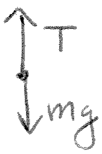
① a) $U_0 = K$

$m_1 g L = \frac{1}{2} m_1 v^2 \quad \therefore \quad V = \sqrt{2gL}$

b) $\Sigma F = ma$

at the bottom



a is up & $a = \frac{V^2}{r}$

$\therefore$ $\Sigma F = ma$

$T - m_1 g = m_1 \frac{v^2}{L}$

$T - m_1 g = m_1 \frac{(\sqrt{2gL})^2}{L}$

$T - m_1 g = 2 m_1 g$

$T = 3 m_1 g$

c) Cons. of Momentum

$m_1 v_0 = (m_1 + m_2) V$

$m_1 \sqrt{2gL} = (m_1 + m_2) v \qquad V = \frac{m_1}{m_1 + m_2}(\sqrt{2gL})$

d) Before $K_0 = \frac{1}{2} m_1 v_0^2 = \frac{1}{2} m_1 (2gL) = m_1 g L$

notice: this is the potential energy at the top!

After $K = \frac{1}{2}(m_1 + m_2)\left(\frac{m_1}{m_1 + m_2}(\sqrt{2gL})\right)^2$

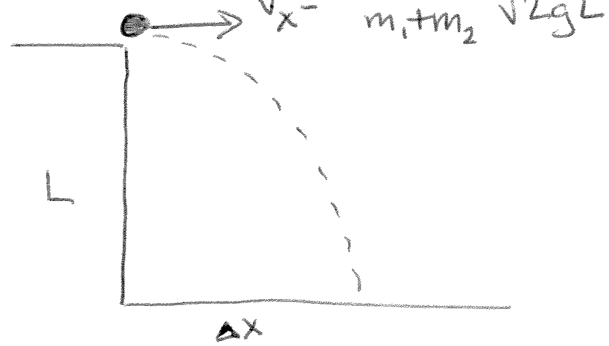
$K = \frac{m_1^2 g L}{m_1 + m_2}$

$\therefore \quad \frac{K_0}{K} = \frac{m_1 g L}{\left(\frac{m_1^2 g L}{m_1 + m_2}\right)} = \frac{m_1 + m_2}{m_1}$

① Continued

e) Projectile

From pt C



Vertical

$y = \frac{1}{2}at^2 + V_{oy}t + y_0$

$0 = \frac{1}{2}(-g)t^2 + 0t^{\nearrow 0} + L$

$t = \sqrt{\frac{2L}{g}}$

Horizontal

$\Delta x = V_x t$

$\Delta X = \frac{m_1}{m_1+m_2}\left(\sqrt{2gL}\right)\left(\sqrt{\frac{2L}{g}}\right)$

$\Delta X = \frac{2m_1L}{m_1+m_2}$

$\therefore$ Total displacement $X = L + \Delta X = L + \frac{2m_1L}{m_1+m_2}$

② a) $a = \frac{\Delta V}{\Delta t} = \frac{V - V_0}{t - t_0} = \frac{-0.18 - 0.22}{0.37 - 0.33} = \frac{-0.4}{0.04} = -10\,m/s^2$

b) Δp = Impulse = Area of F/t graph

$\therefore \Delta p$ = 6 grid squares @ 10N(0.01s) per square or 0.1 N·s per square

$\Delta p = 0.6\,N \cdot s$

c) $\Delta p = p - p_0 = mV - mV_0 = m(V - V_0)$

$0.6\,Ns = m(-0.18 - 0.22)$ $\therefore$ $m = 1.5\,kg$

d) $\Delta E = K - K_0 = \frac{1}{2}(1.5)(0.18^2 - 0.22^2) = -0.024\,J$

(3) a) Cons. of momentum

m_1 = bullet
m_2 = block

$$p_0 = p$$

$$m_1 v_0 = (m_1 + m_2) v$$

$$(0.003\text{kg})(1000\text{m/s}) = (2.003\text{kg})\, v \qquad \underline{\underline{v = 1.50\text{m/s}}}$$

b)

$$\frac{K_0}{K} = \frac{\frac{1}{2} m_1 v_0^2}{\frac{1}{2}(m_1+m_2)v^2} = \frac{(0.003\text{kg})(1000\text{m/s})^2}{(2.003\text{kg})(1.5\text{m/s})^2} = \underline{\underline{665}}$$

c) Conservation of Energy (After collision!)

$$K = U$$

mass is the same & cancels.

