

# Solutions

PHYS-205A

(Midterm Exam 03)

Spring 2024

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## Problem 1

(change in) kinetic energy

## Problem 2

$$W_N = 0.$$

Normal force is perpendicular to trajectory.

## Problem 3

$$W_g = 0.$$

Work done by a conservative force, along a closed loop of a trajectory is zero.

## Problem 4

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

$$V_{2f} = \left( \frac{2m_1}{m_1 + m_2} \right) V_{1i} + \left( \frac{m_2 - m_1}{m_1 + m_2} \right) V_{2i} = V_{1i} = 5.0 \frac{\text{m}}{\text{s}}.$$

## Problem 5

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

$$W_N = 0.$$

$$\Delta K + \Delta U = W_N$$

$$K_A + U_A = K_c + U_c.$$

$$\frac{1}{2} m v_A^2 + mgh_A = \frac{1}{2} m v_c^2 + mgh_c$$

$$v_c = \sqrt{2g(h_A - h_c)}$$

$$= \sqrt{2(9.8)(40.0 - 30.0)} = 14 \text{ m/s.}$$

### Problem 6

$$U = -ax^2 - bx^4$$

$$a = 4.0 \frac{J}{m^2}$$

$$b = 1.0 \frac{J}{m^4}$$

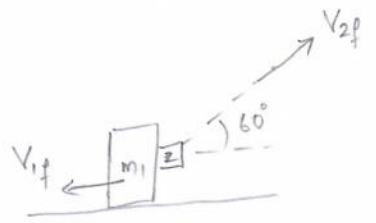
(a)  $U=0$       $-4x^2 - x^4 = 0$   
 $-x^2(4+x^2) = 0 \Rightarrow x=0$      ( $x = \pm 2i$  are not physical.)

(b)  $\frac{dU}{dx} = -2ax - 4bx^3$   
 $F = -\frac{dU}{dx} = 2ax + 4bx^3$   
 $F=0$       $8x + 4x^3 = 0 \Rightarrow 4x(2+x^2) = 0$   
 $\Rightarrow x=0$      ( $x = \pm \sqrt{2}i$  are not physical.)

(c)  $\frac{d^2U}{dx^2} = -2a - 12bx^2$   
 $\frac{d^2U}{dx^2} \Big|_{x=0} = -2a = -8.0 \frac{J}{m^2} < 0 \Rightarrow$  unstable point

### Problem 7

$$m_1 \vec{V}_{1i} + m_2 \vec{V}_{2i} = m_1 \vec{V}_{1f} + m_2 \vec{V}_{2f}$$



x:  $m_1 V_{1ix} + m_2 V_{2ix} = m_1 V_{1fx} + m_2 V_{2fx}$   
 $0 + 0 = (90.0) V_{1fx} + (3.0)(3.0)$   
 $V_{1fx} = -0.10 \frac{m}{s}$

$$V_{2fx} = V_{2f} \cos 60$$

$$= (6.0) \cos 60$$

$$= 3.0 \frac{m}{s}$$