CHAPTER 7

1. $p = mv = (0.022\text{ kg})(8.1\text{ m/s}) =$ $\boxed{0.18\text{ kg·m/s.}}$

2. During the throwing we use momentum conservation for the one-dimensional motion:
   $0 = (m_{boat} + m_{child})v_{boat} + m_{package}v_{package}$;
   $0 = (55.0\text{ kg} + 28.0\text{ kg})v_{boat} + (5.40\text{ kg})(10.0\text{ m/s})$, which gives
   $v_{boat} =$ $\boxed{-0.720\text{ m/s (opposite to the direction of the package).}}$

3. We find the force on the expelled gases from
   $F = \Delta p/\Delta t = (\Delta m/\Delta t)v = (1300\text{ kg/s})(40,000\text{ m/s}) = 5.2\times10^7\text{ N}.$
   An equal, but opposite, force will be exerted on the rocket: $\boxed{5.2\times10^7\text{ N, up.}}$

4. For this one-dimensional motion, we take the direction of the halfback for the positive direction.
   For this perfectly inelastic collision, we use momentum conservation:
   $M_1v_1 + M_2v_2 = (M_1 + M_2)V$;
   $(95\text{ kg})(4.1\text{ m/s}) + (85\text{ kg})(5.5\text{ m/s}) = (95\text{ kg} + 85\text{ kg})V$, which gives $\boxed{V = 4.8\text{ m/s.}}$

5. For the horizontal motion, we take the direction of the car for the positive direction.
   The load initially has no horizontal velocity. For this perfectly inelastic collision,
   we use momentum conservation:
   $M_1v_1 + M_2v_2 = (M_1 + M_2)V$;
   $(12,500\text{ kg})(18.0\text{ m/s}) + 0 = (12,500\text{ kg} + 5750\text{ kg})V$, which gives $\boxed{V = 12.3\text{ m/s.}}$

6. For the one-dimensional motion, we take the direction of the first car for the positive direction.
   For this perfectly inelastic collision, we use momentum conservation:
   $M_1v_1 + M_2v_2 = (M_1 + M_2)V$;
   $(9500\text{ kg})(16\text{ m/s}) + 0 = (9500\text{ kg} + M_2)(6.0\text{ m/s})$, which gives $\boxed{M_2 = 1.6\times10^4\text{ kg.}}$

7. We let V be the speed of the block and bullet immediately after the
   embedding and before the two start to rise.
   For this perfectly inelastic collision, we use momentum conservation:
   $mv + 0 = (M + m)V$;
   $(0.021\text{ kg})(210\text{ m/s}) = (0.021\text{ kg} + 1.40\text{ kg})V$, which gives $V = 3.10\text{ m/s}$.
   For the rising motion we use energy conservation, with the potential
   reference level at the ground:
   $\text{KE}_i + \text{PE}_i = \text{KE}_f + \text{PE}_f$;
   $\frac{1}{2}(M + m)V^2 + 0 = 0 + (m + M)gh$, or
   $h = V^2/2g = (3.10\text{ m/s})^2/2(9.80\text{ m/s}^2) =$ $\boxed{0.491\text{ m.}}$