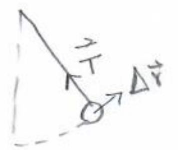
Solutions

Midterm Exam 03 (PHYS-203A) Fall 2020

Problem 1



$$W = \vec{T} \cdot \Delta\vec{r} = T\, \Delta r \cos 90 = 0.$$

Problem 2

Kinetic energy is conserved in elastic collisions, but not conserved in inelastic collisions.

Problem 3

Impulse $= \vec{F}\,\Delta t \rightarrow N \cdot s$

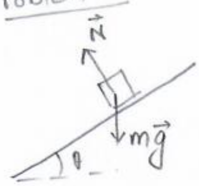
Momentum $= m\vec{v} \rightarrow kg\,\frac{m}{s}$

Same $\quad N\,s = kg\,\frac{m}{s^2}\,s = kg\,\frac{m}{s}$

Problem 4

$$W = -\Delta U = -mg\,\Delta h = 0 \qquad (\text{because } \Delta h = 0)$$

Problem 5



(a) Gravity and Normal force.

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

(b) Using work-energy theorem

$$\Delta K = W_g + W_N$$
$$= W_g + 0 \qquad (\because W_N = 0)$$

$$W_g = \Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$
$$= \frac{1}{2}(20.0)\,0^2 - \frac{1}{2}(20.0)\,5.0^2$$
$$= -250\ J$$

Problem 6

(a) $W_N = 0$ (because normal force is perpendicular to displacement)

(b) $\Delta K = W_g + W_N$

$= -\Delta U + 0$

$= -mg\,\Delta h$

$\frac{1}{2} \cancel{m} v_c^2 - \underbrace{\frac{1}{2} \cancel{m} v_A^2}_{=0} = -\cancel{m}g\,(h_c - h_A)$

$\frac{1}{2} v_c^2 - 0 = -g\,(30.0 - 40.0)$

$v_c = \sqrt{2\,(9.8)(10.0)} = 14\ \frac{m}{s}$

Problem 7

$\Delta K + \Delta U_g + \Delta U_s = 0$

(a) $\Delta K = 0$ (because $v_c = v_A = 0$)

(b) $\Delta U_g = mg\,(h_c - h_A) = -mgh = -(20.0)(9.8)(1.0) = -196\,J = -2.0\times10^{2}\,J.$

(c) $\Delta U_s = -\Delta K - \Delta U_g = -0 - (-196 J) = +196 J = -2.0\times10^{2}\,J.$

Problem 8

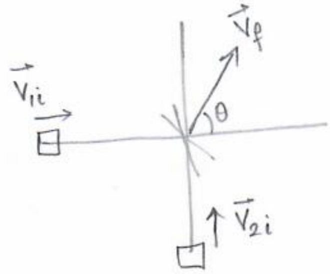
$\Delta K = W$

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

$\frac{1}{2} m \left(30.0^2 - 20.0^2\right) = 440\times10^{3}$

$m = \frac{2\,(440\times10^{3})}{(900. - 400.)} = 1760\ kg.$

Problem 9



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

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

$$= \frac{3}{(3+7)}\,25.0\,\hat{i} + \frac{7}{(3+7)}\,25.0\,\hat{j}$$

$$= 7.50\hat{i} + 17.5\hat{j}.$$

magnitude: $|\vec{V}_f| = \sqrt{7.50^2 + 17.5^2} = 19.0 \frac{m}{s}$

direction: $\theta = \tan^{-1}\left(\frac{17.5}{7.5}\right) = 66.8^\circ$ North of East.

Problem 10

$$V_{1f} = \left(\frac{m_1 - m_2}{m_1+m_2}\right) V_{1i} + \left(\frac{2m_2}{m_1+m_2}\right) V_{2i} = \left(\frac{1.0-1.0}{1.0+1.0}\right) 10.\,\frac{m}{s} + 0 = 0$$

$$V_{2f} = \left(\frac{2m_1}{m_1+m_2}\right) V_{1i} + \left(\frac{m_2 - m_1}{m_1+m_2}\right) V_{2i} = \left(\frac{2\times 1.0}{1.0+1.0}\right) 10. + 0 = 10.\,\frac{m}{s}.$$

Problem 11

$$x_{cm} = \frac{m_1 x_1 + m_2 x_2}{(m_1+m_2)}$$

$$= \frac{(90.0)(7.00) + (60.0)(2.00)}{(90.0 + 60.0)}$$

$$= \frac{630. + 120.}{150.} = 5.00\text{ m}$$