① $r(t) = 3t\hat{i} - 6t^3\hat{j}$

(a) $v(t) = \frac{dr}{dt} = 3\hat{i} - 18t^2\hat{j}$

(b) $a(t) = \frac{dv}{dt} = -36t\hat{j}$

(c) 當 $t = 1s$

$r(1) = (3, -6)m$; $\vec{v}(1) = (3, -18)m/s$

② $v = \sqrt{2as} = \sqrt{2(9.8)(200)} = 27.57 m/s$

牆面影高度 $h_0 = 5\sin 35° = 114.72m$

垂直分量 $v_y = v\sin 35° = 15.81 m/s$

$v_x = v\cos 35° = 22.58 m/s$

(a) $h_{max} = h_0 + \frac{v_y^2}{2g} = 114.72 + \frac{15.81^2}{2(9.8)} = 127.5m$

(b) $v = 27.6 m/s$, $h_{max} = 127.5m$,

range $= 315.5m$

③ (a) $a = \frac{F_2}{m_1 + m_2} = \frac{72}{18} = 4 ms^{-2}$

(b) $12kg \Rightarrow a$, $\Rightarrow 48$

$6kg \Rightarrow a$, $\Rightarrow 48$

(c) $F_{net,b} = m_1 a = 6 \times 4 = 24N$

④ $m = 0.8kg$, $R = 5m$, N_B (上台秤讀數) $= 6N$

$\frac{mv^2}{R} = N_B + mg \Rightarrow N_A - mg = \frac{mv^2}{R}$

$N_A = N_B + 2mg$

$N_A = 6 + 2(0.8)(9.8) = 21.68N$

⑤ $m = 2.2kg$, $T = 3 \times mg$

$= 3mg$

$mg = 2.2 \times 9.8 = 21.56N$, $T = 64.68N$

$a = \frac{T - mg}{m} = \frac{64.68 - 21.56}{2.2} = 19.6 ms^{-2}$ (向上)

⑥ $T_1\cos\theta_1 = T_2\cos\theta_2$ (水平)

(a) $T_1\sin\theta_1 + T_2\sin\theta_2 = W$ (垂直)

$T_1 = W\frac{\sin\theta_2}{\sin(\theta_1 + \theta_2)}$, $T_2 = W\frac{\sin\theta_1}{\sin(\theta_1 + \theta_2)}$

(b) $T_{max} = 5000N$,

$W_{max} = \min\left(T_{max}\frac{\sin(\theta_1+\theta_2)}{\sin\theta_2}, T_{max}\frac{\sin(\theta_1+\theta_2)}{\sin\theta_1}\right)$

⑦ $m_B = 5kg$ (下), $m_A = 8kg$ (下), $\mu_s = 0.75$

$a = \frac{m_C g}{m_A + m_B + m_C}$

$a \le \mu_s g \Rightarrow \frac{m_C g}{m_A + m_B + m_C} \le \mu_s g$

$m_C \le \frac{\mu_s(m_A + m_B)}{1 - \mu_s}$

$m_C \le \frac{0.75 \times 13}{1 - 0.75} = 39kg$

$\therefore$ 最大 $m_C = 39kg$

⑧ (a) $f_d = cv^2$

$m\frac{dv}{dt} = mg - cv^2$

(b) $mg - cv_t^2 = 0$,

$v_t = \sqrt{\frac{mg}{c}}$

(c) $v(t) = v_t \tanh\left(\frac{gt}{v_t}\right)$

(d) $m = 60kg$, $c = 0.43$

$v_t = \sqrt{\frac{60 \times 9.8}{0.43}} = 36.98 ms^{-1}$

Let $\tanh(x) = 0.9 \Rightarrow x = \tanh^{-1}(0.9) = \frac{1}{2}\ln\frac{1.9}{0.1} = 1.47$

$t = \frac{v_t}{g}x = \frac{36.98}{9.8} \times 1.47 = 5.555$

(9) $m = 1400\,kg$, $33.3\,m/s$

(a) $0 = v^2 + 2a\Delta x$

$a = -\frac{(33.3)^2}{2(180)} = -3.08\,m/s^2$

(b) $F_{net} = ma = 1400 \times 3.08 = 4.3 \times 10^3\,N$

(c) $\mu_s = \frac{|a|}{g} = \frac{3.08}{9.8} = 0.314$

(10) $N = Mg\cos\theta$

정지마찰력 $= kx_{max} = Mg\sin\theta + \mu Mg\cos\theta$

$x_{max} = \frac{Mg\sin\theta + \mu Mg\cos\theta}{k}$

정지마찰력 $= kx_{max} = Mg\sin\theta - \mu Mg\cos\theta$

$x_{max} = \frac{Mg(\sin\theta - \mu\cos\theta)}{k}$

(11) a) $a = g\tan\theta$

$F = (M+m)a = (M+m)g\tan\theta$

(b) $ma\cos\theta - mg\sin\theta + f = 0$

$|mg\sin\theta - ma\cos\theta| \le \mu Mg\cos\theta$

$|g\sin\theta - \frac{F}{M+m}\cos\theta| \le \mu g\cos\theta$

(12) $m = 20\,kg$, $h = 80$, $v = 30\,ms^{-1}$, $g = -mg$

$a = \frac{F}{m} - g \Rightarrow v^2 = v_0^2 + 2ay$

$0 = v_0^2 + 2a(y - y_0) = 30^2 + 2a(-80)$

$a = \frac{30^2}{2\times 80} = 5.625\,m/s^2$ (위로)

$\frac{F}{m} - g = a \Rightarrow F = m(a+g)$

$F = 20 \times (5.625 + 9.8) = 308.5\,N$

(13) $\Delta L = \frac{\rho g L^2}{2k} \Rightarrow L_{new} = L + \frac{\rho g L^2}{2k}$

(14) $m = 0.42\,kg$,

$\Delta K = \frac{1}{2}m(v^2 - v_0^2) = \frac{1}{2}(0.42)(36-4)$

$W = F_s$ $= 0.21 \times 32$

$= 6.72\,J$

$s = \frac{\Delta K}{F} = \frac{6.72}{40} = 0.168\,m$

(15) $F(x) = 18 - 0.53x$

$W = \int_0^{14}(18 - 0.53x)\,dx = 18\times 14 - 0.53 \times \frac{14^2}{2}$

$= 200.06\,J$

$\frac{1}{2}mv^2 = W$

$v = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2\times 200.06}{6}} = 8.17\,ms^{-1}$

(16) 5 km

달릴 때 $\Rightarrow t = \frac{s}{v} = \frac{5}{10} = 0.5\,h = 1800\,s$

$E_{run} = 700 \times 1800 = 1260000\,J$

walk $\Rightarrow t = \frac{s}{v} = \frac{5}{3}\,h = 1.6667\,h = 6000\,s$

$E_{walk} = 290 \times 6000 = 1740000\,J$

사용한 칼로리 $\Rightarrow \Delta E = 1740000 - 1260000 = 480000\,J$