$$\frac{1}{2} \cancel{m} v^2 = \cancel{m} g h$$

$$\therefore\ h = \frac{v^2}{2g} = \frac{(1.5\text{m/s})^2}{2(10\text{m/s}^2)} = \underline{\underline{0.11\text{m}}}$$

(4) a) Cons. of Energy

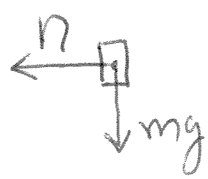
A → C

$$U_0 = K_c + U_c$$

$$\cancel{m} g h_A = \frac{1}{2} \cancel{m} v_c^2 + \cancel{m} g h_c$$

$$h_A = \frac{v_c^2}{2g} + h_c = \frac{(4\text{m/s})^2}{2(10\text{m/s}^2)} + 0.5\text{m} = \underline{\underline{1.3\text{m}}}$$

b)



c) at B $\Sigma F = ma$ circular motion $a = \frac{v^2}{r}$

$v_B = v_c$

$$n = m\frac{v^2}{r} = (0.1\text{kg})\frac{(4\text{m/s})^2}{0.5\text{m}} = \underline{\underline{3.2\text{N}}}$$

④ Continued

d) At max height $V = V_{cx} = V_c \cos\theta$

$V = (4\,\frac{m}{s})\cos 30 = \underline{3.46\,m/s}$

Cons. of Energy

$U_A = U_{max} + K_{MAX}$

$mgh_A = mgh_{max} + \frac{1}{2}mV_{cx}^2$

$h_{max} = h_A - \frac{V_{cx}^2}{2g} = 1.3m - \frac{(3.46\,m/s)^2}{2\,(10\,m/s^2)}$

$\underline{\underline{h_{max} = 0.70m}}$

e) W_f = Diff in initial U

$\therefore\ W_f = mgh_{Nof} - mgh_f$

$W_f = (0.1kg)(10\,m/s^2)(1.3m - 2.0m)$

$\underline{\underline{W_f = -0.7\,J}}$ Negative signifies that friction removes some of the mech. Energy from the system

(5) a) Cons. of energy

$$U_x = K_y$$

$$MgR = \frac{1}{2}Mv_y^2 \qquad \underline{\underline{v_y = \sqrt{2gR}}}$$

b) Cons. of Momentum

$$p_0 = p$$

$$Mv_y = (2M)v$$

$$M\sqrt{2gR} = 2Mv \qquad \underline{\underline{v = \frac{\sqrt{2gR}}{2}}}$$

c) $\Delta K = K_y - K_{after}$ Remember, $U_x = K_y$

$$\Delta K = MgR - \frac{1}{2}(2M)\left(\frac{\sqrt{2gR}}{2}\right)^2$$

$$\Delta K = MgR - M\frac{gR}{2} = \underline{\underline{\frac{MgR}{2}}}$$

d) Skip this

e) Thermal energy = Q = Work done by friction

$$W_f = F \cdot d = \underline{\underline{\mu Mg l}}$$

(6)

a) $\Sigma F = ma \qquad a = \frac{F}{m} = \frac{4N}{0.2kg} = \underline{20\ m/s^2}$

b) $d = \frac{1}{2}at^2 + \cancel{v_0 t} + \cancel{d_0}$ (0, 0)

$t = \sqrt{\frac{2d}{a}} = \sqrt{\frac{2(12m)}{20\ m/s^2}} = \underline{1.1\ sec}$

c) $W = \text{Area} = F \cdot d = (4N)(12m) = \underline{48J}$

d) $W = \Delta K$

$W = \frac{1}{2}mv^2 - \frac{1}{2}m\cancel{v_0^2}$ (0)

$48J = \frac{1}{2}(0.2kg)v^2 \qquad \underline{v = 21.9\ m/s}$

* Alt. Sol'n for part b $\quad a = \frac{\Delta v}{t}$ so $t = \frac{\Delta v}{a}$

$t = \frac{0 - 21.9\ m/s}{20\ m/s^2} = \underline{1.1\ sec}$

e) $W = \text{Area} = \Delta K$

$48J + \frac{1}{2}(4N)(8m) = \frac{1}{2}(0.2kg)v^2$

$\underline{v = 25.3\ m/s}$

f) $\Delta p = p - p_0 = m(v - v_0) = 0.2kg(25.3\ m/s - 21.9\ m/s)$

$\underline{\Delta p = 0.68\ kg\,m/s}$