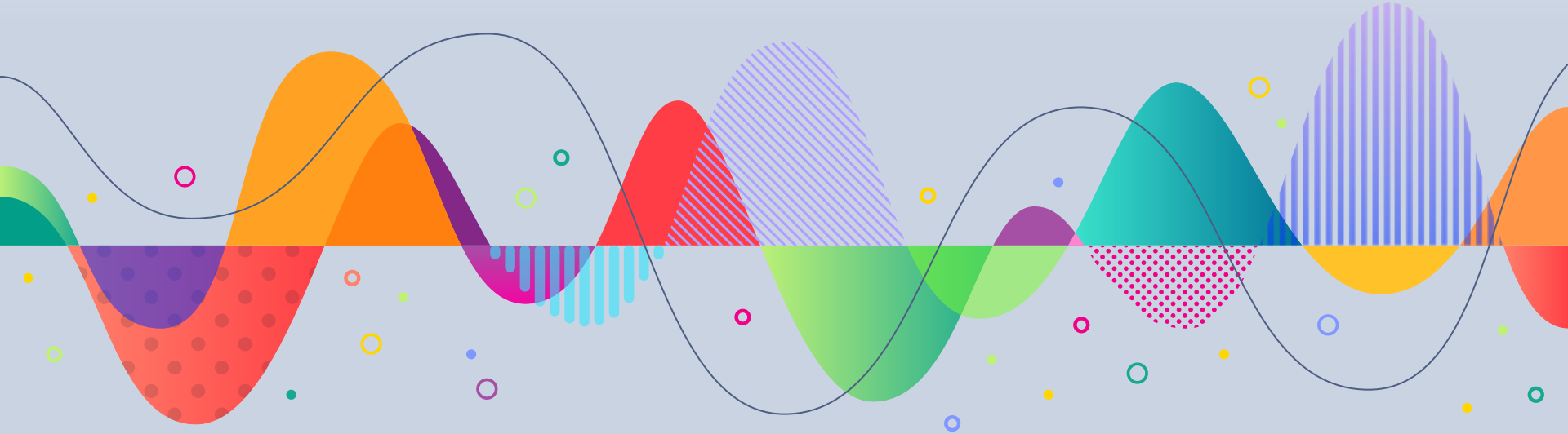
PHYS211
Exam 2 Prep

1.
Overview
Quick bits of info to know



Forces

- Conservative
  - Weight (gravity)
  - Spring Force: $F_s = -k \Delta x$
  - 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, $\Delta KE = W = \frac{1}{2} mv_f^2 - \frac{1}{2} mv_i^2$
- $W = F*d$
- $W = -\Delta PE$ (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 $W_{spring} = -k(x_f^2 - x_i^2)/2$
- Work and Energy are intimately related, using the theorems and conservation laws will help a lot!
- Total mechanical energy = KE + PE = Work from nonconservative forces

$F_{NET} = \Delta p$

Momentum and Impulse

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

- Inelastic
  - KE is <u>not</u> 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
  - $V^*_{obj,\,CM} = V_{obj,\,lab} - V_{CM,lab}$

