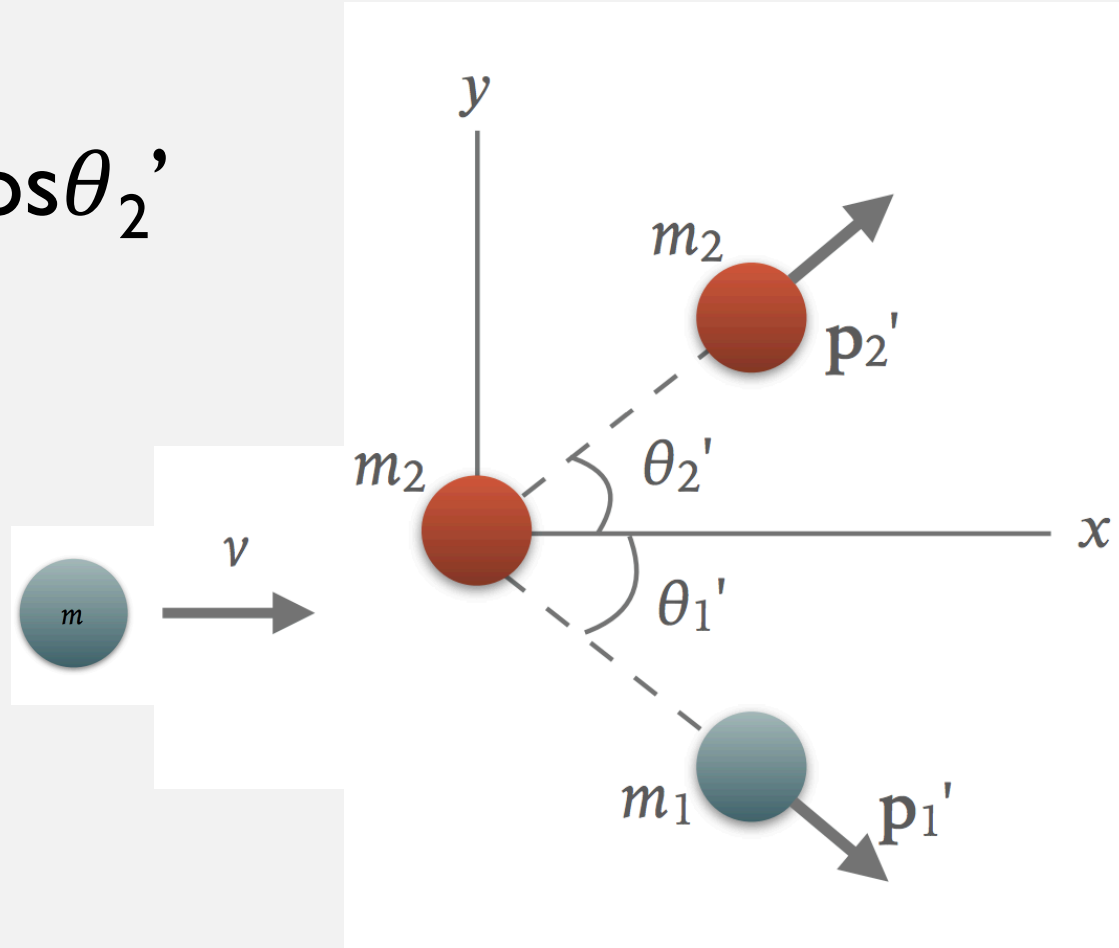
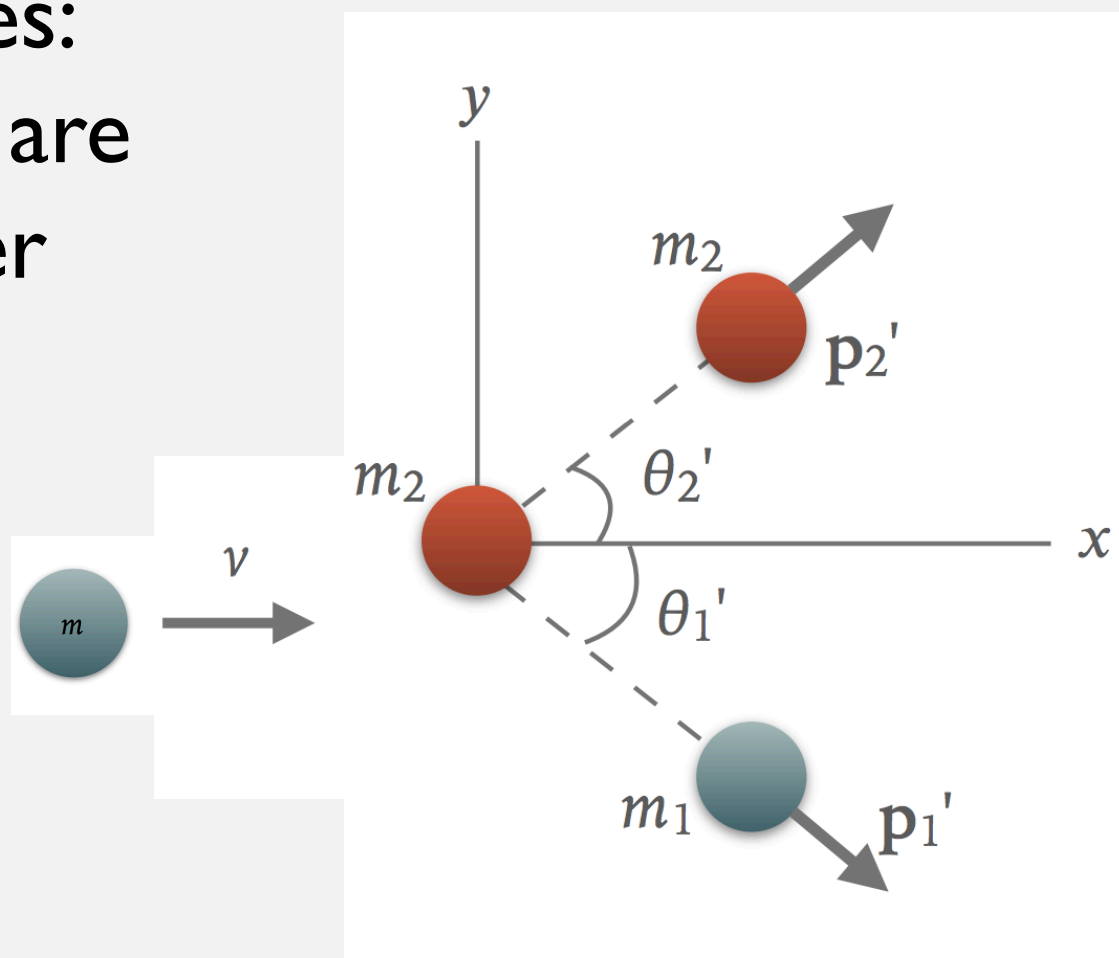
2D OR 3D COLLISIONS

