Serway problem 9-28: A 7.00 g bullet, when fired from a gun into a 1.00 kg block of wood held in a vise, would penetrate the block to a depth of 8.00 cm. This block of wood is placed on a frictionless horizontal surface, and a 7.00 g bullet is fired from the gun into the block. To what depth will the bullet penetrate the block in this case?

Let mass of bullet = m, mass of block = M, initial velocity of bullet = \( v_i \). The solution manual assumes that the resistive force \( F \) exerted by the block on the bullet is the same in both cases. **I'm not convinced this is a valid assumption.** But if we do make the assumption that \( F \) is unchanged, then

1. Apply conservation of energy to bullet + block in vise:

   \[
   W_{\text{nonconserv.}} = \Delta K + \Delta U
   \]

   \[
   -F \cdot (8 \text{ cm}) = \Delta K + \Delta U
   \]

   \[
   -F \cdot (8 \text{ cm}) = 0 - \frac{mv_i^2}{2}
   \]

2. Apply conservation of energy to bullet + block on frictionless surface:

   \[
   W_{\text{nonconserv.}} = \Delta K + \Delta U
   \]

   \[
   -F \cdot d = \Delta K + \Delta U
   \]

   \[
   -F \cdot d = \frac{mv_f^2}{2} - \frac{mv_i^2}{2} + \frac{Mv_f^2}{2} - 0
   \]

3. Apply conservation of momentum to bullet + block on frictionless surface:

   \[
   \Delta p = 0
   \]

   \[
   mv_f - mv_i + Mv_f - 0 = 0
   \]

This gives us only 3 equations in the 4 unknowns \( v_i, v_f, F, \) and \( d \), but it turns out that this system of equations can be solved for \( d \). We could also solve the problem using the kinematic equation/conservation of momentum approach that we tried in class -- we would need to assume that the bullet's acceleration was equal in the two situations (equivalent to assuming that the resistive force on the bullet was the same).