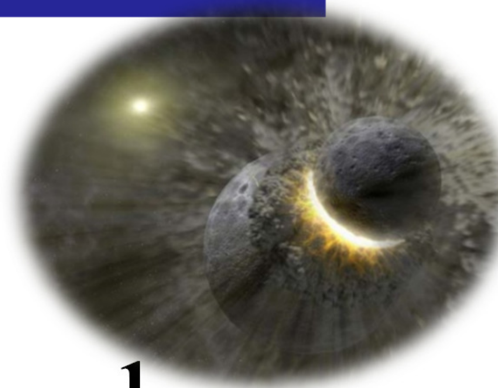
Main Ideas in Class Today



You should be able to:

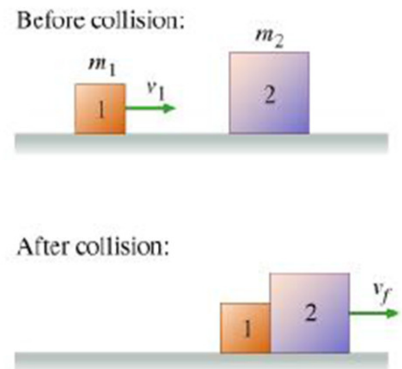
- Distinguish between Elastic and Inelastic Collisions

- Solve Collisions in 1 & 2 Dimensions

Practice: 6.31, 6.33, 6.35, 6.43, 6.45, 6.47, 6.49, 6.51, 6.53, 6.63, 6.65, 6.67

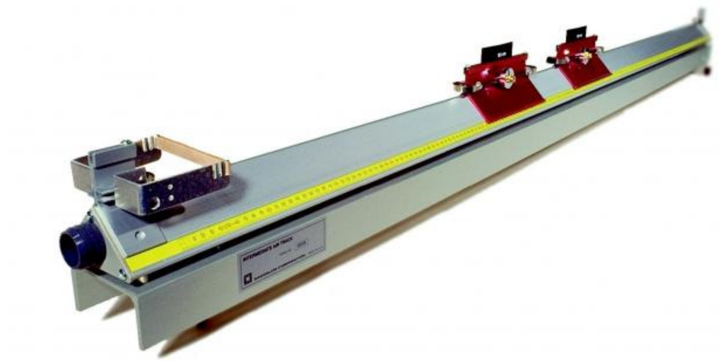
Elastic and Inelastic Collisions

- Inelastic collisions: mechanical energy (KE+PE) is **not** conserved $W_{NC} = \Delta PE + \Delta KE$

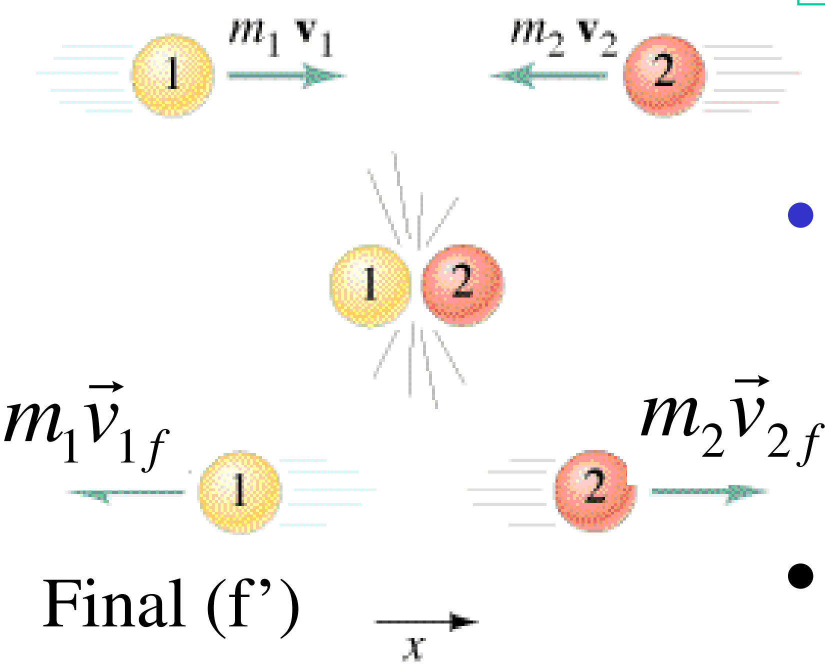


  - Initial mechanical energy $\neq$ mechanical energy after collision
  - Energy lost in the form of heat (dissipative forces)
- Special case: **Perfectly inelastic**, objects stick
- Elastic collisions: mechanical energy **is** conserved
- In all real cases, some energy is lost to heat. In many cases (eg billiard balls), however, this amount is so small that it makes more sense to ignore this loss.

