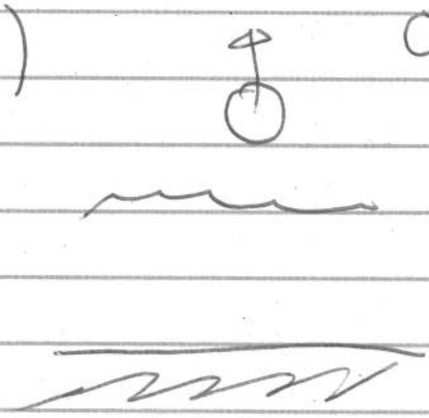
$\rightarrow \boxed{F_N = 652 \text{ N}}$

(b) $F_N = m_B a. \Rightarrow a = F_N / m_{BALL}$

$s = \frac{1}{2} a t^2$

$t = \sqrt{2s/a} = \left[\frac{2h}{F_N/m}\right]^{1/2}$

$\boxed{t = 0.055 \text{ sec}}$

(c)  COMPUTE v @ TOP:

$$V_{esc} = a\,t$$

$$= \frac{F_N}{m} \cdot t$$

$$\boxed{V_{esc} = 180 \text{ m/s}}$$

ALSO, $V_{esc} = V_0^2 + 2aX$

$$= 0 + 2ah$$

$$\boxed{V_{esc} = 180 \text{ m/s}}$$

How HIGH H?

$$v^2 = v_0^2 + 2aX$$

$$0 = V_{esc}^2 - 2gH$$

$$H = V_{esc}^2/2g$$

$$\boxed{H = 1620 \text{ m}}$$ 

NIAGARA FALLS

$y = \frac{1}{2} g t^2$ FALL TIME

$t = \sqrt{2y/g}$

$t = \sqrt{104 \times 10}$ s

$t = 3.22$ s.

$x = v_0 t$

$= 2.7 \times 3.22$ m

$\boxed{x = 8.71 \text{ m}}$

$$\boxed{\text{BOWLING BALL}}$$

$$E_{TTL} = \text{const}$$

$$\underbrace{\frac{1}{2} m V_{cm}^2 + \frac{1}{2} I\omega^2 + GPE}_{\text{low level}} = \underbrace{\frac{1}{2} m V_{cm}^2 + \frac{1}{2} I\omega^2 + mgh}_{\text{UPPER}}$$

LOWER LEVEL: $GPE = 0$

AND

$$\frac{1}{2} m V_{cm}^2 + \frac{1}{2}\left(\frac{2}{5}\right) m R^2 \omega^2$$

$$= \frac{1}{2} m V_{cm}^2 + \frac{1}{5} m R^2 \left(\frac{V_{cm}}{R}\right)^2$$

$$= \frac{1}{2} m V_{cm}^2 + \frac{1}{5} m V_{cm}^2$$

$$\boxed{E_{TTL} = 7/10 \; m V_{cm}^2} \quad w/ \; V_{cm} = 3.5 \, m/s.$$

UPPER LEVEL: $E_{TTL} = \frac{7}{10} m V_{cm\,upper}^2 + mgh.$

$$E_{TTL\,low} = E_{TTL\,HI}$$

$$\frac{7}{10} m V_{cm}^2 = \frac{7}{10} m V_{cm\,up}^2 + mgh$$

BOWLING BALL

$$\cancel{\frac{7}{10} m v} \; \frac{7}{10} V_{cm}^2 - gh = \frac{7}{10} V_{cm_{up}}^2$$

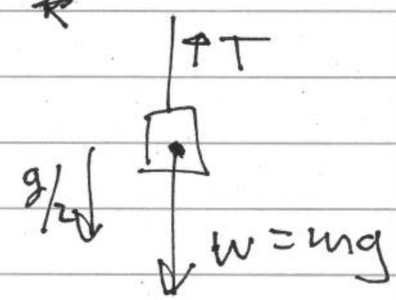
$$V_{cm_{up}}^2 = V_{cm}^2 - \frac{10}{7} gh$$

$$V_{cm_{up}}^{\cancel{2}} = \left[V_{cm}^2 - \frac{10}{7} gh \right]^{1/2}$$

$$\boxed{V_{cm_{up}} = 1.18 \text{ m/s}}$$

PULLEY

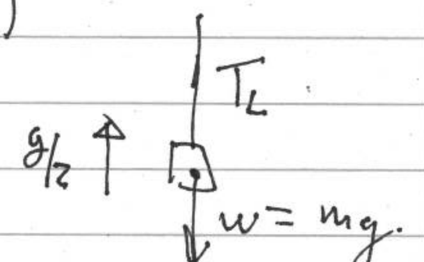
(a) $mg - T_R = mg/2$ w/ $m = m_R$



$\Rightarrow \boxed{T_R = mg/2}$

$\boxed{T_R = 220\ \text{N}}$

(b)



$T_L - mg = mg/2$

w/ $m = m_L$

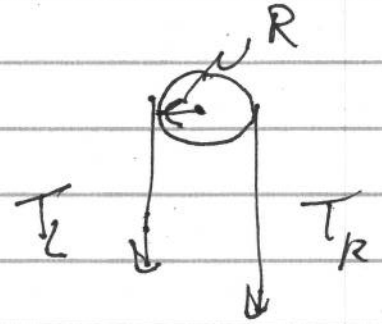
$\boxed{T_L = \frac{3}{2} mg}$

$\boxed{T_L = 165\ \text{N}}$

PULLEY

(c)

COMPUTE NET TORQUE



$$(T_R - T_L)R = \text{NET TORQUE } \tau_N$$

$$\tau_N = I_p \alpha = I_p (a/R)$$

$$(T_R - T_L)R = I_p (a/R)$$

$$\Delta T \cdot R_p = \tfrac{1}{2} m_p R_p^2 (a/R_p)$$

$$\Delta T = \tfrac{1}{2} m_p \cdot a$$

$$m_p = \frac{2\Delta T}{a} = 2\Delta T / g/2$$

$$= 4\Delta T / g$$

$$m_p = 4 * (220-165)/10 \quad \text{kg.}$$

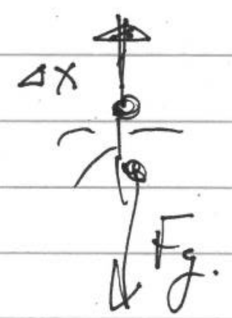
$$\boxed{m_p = 22 \text{ kg.}}$$

TRAMPOLINE

NET WORK DONE = ΔKE

GRAVITY ONLY FORCE AROUND.

$$\underset{\sim}{F}_g \cdot \Delta \underset{\sim}{x} = \Delta KE \qquad (1)$$



$$\Delta x = \left| \frac{\Delta KE}{F_g} \right|$$

$$= \left| \frac{210 - 460}{mg} \right|$$

NOTE: $\underset{\sim}{F}$ IS ANTI-PARALLEL TO $\Delta \underset{\sim}{x}$

SO NEGATIVE SIGNS CANCEL

$$\Delta x = \frac{250}{35 \times 10} \text{ m.}$$

$$\boxed{\Delta x = \frac{5}{7} \text{ m} = 0.71 \text{ m}}$$