PHYS 211
Exam 2 Prep

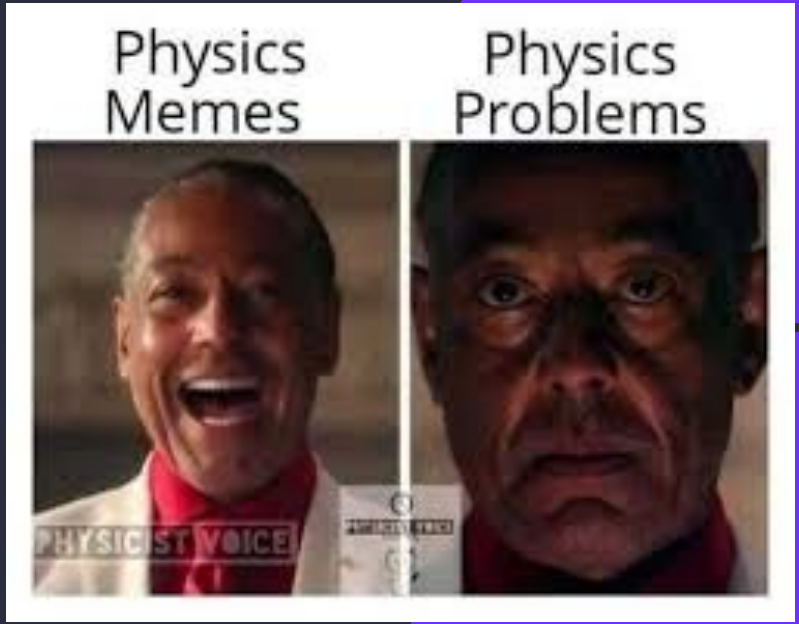
UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

SCAN ME

Center for Academic Resources in Engineering
CARE

1. Overview

Quick Bits of info to know



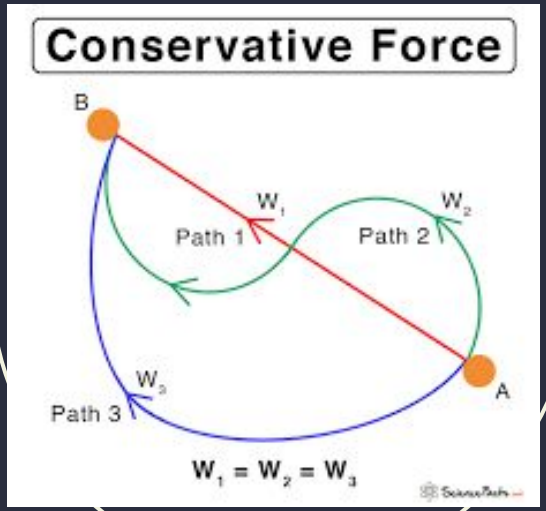
Forces

Conservative:

- Weight (gravity)
- Spring Force: $F = -k\,\Delta x$
- Potential Energy diff

Nonconservative:

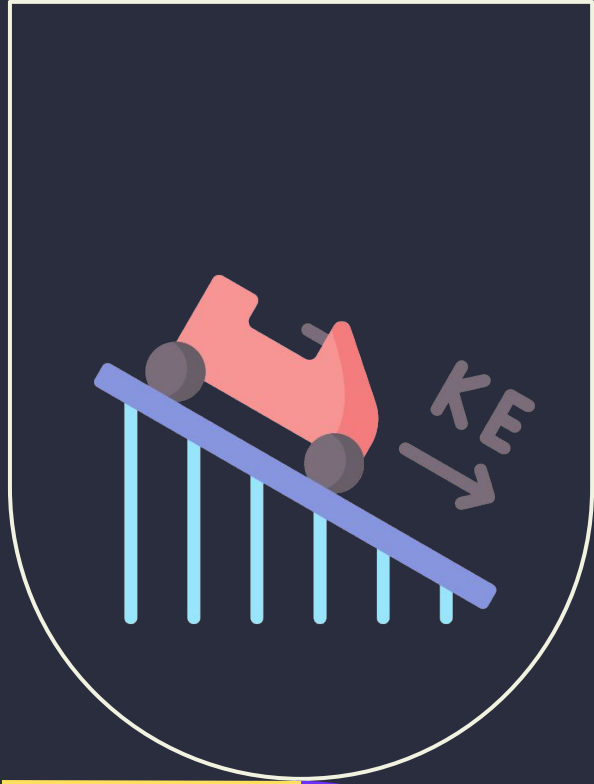
- Normal: Perpendicular to an object's surface by below surface
- Tension: points away from object
- Friction: $f = \mu N$



