Physics 105 Class 10

MOMENTUM

Collisions

Newton's third law says the forces in the collision are

_____

Draw the forces.

$\Delta v_1 = a_1 t$ $\Delta v_2 = a_2 t$

$m_1 \Delta v_1 =$ $m_2 \Delta v_2 =$

$m_1 \Delta v_1 + m_2 \Delta v_2 =$

If we define $p = mv$, then $\Delta p_{total} =$

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Total momentum is conserved in any collision!

Momentum and collisions
We don't worry about *details* of forces, just relatively **sudden** changes in velocities:

If collision is sudden enough, we can ignore external forces during collision

Elastic collisions

Inelastic

Perfectly inelastic

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Strategies for momentum problems

1-D problems

1. Draw initial and final pictures separately

2. Choose a positive direction for velocities

3. Show all velocity vectors and masses; label with velocity **magnitudes** only

4. Use $p_{total,initial} = p_{total,final}$ first and see if it gives you enough information to solve for the unknowns. Make the **sign** of v's used match their **direction**.

5. If it's truly "elastic", you can also use $KE_{total,initial} = KE_{total,final}$ (or use concept that *relative* velocities are *reversed*)

2-D problems

1. Draw a sketch of the motion before and after, including m's and v's.

2. Draw vector diagrams representing vectors of total momentum $\mathbf{p}_i$ and $\mathbf{p}_f$

3. Use $\mathbf{p}_i = \mathbf{p}_f$ or $p_{xi} = p_{xf}$ and $p_{yi} = p_{yf}$

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1-D Example

A 100 kg defensive end running north at 4 m/s tackles a 75 kg quarterback running south at 7 m/s.

a) What is their velocity right after the tackle?

b) How much kinetic energy was gained or lost in the collision?

2-D Example

A 100 kg defensive end running *north* at 4 m/s tackles a 75 kg quarterback running *east* at 7 m/s. What is their velocity right after the tackle?

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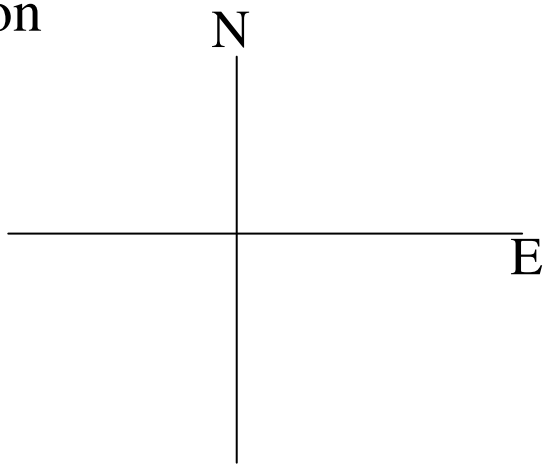
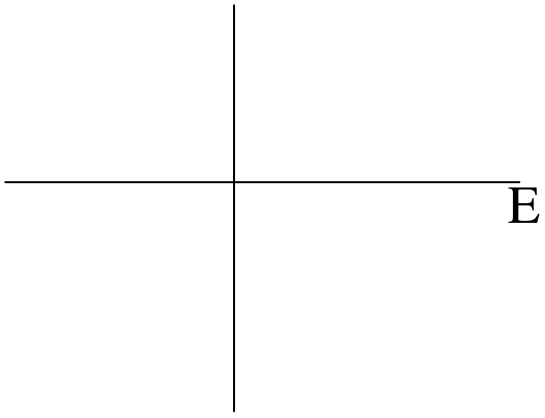
An artillery shell of mass 20 kg moves east at 100 m/s. It explodes into two pieces. After, one piece of mass 12 kg is then seen moving north at 50 m/s.

P1. Draw a vector that show the momentum of the shell before the collision



P2. Draw the vector representing $\mathbf{p}_{total}$ after the explosion using conservation of total momentum. Draw (to scale) the vector representing the final **p** of the 12 kg piece. From these two, draw the **p** vector of the second piece

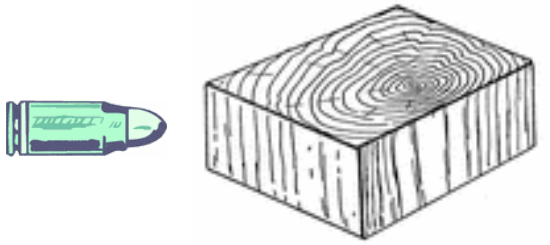


Problems that involve p and E conservation at *different times*

1. Collision part: p is conserved but KE usually is not.

2. Motion part: Use Cons. of Energy.

A bullet of mass m and speed v embeds in a block of wood of mass M at rest on the floor. If the frictional force on the block is f, how far does the block slide?



A girl of mass m hangs on a rope. A boy of mass M runs at speed v horizontally and jumps on the rope, too. How high do they swing off the ground?

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HOMEWORK HINTS: