Midterm Exam 02 Solutions (Summer 2015, 203A)

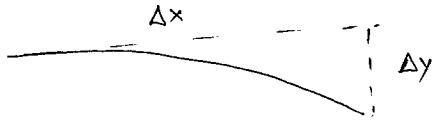
MT-02, prob. 1

(a) initial vertical velocity = 0

initial horizontal velocity = 350 $\frac{km}{h}$

(b) final horizontal velocity = 350 $\frac{km}{h}$ (does not accelerate horizontally.)

MT-02, prob. 2



$\Delta x = v\,\Delta t$

$v = \frac{\Delta x}{\Delta t}$

$= \frac{30\ m}{0.0623\ s}$

$= 482\ \frac{m}{s}$

$\Delta y = \cancel{v_{iy}}^{=0}\,\Delta t + \frac{1}{2} a\,\Delta t^2$

$1.9\times10^{-2}\ m = \frac{1}{2}\ 9.8\ \frac{m}{s^2}\ \Delta t^2$

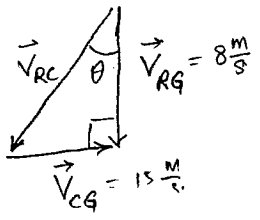
$\Delta t = \sqrt{\frac{2\times1.9\times10^{-2}}{9.8}} = 0.0623\ sec.$

MT-02, prob. 3

R - Rain
C - Car
G - Ground

$\vec{V}_{RC} = \vec{V}_{RG} - \vec{V}_{CG}$

$\tan\theta = \frac{15\ m/s}{8\ m/s} \Rightarrow \theta = 61.9°$

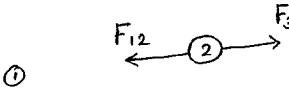


MT-02, prob. 4

$\vec{F}_{tot} = F_{32}\,\hat{i} - F_{12}\,\hat{i}$

$= (10.7\times10^{-9} - 4.0\times10^{-9})\ N$

$= 6.7\times10^{-9}\ N$



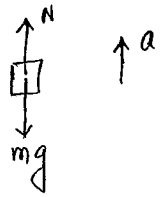
$F_{12} = \frac{G m_1 m_2}{r_{12}^2} = \frac{6.67\times10^{-11}\times300\times500}{(50\ m)^2}$

$= 4.0\times10^{-9}\ N$

$F_{32} = \frac{G m_2 m_3}{r_{23}^2} = \frac{6.67\times10^{-11}\times500\times200}{(25\ m)^2}$

$= 10.7\times10^{-9}\ N$

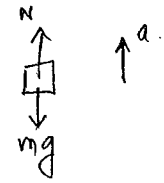
MT-02, prob. 5

(a) 

$N - mg = ma$

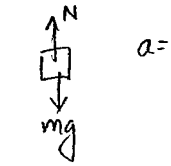
$N = m(g+a) = 75\,kg\,(9.8+2)$

$= 885\ N$

(b) 

$N - mg = ma$

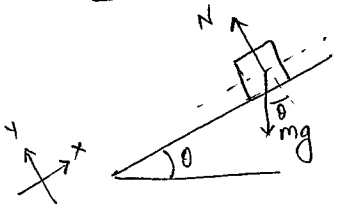
$N = m(g+a) = 885\ N$

(c) 

$N - mg = 0$

$N = mg = 75\,kg \times 9.8\,\frac{m}{s^2} = 735\ N$

MT-02, prob. 6



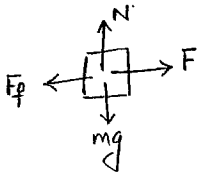
$\vec{N} + m\vec{g} = m\vec{a}$

x: $-mg\sin\theta = ma$ $\Rightarrow$ $a = -g\sin\theta = -9.8 \times \sin 32 = -5.19\,\frac{m}{s^2}$

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

$\Delta x = \frac{v_f^2 - v_i^2}{2a} = \frac{0 - (3.5)^2}{2\times(-5.19)} = 1.18\ m$

MT-02, prob 7

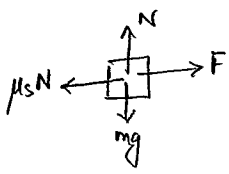


(a) $N = mg$

$F - F_f = m\cancel{a}^{=0}$ $\quad (F_f \le \mu_s N)$

$F \le \mu_s N = \mu_s mg = 0.41 \times 220 = 90.2\ N$

$\Rightarrow$



(b) $N = mg$

$F = \mu_k N = \mu_k mg = 0.32 \times 220$

$= 70.4\ N$

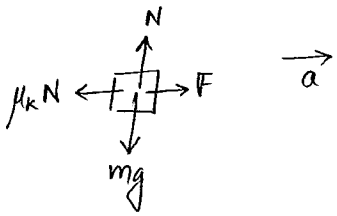
(c) $N = mg$

$F - \mu_k N = ma$

$90.2 - \underbrace{0.32 \times 220}_{70.4} = ma$

$\frac{90.2 - 70.4}{22.45} = a$

$a = 0.88 \frac{m}{s^2}$.



$m = \frac{220}{9.8} = 22.45 kg$

MT-02, prob. 8

(a) $a = \left(\frac{3m_a - m_a}{3m_a + m_a}\right) g = \frac{1}{2} g = 4.9 \frac{m}{s^2}$.

(b) $T = \left(\frac{3m_a}{3m_a + m_a}\right) 2m_a g = \frac{3}{4} 2 m_a g = \frac{3}{2} m_a g$

(c) $T = \left(\frac{100 m_a}{100 m_a + m_a}\right) 2 m_a g = \frac{100}{101} T_{max} < T_{max}$

Thus, the cord will not break.

(d) $T = \left(\frac{N m_a}{N m_a + m_a}\right) 2 m_a g = \left(\frac{N}{N+1}\right) T_{max} < T_{max}$

$N > 1$ because $m_b > m_a$.

Thus, there is no N for which the cord breaks.