Elastic and Inelastic Collisions



For both elastic and inelastic collisions linear <u>momentum is conserved</u> (unlike energy)



$$m_1\vec{v}_{1i} + m_2\vec{v}_{2i} = m_1\vec{v}_{1f} + m_2\vec{v}_{2f}$$

- Only for elastic collisions, mechanical energy (KE+PE) of **the system** is also conserved.
- $\Delta y=0$, then $PE_i = PE_f$ and

$$KE_{o1} + KE_{o2} = KE_{1f} + KE_{2f}$$

Book derives (does not depend on mass!)

$$(\vec{v}_1 - \vec{v}_2)_{initial} = -(\vec{v}_1 - \vec{v}_2)_{final}$$

These v's are vectors, so can break into x and y components

A compact car and a large truck collide head on and stick together. Which vehicle undergoes the larger magnitude of acceleration during the collision?

A. car
B. truck
C. Both experience the same acceleration.
D. Can't tell without knowing the initial and final velocities.

Suppose that a 2000.0-kg car, initially at rest, is struck head on by a 36,000.0-kg semitruck moving at 20.0 m/s. **Determine the velocity of each of the vehicles after the collision, assuming that the collision is elastic**.

(This is not a very good assumption because it would assume they bounce right off of each other instead of crushing the bumpers/car.)

Repeat the previous problem s
the cars stick together after the
(perfectly inelastic). (much mo

Assuming you had to pick one, which **car** would you rather be in?

(assume you want to minimize your injuries)

A) The car during the elastic collision

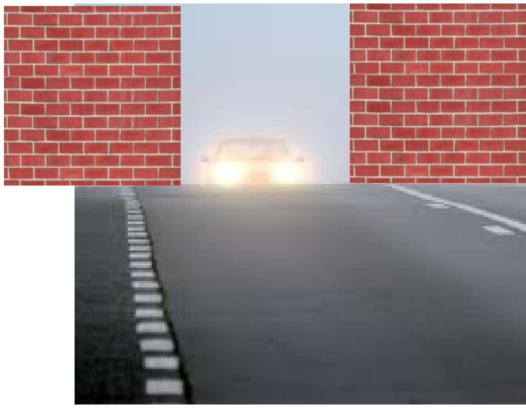
B) The car during the inelastic collision

C) Doesn’t matter, experience same force either way

How to Redesign The Body to Withstand a High Speed Car Crash

https://www.thesun.co.uk/news/1483631/graham-sculpture-shows-human-vulnerability-in-crashes-to-promote-road-safety/

Think fast! You've just driven around a curve in a narrow, one-way street when you notice **a car identical to yours** coming straight toward you at the same speed. You have **only 2 options**: hitting the other car head on or swerving into a sturdy concrete wall, also head on. What should you decide to do in order to minimize **your** injury (and impulse)? (Assume no time to stop)



A. hit the other car.
B. hit the wall.
C. hit either one—it makes no difference to you.
D. consult your lecture notes (not correct, fyi)

Let’s Experiment

A similar idea:

- Fist bump a friend or fist bump a flat surface
- In order to compare, bump at same speed

Why is this the case?