- Equal & Opposite Forces
- X and Y components still apply, especially for ramp problems

Work

- Work-Energy Theorem: The work done on a system by the sum of forces acting on it is equal to the change of kinetic energy of the system, $\Delta KE = W = 1/2mv_f^2 - 1/2mv_i^2$
- $W = F*d$
- $W = -\Delta PE$ (for work done in a conservative field, such as dropping a ball with no air resistance)



Work and Mechanical Energy

- For ΔE, you can choose whichever two points you want for the initial and final energy (E_f - E_i)
- Don't mix up potential energy equations with work equations.
  - i.e. $U_{spring} = (kx^2)/2$, but $W_{spring} = -k(x_f2 - x_i^2)/2$
- Work and Energy are intimately related, using the theorems and conservation laws will help a lot!
- Total mechanical energy: KE + PE = W_{NC}

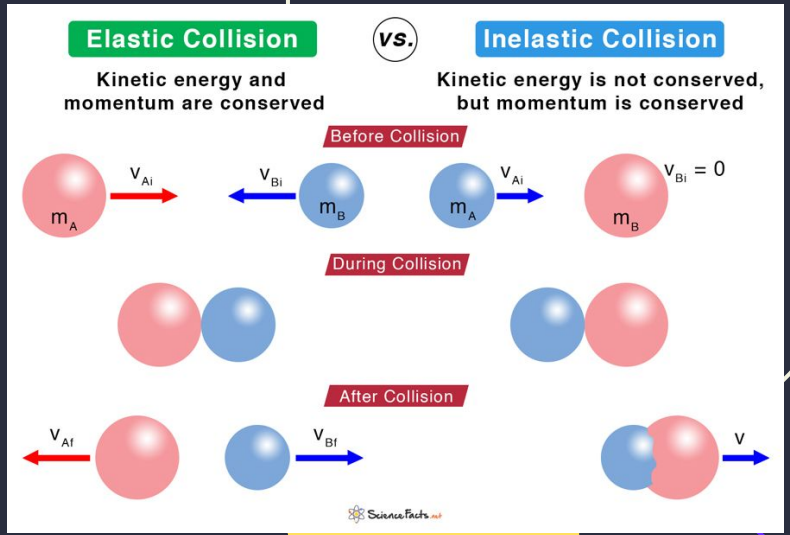
Momentum and Impulse

- $p = mv$
- $F_{net,\ external} = dp_{total}/dt$
  - When $F_{ext} = 0$, $dp/dt = 0$, momentum is conserved
- Is conserved in both the x and y direction
- Impulse: change in momentum
  - $I = F_{AVG}\Delta t = \Delta p$

$$F_{NET} = \Delta p$$

Momentum and Impulse

- Inelastic
  - KE is NOT conserved
  - Objects can stick together
- Elastic
  - Momentum + KE is conserved
  - Objects bounce apart



