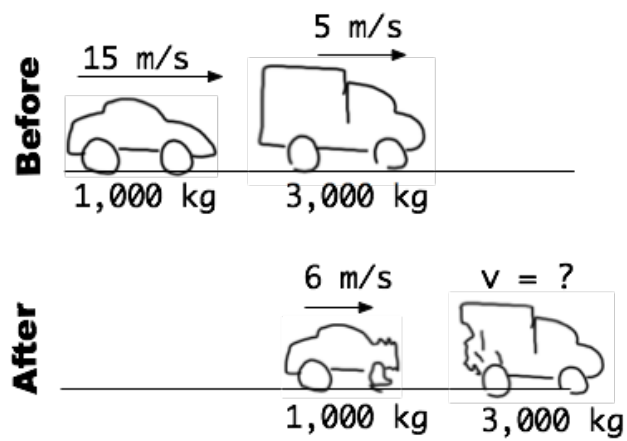


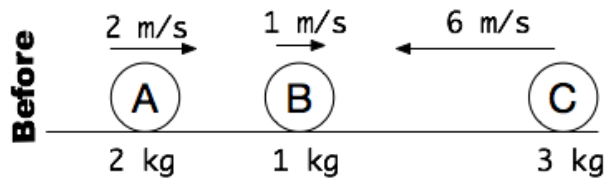
**In any system of objects where
there are only internal forces...**

Momentum is Conserved.

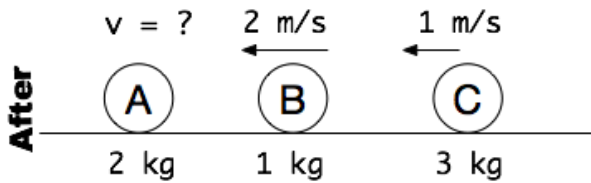
$$\underset{\text{(total)}}{p_i} = \underset{\text{(total)}}{p_f}$$

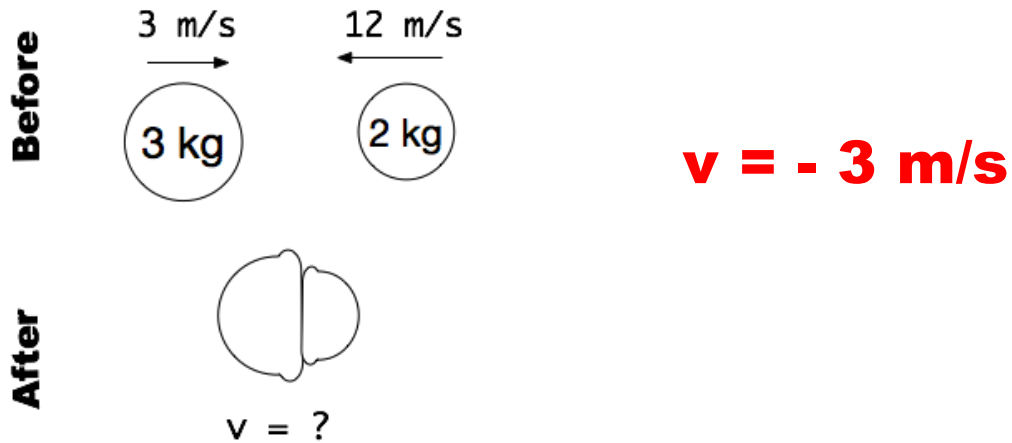


$$v = 8 \text{ m/s}$$

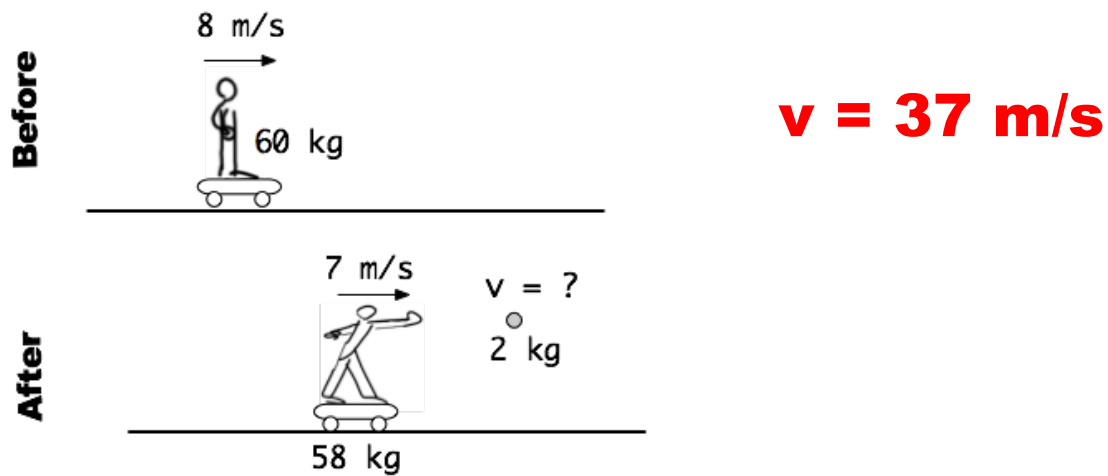


$$v = -4 \text{ m/s}$$





$$(3)(3) + (2)(-12) = (5)(v)$$



$$(60)(8) = (58)(7) + (2)v$$

Kinetic Energy

$$\mathbf{K} = \frac{\mathbf{mv}^2}{2}$$

Predicts

How hard it is to stop.

