Chapter **5** (Benson)

E16 $m = 1\,\text{kg}$, $F = 5\,\text{N}$ & $\theta = 37^0$. (a) $ma = F\cos\theta - mg\sin\theta$, $a = -1.90\,\text{m/s}^2$ (down); (b) $v_0 = 4\,\text{m/s}$ & $t = 2\,\text{s}$. $\Delta x = v_0 t + a\,t^2/2 = 4.2\,\text{m}$ (up incline).

E29 Moving down: $Mg - F_B = Ma$; Moving up: $F_B - (M - m)g = (M - m)a$, where m is the ballast. Solving above eqs. to obtain $m = 2Ma/(a + g)$.

E31 $m_A = 2\,\text{kg}$, $m_B = 3\,\text{kg}$ & $F = 20\,\text{N}$. $F - F_{BA} = m_B a$ & $F_{BA} = m_A a \Rightarrow a = F/(m_B + m_A)$ & $F_{BA} = m_A F/(m_B + m_A)$. (a) $a = 4\,\text{m/s}^2$; (b) $F_{BA} = 8\,\text{N}$; (c) $F_B = 12\,\text{N}$; (d) $F_{BA} = m_B F/(m_A + m_B) = 12\,\text{N}$.

E36 $m_1 = 5\,\text{kg}$, $m_2 = 6\,\text{kg}$, $\theta_1 = 30^0$ & $\theta_2 = 60^0$. $m_2 g\sin\theta_2 - T = m_2 a$ & $T - m_1 g\sin\theta_1 = m_1 a$ $\Rightarrow a = g\,(m_2\sin\theta_2 - m_1\sin\theta_1)/(m_1 + m_2)$ & $T = m_1 m_2(\sin\theta_1 + \sin\theta_2)\,g/(m_1 + m_2)$. So $a = 2.40\,\text{m/s}^2$ & $T = 36.5\,\text{T}$.

E37 $m_A = 0.2\,\text{kg}$ & $m_B = 0.3\,\text{kg}$. (a) $T_1 = (m_A + m_B)\,g = 4.9\,\text{N}$, $T_2 = m_B g = 2.94\,\text{N}$; (b) same as (a); (c) $a = 2\,\text{m/s}^2$ (up). $T_1 = (m_A + m_B)\,(g + a) = 5.9\,\text{N}$, $T_2 = m_B(g + a) = 3.54\,\text{N}$; (d) $a = 2\,\text{m/s}^2$ (down). $T_1 = (m_A + m_B)\,(g - a) = 3.9\,\text{N}$, $T_2 = m_B(g - a) = 2.34\,\text{N}$; (e) $T_1 = (m_A + m_B)\,(g + a) \le 10$, $a \le 10.2\,\text{m/s}^2$.

E38 $8Mg - T_1 = 8Ma$, $T_1 - 2Mg\sin\theta - T_2 = 2Ma$ & $T_2 - 4Mg\sin\theta = 4Ma \Rightarrow a = g\,(4 - 3\sin\theta)/7$ (a) & $T_1 - T_2 = 8Mg(1 + \sin\theta)/7$ (b); (c) $M = 1\,\text{kg}$ & $\theta = 45^0 \Rightarrow a = 2.63\,\text{m/s}^2$ & $T_1 - T_2 = 19.1\,\text{N}$.

E41 $m_1 = 5\,\text{kg}$, $m_2 = 3\,\text{kg}$, $M = 2\,\text{kg}$ & $a = 2\,\text{m/s}^2$ (up). $F_0 - T_1 - m_1 g = m_1 a \cdot\cdot$①, $T_2 - m_2 g = m_2 a \cdot\cdot$②, $T_1 - T_2 = M(a + g) \cdot\cdot$③. (a) ①+②+③$\Rightarrow F_0 = (m_1 + m_2 + M)(a + g) = (10)(9.8 + 2) = 118\,(\text{N})$; (b) $F_{net} = Ma = (2)(2) = 4\,(\text{N})$; (c) $T_m = (M_B + m_2)(g + a) = (1 + 3)(9.8 + 2) = 47.2\,(\text{N})$.