Center of Mass + Frames

- For a system of objects, we treat them as point masses
- More massive object has more influence on center of mass

$$X_{CM} = \frac{\sum m_i x_i}{\sum m_i}$$

$$V_{CM} = \frac{\sum m_i v_i}{\sum m_i}$$

$$A_{CM} = \frac{\sum m_i a_i}{\sum m_i} = \frac{F_{Net,External}}{M_{Total}}$$

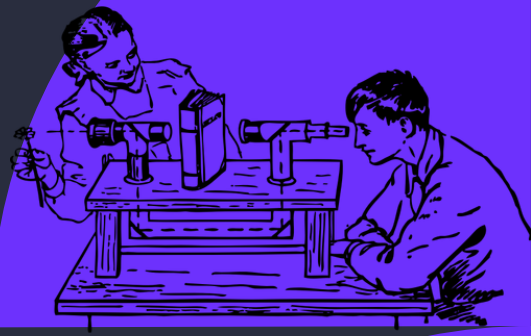
- Lab Reference Frame
  - Observe from outside system
- Center of Mass Reference Frame
  - Observing from inside system
  - $v^*_{obj,\,CM} = v_{obj,\,lab} - v_{CM,\,lab}$

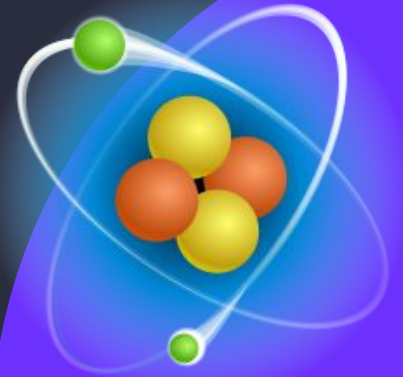
Transformation to the CM Frame

$$\vec{v}_{object,B} - \vec{v}_{CM,B} = \vec{v}_{object,CM}$$

2. Problem Solving

Some Steps to Follow If You Are Lost





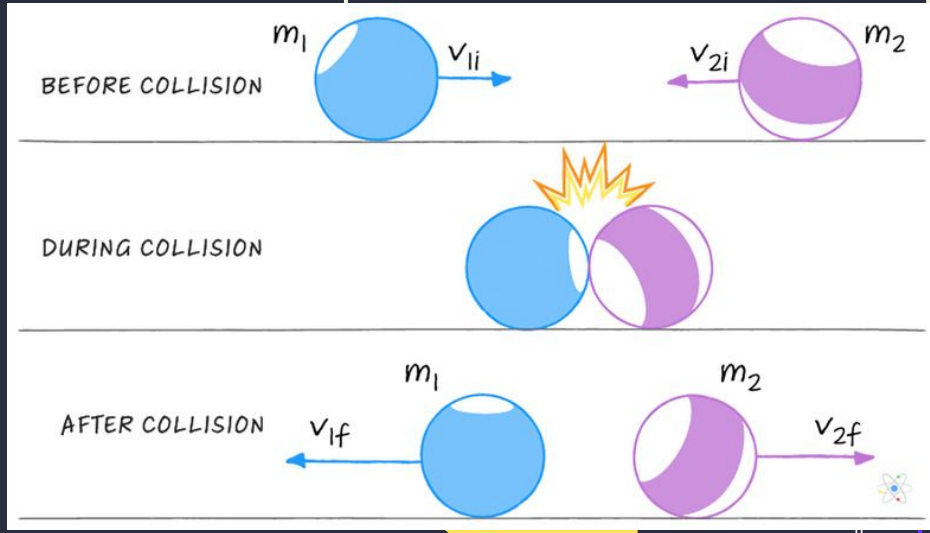
Momentum

How to Identify:

- Collisions
- Explosions
- Impulse

Momentum

- List given variables
  - In both x and y directions if necessary
- Identify if momentum is conserved (it almost always is)
- List all initial momentums and all final momentums
- Solve for missing variable
- *You will almost never need to use Kinematics, think of Energy, Work, or Momentum instead*
- Impulse:
  - Use F <u>average</u>

