Chapter 6

Momentum

Linear Momentum

- Momentum = p
- Momentum = mass x velocity
- p = mv
- Units are kilogram-meters per second (kg·m/s)

Momentum is the product of what?

- ○ Force and velocity
- ○ Mass and acceleration
- ○ Force and inertia
- ◉ Mass and velocity

- The faster you move, the more momentum you have and the more difficult it is to come to a stop.
- The more massive a ball is, the more force it will exert on another object because of the momentum.


An easy risk assessment
30MPH
TikTok

- Bowling ball versus soccer ball demo

Impulse

- A change in momentum takes force and time – Impulse-momentum theorem
- Force(time) = change in momentum
- $Ft = mv_f – mv_i$
- Ft is called impulse
- Units of impulse are Ns

- A 1000 g football is thrown with a velocity of 10 m/s to the right. A stationary receiver catches the ball and brings it to rest in .02 seconds. What is the force exerted on the ball by the receiver?

- Stopping time and distances depend on the impulse-momentum theorem.
- Highway safety engineers use the impulse-momentum theorem to determine stopping distances and safe following distances for cars and trucks.
- The impulse-momentum theorem is used to design safety equipment that reduces the forces exerted on a human body during collisions


@engineeringandarchitecture

- On a trampoline, jumpers are protected from injury because the rubber reduces the force of the collision by allowing it to take place over a longer period of time.

