

Solutions

PHYS 205A-001

(Midterm Exam 03)

Spring 2025

①

Problem 1

$$K = \frac{1}{2} m \vec{v} \cdot \vec{v} = \frac{1}{2} (20)(25) = 250 \text{ J}$$

Problem 2

Gravitational force is a conservative force. The work done by a conservative force along a closed path is 0. Thus, answer is 0.

Problem 3

Force.

Problem 4

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

$$= (0)(10.) + (1)(0) = 0. \rightarrow \text{rest.}$$

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

$$= (1)(10.) + (0)(0) = 10. \text{ m/s}$$

$$\begin{array}{c} \rightarrow v_{1i} \\ \textcircled{1} \end{array} \quad \begin{array}{c} v_{2i} = 0 \\ \textcircled{2} \end{array} \quad \times \quad \begin{array}{c} v_{1f} \\ \textcircled{1} \end{array} \quad \begin{array}{c} v_{2f} \\ \textcircled{2} \end{array}$$

Velocities swap.

Problem 5

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

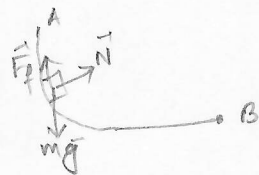
$$W_H = 0$$

$$\Delta K + \Delta U_g = W_H + W_f$$

$$W_f = \Delta K + \Delta U_g$$

$$= \left(\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 \right) + (mgh_f - mgh_i)$$

$$= \frac{1}{2} (25) (4.0)^2 - (25) (9.8) (3.0) = 200 - 735 = -540 \text{ J}$$



Problem 6

$$U = 8.0x - x^4$$

$$-F = \frac{dU}{dx} = 8.0 - 4x^3$$

$$\frac{d^2U}{dx^2} = -12x^2$$

(a) $U=0$
 $8.0x - x^4 = 0$
 $x(8.0 - x^3) = 0$

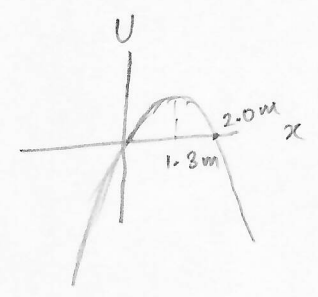
$$x = 0 \text{ m}, \quad x = +2.0 \text{ m}$$

(b) $F=0 \Rightarrow 8.0 - 4x^3 = 0$
 $x^3 = 2.0$

$$x = +1.3 \text{ m}$$

(c) $\left. \frac{d^2U}{dx^2} \right|_{x=+1.3} = -12(+1.3)^2 < 0$

$\Rightarrow x = +1.3$ is an unstable point



Problem 7

$$(m_1 + m_2) \vec{V}_f = m_1 \vec{V}_{1i} + m_2 \vec{V}_{2i}$$

$$(8000.0) \vec{V}_f = (2000.0) 30. \hat{i} - (6000.0) 20. \hat{j}$$

$$\vec{V}_f = (7.5 \hat{i} - 15 \hat{j}) \frac{\text{m}}{\text{s}}$$

magnitude: $|\vec{V}_f| = \sqrt{(7.5)^2 + (15)^2} = 17 \frac{\text{m}}{\text{s}}$

direction: $\theta_f = \tan^{-1}\left(\frac{7.5}{15}\right) = 27^\circ \text{ E of S.}$

