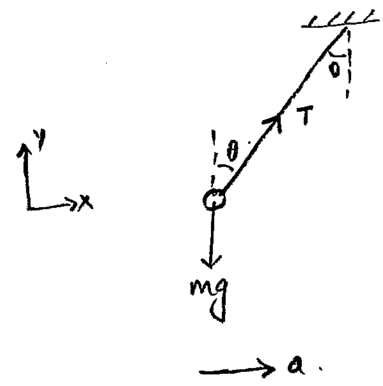
Midterm Exam 02 (PHYS-205A, Fall 2014)

MT-02, prob 1

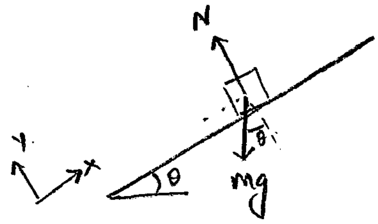


x: $T \sin\theta = ma$.

y: $T \cos\theta = mg$

$$\Rightarrow \quad a = g \tan\theta$$
$$= 9.8 \tan 15$$
$$= 2.63 \ \frac{m}{s^2}$$

MT-02, prob 2



x: $-mg\sin\theta = ma$.

y: $N - mg\cos\theta = 0$

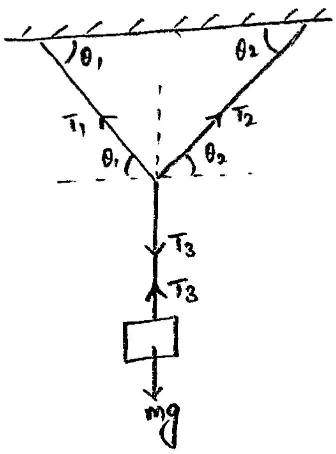
$$\Rightarrow \quad a = -g\sin\theta$$

(a) Using $V_f^2 = V_i^2 + 2a\Delta x$ (with $V_f = 0$)

$$\Delta x = \frac{V_i^2}{2a} = \frac{V_i^2}{2g\sin\theta} = \frac{3.50^2}{2\times 9.8\times \sin 30} = 1.25\ m$$

(b) Since the incline is frictionless, the speed when it gets back to bottom will be $3.50 \frac{m}{s}$.

MT-02, prob 3



At the junction:

x: $\quad T_1 \cos\theta_1 = T_2 \cos\theta_2 \Rightarrow T_1 = T_2$ (for $\theta_1 = \theta_2$

y: $\quad T_1 \sin\theta_1 + T_2 \sin\theta_2 = T_3 = mg$

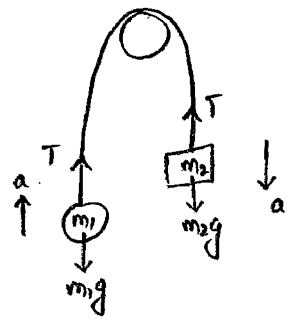
Thus, $\quad 2T_1 \sin\theta_1 = T_3$

$(\sin 30 = \frac{1}{2})$

$\Rightarrow \quad T_1 = T_3$

$\Rightarrow \quad T_1 = T_2 = T_3 = 500\,N.$

MT-02, prob 4



for m_2: $\quad m_2 g - T = m_2 a.$

for m_1: $\quad T - m_1 g = m_1 a.$

(a) Adding the two equation

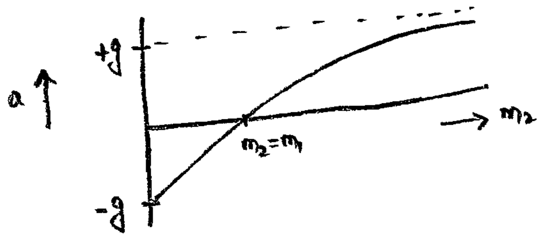
$$m_2 g - m_1 g = m_2 a + m_1 a$$

$$\Rightarrow \quad a = \frac{m_2 - m_1}{m_2 + m_1} g$$

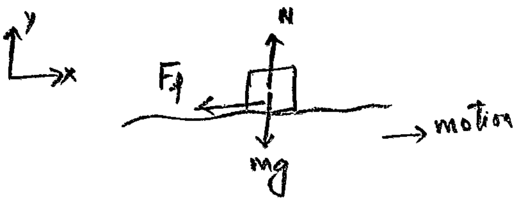
(b) $m_2 \gg m_1$, $\quad a = g$, m_2 falls down as if m_1 does not exist.

