PHYS 2311 Ch. 9 HW

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Problem 1.

$$p = mv = (0.032)(8.4) = \boxed{0.2688\,\text{Ns}}$$

Problem 2.

$$m_A\vec{v}_A + m_B\vec{v}_B = m_A\vec{v}'_A + m_B\vec{v}'_B$$

$$(7150)(15.0) + (3650)(0) = (10800)\vec{v}'$$

$$\vec{v}' = \frac{(7150)(15.0)}{10800} = \boxed{9.93\,\text{m/s}}$$

Problem 4.

$$\vec{F}_{\text{inst}} = \frac{d\vec{p}}{dt} = m\frac{d\vec{v}}{dt} + \vec{v}\frac{dm}{dt}$$

$$= 0 + (4.5 \times 10^4)(1200) = \boxed{5.4 \times 10^7\,\text{N}}$$

Problem 5.

$$\vec{p} = 4.8t^2\hat{i} - 8.0\hat{j} - 9.4t\hat{k}$$

$$\vec{F} = \frac{d\vec{p}}{dt}$$

$$\vec{F} = \boxed{(9.6t\hat{i} - 9.4\hat{k})\text{N}}$$

Problem 6.

$$m_B = 42 + 24 = 66$$

$$m_A\vec{v}_A + m_B\vec{v}_B = m_A\vec{v}'_A + m_B\vec{v}'_B$$

$$(5.30)(0) + (66)(0) = (5.30)(10\hat{i}) + (66)(\vec{v}'_B)$$

$$\frac{-(5.30)(10\hat{i})}{66} = \vec{v}'_B = \boxed{-0.803\,\hat{\text{i}}\text{m/s}}$$

Problem 8.

$$\vec{F} = 26\hat{i} - 12t^2\hat{j}$$

$$\Delta\vec{p} = \int_{t_1}^{t_2} \vec{F}\,dt = \int_{1.0}^{2.0} 26\hat{i} - 12t^2\hat{j}\,dt$$

$$26t\hat{i} - 4t^3\hat{j}\Big|_{1.0}^{2.0} = (26(2.0)\hat{i} - 4(2.0)^3\hat{j}) - (26(1.0)\hat{i} - 4(1.0)^3\hat{j})$$

$$= \boxed{(26\hat{i} - 28\hat{j})\text{Ns}}$$

Problem 9.

$$\vec{p}_i = \vec{p}_f$$

$$m_1 v_1 = m_2 v_2$$
$$v_1 = \frac{m_2}{m_1} v_2$$

$$K_1 = 2K_2$$
$$\frac{1}{2} m_1 v_1^2 = m_2 v_2^2$$
$$m_1 v_1^2 = 2m_2 v_2^2$$
$$m_1 \left(\frac{m_2}{m_1} v_2\right)^2 = 2m_2 v_2^2$$
$$\frac{m_2^2}{m_1} = 2m_2$$
$$\frac{m_2}{m_1} = 2$$
$$\frac{m_1}{m_2} = \boxed{\frac{1}{2}}$$

Problem 18.

$$\Delta\vec{p} = \vec{p}_i - \vec{p}_f$$

$$= (0.145)(31.0 - (-46.0)) = 11.165\,\text{Ns}$$

$$\vec{F} = \frac{\Delta p}{\Delta t} = \frac{11.165}{5 \times 10^{-3}\,\text{s}} = \boxed{2233\,\text{N}}$$

Problem 21.

(a)

$$\vec{p}_i = \vec{p}_f$$

$$0 = m_A v_A + m_C v_C$$

$$\Delta v_C = \left| \frac{-m_A v_A}{m_C} \right| = \frac{(125)(2.50)}{(2200)} = \boxed{0.14\,\text{m/s}}$$

(b)

$$\Delta t = 0.600\,\text{s}$$

$$\Delta \vec{p} = m_A v_A = (125)(2.50) = 312.5\,\text{Ns}$$

$$\vec{F}_{avg} = \frac{\Delta \vec{p}}{\Delta t} = \frac{312.5}{0.600} = \boxed{521\,\text{N}}$$

(c)

$$K = \frac{1}{2} m v^2$$

$$K_A = \frac{1}{2}(125)(2.50)^2 = \boxed{391\,\text{J}}$$

$$K_C = \frac{1}{2}(2200)(0.14)^2 = \boxed{22\,\text{N}}$$

Problem 23.