- Vector nature of momentum is important
- Each component of the momentum is conserved
- $P_{1x} + P_{2x} = P_{1x}' + P_{2x}'$
  - $m_1v_1 = m_1v_1'\cos\theta_1' + m_2v_2'\cos\theta_2'$
- $P_{1y} + P_{2y} = P_{1y}' + P_{2y}'$
  - $0 = m_1v_1'\sin\theta_1' + m_2v_2'\sin\theta_2'$



2D OR 3D COLLISIONS

- A billiard ball moving with speed v_1 = 3.0 m/s in the +x direction strikes an equal-mass ball initially at rest
- The balls move off at 45 degrees: m_2 above and m_1 below. What are the speeds of the two balls after the collision?
- Both 2.1 m/s



SYSTEMS

- Why would it be stupid to shoot a rifle with a loose arm instead of resting the butt of the rifle against your shoulder?
- Loose arm: system = arm + rifle, shoulder: system = whole body + rifle

INELASTIC COLLISIONS AND EXPLOSIONS

- **Inelastic collisions** – KE is **not** conserved
- $KE_f < KE_i$
- Explosions are just inelastic collisions in reverse
  - PE → KE

INELASTIC COLLISIONS

- If two objects stick together after the collision, it is perfectly inelastic
  - I.e. Football tackle
  - 2 balls of putty colliding

Note: even though KE is not conserved, ***total energy*** *is always conserved, as is* ***total vector momentum***

CONSERVATION OF MOMENTUM IN INELASTIC COLLISIONS

- $m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$
- If they stick together, $v_1' = v_2'$
- $m_1v_1 + m_2v_2 = (m_1 + m_2)v'$

