Solutions

PHYS - 205A-001 (Midterm Exam 03) Spring 2026

Problem 1

$$K = \frac{1}{2} m \vec{V} \cdot \vec{V}$$

$$= \frac{1}{2}(2.0)\, 25 = 25 \text{ J}$$

$$\vec{V} = 4.0\,\hat{i} + 3.0\,\hat{j}$$

$$\vec{V} \cdot \vec{V} = (4.0)^2 + (3.0)^2 = 25$$

Problem 2

Zero, because gravitational force is conservative.

Problem 3

$$U = -x^2$$

$$-F = \frac{\partial U}{\partial x} = -2x$$

$$\frac{\partial^2 U}{\partial x^2} = -2.0$$

$$\left.\frac{\partial^2 U}{\partial x^2}\right|_{x=0} = -2.0 < 0 \quad \text{(unstable)} \rightarrow \text{answer}$$

Problem 4

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

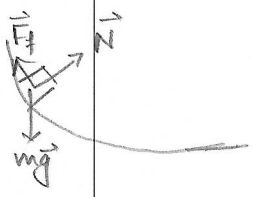
$$m_1 (+4.00) + (3m_1)(2.00) = (4m_1) V_f$$

$$4.00 + 6.00 = 4 V_f \Rightarrow V_f = 2.50 \frac{m}{s}$$

Problem 5

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

$$\Delta K + \Delta U = W_N + W_f \qquad W_N = 0$$



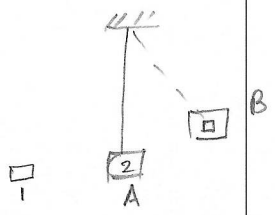
$$W_f = \Delta K + \Delta U$$

$$= \frac{1}{2} m V_f^2 - \frac{1}{2} m V_i^2 + mgh_f - mgh_i$$

$$= \frac{1}{2} 25 (4.0)^2 - 0 + 0 - (25)(9.8)(3.0) = -540 \text{ J}$$

Problem 6

$V_f = V_A$



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

($V_{2i} = 0$)

$$V_{1i} = \left(\frac{0.03000 + 3.000}{0.03000}\right) V_f = 101.0\, V_f$$

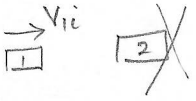
$$\frac{1}{2}(m_1 + m_2) V_A^2 + (m_1 + m_2) g h_A = \frac{1}{2}(m_1 + m_2) V_B^2 + (m_1 + m_2) g h_B$$

($h_A = 0$, $V_B = 0$)

$$V_A = \sqrt{2 g h_B} = \sqrt{2(9.8)(0.30)} = 2.4 \frac{m}{s} = V_f$$

$$V_{1i} = (101.0)\, V_f = (101.0)(2.4) = 240 \frac{m}{s}$$

Problem 7



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

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

$$V_{1f} = \left(\frac{1.0 - 2.0}{1.0 + 2.0}\right) V_{1i} + 0 \quad \Rightarrow \quad V_{1f} = -\frac{1.0}{3.0} V_{1i}$$

$$3.0 = \frac{2(1.0)}{(1.0 + 2.0)} V_{1i} + 0 \quad \Rightarrow \quad V_{1i} = 4.5 \frac{m}{s}$$

Thus, $V_{1i} = 4.5 \frac{m}{s}$ → answer.

$$V_{1f} = -1.5 \frac{m}{s}$$