FOCUSED REVIEW

Focused Review: Center of Mass and Systems of Particles

Reinforce the most important center-of-mass ideas and confirm you can reason about system motion and external forces.

TIME	BEST FOR	FINISH WITH
15 minutes	Focused review	Greater confidence

After this focused review, you'll be able to…

identify where a center of mass lies, distinguish particle motion from system motion, and classify internal versus external interactions.

HOW TO USE THIS GUIDE

Work through the stages in order. Write directly in the spaces provided, check your work in the Solutions section, and finish by choosing the next resource that matches your confidence.

Choose how you want to review: work through this guide, follow the online review, or watch the video review.

Start the Review Online →
Watch the Video Review →

YOU WILL NEED

Pencil or pen • Calculator if needed • Approximately 15 minutes

FR-02 • PHYSICS SENSEI UNIT REVIEW

Physics Sensei Unit Review

Use this Physics Sensei Unit Review to reinforce key concepts, prepare for homework, and review before a quiz or exam.

UNIT: MEC-U19
TOPIC FAMILY: Mechanics
TOPIC: Center of Mass and Systems of Particles
COURSE LEVEL: Foundational introductory college physics

BEST USED

- ✓ **To reinforce key concepts**
- ✓ Before starting homework
- ✓ Before a quiz or exam

Continue with Physics Sensei →

Physics Sensei is an independent educational resource organized around core college-physics ideas, problem-solving models, and study workflows.

FR-03 • YOUR REVIEW PLAN

Your Review Plan

Complete these six focused stages in order. Each stage reinforces your understanding and prepares you for a final confidence check.

6 stages • Approximately 15 minutes

1 **Warm-Up Check — page 4** Refresh key ideas.	2 **Core Concepts — page 6** Reinforce the essentials.	3 **Guided Practice — page 7** Strengthen key skills.
4 **Confidence Check — page 9** Confirm your understanding.	5 **Summary — page 10** Remember the essentials.	6 **Next Step — page 14** Choose your next step.

PRINTING TIP

For student copies, print double-sided and keep the Solutions section after the student activities so learners attempt each activity before checking their work.

FR-04 • STAGE 1 OF 6

Warm-Up Check

Before you begin, take a minute to reactivate what you already know. This quick warm-up will help you focus on the most important ideas before moving on.

WARM-UP 1

Key Ideas

Recall how mass distribution affects the center of mass.

If one object in a two-object system is much heavier, is the center of mass closer to the lighter object or the heavier object?

WARM-UP 2

Common Mistakes

Identify what controls the motion of the center of mass.

If a system's parts push on each other but the net external force is zero, can those internal pushes accelerate the center of mass?

WARM-UP 3

Quick Application

Distinguish internal from external interactions.

For a two-cart system, are the forces the carts exert on each other internal or external?

Ready to strengthen your understanding?

You've refreshed the most important ideas. Now reinforce the concepts you'll use most often.

Continue to Core Concepts — page 6 →

FR-05 • STAGE 2 OF 6

Core Concepts

Let's reinforce the most important concepts you'll need to solve problems with confidence. Focus on the ideas that appear most often in homework, quizzes, and exams.

KEY CONCEPT 1

Center of Mass and Mass Distribution

The center of mass is the mass-weighted average position of the chosen system. It lies closer to regions containing more mass. For symmetric systems, symmetry may locate it immediately. Define the system before reasoning about its center of mass.

Conceptual rule: more mass gives more weight to that location in the system average.

EXAMPLE If two equal masses are separated by 4 m, their center of mass lies at the midpoint. If one mass becomes much larger, the center of mass shifts toward that heavier mass.

SENSEI NOTE The center of mass is not generally the geometric midpoint. It is determined by how the system's mass is distributed.

KEY CONCEPT 2

System Motion and External Force

Individual particles can move or interact internally while the center of mass follows the motion dictated by the net external force on the complete system. Internal forces can redistribute motion but do not by themselves determine center-of-mass acceleration.

System rule: net external force controls the acceleration of the center of mass.

EXAMPLE Two carts collide on a nearly frictionless track. Their contact forces are internal to the two-cart system. A push from a person outside the system would be external and could change the center-of-mass motion.

SENSEI NOTE Internal and external are system-dependent labels. Always define the system boundary first.

Ready to apply these ideas?

You've reinforced the essential concepts. Now strengthen your problem-solving skills by working through a few guided examples.

Continue to Guided Practice — page 7 →

FR-06 • STAGE 3 OF 6

Guided Practice

Now apply the key concepts you've just reviewed. Work through these focused practice activities to reinforce your problem-solving skills before the final confidence check.

PRACTICE 1

Guided Example

Use mass distribution to locate the center of mass.

Two equal masses are separated by 4 m. Where is their center of mass? How does it shift if one mass becomes much larger?