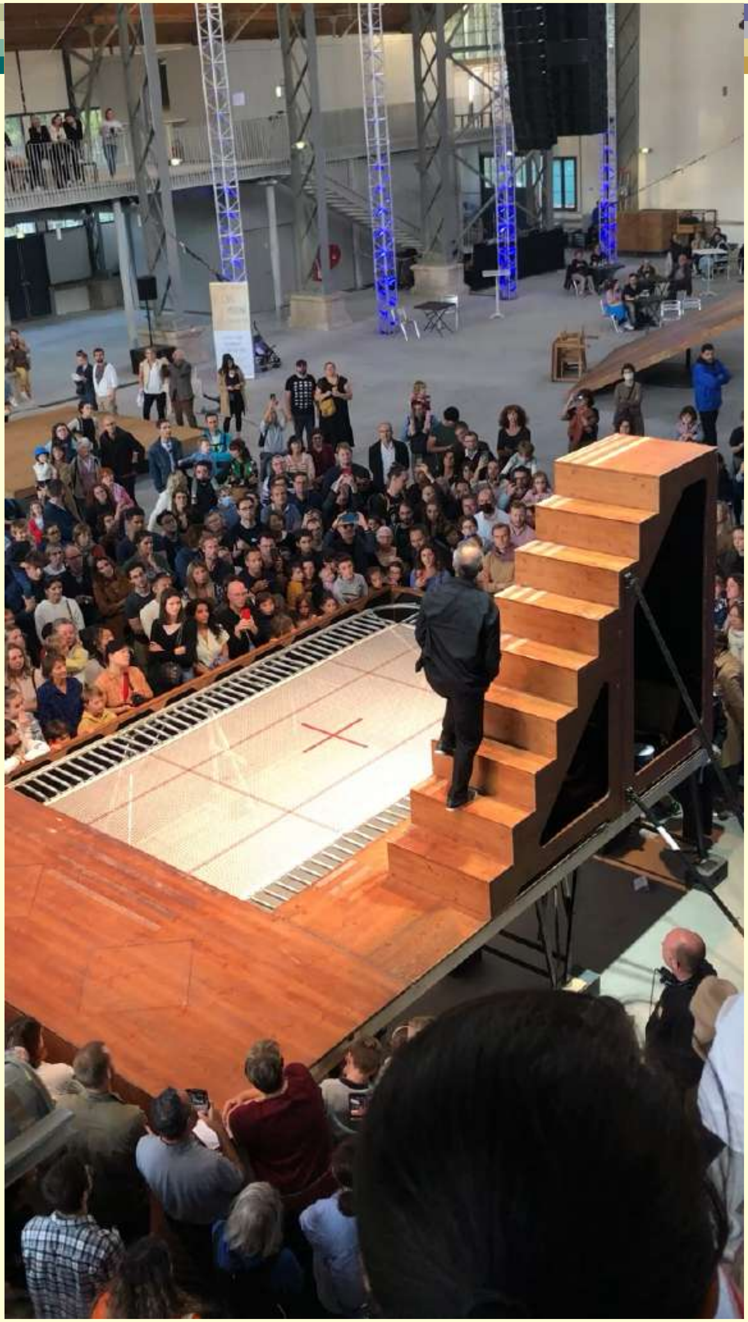
Egg Impulse


LIVE
ALT.
25000
23000
21000
19000
17000
15000
13000
11000
9000
7000
5000
3000
1000
0

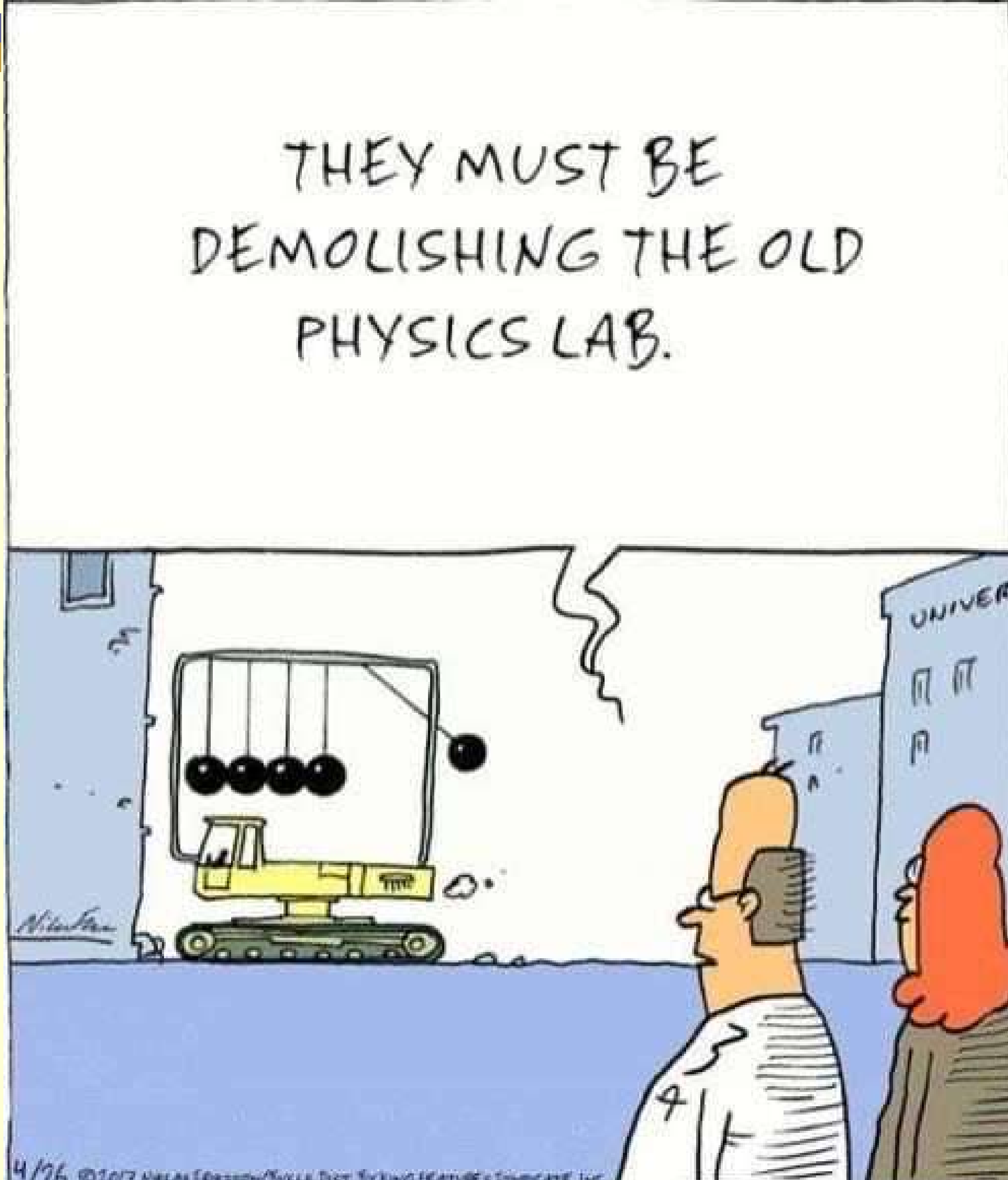

flipping physics
water
soil
wood

Conservation of Momentum

- When two or more objects collide, the total momentum of the two objects together remains the same.
- $M_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$
- The total momentum before = the total momentum after
- If initially both objects are at rest, then the initial momentum = 0



Newton’s Cradle


THEY MUST BE DEMOLISHING THE OLD PHYSICS LAB.
UNIVER

STEM Challenge Build a Newton's Cradle- featuring Newton's 3rd Law

Clackers

- A 50,000 g throws a 10 kg tank with a speed of 10 m/s. Assuming the astronaut starts from rest, find the astronaut’s final speed.


Wait for it 😱

Swinging Weight Demo


1° Lei de Newton

Collisions (Puck Demo)

- 2 major types of collisions:
- Perfectly inelastic collisions – when 2 objects collide and move together as one mass. (Some car accidents)
- Elastic collisions – 2 objects collide and return to their original shapes with no change in total kinetic energy. After the collisions, the objects move off separately. (Marbles and Pool/Billiards)

Happy Sad Balls Demo

Train Collisions

- A 1000 kg car traveling at 10 m/s collides with a 4000 kg truck that is initially at rest. The car and truck stick together and move together after the collision. What is the final velocity of the two vehicle mass?

Perfectly Inelastic Collisions

- $M_1v_{1i} + m_2v_{2i} = (m_1 + m_2)v_f$
- Kinetic energy is not constant in inelastic collisions.
- Some of the energy is converted to sound and heat (like in a car wreck).
- "Perfectly" inelastic collisions – no energy is lost due to sound and heat.

Elastic Collisions

- Momentum and kinetic energy remain constant in an elastic collision.
- $m_1 v_{1i} + m_2 v_{2i} = m_1 v_{1f} + m_2 v_{2f}$
- v is positive if the object moves to the right and negative if moves to the left.

- A .04 kg marble sliding to the right at 5 m/s makes an elastic collision with a .05 kg marble moving to the left at 2 m/s. After the collision, the first marble moves to the left at 1 m/s. Find the velocity of the second marble after the collision.