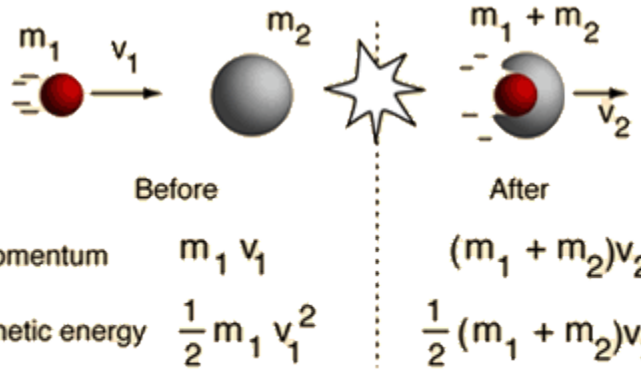
AP Physics 1

Inelastic Collisions: Perfectly elastic collisions are those in which no kinetic energy is lost in the collision. Macroscopic collisions are generally inelastic and do not conserve kinetic energy, though of course the total energy is conserved as required by the general principle of conservation of energy. The extreme inelastic collision is one in which the colliding objects stick together after the collision, and this case may be analyzed in general terms:

Conservation of Momentum: Total Momentum *before* and *after* an Inelastic Collision is Conserved.

Scenario 1: One Object in Motion/One Object at Rest



	Before	After
Momentum	$m_1 v_1$	$(m_1 + m_2)v_2$
Kinetic energy	$\frac{1}{2} m_1 v_1^2$	$\frac{1}{2}(m_1 + m_2)v_2^2$

From conservation of momentum:

$$m_1 v_1 = (m_1 + m_2)v_2 \Rightarrow v_2 = \frac{m_1}{m_1 + m_2} v_1$$

Ratio of kinetic energies before and after collision:

$$\frac{KE_f}{KE_i} = \frac{m_1}{m_1 + m_2}$$

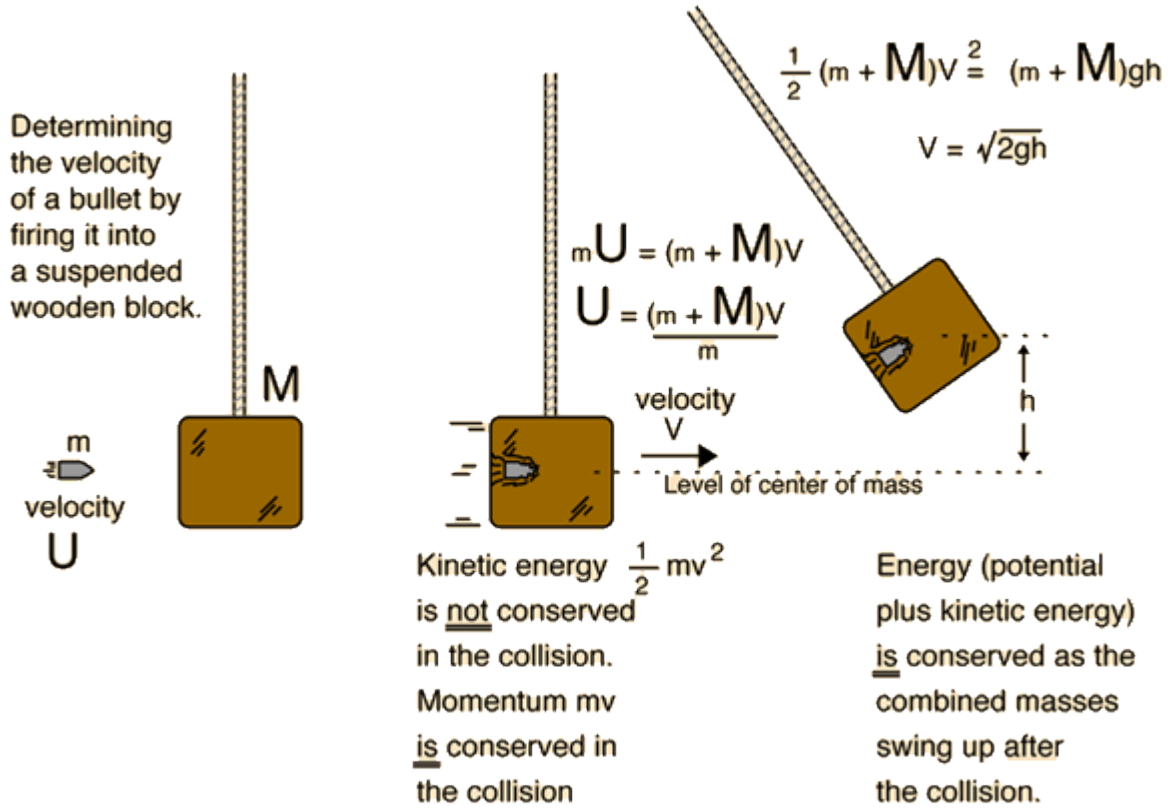
Fraction of kinetic energy lost in the collision:

$$\frac{KE_i - KE_f}{KE_i} = \frac{m_2}{m_1 + m_2}$$

Example 1:

A 10 kg mass is moving East at 5 m/s when it strikes a 5 kg mass at rest. What will the resultant velocity of both masses after the collision?