PRACTICE 2

Independent Check

Define the system boundary before classifying forces.

Two carts collide on a nearly frictionless track. Identify which forces are internal to the two-cart system and what kind of force would be required to accelerate its center of mass.

Ready for a confidence check?

You've reinforced the essential skills through focused practice. Now confirm your understanding with two short questions.

Continue to Confidence Check — page 9 →

FR-07 • STAGE 4 OF 6

Confidence Check

You've reinforced the key concepts and practiced the essential skills. Now confirm you're ready to move forward by completing these short confidence checks.

CONFIDENCE CHECK 1

Center-of-Mass Motion

Reason from the net external force on the complete system.

A system initially at rest undergoes an internal explosion while net external force is zero. Does the center of mass begin moving?

CONFIDENCE CHECK 2

Internal and External Forces

Classify each interaction relative to the chosen system boundary.

For two colliding carts treated as one system, classify the cart-on-cart forces and a friction force from the floor. Which affects the center-of-mass acceleration?

HOW DID IT GO?

I answered ____ of 2 questions correctly.

Use the Solutions section to check your reasoning, then take one final look at the essential ideas.

You've confirmed your understanding.

Take one final look at the essential ideas before choosing your next step.

Continue to Summary — page 10 →

FR-08 • STAGE 5 OF 6

Summary

Before moving on, take one final look at the essential ideas you'll want to remember.

KEY TAKEAWAY 1

Use Mass Distribution to Locate the Center of Mass

The center of mass is a mass-weighted position, so it shifts toward where more mass is located.

KEY TAKEAWAY 2

Separate Internal Motion from System Motion

Internal interactions can change particle motion, while net external force determines center-of-mass acceleration.

MY ONE-SENTENCE SUMMARY

In my own words, the most important idea is:

Ready for your next step?

You've reviewed the essential ideas one last time. Now choose the resource that best matches how confident you feel.

Continue to Next Step — page 14 →

ANSWER KEY • CHECK AFTER ATTEMPTING

Solutions and Explanations

Use these solutions to check your reasoning—not only your final answer. Use each answer and explanation to check both the setup and the physical interpretation.

WARM-UP • ACTIVITY 1

Key Ideas

Closer to the heavier object.

WHY IT WORKS Center of mass is a mass-weighted average position, so the heavier object contributes more strongly.

WARM-UP • ACTIVITY 2

Common Mistakes

No. Internal pushes alone cannot accelerate the center of mass when the net external force is zero.

WHY IT WORKS Internal forces can change the motions of parts of the system, but the center-of-mass acceleration is controlled by the net external force.

WARM-UP • ACTIVITY 3

Quick Application

They are internal forces.

WHY IT WORKS The cart-on-cart forces act between objects that are both inside the chosen two-cart system.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

For equal masses, the center of mass is at the midpoint, 2 m from either mass. Making one mass much larger shifts the center of mass toward the heavier mass.

WHY IT WORKS Equal masses weight the two positions equally. Increasing one mass increases the weight of that location in the system average.

PRACTICE 2

Independent Check

The cart-on-cart forces are internal. A force from outside the two-cart system, such as friction from the track or a push from a person, is external and can accelerate the center of mass.

WHY IT WORKS Internal interactions occur within the system boundary. Center-of-mass acceleration is determined by the net force exerted from outside that boundary.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Center-of-Mass Motion

No. The center of mass remains at rest if it was initially at rest and the net external force stays zero.

WHY IT WORKS The explosion forces are internal. With zero net external force, the center-of-mass velocity does not change.

CONFIDENCE CHECK 2

Internal and External Forces

The cart-on-cart forces are internal; friction from the floor is external. The external force affects the center-of-mass acceleration.

WHY IT WORKS Forces between members of the chosen system are internal. Forces exerted by objects outside the system are external, and the net external force governs the center-of-mass acceleration.

READINESS GUIDE

2 correct: You're ready to continue. • 1 correct: Review the missed idea, then continue. • 0 correct: Revisit Core Concepts or choose more practice.

FR-09 • STAGE 6 OF 6

Next Step: Continue Learning

Great work! You've completed this focused review. Choose the next resource that best matches how confident you feel.

?	◎	✓
I'm Still Unsure	**I Need More Practice**	**I'm Ready**
Review the focused review again to strengthen the essential concepts.	Build confidence with additional practice problems.	Continue to the next topic or learning resource.
Review again: return to Warm-Up Check on page 4.	**Go to Practice →**	**Continue →**

RECOMMENDED LINKS

Review again: return to Warm-Up Check on page 4.

Find additional practice →

Choose another type of physics help →

Continue reviewing with these companion resources.

Start the Review Online →
Watch the Video Review →

PHYSICS HELP THAT MAKES SENSE

A Physics Sensei review never ends at the last question. It always guides you toward the next useful step.

PhysicsSensei.com