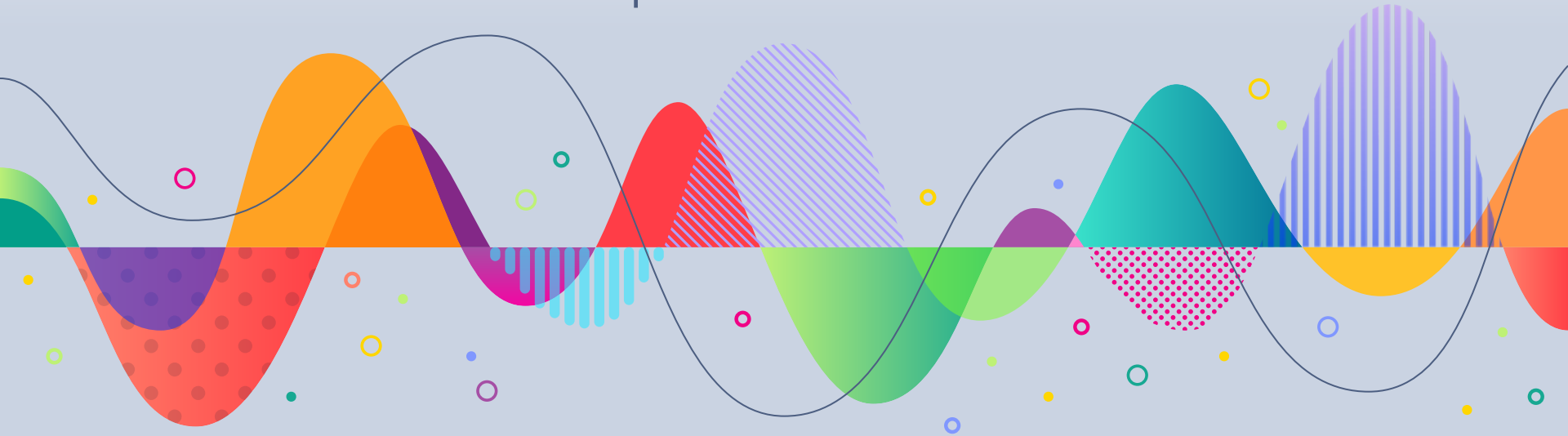
Transformation to the CM Frame

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

2.

Problem Solving

Some Steps to Follow If You’re 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 average

CoM + Frames

How to Identify:

- “In _ ref 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 vs 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:

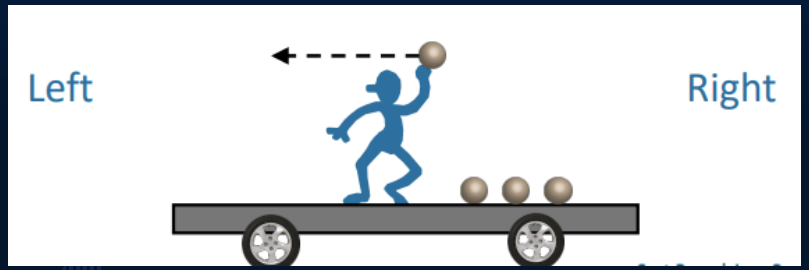
- Change in Height
- Starts & ends at rest
- Kinematics/Force eqns look too complicated
- ...all else fails

Work/Energy

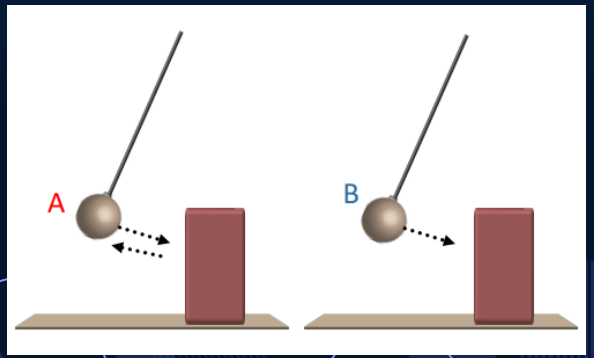
- Conservation of Energy: $E_i=E_f$
- Work-KE Theorem: $W_{NET} = W_C + W_{NC} = \Delta KE$
- Conservation of Mechanical E: $W_{NC} = \Delta E = \Delta K + \Delta U$
  - Nonconservative Forces: Friction, Normal, Tension
- Choose one of the above paths and plug in your variables
- Make sure you have the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

Momentum Concept Question

Will the carts position or velocity change?

