7–5)

Break this problem up into three sections. A different approach is best for each.

1 - Swinging down

We can use conservation of mechanical energy, since $W_{NC} = 0$ (the tension is always perpendicular to the motion)

$0 = K_f - K_i + U_{Gf} - U_{Gi}$

The swinger starts from rest, so $v_{1i} = 0$ and ends up at the floor, where we can set y = 0. We're looking for v_m, the speed at which he hits the target.

$0 + = {}^1/_2 m_1 v_{1m}^2 - g m_1 y_i$

$g y_i = {}^1/_2 v_{1m}^2$

$v_{1m} = [2 g y_i]^{1/2} = [2*9.8*5]^{1/2} =$ 9.9 m/s

NOTE: We don't want to use the impulse-momentum picture, since there are two external forces (tension and weight), and calculating the impulse from each (in two dimensions, yet), while not impossible, would be difficult.

2 – Collision

Here, conservation of momentum is a good choice, provided that the collision occurs over a fairly short period of time. This last is important, since conservation of p requires there to be no forces external to the system, yet we might conclude that friction acts on the persons during the collision; if the time interval is small, then we might ignore the external impulse and still get a reasonably accurate result. Vertical external forces cancel, but are of no interest to us anyway.

$m_1 v_{1m} + m_2 v_{2m} = (m_1 + m_2) v_{mm}$

The target is initially at rest, and the collision is totally inelastic, so they share a common 'final' velocity.

$m_1 v_{1m} + 0 = (m_1 + m_2) v_{mm}$

$v_{mm} = m_1 v_{1m} /(m_1 + m_2) = 80*9.9/(80 + 70) =$ 5.28 m/s

NOTE: We don't want to use Work-Energy Thm here, because we have no idea about the forces that each person exerts on the other, nor about the displacements over which those forces act (they will not be the same!).

3 – Sliding

Here, we'll use NII and a kinematic equation, although WE thm would be just as OK. Let to the right be positive x and up be positive y.

x: $-F_{fK} = m_{TOTAL}\, a_x$

y: $+F_N - gm_{TOTAL} = m_{TOTAL}\, a_y = 0$

$F_{fK} = \mu_K F_N$

So, $a_x = -F_{fK}.m_{TOTAL} = -\mu_K F_N/m_{TOTAL} = -\mu_K g = -0.25*10 = -2.5$ m/s^2

Try K Eq 4:

$v_f^2 = v_{mm}^2 + 2a_x\Delta x$

Since they come to rest, $v_f = 0$.

$0 = v_{mm}^2 + 2a_x\Delta x$

$\Delta x = -\ v_{mm}^2/2a_x = -\ 5.28^2/(2*(-2.5)) =$ 5.69 m