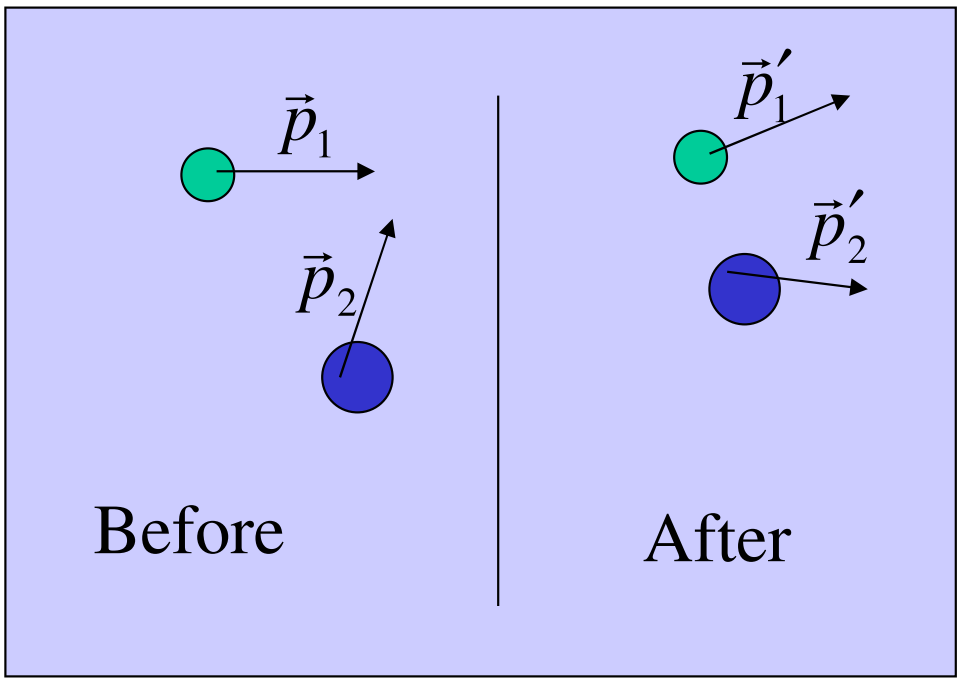
What if the car is going a different speed? Maybe at rest?
What if a truck (same speed)?

At your own risk

Collisions in Two Dimensions

- Linear momentum of an isolated system is always conserved
- In two dimensions, components of vectors are conserved

$$\vec{p}_{i,system} = \vec{p}_{f,system}$$



means

$$p_{1ox} + p_{2ox} = p_{1x}' + p_{2x}'$$

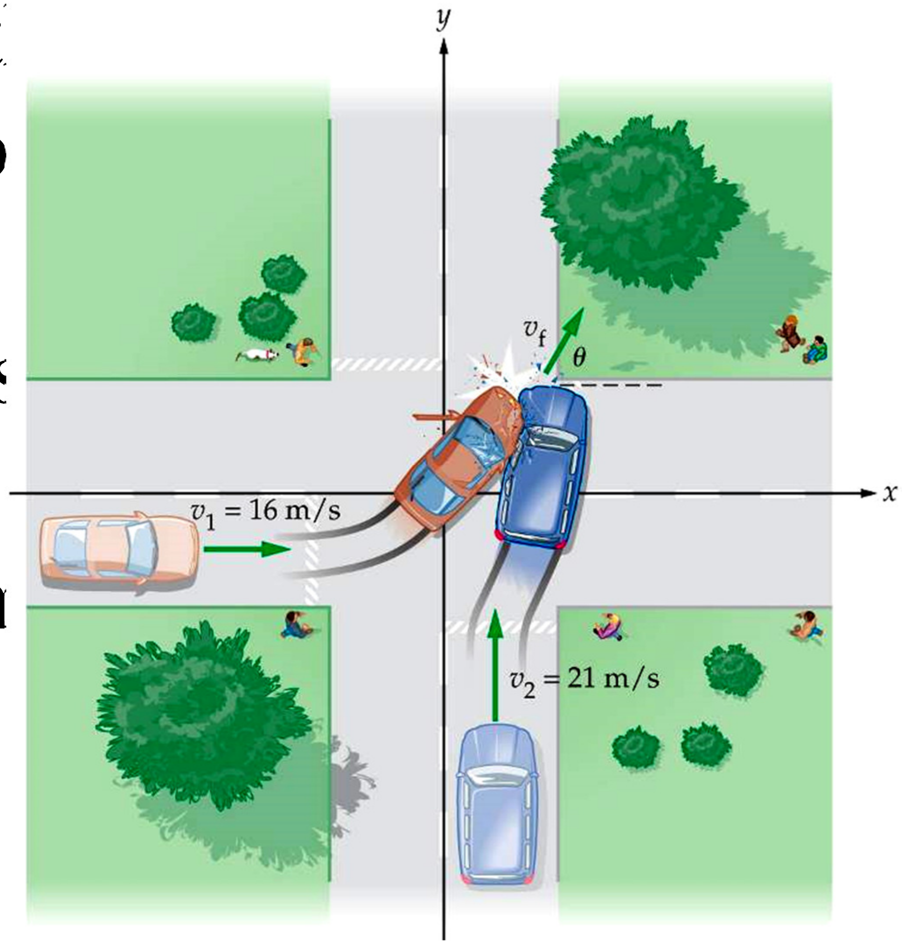
$$p_{1oy} + p_{2oy} = p_{1y}' + p_{2y}'$$

