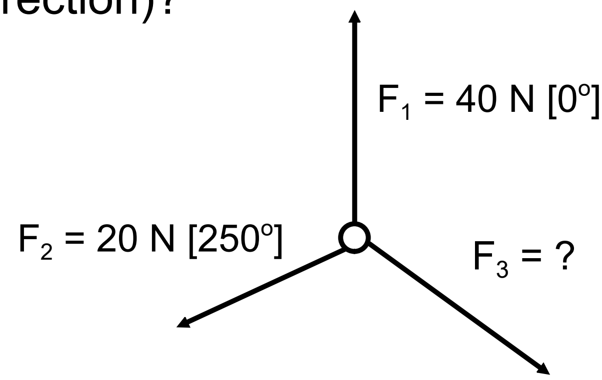
Sec. 5.4 - Collisions in Two Dimensions

Learning Goal: By the end of today I will be able to solve collision problems in two dimensions using a component approach.

Rewind

If the following metal hoop has three forces acting on it, but has an Fnet of Zero, how can we determine the missing force (mag. and direction)?



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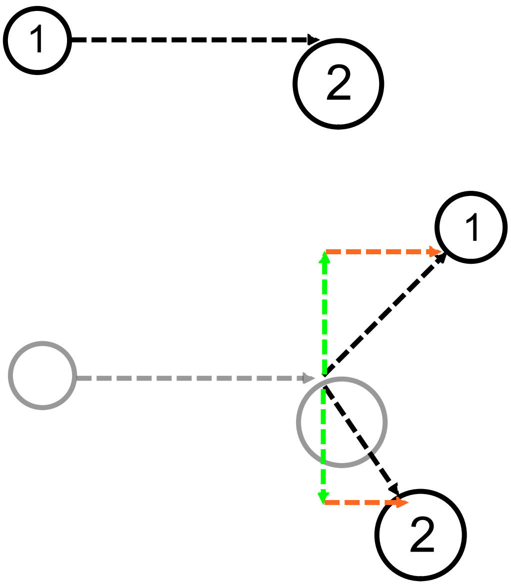
Solving 2 Dim Collision Problems

- conservation of momentum must apply (Fnet = 0)
- we can use components typically in the x and y direction

Example - Warmup



- ball 1 has only horizontal momentum
- ball 2 is stationary

Y direction

$p_{1i} + p_{2i} = p_{1f} + p_{2f}$

$0 = p_{1f} + p_{2f}$

$0 = m_1v_{1f} + m_2v_{2f}$

X direction

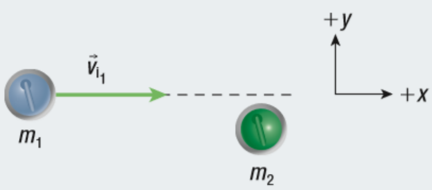
$p_{1i} + p_{2i} = p_{1f} + p_{2f}$

$p_{1i} + 0 = p_{1f} + p_{2f}$

$m_1v_{1i} = m_1v_{1f} + m_2v_{2f}$

In a game of curling, a collision occurs between two stones of equal mass. The object stone is initially at rest. After the collision, the stone that is thrown has a speed of 0.56 m/s in some direction, represented by θ in **Figure 3.** The object stone acquires a velocity $\vec{v}_{f_2} = 0.42$ m/s at an angle of $\phi = 30.0°$ from the original direction of motion of the thrown stone. Determine the initial velocity of the thrown stone.

before the collision



(a)

X direction

$p_{1i} + p_{2i} = p_{1f} + p_{2f}$

$m_1v_{1i} + 0 = m_1v_{1f} + m_2v_{2f}$

Y direction

$p_{1i} + p_{2i} = p_{1f} + p_{2f}$

$0 = m_1v_{1f} + m_2v_{2f}$

Two cross-country skiers are skiing to a crossing of horizontal trails in the woods as shown in **Figure 4**. Skier 1 is travelling east and has a mass of 84 kg. Skier 2 is travelling north and has a mass of 72 kg. Both skiers are travelling with an initial speed of 5.1 m/s. One of the skiers forgets to look, resulting in a right-angle collision with the skis locked together after the collision. Calculate the final velocity of the two skiers.

"sticky" collision

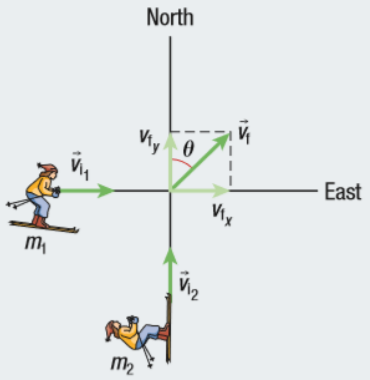


Figure 4

SUMMARY Conservation of Momentum in Two Dimensions

- Collisions in two dimensions are analyzed using the same principles as collisions in one dimension: conservation of momentum for all collisions for which the net force on the system is zero, and both conservation of momentum and conservation of kinetic energy if the collision is elastic.

Homework

Read 254 - 259 (example 1 is difficult to follow)

page 257 #3, 4, 5 (if you are brave)

page 258 #2, 4

Alternate text reading - see website

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