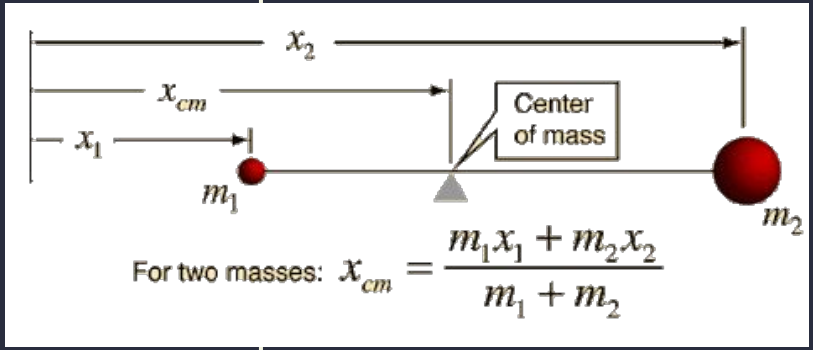


CoM + Frames

How to Identify:

- "In _ reference frame"
- Canoe/Plank
- Usually says "Center of Mass"

Center of Mass + Frames



- Center of Mass
- Identify X_{CM}, V_{CM} if necessary
  - Pay attention to x and y direction
- Frames
- List variables and their frames
  - V_{lab}, V_{cm}, etc.
- Solve for the variable you're looking for

$$V_i^* = V_i - V_{CM}$$
$$V_i^* = -V_f^*$$
$$V_f = V_f^* + V_{CM}$$

Work/Energy

How to Identify:

- Change in height
- Starts & ends at rest
- Kinematics/Force equations look too complicated

Work/Energy

- Conservation of Energy: $E_i = E_f$
- Work-KE Theorem: $W_{NET} = W_c + W_{NC} = \Delta KE$
- Conservation of Mechanical E: $W_{NC} = \Delta E = \Delta K + \Delta U$
  - Nonconservative Forces: Friction, Normal, Tension
- Choose one of the above paths and plug in your variables
- Make sure you have the right SIGN for work!
  - Remember, opposing force & distance -> -W

Momentum Concept Question

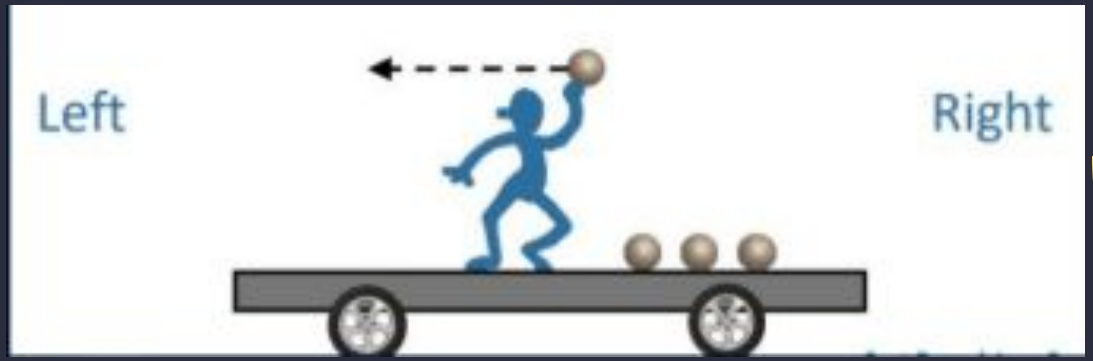
How will the cart's position change?

1. Move to the left
2. Move to the right
3. Will not move

Momentum Concept Question

How will the cart's position change?

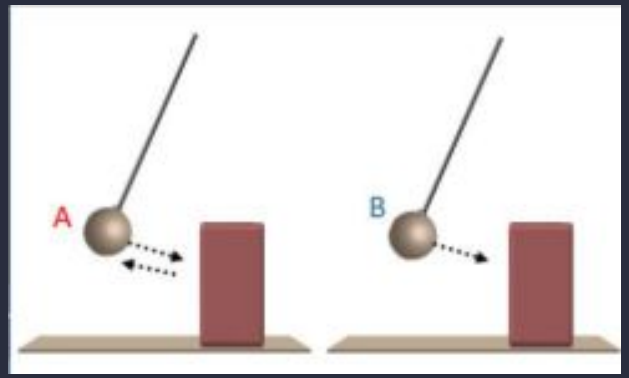
1. Move to the left
2. Move to the right
3. Will not move



Momentum Concept Question

Which brick will fall over and why?

