Solutions to Final Exam (PHYS 205A, Fall 2014)

Final Exam, prob. 1

S - Speeder
P - Police.

$d_s = v_s t$

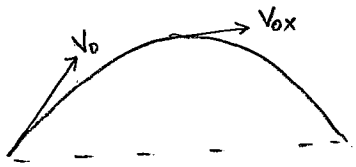
$d_p = \frac{1}{2} a_p t^2$

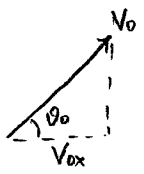
when they overtake $d_s = d_p$ and t is same.

$$d = \frac{1}{2} a_p \left(\frac{d}{v_s}\right)^2$$

$$d = \frac{2 v_s^2}{a_p} = \frac{2 \times 40^2}{4.0} = 800 \text{ m}$$

Final Exam, prob. 2





$V_0 = 5 V_{ox}$

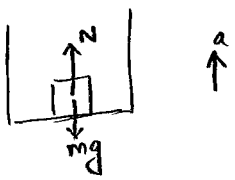
$\cos\theta_0 = \frac{V_{ox}}{V_0} = \frac{1}{5}$

$\theta_0 = \cos^{-1}\left(\frac{1}{5}\right)$

$= 78.46$

Final Exam, prob 3

(a)



$N - mg = ma$.

$N = mg + ma$.

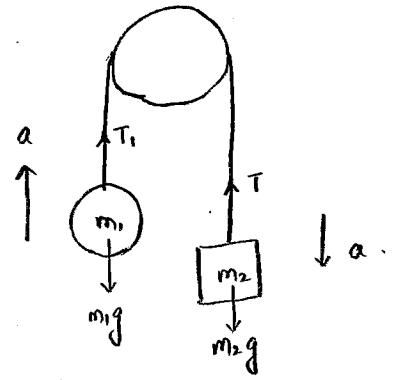
$= 735 + 75 \times 2 = 885 \text{ N} \rightarrow 90.31 \text{ kg}$.

(b)

$N - mg = ma$

$N = mg + ma = 885 \text{ N} \rightarrow 90.31 \text{ kg}$.

Final Exam, prob 4



$$T - m_1 g = m_1 a$$

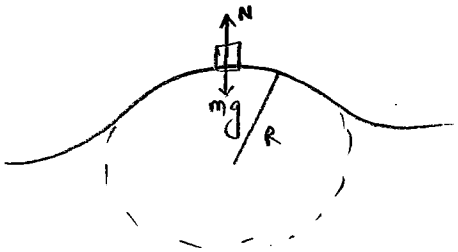
$$m_2 g - T = m_2 a$$

Adding the two equations

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

$$\Rightarrow \quad a = \left(\frac{m_2 - m_1}{m_2 + m_1}\right) g$$

Final Exam, prob 5



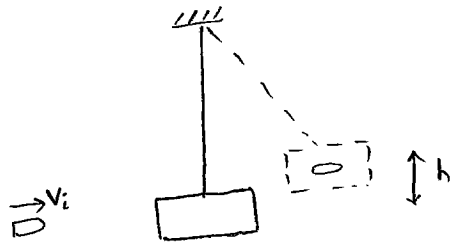
$$mg - N = \frac{mv^2}{R}$$

$$N = 0 \quad \Rightarrow \quad v_{max} = \sqrt{gR}$$

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

$$= 49.50 \ \frac{m}{s}$$

Final Exam, prob 6



$$m_B v_{Bi} = (m_B + m_P) v_f$$

$$\frac{1}{2}(m_B + m_P) v_f^2 = (m_B + m_P) g h$$

$$v_f^2 = 2gh$$

$$v_f = \sqrt{2gh}$$

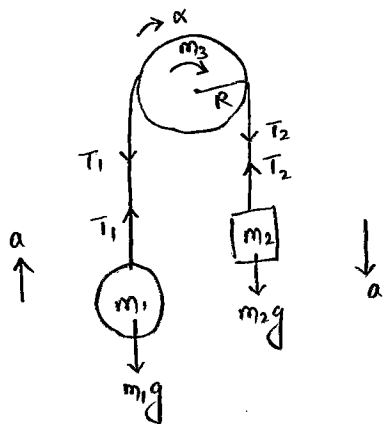
$$m_B v_{Bi} = (m_B + m_P)\sqrt{2gh}$$

$$v_{Bi} = \left(1 + \frac{m_P}{m_B}\right)\sqrt{2gh}$$

$$= \left(1 + \frac{2500}{5.0}\right)\sqrt{2 \times 9.8 \times 4.0 \times 10^{-2}}$$

$$= 443.6 \ \frac{m}{s}$$

Final Exam, prob 7



$$T_1 - m_1 g = m_1 a$$

$$m_2 g - T_2 = m_2 a$$

$$T_2 - T_1 = \frac{I\alpha}{R} = \frac{1}{2} m_3 a$$

Adding the equations

$$m_2 g - m_1 g = m_1 a + m_2 a + \frac{1}{2} m_3 a$$

$$a = \left(\frac{m_2 - m_1}{m_1 + m_2 + \frac{m_3}{2}} \right) g$$

Final Exam, prob 8

$$I_i \omega_i = I_f \omega_f$$

$$\frac{\omega_i}{\omega_f} = \frac{I_f}{I_i} = \frac{1}{4}$$

$$\frac{K_f}{K_i} = \frac{\frac{1}{2} I_f \omega_f^2}{\frac{1}{2} I_i \omega_i^2}$$

$$= \left(\frac{I_f}{I_i} \right) \left(\frac{\omega_f}{\omega_i} \right)^2$$

$$= \frac{1}{4} (4)^2 = 4 .$$

Final Exam, prob 9

$$\frac{1}{2} m V_i^2 - \frac{G M_E m}{R_E} = \frac{1}{2} m V_f^2 - \frac{G M_E m}{\infty}, \quad \infty = 0$$

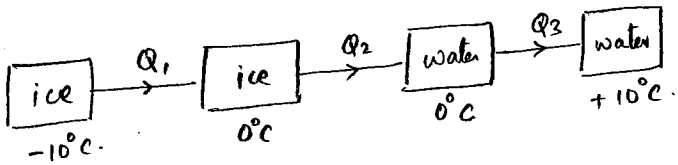
$$V_f^2 = V_i^2 - \frac{2 G M_E}{R_E}$$

$$V_f = \sqrt{\left(1.78 \times 10^4\right)^2 - \frac{2 \times 6.67 \times 10^{-11} \times 5.97 \times 10^{24}\ kg}{6.37 \times 10^6\ m}}$$

$$= \sqrt{3.17 \times 10^8 - 1.25 \times 10^8}$$

$$= 1.386 \times 10^4\ \frac{m}{s}$$

Final Exam, prob 10



$$Q_1 = m\, C_{ice}\, \Delta T$$

$$= 50 \times 10^{-3} \times 2090 \times 10 = 1045 \text{ J}$$

$$Q_2 = m\, L_f$$

$$= 50 \times 10^{-3} \times 330 \times 10^{3} = 16500 \text{ J}$$

$$Q_3 = m\, C_{water}\, \Delta T$$

$$= 50 \times 10^{-3} \times 4186 \times 10 = 2093 \text{ J}$$

$$Q_{tot} = Q_1 + Q_2 + Q_3$$

$$= 19\,638 \text{ J}$$