INELASTIC COLLISIONS

$$m_1v_1 + m_2v_2 = (m_1 + m_2)v'$$

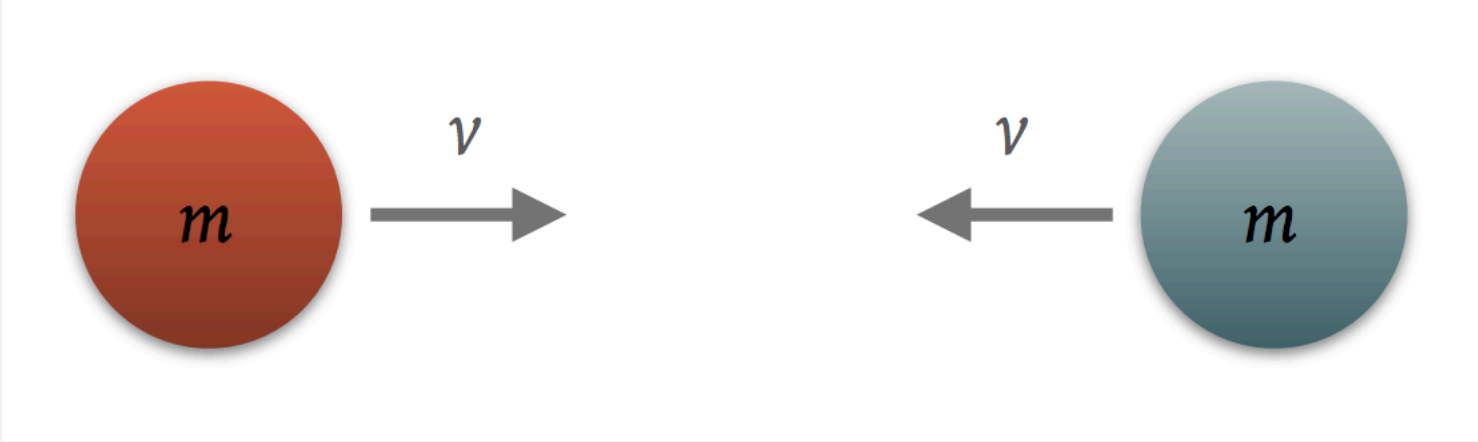
- A 155 kg football player running at 6.00 m/s tackles his 103 kg opponent (initially at rest) in a perfectly inelastic collision.
- How fast do they move after they collide?
  - 3.60 m/s

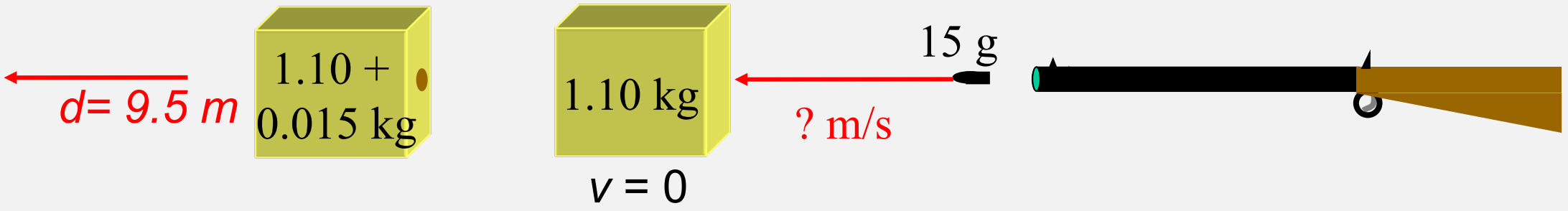
How much of the initial KE is transformed into thermal or other forms of energy?

- -1.12 kJ

ELASTIC VS. INELASTIC COLLISIONS

- 2 spheres, both with mass *m* and speed *v*, collide head-on. What are the velocities after the collision assuming the collision is a) perfectly elastic and b) perfectly inelastic?
  - A) $v_1' = -v, v_2' = +v$
  - B) $v' = 0$





A 15-g bullet strikes and becomes embedded in a 1.10 kg block of wood placed on a horizontal surface just in front of the gun.

If the coefficient of kinetic friction between the block and the surface is 0.25, and the impact drives the block a distance of 9.5 m before it comes to rest, what was the muzzle speed of the bullet?

510 m/s