

# Solutions

PHYS-205A-002

(Midterm Exam 03)

Fall 2024

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## Problem 1

Gravitational force.

## Problem 2

$$K = \frac{p^2}{2m} = \frac{(40.)^2}{2(20.)} = 40. \text{ J}$$

## Problem 3

$$\left[ \frac{K}{U} \right] = \text{dimensionless}$$

(because  $K$  and  $U$  have the same dimension)

## Problem 4

$$\Delta K = W_1 + W_2 + \dots = W_{\text{total}}$$

$$W_{\text{total}} = \Delta K = 0 \quad (\text{speed does not change for uniform circular motion.})$$

## Problem 5

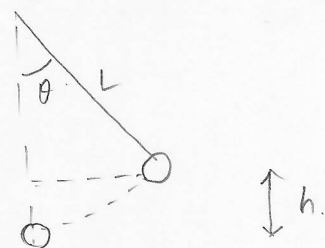
$$m\vec{a} = m\vec{g} + \vec{T}$$

$$\Delta K + \Delta U = W_T$$

$$\Delta K + \Delta U = 0 \quad (W_T = 0)$$

$$0 + mgh = \frac{1}{2}mv^2 + 0$$

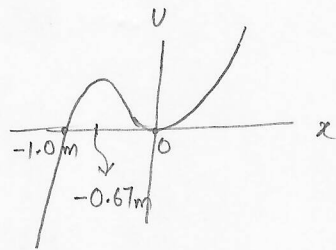
$$v = \sqrt{2gh} = \sqrt{2(9.8)(0.40)} = 2.8 \frac{\text{m}}{\text{s}}$$



$$\begin{aligned} h &= L - L \cos \theta \\ &= L(1 - \cos \theta) \\ &= 3.0(1 - \cos 30) \\ &= 0.40 \text{ m} \end{aligned}$$

Problem 6

$$U = x^2 + x^3$$



(a)  $U=0 \Rightarrow x^2(1+x)=0 \Rightarrow x=0, x=-1.0m$

(b)  $-F = \frac{dU}{dx} = 2x + 3x^2$

$$F=0 \Rightarrow x(2+3x)=0 \Rightarrow x=0, x=-0.67m$$

(c)  $\frac{d^2U}{dx^2} = 2 + 6x$

$$\left. \frac{d^2U}{dx^2} \right|_{x=0} = 2.0 \frac{J}{m^2} > 0 \Rightarrow \text{stable point}$$

$$\left. \frac{d^2U}{dx^2} \right|_{x=-0.67m} = 2.0 + 6(-0.67) = -2.0 \frac{J}{m^2} \Rightarrow \text{unstable point}$$

Problem 7

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

$$m(4.0) + 3m(2.0) = 4m v_f$$

$$v_f = 2.5 \frac{m}{s}$$

$$K_i = \frac{1}{2} m_1 v_{1i}^2 + \frac{1}{2} m_2 v_{2i}^2 = \frac{1}{2} m(4.0)^2 + \frac{1}{2} 3m(2.0)^2 = 14. m$$

$$K_f = \frac{1}{2} (m_1 + m_2) v_f^2 = \frac{1}{2} 4m(2.5)^2 = 12.5 m$$

$$\frac{K_i}{K_f} = \frac{14. m}{12.5 m} = 1.1$$

