(Solution)   PHYS-205A   (Midterm Exam 03)   Spring 2021

Problem 1

Work done by a conservative force in a round trip is zero.

Gravity is a conservative force.

Problem 2

$$K > 0$$

$$E - U = K > 0$$

$$\Rightarrow \quad E > U$$

Since $U \geqslant U_0$ the total energy $E \geqslant U_0$. Thus, the total energy has a minimum of U_0. It has no maximum.

Problem 3

$$\kappa = \frac{P}{J} \qquad [\kappa] = \frac{[P]}{[J]} = \frac{MLT^{-1}}{MLT^{-1}} = M^0 L^0 T^0$$

Thus, κ is dimensionless.

Problem 4

Above height R.

Problem 5
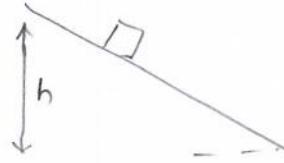
$$W = -mgh = -(3.0)(9.8)(10.0) = -290 \text{ J}$$

Problem 6

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

$$\Delta K = W_g + W_N + W_f \underset{\downarrow \, =0}{}$$

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

$$= \left(\frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2 \underset{\downarrow 0}{}\right) + \left(0 - mgh\right)$$

$$= \frac{1}{2} m v_f^2 - mgh$$

$$= \frac{1}{2} (25)(5.0)^2 - 25(9.8)(10.0)$$

$$= 2100 \text{ J}$$

Problem 7

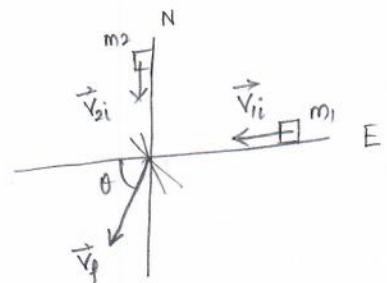$$m_1 \vec{V_{1i}} + m_2 \vec{V_{2i}} = (m_1 + m_2) \vec{V_f}$$

$$\vec{V_f} = \frac{m_1}{m_1 + m_2} \vec{V_{1i}} + \frac{m_2}{m_1 + m_2} \vec{V_{2i}}$$

$$= \frac{3000}{10000} \left(-25.0\,\hat{i}\right) + \frac{7000}{10000} \left(-15.0\,\hat{j}\right)$$

$$= -7.50\,\hat{i} - 10.5\,\hat{j}$$

$$|\vec{V_f}| = \sqrt{7.50^2 + 10.5^2}$$

$$= 12.9 \frac{m}{s}$$

$$\theta = \tan^{-1}\left(\frac{10.5}{7.50}\right) = 54.5° \quad S \text{ of } W.$$

Problem 8

momentum: $m_1 V_{1i} + m_2 V_{2i} = m_1 V_{1f} + m_2 V_{2f}$

$$(1.0)\, V_{1i} + (2.0)(0) = (1.0)\, V_{1f} + (2.0)(3.0)$$

$$V_{1i} - V_{1f} = 6.0 \quad\quad\text{— (i)}$$

kinetic energy (linearized form)

$$V_{1i} + V_{1f} = V_{2i} + V_{2f}$$

$$V_{1i} + V_{1f} = 0 + 3.0 \quad\quad\text{— (ii)}$$

Adding (i) and (ii) we have

$$2 V_{1i} = 6.0 + 3.0 \quad\Rightarrow\quad V_{1i} = 4.5 \tfrac{m}{s}.$$