Solutions

PHYS-205A-002 (Midterm Exam 03) Fall 2025

Problem 1

Force and infinitesimal displacement are perpendicular at each instant. Thus, $\int_i^f \vec{F} \cdot d\vec{r} = 0$. So, work done is zero.

Problem 2

Force = − (slope of energy curve)

= − (positive slope at 3.0m)

= −

Thus, the direction of force is towards origin at $x = 3.0\,m$.

Problem 3

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

$$V_{1i} = 2 V_f$$

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

$$= \frac{V_{1i}^2}{2 V_f^2}$$

$$= \frac{(2V_f)^2}{2 V_f^2} = 2$$

Problem 4

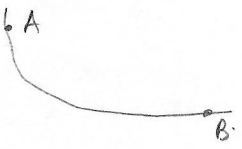
$$V_{1f} = \left(\frac{m_1 - m_2}{m_2 + m_1}\right) V_{1i} + \frac{2 m_2}{m_1 + m_2} V_{2i} = (0) V_{1i} + 0 = 0$$

$$V_{2f} = \left(\frac{2 m_1}{m_1 + m_2}\right) V_{1i} + \left(\frac{m_2 - m_1}{m_1 + m_2}\right) V_{2i} = V_{1i} = 10. \frac{m}{s}.$$

The velocities of the masses swap after collision.

Problem 5

$W_N = 0$



$$\Delta K + \Delta U_g = W_N$$

$$K_B + \cancel{U_B}^{=0} = \cancel{K_A}^{=0} + U_B$$

$$\frac{1}{2} m v_B^2 = mg h_A$$

$$h_A = \frac{v_B^2}{2g} = \frac{(14)^2}{2(9.8)} = 10.\ m.$$

Problem 6

$$U = 8x^2 - x^4$$

$$-F = \frac{\partial U}{\partial x} = 16x - 4x^3$$

$$F = 0 \Rightarrow 4x(4 - x^2) = 0$$

$$x = 0,\ x = \pm 2.0\ m$$

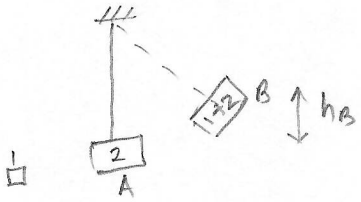
$$\frac{\partial^2 U}{\partial x^2} = 16 - 12x^2$$

$$\left.\frac{\partial^2 U}{\partial x^2}\right|_{x=0} = 16 > 0 \Rightarrow x = 0 \text{ is stable}$$

$$\left.\frac{\partial^2 U}{\partial x^2}\right|_{x=\pm 2.0m} = 16 - 12(\pm 2.0)^2 = -32 < 0$$

$\Rightarrow x = \pm 2.0m$ is unstable.

Problem 7



$$m_1 v_{1i} + m_2 \underbrace{v_{2i}}_{=0} = (m_1 + m_2) v_f$$

$$v_f = \frac{m_1}{m_1 + m_2} v_{1i} = \frac{0.0300}{3.030} v_{1i}$$

$$\frac{1}{2}(m_1 + m_2) v_f^2 = (m_1 + m_2) g h_B$$

$$\frac{1}{2}\left(\frac{0.0300}{3.030}\right)^2 v_{1i}^2 = (9.8)(0.30)$$

$$v_{1i} = \left(\frac{3.030}{0.0300}\right)\sqrt{2(9.8)(0.30)} = 250\ \frac{m}{s}$$