If collision is **elastic**, then we also have

$$(\vec{v}_1 - \vec{v}_2)_{initial} = -(\vec{v}_1 - \vec{v}_2)_{final}$$

Car Accident Example

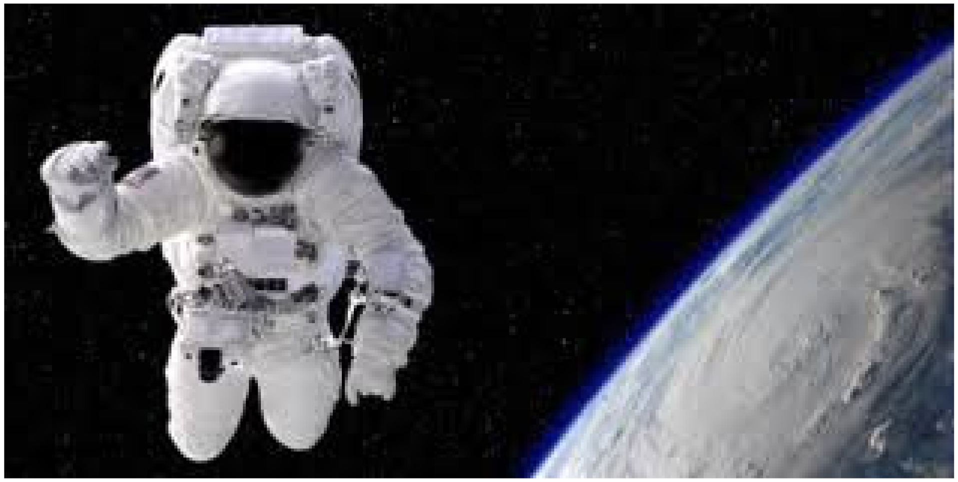
An eastward car strikes a nort
at an intersection, and the two
unit. A property owner on the
the intersection claims that his
down in the collision. Should
damages by the insurance con

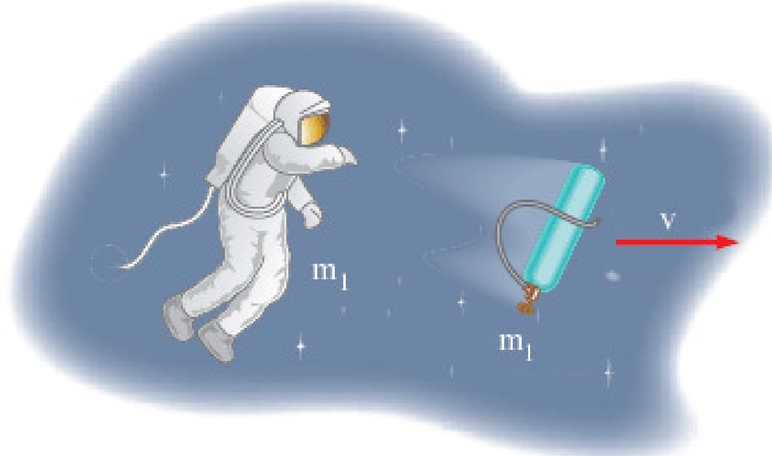


A. Yes, seems possible

B. No, it's impossible

Let the eastward car have a mass of 1250 kg and a speed of 16 m/s and the northward car a mass of 1100 kg and a speed of 21 m/s. Find the velocity after the collision.

