Solutions

Midterm Exam 03 (Fall 2017) PHYS-205A-002

Prob. 1

$$W = \int d\vec{x} \cdot \vec{F} = \text{Area under curve.}$$

$$= \frac{1}{2}(20-10)\,6 - \frac{1}{2}(30-20)\,3$$

$$= 30 - 15 = 15\ \text{J}$$

Prob. 2

(a) $W_N = 0$. Because normal force is perpendicular to instantaneous displacement.

(b) $W_s = -\Delta U_s = -\left(\frac{1}{2}k x_f^2 - \frac{1}{2}k \underbrace{x_i^2}_{=0}\right)$

$$= -\left(\frac{1}{2}(4.0\times10^4)(0.15)^2 - 0\right) = -450\ \text{J}$$

(c) $\Delta K = \frac{1}{2}m \underbrace{V_c^2}_{=0} - \frac{1}{2}m \underbrace{V_A^2}_{=0} = 0$

(d) Using $\Delta K = W_N + W_g + W_s$

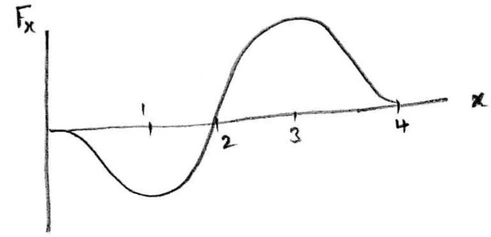
$$0 = 0 + W_g - 450 \Rightarrow W_g = 450\ \text{J}$$

Prob. 3

(a) $F_x = -\dfrac{\partial U}{\partial x} = -(\text{slope})$

At $x = 3\,\text{m}$, F_x is positive.

(b)



Prob. 4

$$\frac{1}{2} m \underbrace{v_A^2}_{=0} + \cancel{m} g h_A = \frac{1}{2} \cancel{m} v_B^2 + \cancel{m} g h_B$$

$$v_B = \sqrt{2g(h_A - h_B)} = \sqrt{2(9.8)(7.00 - 3.20)} = 8.6 \ \frac{m}{s}$$

Prob. 5

(i) $\frac{1}{2} m v^2 = 60.5 \text{ J}$

(ii) $m v = 11 \ kg \frac{m}{s}$

$$\frac{1}{2} m \left(\frac{11}{m}\right)^2 = 60.5$$

$$\frac{1}{2} \frac{121}{m} = 60.5 \Rightarrow m = 1.0 \text{ kg}$$

$$m v = 11$$

$$(1.0)\, v = 11 \Rightarrow v = 11 \ \frac{m}{s}$$

Prob. 6

$m_1 = m$

$m_2 = 3m$

(a)

$$m_1 v_{1i} + m_2 v_{2i} = (m_1 + m_2) v_f$$

$$\cancel{m} v_{1i} + 3 \cancel{m} v_{2i} = (\cancel{m} + 3\cancel{m}) v_f$$

$$v_{1i} + 3 v_{2i} = 4 v_f$$

$$4.00 + 3(2.00) = 4 v_f \Rightarrow v_f = 2.50 \ \frac{m}{s}$$

(b)

$$\frac{K_f}{K_i} = \frac{\frac{1}{2}(m_1 + m_2) v_f^2}{\frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2}$$

$$= \frac{\cancel{\tfrac{1}{2}}(1+3) v_f^2}{\cancel{\tfrac{1}{2}} v_{1i}^2 + \cancel{\tfrac{1}{2}} 3 v_{2i}^2}$$

$$= \frac{4 v_f^2}{v_{1i}^2 + 3 v_{2i}^2} = \frac{4(2.50)^2}{(4.00)^2 + 3(2.00)^2} = \frac{25}{16 + 12}$$

$$= \frac{25}{28} = 0.89.$$

Prob. 7

$\Delta\theta =$ $\qquad \omega_i = 0$ $\qquad \alpha = 4.00 \frac{rad}{s^2}$

$\Delta t = 2.00 s$ $\qquad \omega_f =$

$$\Delta\theta = \omega_i \Delta t + \frac{1}{2}\alpha \Delta t^2$$
$$= 0 + \frac{1}{2}(4.00)(2.00)^2$$
$$= 8.00 \text{ rad}$$

$$\theta_f - \theta_i = 8.00 \text{ rad}$$
$$\theta_f - 1.00 \text{ rad} = 8.00 \text{ rad}$$
$$\theta_f = 9.00 \text{ radians}$$
$$\theta_f = (9.00 - 2\pi) \text{ radians} = 2.71 \text{ radians.}$$