1. (a) The final velocity is equal in magnitude but opposite in direction to the initial velocity.

$\Delta p = m\Delta v = m(v - v_o) = m(-v_o - v_o) = -2mv_o = -2(120\text{ lb}) \times \dfrac{1\text{ kg}}{2.2\text{ lb}} \times (4.50\text{ m/s})$

$= -491\text{ kg·m/s} = \boxed{491\text{ kg·m/s downward}}$.

(b) $\boxed{\text{Yes}}$, there would be a difference.

$v^2 = v_o^2 - 2gy = (4.50\text{ m/s})^2 - 2(9.80\text{ m/s}^2)(-0.300\text{ m}) = 26.13\text{ m}^2/\text{s}^2$, ☞ $v = -5.11$ m/s.

So $\Delta p = (120\text{ lb}) \times \dfrac{1\text{ kg}}{2.2\text{ lb}} \times (-5.11\text{ m/s} - 4.50\text{ m/s}) = -524\text{ kg·m/s} = \boxed{524\text{ kg·m/s downward}}$.

2. (a) Apply momentum conservation $\vec{\mathbf{P}}_o = \vec{\mathbf{P}}$

in x-axis: $(0.010\text{ kg})(2000\text{ m/s}) + 0 = (0.010\text{ kg})(1000\text{ m/s})\cos 10° + (100\text{ kg})\, v_{2x}$,

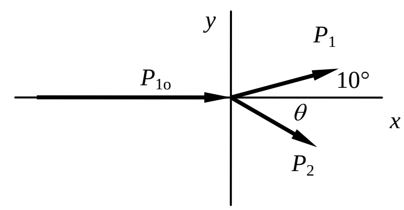
so $v_{2x} = 0.1015$ m/s;

in y-axis: $0 + 0 = (0.010\text{ kg})(1000\text{ m/s})\sin 10° + (100\text{ kg})\, v_{2y}$,

so $v_{2y} = -0.01736$ m/s.

$\theta_2 = \tan^{-1}\left(\dfrac{-0.01736}{0.1015}\right) = \boxed{9.7°}$ below the $+x$-axis.

(b) $v_2 = \sqrt{(0.1015\text{ m/s})^2 + (-0.0174\text{ m/s})^2} = \boxed{0.10\text{ m/s}}$.



3. First consider the collision between car 1 and 2.

$v_1 = \dfrac{m_1 - m_2}{m_1 + m_2} v_{1o} = \dfrac{2000\text{ kg} - 1500\text{ kg}}{2000\text{ kg} + 1500\text{ kg}} \times (15.0\text{ m/s}) = \boxed{2.14\text{ m/s}}$.

$v_2 = \dfrac{2m_1}{m_1 + m_2} v_{1o} = \dfrac{2(2000\text{ kg})}{2000\text{ kg} + 1500\text{ kg}} \times (15.0\text{ m/s}) = \boxed{17.1\text{ m/s}}$.

Now consider the collision between car 2 and 3.
The 17.1 m/s becomes the initial velocity in this collision. $v_2 = v_3 = v$.

$(1500\text{ kg})(17.1\text{ m/s}) + (2500\text{ kg})(0) = (1500\text{ kg} + 2500\text{ kg})\, v$, ☞ $v = \boxed{6.41\text{ m/s}}$.

4. (a) $\vec{\mathbf{P}}_o = \vec{\mathbf{P}}$, ☞ $m_1 v_{1o} + m_2 v_{2o} = m_1 v_1 + m_2 v_2$.

$(0.0200\text{ kg})(300\text{ m/s}) + (1.000\text{ kg})(0) = (0.0200\text{ kg})(50.0\text{ m/s}) + (1.000\text{ kg})\, v_2$. So $v_2 = \boxed{5.00\text{ m/s}}$.

(b) $K_o = \frac{1}{2}(0.0200\text{ kg})(300\text{ m/s})^2 + \frac{1}{2}(1.000\text{ kg})(0)^2 = 900$ J.

$K = \frac{1}{2}(0.0200\text{ kg})(50.0\text{ m/s})^2 + \frac{1}{2}(1.000\text{ kg})(5.00\text{ m/s})^2 = 37.5$ J.

So the fraction of the total initial kinetic energy lost is $\dfrac{900\text{ J} - 37.5\text{ J}}{900\text{ J}} = \boxed{95.8\%}$.

5. (a) $v_1 = v_2 = v$ (forma single object). Apply momentum conservation $\vec{\mathbf{P}}_o = \vec{\mathbf{P}}$

in x-axis: $(50.0\text{ kg})(5.00\text{ m/s}) - (0.50\text{ kg})(35.0\text{ m/s})\cos 30° = (50.0\text{ kg} + 0.50\text{ kg})\, v_x$, so $v_x = 4.650$ m/s;

in y-axis: $0 - (0.50\text{ kg})(35.0\text{ m/s})\sin 30° = (50.0\text{ kg} + 0.50\text{ kg})\, v_y$, so $v_y = -0.1733$ m/s.

$\theta_2 = \tan^{-1}\left(\dfrac{-0.1733}{4.650}\right) = \boxed{2.13°}$ below the $-x$-axis. $v = \sqrt{(-0.1733\text{ m/s})^2 + (4.650\text{ m/s})^2} = \boxed{4.65\text{ m/s}}$.

(b) $K_o = \frac{1}{2}(50.0\text{ kg})(5.00\text{ m/s})^2 + \frac{1}{2}(0.50\text{ kg})(35.0\text{ m/s})^2 = 931$ J.

$K = \frac{1}{2}(50.0\text{ kg} + 0.50\text{ kg})(4.65\text{ m/s})^2 = 546$ J. So the answer is $\boxed{K < K_o\text{, inelastic}}$.