Solutions

Final Exam (PHYS-205A-001) Fall 2017

Prob. 1

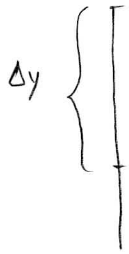
$\Delta y = 12.2 - 36.6$
$= -24.4 m$

$\Delta t = 2.00 s$

$V_i =$

$V_f = ?$

$a = -9.8 \frac{m}{s^2}$



$\Delta y = V_f \Delta t - \frac{1}{2} a \Delta t^2$

$-24.4 = V_f (2.00) - \frac{1}{2} (-9.8)(2.00)^2 \Rightarrow V_f = -22 \frac{m}{s}$.

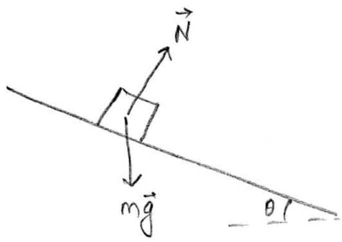
Prob. 2

(a)

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

x: $mg \sin\theta = ma$

$\Rightarrow a = g \sin\theta = 9.8 \sin 20 = 3.35 \frac{m}{s^2}$.



(b)

$V_i = 0$

$V_f =$

$\Delta x = +3.00 m$

$\Delta t =$

$a = +3.35 \frac{m}{s^2}$.

$\Delta x = V_i \Delta t + \frac{1}{2} a \Delta t^2$
(V_i = 0)

$3.00 = \frac{1}{2}(3.35) \Delta t^2 \Rightarrow \Delta t = \sqrt{\frac{2(3.00)}{3.35}} = 1.34$ seconds.

Prob. 3

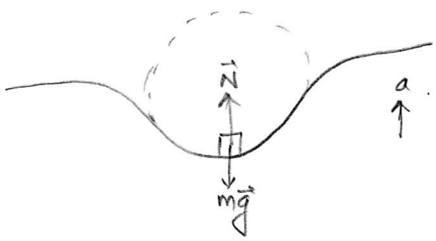
$\vec{N} + m\vec{g} = m\vec{a}$

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

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

$= (75)(9.8) + \frac{75(25)^2}{150}$

$= 735 + 312.5 = 1050$ Newtons



Prob. 4

$$K = \frac{1}{2} m v^2 = \frac{p^2}{2m}$$

$$p = mv$$

$$m = \frac{p^2}{2K} = \frac{(11)^2}{2\,(60.5)} = 1.0\ kg$$

$$v = \frac{p}{m} = \frac{11}{1.0} = 11\ \frac{m}{s}$$

Prob. 5

(a) $W_N = N\,\Delta x \cos 90 = 0.$

(b) $W_s = -\Delta U_s = -\left(\frac{1}{2} k x_c^2 - \frac{1}{2} k x_A^2\right)$, where $x_A \to 0$

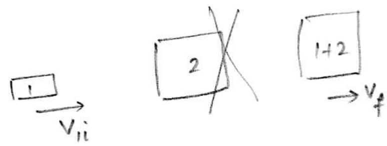
$$= -\frac{1}{2}(4.0\times 10^4)(0.15 m)^2 + 0 = -450\ J$$

(c) $\Delta K = \frac{1}{2} m V_c^2 - \frac{1}{2} m V_A^2 = 0$, where $V_c \to 0$ and $V_A \to 0$

(d) $W_g = -\Delta U_g = -(mgh_c - mgh_A)$

$$= mgh_A = \frac{1}{2} k x_c^2 = 450\ J.$$

Prob. 6



$$m_1 V_{1i} + m_2 V_{2i} = (m_1 + m_2) V_f.$$

where $V_{2i} \to 0$

$$V_{1i} = \left(\frac{m_1 + m_2}{m_1}\right) V_f = \frac{(0.0101 + 5.09)}{0.0101}\, 0.597 = 302\ \frac{m}{s}$$