1. brick A
2. brick B

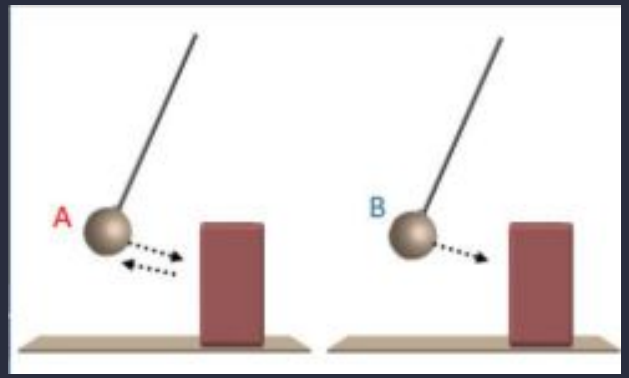


Momentum Concept Question

Which brick will fall over and why?

1. brick A
2. brick B

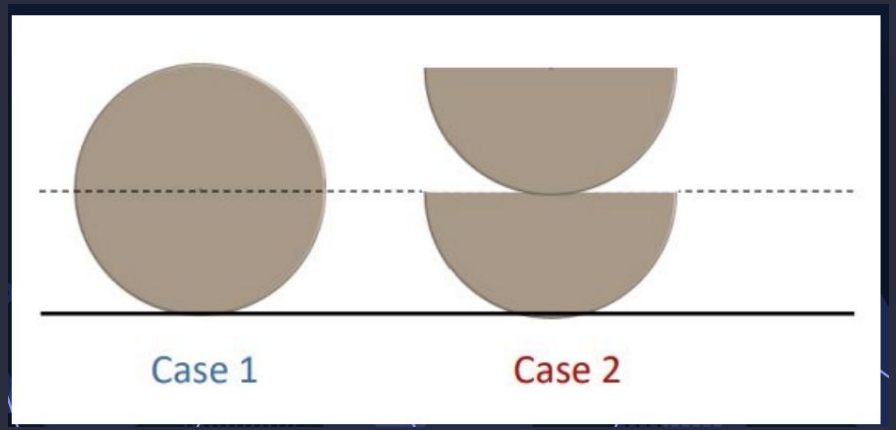
Situation A has a larger impulse moment!



CoM and Reference Frames Concept Question

Which case has the higher center of mass?

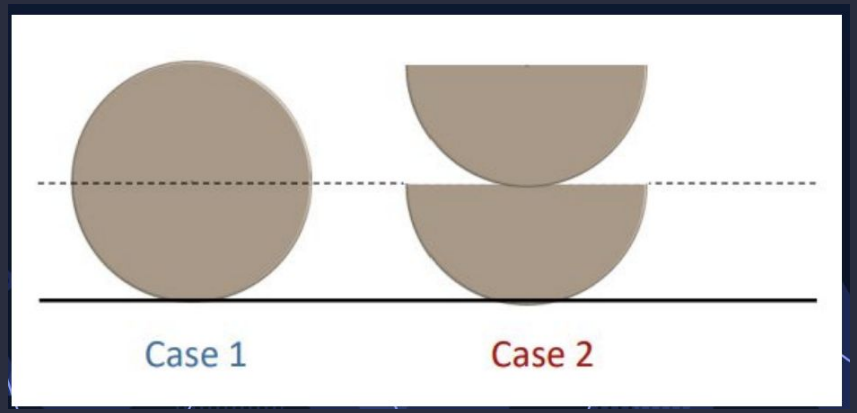
1. Case 1
2. Case
3. Same CoM



Solution:
CoM and Reference Frames Concept Question

Which case has the higher center of mass?