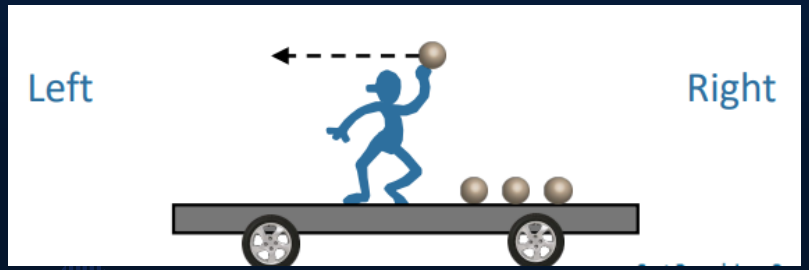


Which brick will fall over and why?

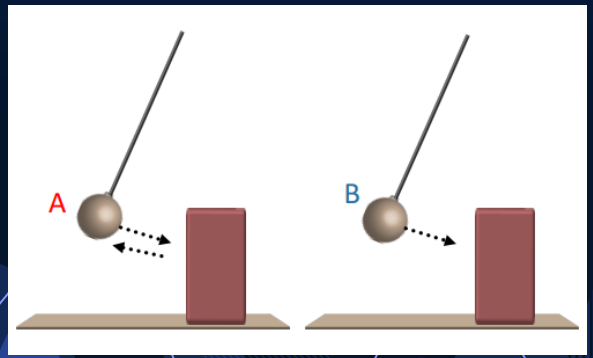


SOLUTION: Momentum Concept Question

Will the carts position or velocity change? Yes, to the right

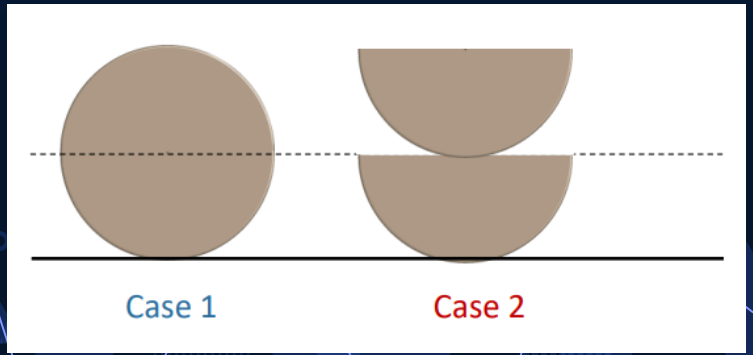


Which brick will fall over and why? A, it has a larger impulse moment

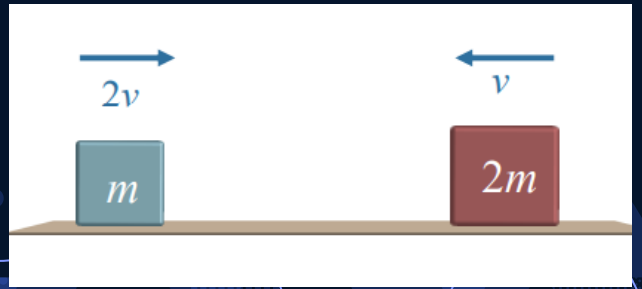


CoM and Reference Frames Concept Question

Which case has the higher center of mass?

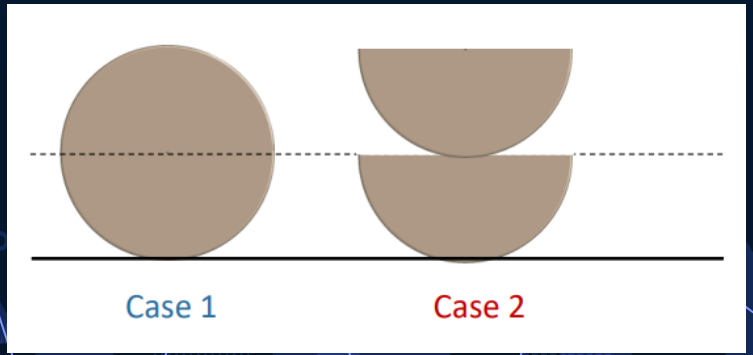


What is the momentum in the center of mass frame?