E42 $m_1 = 2\,\text{kg}$. $m_1 g - T = m_1 a$ & $T = m_2 a \Rightarrow a = m_1 g/(m_1 + m_2)$ & $T = m_1 m_2 g/(m_1 + m_2)$. (a) If $m_1 = 2\,\text{kg}$, $m_2 = 2.9\,\text{kg}$; (b) If $T = 8\,\text{N}$, $m_2 = 1.38\,\text{N}$.

P01 $M = 75\,\text{Kg}$ & $m = 15\,\text{kg}$. (a) $2T - (m + M)\,g = 0$, $T = (m + M)\,g/2 = 441\,\text{N}$; (b) $a = 0.4\,\text{m/s}^2$ upward. $2T - (m + M)\,g = (m + M)\,a$, $T = (m + M)(a + g)/2 = 459\,\text{N}$; (c) $T = (m + M)\,g = 90g = 882 > 700$. Rope breaks.

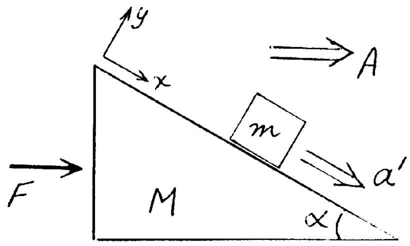
P02 $m_1 g - T = m_1 a_1$, $2T - m_2 g = m_2 a_2$ & $a_1 = 2a_2 \Rightarrow a_2 = g\,(2m_1 - m_2)/(4m_1 + m_2)$ & $T = 3m_1 m_2 g/(4m_1 + m_2)$. Using $m_1 = m_2 = 1\,\text{kg}$, $a_1 = 3.92\,\text{m/s}^2$, $a_2 = 1.96\,\text{m/s}^2$ & $T = 5.88\,\text{N}$. (Teacher: Jyh-Shinn Yang, 89.10.16)

P03 $m_5 = 5\,\text{kg}$, $m_2 = 2\,\text{kg}$ & $F_0 = 100\,\text{N}$. Let A be the upward acceleration of the pulley and a be the acceleration of m_i relative to the pulley. $m_5 g - T = m_5(a - A)$, $T - m_2 g = m_2(a + A)$ & $F_0 = 2T \Rightarrow a = F_0(m_5 - m_2)/4m_5 m_2$, $A = (m_5 + m_2)F_0/4m_5 m_2 - g$ & $T = F_0/2$.

So $a = 7.5\,\mathrm{m/s^2}$, $A = 7.7\,\mathrm{m/s^2}$. (a) $a_2 = 15.2\,\mathrm{m/s^2}$ upward, $a_5 = 0.2\,\mathrm{m/s^2}$ upward; (b) $T = 50\,\mathrm{N}$.

P05 Let θ be the angle of chord w.r.t. the vertical. $a = g\sin\theta$ & $L = a\,t^2/2 \Rightarrow t = \sqrt{4R/g}$.

P06 Let A be the acceleration relative to the ground and a be the downward acceleration of m relative to the wedge. $F = 5\,(M+m)$. $\sum F_x = mg\sin\alpha = m(a + A\cos\alpha)$, $\sum F_y = N - mg\cos\alpha = mA\sin\alpha$. Thus $a = g\sin\alpha - A\cos\alpha = 1.9\,\mathrm{m/s^2}$.



P08 Let a_1 and a_2 be the acceleration of wedge and block relative to the ground. For B $\sum F_x = N\sin\theta = ma_{2x}$ & $\sum F_y = mg - N\cos\theta = ma_{2y}$. For W $\sum F_x = -N\sin\theta = Ma_1$. $a_{2y}/(a_{2x} - a_1) = \tan\theta$. Solving these eqs. to obtain $N = mMg\sin\theta/(M + m\sin^2\theta)$. (Teacher: Jyh-Shinn Yang, 89.10.16)