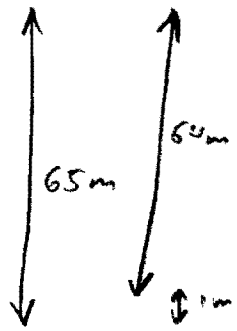
PHYS 10310 EXAM 3-2010 SOLUTIONS

1)



$m = 52.5\,kg$

$s = \frac{1}{2} a t^2 = \frac{1}{2} g t^2 = 64$

$t = \sqrt{\frac{2 \cdot 64}{g}} = \frac{2 \cdot 64}{9.8} = 3.61\,s$

$V = gt = 35.4\ m/s$

$p = mV = 1859\ kg\,m/s$

a) $\vec{J} = \Delta \vec{p} = \vec{p}_f - \vec{p}_i = 0 - 1859 = -1859\ kg\,m/s$

c) $J = \vec{F}_{av} \Delta t = ma\,t \Rightarrow t = \frac{J}{ma}$

F constant $\Rightarrow$ a constant

$V = V_i + at = 0 \qquad t = -V_i/a$

$s = V_0 t + \frac{1}{2} a t^2 = 1\ m$

$s = -\frac{V_0^2}{a} + \frac{1}{2} a \frac{V_0^2}{a^2} = -\frac{1}{2}\frac{V_0^2}{a} = 1\ m$

So $a = -\frac{1}{2}\frac{V_i^2}{1\ m} = -626.6\ m/s^2 = 63.9\,g$

$F = ma = 3.29 \times 10^4\ N$

b) $t = -V_i/a = 0.056\ sec$

Check $J = F_{av} \Delta t$

2) 

$M_T = m_1 + m_2 + M$

Conservation of momentum

$P_f = P_i = P_s + P_1 + P_2 = 0$ (at rest)

$P_s = -P_1 - P_2$

All $\vec{v}$ in Lake frame

A) $MV_s = -m_1 v - m_2 v$

$V_s = -\frac{m_1 + m_2}{M} v$

B) Same $V_s = -\frac{m_2 + m_1}{M} v$

C) Same $V_s = -\frac{m_2 - m_1}{M} v$

3) $T = \frac{2\pi}{\omega}$ $\omega = \alpha t$ $\frac{d\alpha}{dt} = 0$

a) $\frac{dT}{dt} = 2\pi\left(-\frac{1}{\omega^2}\cdot\frac{d\omega}{dt}\right) = -2\pi\left(\frac{\alpha}{(\alpha t)^2}\right) = -\frac{2\pi}{\alpha t^2}$

b) $T(t_2) - T(t_1) = \frac{2\pi}{\omega_2} - \frac{2\pi}{\omega_1} = \frac{2\pi}{\alpha}\left(\frac{1}{t_2} - \frac{1}{t_1}\right)$

4) $\bar{\alpha} = \frac{\Delta\omega}{\Delta t} = \frac{4.15}{2.68} = 1.55 \text{ r/s}^2$

$r = 24.6 \text{ cm}$
$F = 13.4 \text{ N}$

$\tau = I\alpha = Fr$

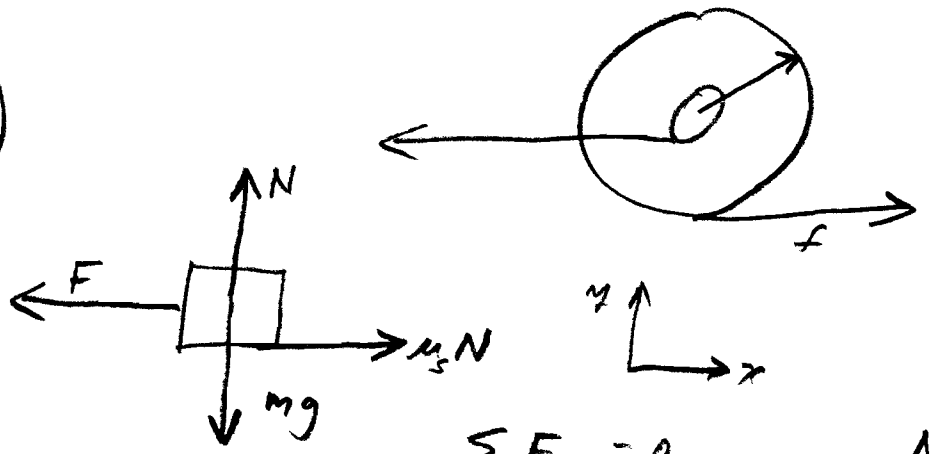
a) $I = Fr/\alpha = \frac{13.4 \cdot .246}{1.55} = 2.13 \text{ kg m}^2$

b) $\Delta L = L_f - L_i = I\omega - 0$
$= 2.13 \cdot 4.15 = 8.84 \frac{\text{kg m}^2}{\text{s}}$

c) $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$
$= \frac{1}{2} \cdot 1.55 \cdot (2.68)^2 = 5.57 \text{ radians}$

d) $K = \frac{1}{2} I\omega^2$
$= \frac{1}{2} \cdot 2.13 \cdot (4.15)^2 = 18.3 \text{ J}$

5)



M, R, r, μ_s

$\sum F_y = 0$ $\quad N = mg$

$f \le \mu_s mg = \mu_s N$

$\tau = Fr - fR = I\alpha$

$F_x = f - F = Ma$

$I = \frac{1}{2}MR^2$

$a = R\alpha$

$Fr - fR = \frac{1}{2}MR^2\left(\frac{a}{R}\right) = \frac{R}{2}Ma$

$Fr - fR = \frac{R}{2}(f - F) = \frac{fR}{2} - \frac{FR}{2}$

$F\left(r + \frac{R}{2}\right) = fR + \frac{fR}{2} = \frac{3}{2}fR$

$F = \frac{\frac{3}{2}fR}{r + \frac{R}{2}} = \frac{3fR}{2r + R} = \frac{3\mu_s mgR}{R + 2r}$

$F \le \frac{3\mu_s mgR}{R + 2r}$