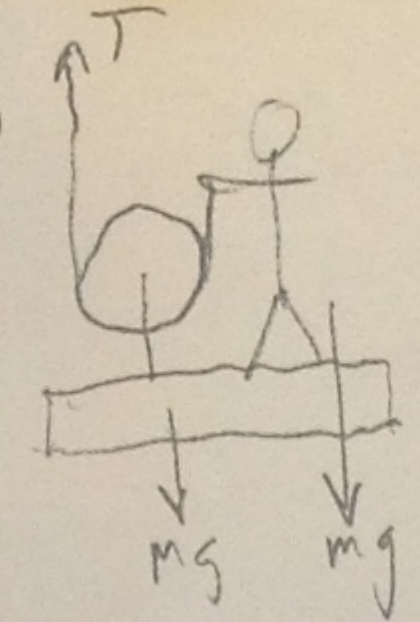
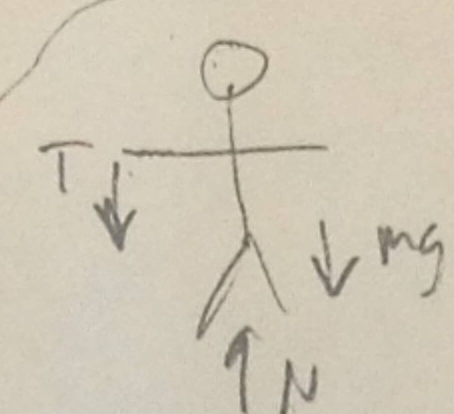
HW # 3

(1)

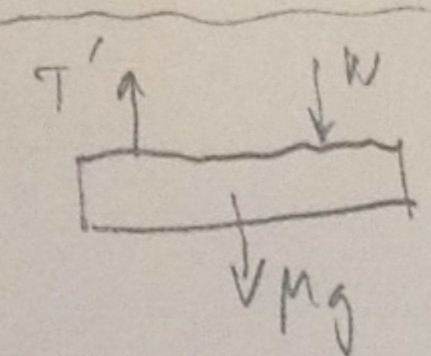


$\leftarrow$ system = man + platform $\Rightarrow$ $T-(M+m)g = (m+M)a \Rightarrow \boxed{T=(M+m)(g+a)}$



$\leftarrow$ system = man $\Rightarrow$ $N-T-mg = ma$

$\Rightarrow N = T + m(g+a) = \boxed{(M+2m)(g+a) = N}$



$\leftarrow$ system = platform $\Rightarrow$ $T'-N-Mg = Ma \rightarrow T' = N + M(g+a)$

$\Rightarrow \boxed{T' = 2(M+m)(g+a)}$

Note that this means $T' = 2T$, which would also be obtained if the system = pulley

---

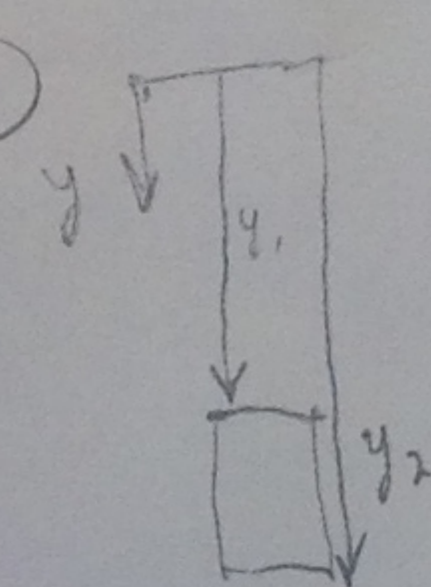
(2) $\vec{F} = -T\hat{r} \Rightarrow a_\theta = 0 = r\ddot{\theta} + 2\dot{r}\dot{\theta} = r\dot{\omega} + 2\dot{r}\omega \Rightarrow \frac{d}{dt}(r^2\omega) = 0$

and so $r^2\omega = r_0^2\omega_0 \rightarrow \omega = \left(\frac{r_0}{r}\right)^2\omega_0 = \boxed{\frac{\omega_0 r_0^2}{(r_0-vt)^2} = \omega(t)}$

Then $a_r = \underset{0}{\ddot{r}} - r\dot{\theta}^2 = -\frac{T}{m}$ becomes $T = mr\omega^2 = \boxed{m r_0^4\omega_0^2/(r_0-vt)^3 = T}$

---

(3)



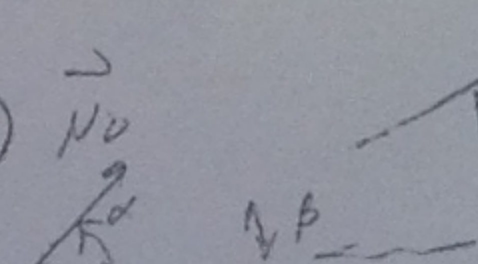
$y = \frac{1}{2}gt^2 \Rightarrow y_2 - y_1 = 1.0\,m = \frac{1}{2}g(t_2^2 - t_1^2) = \frac{1}{2}g\underbrace{(t_2-t_1)}_{0.1s}(t_2+t_1)$

So $t_2 + t_1 = 2t_1 + 0.1s = \frac{20\,m/s}{g} \Rightarrow t_1 = 0.970\,s$

Then $y_1 = \frac{1}{2}gt_1^2 = \frac{1}{2}g\,(0.970s)^2 = \boxed{4.61\,m}$

---

(4)



$y = (\tan\beta)x$ for sloping hill

projectile: $x = (v_0\cos\alpha)t$

$y = (v_0\sin\alpha)t - \frac{1}{2}gt^2$

hitting ground $\Rightarrow (v_0\sin\alpha)t - \frac{1}{2}gt^2 = v_0\cos\alpha(\tan\beta)t$

(b) $\boxed{t = \frac{2v_0}{g}\{\sin\alpha - \cos\alpha\tan\beta\}}$

(a) $R = \frac{R_x}{\cos\beta} = \frac{(v_0\cos\alpha)t}{\cos\beta} = \frac{2v_0^2}{g}\frac{\cos\alpha}{\cos\beta}(\sin\alpha - \cos\alpha\tan\beta)$