74. We find the speed for falling or rising through a height h from energy conservation:

$\frac{1}{2}mv^2 = mgh$, or $v^2 = 2gh$.

(a) The speed of the first block after sliding down the incline and just before the collision is

$v_1 = [2(9.80 \text{ m/s}^2)(3.60 \text{ m})]^{1/2} = 8.40 \text{ m/s}$.

For the elastic collision of the two blocks, we use momentum conservation:

$mv_1 + Mv_2 = mv_1' + Mv_2'$;

$(2.20 \text{ kg})(8.40 \text{ m/s}) + (7.00 \text{ kg})(0) = (2.20 \text{ kg})v_1' + (7.00 \text{ kg})v_2'$.

Because the collision is elastic, the relative speed does not change:

$v_1 - v_2 = -(v_1' - v_2')$, or $8.40 \text{ m/s} - 0 = v_2' - v_1'$.

Combining these two equations, we get

$v_1' = -4.38 \text{ m/s}, \; v_2' = 4.02 \text{ m/s}$.

(b) We find the height of the rebound from

$v_1'^2 = 2gh'$;

$(-4.38 \text{ m/s})^2 = 2(9.80 \text{ m/s}^2)h'$, which gives $h' = 0.979$ m.

The distance along the incline is

$d = h'/\sin\theta = (0.979 \text{ m})/\sin 30° =$ 1.96 m.

75. Because energy is conserved for the motion up and down the incline, mass m will return to the level with the speed $-v_1'$. For a second collision to occur, mass m must be moving faster than mass M: $-v_1' \geq v_2'$.

In the first collision, the relative speed does not change:

$v_1 - 0 = -(v_1' - v_2')$, or $-v_1' = v_1 - v_2'$,

so the condition becomes $v_1 - v_2' \geq v_2'$, or $v_1 \geq 2v_2'$.

For the first collision, we use momentum conservation:

$mv_1 + 0 = mv_1' + Mv_2'$, or $v_1 - v_1' = (M/m)v_2'$.

When we use the two versions of the condition, we get $v_1 - v_1' \geq 3v_2'$, so we need

$(M/m) \geq 3$, or $m \leq M/3$.