(a) Counted 10 squares

$$\Delta p = 10(0.01)(50) = \boxed{5\,\text{N}}$$

(b)

$$v = \frac{p}{m} = \frac{5}{0.060} = \boxed{83\,\text{m/s}}$$

Problem 28.

$$v_{2i} = 0$$

$$v_{1f} = v_{1i}\left(\frac{m_1 - m_2}{m_1 + m_2}\right) = (7.40\hat{i})\left(\frac{0.450 - 0.900}{0.450 + 0.900}\right) = \boxed{-2.47\,\hat{\text{i}}\text{m/s}}$$

$$v_{2f} = \left(\frac{2m_2}{m_1+m_2}\right) v_{1i} = (7.40\hat{i}) \left(\frac{2(0.900)}{0.450+0.900}\right) = \boxed{9.87\,\hat{\text{i}}\text{m/s}}$$

Problem 37.

$$m_1 = m_2, h_2 = 2h_1$$

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

$$\frac{1}{2}v^2 = gh$$

$$v = \sqrt{2gh}$$

$$v_2 = \sqrt{2gh_2} = \sqrt{2g(2h_1)} == \sqrt{2}\sqrt{2gh_1} = \boxed{\sqrt{2}v_1}$$

Problem 38.

$$m_b = 0.028\,\text{kg}, \quad v_b = 190\,\text{m/s}, \quad m_p = 3.1\,\text{kg}, \quad l = 2.4\,\text{m}$$

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

$$v_f = \frac{m_1 v_{1i}}{m_1+m_2} = \frac{(0.028)(190)}{0.028+3.1} = 1.70\,\text{m/s}$$

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

$$h = \frac{mv^2}{2mg} = \frac{v^2}{2g} = \frac{(1.70)^2}{2(9.8)} = \boxed{0.147\,\text{m}}$$

$$l^2 = (l-h)^2 + x^2$$

$$x = \sqrt{l^2-(l-h)^2} = \sqrt{(2.4)^2-(2.4-0.147)^2} = \boxed{0.827\,\text{m}}$$

Problem 47.

(a)

$$m_A\vec{v}_{Ax} + m_B\vec{v}_{Bx} = m_A\vec{v}'_{Ax} + m_B\vec{v}'_{Bx}$$

$$(0.120)(2.80) = (0.120)(2.10\cos(35.0)) + (0.140)\vec{v}'_{Bx}$$

$$m_A\vec{v}_{Ay} + m_B\vec{v}_{By} = m_A\vec{v}'_{Ay} + m_B\vec{v}'_{By}$$

$$0 = (0.120)(2.10\sin(35.0)) + (0.140)\vec{v}'_{By}$$

(b)

$$\vec{v}'_{By} = -\frac{(0.120)(2.10\sin(35.0))}{0.140} = -1.03\,\text{m/s}\hat{\text{j}}$$

$$\vec{v}'_{Bx} = \frac{(0.120)(2.80 - 2.10\cos(35.0))}{0.140} = 0.926\,\text{m/s}\hat{\text{i}}$$

$$\vec{v}'_B = \sqrt{(-1.03)^2 + (0.926)^2} = \boxed{1.39\,\text{m/s}}$$

$$\theta_B = \arctan\left(\frac{1.03}{0.926}\right) = \boxed{48.1^\circ}$$

Problem 54.

$$M = 16\,\text{u} + 12\,\text{u} = 28\,\text{u}$$

$$m_1 = 16\,\text{u} \cdot 1.66 \times 10^{-27}\ kg/u = 2.656 \times 10^{-26}\,\text{kg}$$

$$m_2 = 12\,\text{u} \cdot 1.66 \times 10^{-27}\ kg/u = 1.992 \times 10^{-26}\,\text{kg}$$

$$M = 28\,\text{u} \cdot 1.66 \times 10^{-27}\ kg/u = 4.648 \times 10^{-26}\,\text{kg}$$

$$x_{CM} = \frac{\sum m_i x_i}{M} = \frac{(2.656 \times 10^{-26}\,\text{kg})(0) + (1.992 \times 10^{-26}\,\text{kg})(1.13 \times 10^{-10}\,\text{m})}{4.648 \times 10^{-26}\,\text{kg}}$$

$$= \boxed{4.843 \times 10^{-11}\,\text{m}}$$

Problem 55.

$$M = 1.00 + 1.50 + 1.10 = 3.6\,\text{kg}$$

$$x_{CM} = \frac{\sum m_i x_i}{M}$$

$$x_{CM} = \frac{(1.00)(0) + (1.50)(0.50) + (1.10)(0.75)}{3.6} = \boxed{0.4375\,\text{m}}$$