Stopping distance.

Damage it can do.

Speed at the bottom of a hill

Momentum

$$\mathbf{p} = \mathbf{mv}$$

Predicts

How things move after a collision.

(Direction & Speed)

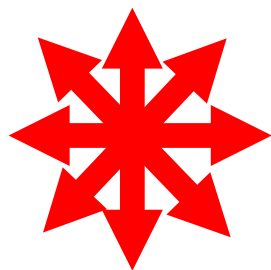
LAW OF CONSERVATION OF MOMENTUM

**If no outside forces act,
momentum is conserved.**

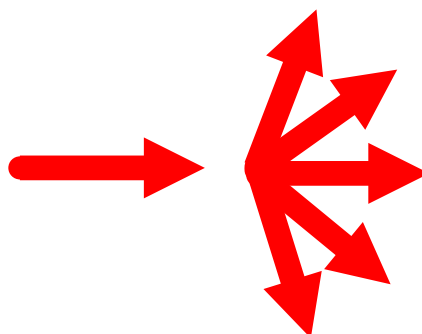
**Total momentum is not changed
by explosions, collisions or any
other situation where objects in
a system push on each other.**

Explosion & Splatter Patterns

If it starts with
NO momentum



If it starts with
SOME momentum





The diagram illustrates a collision between two vehicles. A 2,000 kg vehicle moves horizontally to the right at 10 m/s. A 1,000 kg vehicle moves vertically upwards at 12 m/s. They collide at an intersection. After the collision, the combined wreck can move in several directions, indicated by arrows at 0°, 30°, 45°, 60°, and 90° relative to the horizontal. Handwritten red annotations include: $20,000 \text{ kg m/s}$ (circled around the 2,000 kg vehicle), $12,000 \text{ kg m/s}$ (circled around the 1,000 kg vehicle), and a vector triangle with sides 20,000 and 12,000, and a hypotenuse of 22,000.

2,000 kg
10 m/s

1,000 kg
12 m/s

90°
60°
45°
30°
0°

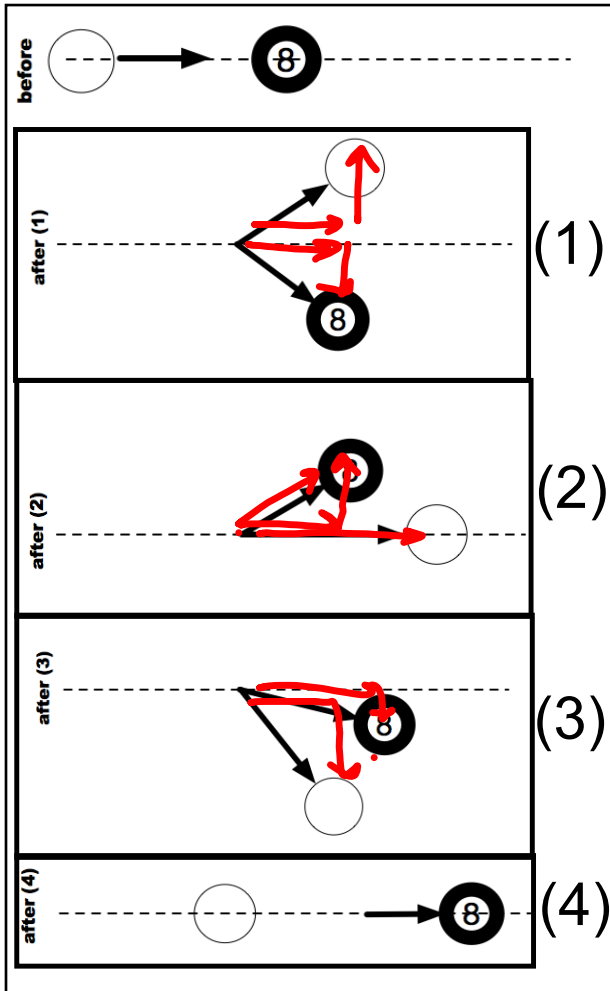
The two vehicles collide and move together after the collision.

Which angled path is the most likely direction of movement after the collision for the combined wreck? **30°**

$20,000 \text{ kg m/s}$

$12,000 \text{ kg m/s}$

20,000
12,000
22,000



The cue ball and the 8-ball
have nearly the same mass

The cue ball (white) is
hit at the 8-ball (black)
as shown. Of the four
after-situations...

Which are possible?

**Ones with no momentum in the y-
direction.**

Which are impossible?

**Ones with momentum in the y-
direction.**

Almost completely elastic collision; same mass.