Mechanical energy lost $= \Delta K$

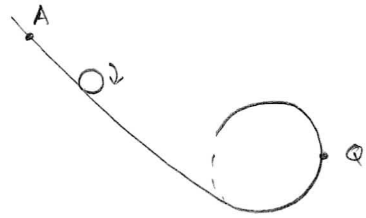
$$= \frac{1}{2} m_1 V_{1i}^2 + \frac{1}{2} m_2 V_{2i}^2 - \frac{1}{2}(m_1 + m_2) V_f^2$$

$$= \frac{1}{2}(0.0101)(302)^2 + 0 - \frac{1}{2}(5.1001)(0.597)^2$$

$$= 461 - 0.91$$

$$= 460\ J$$

Prob. 7



$$\frac{1}{2} m V_A^2 + \frac{1}{2} I \omega_A^2 + mgh_A = \frac{1}{2} m V_Q^2 + \frac{1}{2} I \omega_Q^2 + mgh_Q$$

$V_A = 0$, $\omega_A = 0$, $h_A = 6R$, $h_A = R$.

$$mg(6R) = \frac{1}{2} m V_Q^2 + \frac{1}{2}\frac{2}{5} m \underbrace{r^2 \omega_Q^2}_{V_Q^2} + mgR$$

$$6\,mgR = \frac{1}{2} m V_Q^2 + \frac{1}{5} m V_Q^2 + mgR.$$

$$5\,mgR = \frac{7}{10} m V_Q^2.$$

$$\left.\begin{array}{l}\text{Horizontal component}\\ \text{of force at } Q\end{array}\right\} = m\frac{V_Q^2}{R} = \frac{50}{7} mg \approx 7.1\, mg.$$

Prob. 8

$I_f = \frac{1}{3} I_i$

$$L_i = L_f$$

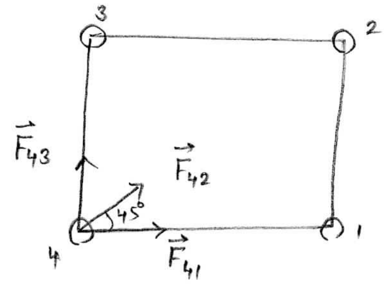
$$I_i \omega_i = I_f \omega_f.$$

$$I_i \omega_i = \frac{1}{3} I_i \omega_f$$

$$\Rightarrow \omega_f = 3\omega_i$$

$$\frac{K_{Rf}}{K_{Ri}} = \frac{\frac{1}{2} I_f \omega_f^2}{\frac{1}{2} I_i \omega_i^2} = \frac{\frac{1}{2}\left(\frac{1}{3} I_i\right)\left(3\omega_i\right)^2}{\frac{1}{2} I_i \omega_i^2} = 3.$$

Prob. 9



$$\vec{F}_{tot} = \vec{F}_{41} + \vec{F}_{42} + \vec{F}_{43}$$

$$|\vec{F}_{41}| = \frac{GM^2}{L^2} = |\vec{F}_{43}| = F_0$$

$$|\vec{F}_{42}| = \frac{GM^2}{(\sqrt{2}L)^2} = \frac{GM^2}{2L^2} = \frac{F_0}{2}$$

$\cos 45 = \sin 45 = \frac{1}{\sqrt{2}}$

$$\vec{F}_{41} = F_0 \hat{i} + 0 \hat{j}$$

$$\vec{F}_{42} = \frac{F_0}{2} \cos 45 \hat{i} + \frac{F_0}{2} \sin 45 \hat{j}$$

$$\vec{F}_{43} = 0 \hat{i} + F_0 \hat{j}$$

$$\vec{F}_{tot} = F_0\left(1 + \frac{1}{2\sqrt{2}}\right) \hat{i} + F_0\left(1 + \frac{1}{2\sqrt{2}}\right) \hat{j}$$

magnitude: $|\vec{F}_{tot}| = F_0 \left(1 + \frac{1}{2\sqrt{2}}\right)\sqrt{2} = F_0\left(\sqrt{2} + \frac{1}{2}\right) = \frac{GM^2}{L^2}\left(\sqrt{2} + \frac{1}{2}\right)$

direction: $\theta = 45$ (towards the center of square.)

Prob. 10

$$x = A \cos\left(\frac{2\pi}{T} t + \delta\right) = 3.00 \cos\left(\frac{\pi}{4} t + \frac{\pi}{7}\right)$$

(a) $A = 3.00$ cm

(b) $T = 8$ seconds.