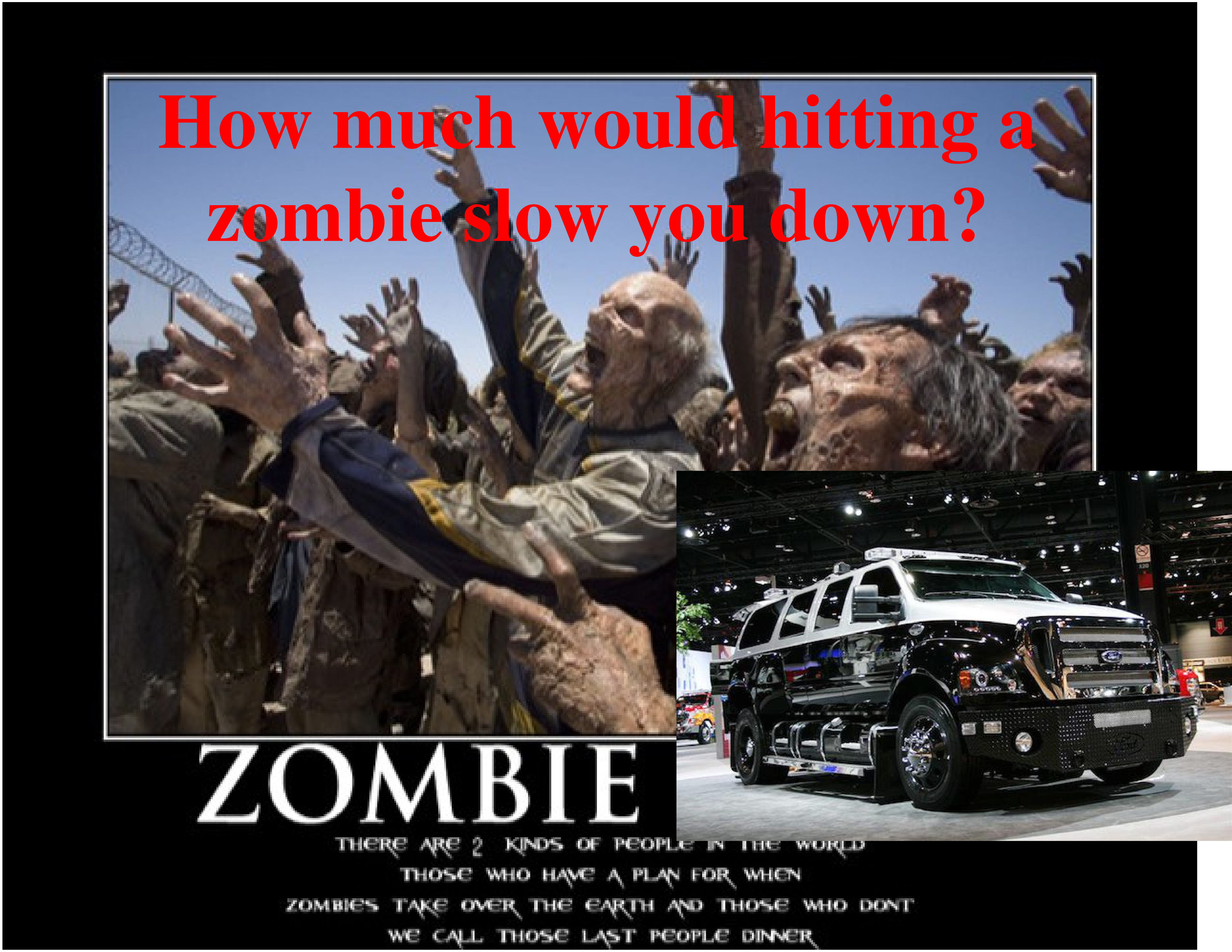




An astronaut in her space suit has a total mass of $m_1 = 87$ kg, including her oxygen tank. Her tether line loses its attachment to her spacecraft and she is too far to grab on! Initially at rest with respect to her spacecraft, she throws her oxygen tank of mass $m_2 = 12.0$-kg away from her spacecraft with a speed $v = 8.00$ m/s to propel herself back toward the spacecraft.

Determine the maximum distance she can be from the craft and still return within 2.00 min (the amount of time the air in her helmet remains breathable).

How much would hitting a zombie slow you down?



Block *A* has mass 1.00 kg and block *B* has mass 3.00 kg. The blocks collide and stick together on a level, frictionless surface. After the collision, the kinetic energy (KE) of block *A* is

A B

A. 1/9 the KE of block *B*.

B. 1/3 the KE of block *B*.

C. 3 times the KE of block *B*.

D. 9 times the KE of block *B*.

E. the same as the KE of block *B*.

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