Scenario 2: Ballistic Pendulum

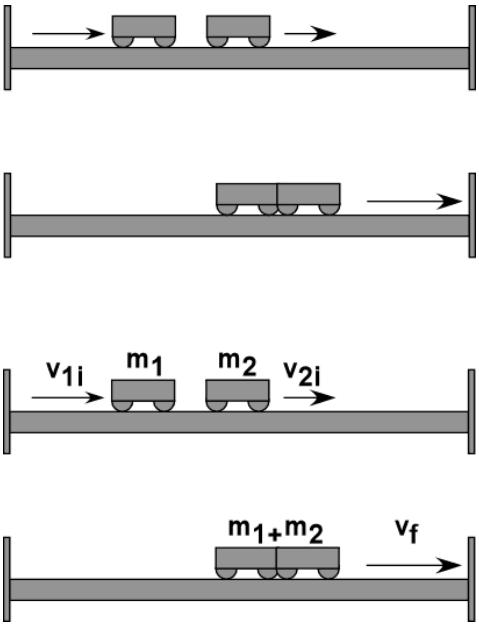


Example 2:

A bullet of mass 0.2 kg is moving horizontally at 105 m/s when it strikes a 5 kg mass connected to a string (acting as a pendulum(, assume the mass was at rest. How high will the bullet/mass system swing?

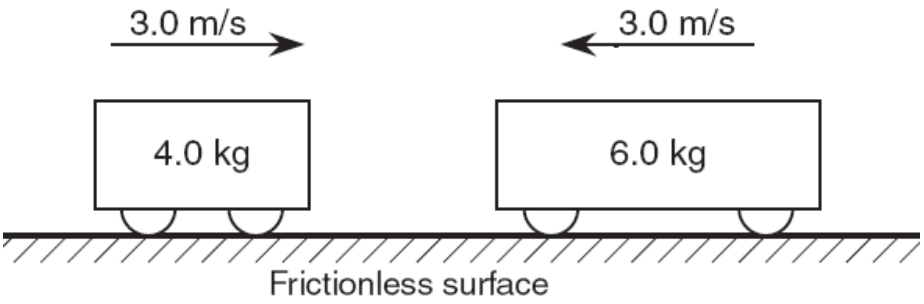
Scenario 3: Two Objects in Motion

A)



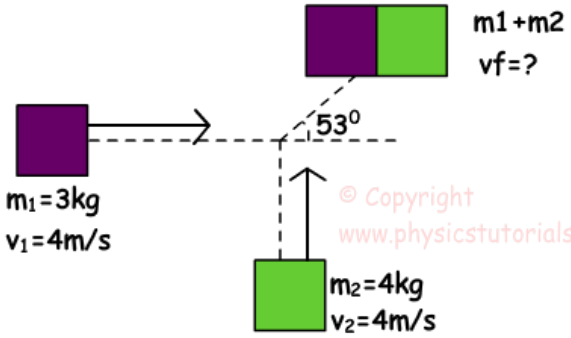
A 10 kg mass is moving horizontally to the right with a velocity of 2 m/s when it strikes a 20 kg mass moving horizontally to the right with a velocity of 1 m/s. What is the final velocity of the cart system if the collision is perfectly inelastic?

B)



Solve for the final velocity of the system, assume the collision is perfectly inelastic.

Two Dimensions:

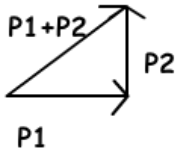


From conservation of momentum law;

$P_{initial}=P_{final}$

P1+P2=Pf

P1=m1.v1=3kg.4m/s=12kg.m/s → P2=m2.v2=4kg.4m/s=16kg.m/s ↑



$(P_1+P_2)^2=P_1^2+P_2^2$

$(P_1+P_2)^2=12^2+16^2$

$P_1+P_2=20kg.m/s$

$P_1+P_2=P_{final}$

$20kg.m/s=(m_1+m_2).V_{final}$

$20kg.m/s=(3kg+4kg).V_{final}$

$V_{final}=\frac{20m}{7}/s$