(c) $m_2 \ll m_1$, $\quad a = -g$, m_2 goes up, i.e. m_1 falls down as if m_2 does not exist.

(d)



MT-02, prob 5



x: $\quad -F_f = ma$

y: $\quad N - mg = 0$

Thus, maximum decelerat is when $F_s = \mu_s N$

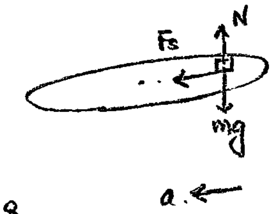
$$\Rightarrow \quad a = -\mu_s g$$

(a) Using $\quad v_f^2 = v_i^2 + 2a\,\Delta x \quad$ (with $v_f = 0$)

$$\Delta x = -\frac{v_i^2}{2a} = \frac{v_i^2}{2\mu_s g} = \frac{31.3^2}{2\times 0.60\times 9.8} = 83.3 \text{ m}$$

(b) $$\Delta x = \frac{v_i^2}{2\mu_s g} = \frac{31.3^2}{2\times 0.40\times 9.8} = 125.0 \text{ m}$$

MT-02, prob 6



(a) $$v = \frac{2\pi R}{T} = \frac{2\times\pi\times 5\text{cm}}{(3.14\text{s}/3)} = \overset{30}{\cancel{10}}\ \frac{\text{cm}}{\text{s}} = \overset{0.3}{\cancel{0.1}}\ \frac{\text{m}}{\text{s}}$$

(b) $$a = \frac{v^2}{R} = \frac{\left(\overset{30}{\cancel{10}}\ \frac{\text{cm}}{\text{s}}\right)^2}{5\text{cm}} = \overset{180}{\cancel{20}}\ \frac{\text{cm}}{\text{s}^2} = \overset{1.8}{\cancel{0.2}}\ \frac{\text{m}}{\text{s}^2}$$

direction: radially inward

(c) $$F_s = ma = (2\times 10^{-3}\text{kg})\times \overset{1.8}{\cancel{0.2}}\ \frac{\text{m}}{\text{s}^2} = \overset{3.6\times 10^{-3}}{\cancel{4\times 10^{-4}}}\ \text{N}$$

direction: radially inward

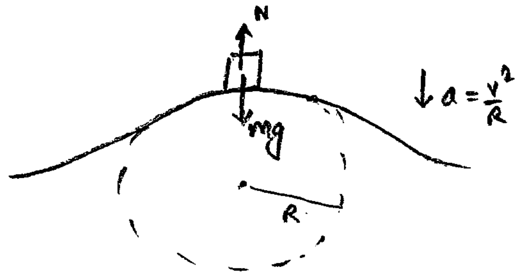
(d) At the verge of slipping, $F_s = \mu_s mg$.

$$\Rightarrow \quad \mu_s \cancel{m} g = \cancel{m} a$$

$$\mu_s = \frac{a}{g} = \frac{v^2}{Rg} = \left(\frac{2\pi R}{T}\right)^2 \frac{1}{Rg} = \frac{4\pi^2 R}{T^2 g}$$

$$= \frac{4\pi^{\cancel{2}}\times(10\times 10^{-2}\text{m})}{\left(\frac{3.14\text{s}}{3}\right)^2 \left(9.8\ \frac{\text{m}}{\text{s}^2}\right)} = \overset{0.37}{\cancel{0.041}}$$

MT-02, prob 7



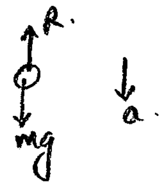
$$mg - N = m\frac{v^2}{R}$$

$N = 0 \Rightarrow$ $\cancel{m}g = \frac{\cancel{m}v^2}{R}$

$$V = \sqrt{gR} = \sqrt{9.8 \times 250}$$

$$= 49.5 \ \frac{m}{s}$$

MT-02, prob 8



$$mg - R = ma$$

for $a = 0$, $mg = R = \frac{1}{2} D \rho A v^2$

$$V_T = \sqrt{\frac{2mg}{D\rho A}}$$

$$= \sqrt{\frac{2 \times 6 \times 9.8}{1.60 \times 1.20 \times 2.83 \times 10^{-3}}}$$

$$= 147 \ \frac{m}{s}$$

$\rho = 1.20 \ \frac{kg}{m^3}$

$A = \pi R^2$
$= \pi \times (3 \times 10^{-2})^2$
$= 2.83 \times 10^{-3} \ m^2$

$D = 1.60$