30. We let V be the speed of the block and bullet immediately after the collision and before the pendulum swings. For this perfectly inelastic collision, we use momentum conservation:

$mv + 0 = (M + m)V;$

$(0.018\text{ kg})(230\text{ m/s}) = (0.018\text{ kg} + 3.6\text{ kg})V,$

which gives $V = 1.14$ m/s.

Because the tension does no work, we can use energy conservation for the swing:

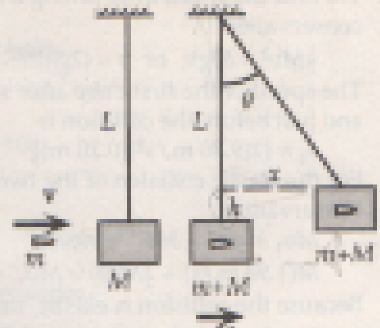
$\frac{1}{2}(M + m)V^2 = (M + m)gh, \text{ or } V = (2gh)^{1/2};$

$1.14\text{ m/s} = [2(9.80\text{ m/s}^2)h]^{1/2}$, which gives $h = 0.0666$ m.

We find the horizontal displacement from the triangle:

$L^2 = (L - h)^2 + x^2;$

$(2.8\text{ m})^2 = (2.8\text{ m} - 0.0666\text{ m})^2 + x^2$, which gives $x =$ **0.61 m.**



31. (*a*) The velocity of the block and projectile after the collision is

$v' = mv_1/(m + M).$

The fraction of kinetic energy lost is

$\text{fraction lost} = -\Delta KE/KE = -[\frac{1}{2}(m + M)v'^2 - \frac{1}{2}mv_1^2]/\frac{1}{2}mv_1^2$

$= -[(m + M)[mv_1/(m + M)]^2 - mv_1^2]/mv_1^2$

$= -[m/(m + M)] + 1 =$ **$+ M/(m + M)$.**

(*b*) For the data given we have

$\text{fraction lost} = M/(m + M) = (14.0\text{ g})/(14.0\text{ g} + 380\text{ g}) =$ **0.964.**

32. Momentum conservation gives

$0 = m_1v_1' + m_2v_2';$

$0 = m_2v_1' + 1.5m_1v_2', \text{ or } v_1' = -1.5v_2'.$

The kinetic energy of each piece is

$KE_2 = \frac{1}{2}m_2v_2'^2;$

$KE_1 = \frac{1}{2}m_1v_1'^2 = \frac{1}{2}(m_2/1.5)(-1.5v_2')^2 = (1.5)\frac{1}{2}m_2v_2'^2 = 1.5KE_2.$

The energy supplied by the explosion produces the kinetic energy:

$E = KE_1 + KE_2 = 2.5KE_2;$

$7500\text{ J} = 2.5KE_2$, which gives $KE_2 = 3000$ J.

For the other piece we have

$KE_1 = E - KE_2 = 7500\text{ J} - 3000\text{ J} = 4500\text{ J}.$

Thus

KE(heavier) = 3000 J; KE(lighter) = 4500 J.

33. On the horizontal surface after the collision, the normal force on the joined cars is $F_N = (m + M)g$. We find the common speed of the joined cars immediately after the collision by using the work-energy principle for the sliding motion:

$W_{fr} = \Delta KE;$

$-\mu_k(m + M)gd = 0 - \frac{1}{2}(M + m)V^2;$

$0.40(9.80\text{ m/s}^2)(2.8\text{ m}) = \frac{1}{2}V^2$, which gives $V = 4.68$ m/s.

For the collision, we use momentum conservation:

$mv + 0 = (m + M)V;$

$(1.0\times10^3\text{ kg})v = (1.0\times10^3\text{ kg} + 2.2\times10^3\text{ kg})(4.68\text{ m/s})$, which gives **$v = 15$ m/s** (54 km/h).