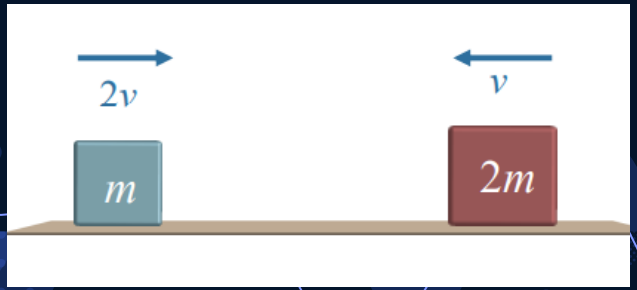


SOLUTION: CoM and Reference Frames Concept Question

Which case has the higher center of mass? Case 2

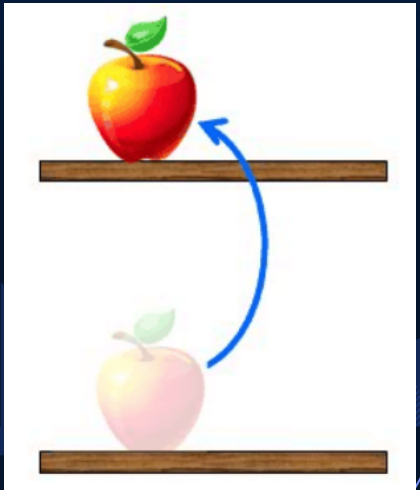


What is the momentum in the center of mass frame? Zero!

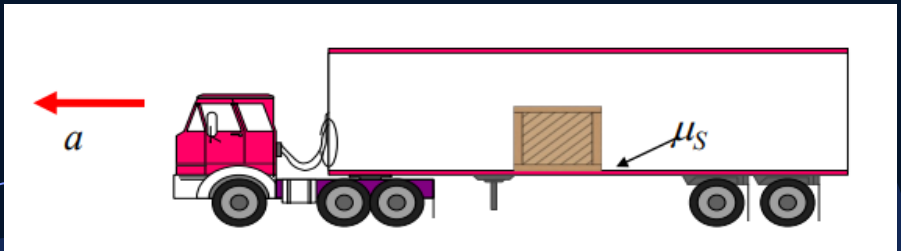


Work and Energy Concept Questions

What is the net work done on the apple?



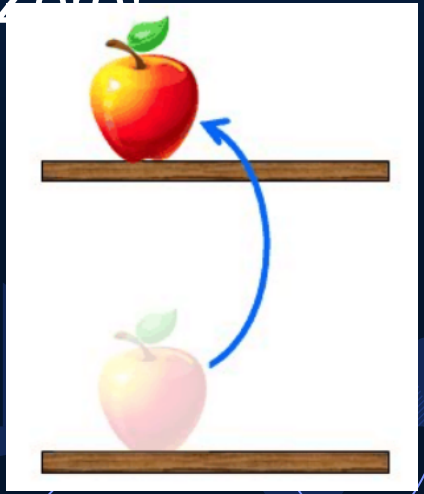
In what direction does the work due to static friction point?



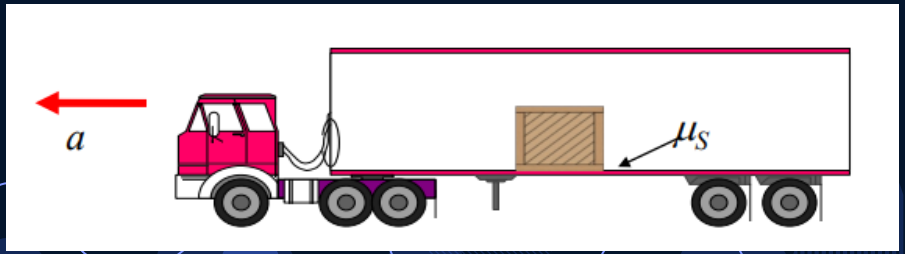
SOLUTION: Work and Energy Concept Questions

What is the net work done on the apple?

Zero!



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



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!