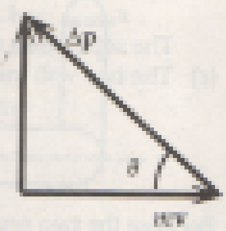
59. The CM will land at the same point, $2D$ from the launch site. If part I is still stopped by the explosion, it will fall straight down, as before.
(*a*) We find the location of part II from the CM:
$x_{CM} = (m_I x_I + m_{II} x_{II})/(m_I + m_{II})$
$2D = [m_I D + 3m_I x_{II}]/(m_I + 3m_I)$, which gives
x_{II} = **7D/3, or 2D/3 closer to the launch site.**
(*b*) For the new mass distribution, we have
$x_{CM} = (m_I x_I + m_{II} x_{II})/(m_I + m_{II})$
$2D = [3m_{II} D + m_{II} x_{II}]/(3m_{II} + m_{II})$, which gives
x_{II} = **5D, or 2D farther from the launch site.**

60. The forces on the balloon, gondola, and passenger are balanced, so the CM does not move relative to the Earth. As the passenger moves down at a speed v relative to the balloon, the balloon will move up. If the speed of the balloon is v' relative to the Earth, the passenger will move down at a speed $v - v'$ relative to the Earth. We choose the location of the CM as the origin and determine the positions after a time t:
$x_{CM} = (m_{balloon} y_{balloon} + m_{passenger} y_{passenger})/(m_{balloon} + m_{passenger})$
$0 = [Mv't + m(v - v')t]/(M + m)$, which gives
$v' = mv/(M + m)$ up.
If the passenger stops, the gondola and **the balloon will also stop.** There will be equal and opposite impulses acting when the passenger grabs the rope to stop.

61. We find the force on the person from the magnitude of the force required to change the momentum of the air:
$F = \Delta p/\Delta t = (\Delta m/\Delta t)v$
$= (40\ kg/s\cdot m^2)(1.50\ m)(0.50\ m)(100\ km/h)/(3.6\ ks/h) =$ **8.3×10^2 N.**
The maximum friction force will be
$F_{fr} = \mu mg = (1.0)(70\ kg)(9.80\ m/s^2) = 6.9 \times 10^2$ N, so the forces are **about the same.**

62. For the system of railroad car and snow, the horizontal momentum will be constant. For the horizontal motion, we take the direction of the car for the positive direction. The snow initially has no horizontal velocity. For this perfectly inelastic collision, we use momentum conservation:
$M_1 v_1 + M_2 v_2 = (M_1 + M_2)V$;
$(5800\ kg)(8.60\ m/s) + 0 = [5800\ kg + (3.50\ kg/min)(90.0\ min)]V$, which gives **$V = 8.16$ m/s.**
Note that there is a vertical impulse, so the vertical momentum is not constant.

63. We find the speed after being hit from the height h using energy conservation:
$\frac{1}{2}mv'^2 = mgh$, or $v' = (2gh)^{1/2} = [2(9.80\ m/s^2)(55.6\ m)]^{1/2} = 33.0\ m/s.$
We see from the diagram that the magnitude of the change in momentum is
$\Delta p = m(v^2 + v'^2)^{1/2}$
$= (0.145\ kg)[(35.0\ m/s)^2 + (33.0\ m/s)^2]^{1/2} = 6.98\ kg\cdot m/s.$



We find the force from
$F\,\Delta t = \Delta p$;
$F(0.50 \times 10^{-3}\ s) = 6.98\ kg\cdot m/s$, which gives $F =$ **1.4×10^4 N.**
We find the direction of the force from
$\tan\theta = v'/v = (33.0\ m/s)/(35.0\ m/s) = 0.943$, $\theta =$ **43.3°.**

64. For momentum conservation we have
x: $mv_0 = \frac{2}{3}mv_x'$, which gives **$v_x' = \frac{3}{2}v_0$;**
y: $0 = \frac{1}{3}m(2v_0) - \frac{2}{3}mv_y'$, which gives **$v_y' = -v_0$.**
The rocket's forward speed increases because the fuel is shot backward relative to the rocket.