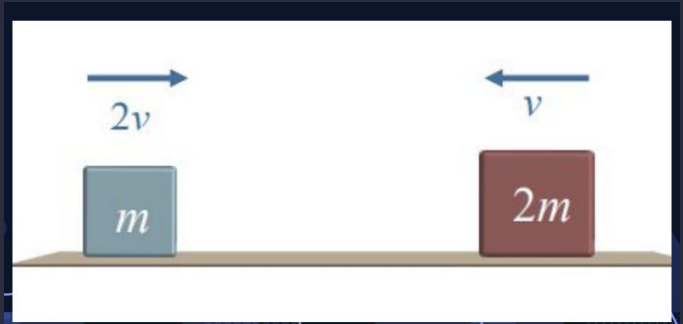
1. ~~Case 1~~
2. Case 2
3. same CoM



CoM and Reference Frames Concept Question

What is the momentum in the center of mass frame?

1. 2vm
2. -2vm
3. 0



CoM and Reference Frames Concept Question

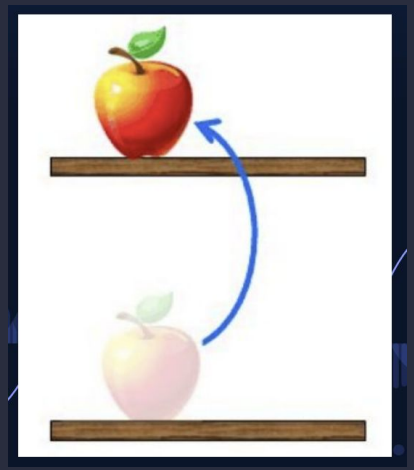
What is the momentum in the center of mass frame?

1. 2vm
2. -2vm
3. 0

Work and Energy Concept Question

What is the net work done on the apple?

1. mgh
2. Zero

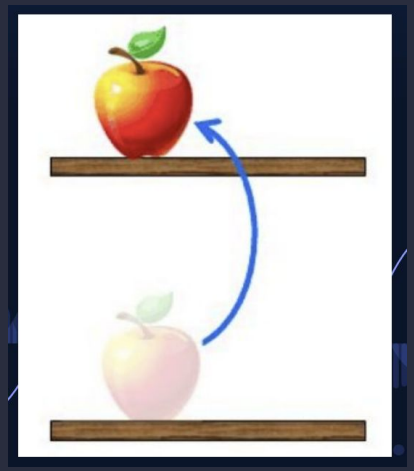


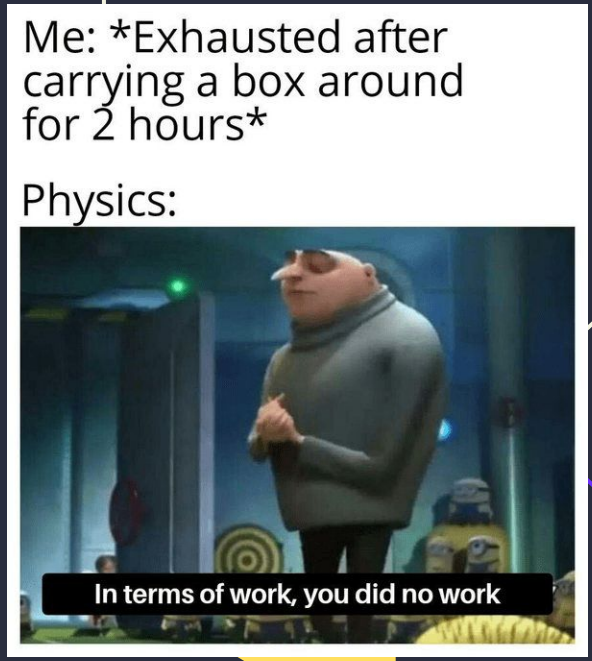
Work and Energy Concept Question

What is the net work done on the apple?

1. mgh
2. Zero

No change in KE!





Work and Energy Concept Question

In what direction does the force due to static friction point?

1. To the Left
2. To the Right

Solution:
Work and Energy Concept Question

In what direction does the force due to static friction point?

1. To the Left
2. To the Right

Worksheet Time!

Enter Queue with your name and net ID:
By entering the queue, you help us:

-Reserve a big enough space at the next review session

-Assign enough tutors for everyone to have access to help

Thank you!