

FOCUSED REVIEW

Focused Review — Relative Velocity in Two Dimensions — Calculus-Based

Review the most important ideas, reinforce the essential skills, and confirm you're ready to move on.

 TIME 15–20 minutes	 BEST FOR Focused review	 FINISH WITH Greater confidence
---	--	---

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

recognize the key concepts, reinforce your problem-solving skills, and continue with greater confidence.

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 15–20 minutes

FR-02 • COURSE ALIGNMENT

Course Alignment

This Physics Sensei Topic Review is an independent learning resource. Use it to reinforce key concepts, prepare for homework, or review before a quiz or exam.

Related Unit Review: If you need to review the complete unit material, review [Motion in Two Dimensions here](#)



RESOURCE: Physics Sensei Topic Review TOPIC ID: MEC-U04-T02 TOPIC: Relative Velocity in Two Dimensions PARENT UNIT: MEC-U04 — Motion in Two Dimensions COURSE LEVEL: Calculus-Based	BEST USED ✓ After learning the topic ✓ Before starting homework ✓ Before a quiz or exam
---	--

BEST USED

- ✓ After learning the topic
- ✓ Before starting homework
- ✓ Before a quiz or exam

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 15–20 minutes

1 Warm-Up Check Refresh key ideas.	2 Core Concepts Reinforce the essentials.	3 Guided Practice Strengthen key skills.
4 Confidence Check Confirm your understanding.	5 Summary Remember the essentials.	6 Next Step 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**

Answer before revealing the response.

What does “A relative to B” mean in a velocity label?

WARM-UP 2**Common Mistakes**

Answer before revealing the response.

If A moves east at 6 m/s and B moves east at 2 m/s, how does A move as B watches?

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

Answer before revealing the response.

If A/B is $(3, -2)$ m/s, what is B/A ?

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 →

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

Choose one reference frame

Label the moving object and observer and express both positions relative to the same ground frame G. Their difference is the relative position; its derivative is the relative velocity.

$$\vec{r}_{A/B}(t) = \vec{r}_{A/G}(t) - \vec{r}_{B/G}(t), \vec{v}_{A/B}(t) = \frac{d\vec{r}_{A/B}(t)}{dt}$$

EXAMPLE A train passenger and a platform observer can assign different velocities to the same walker because their reference positions change differently with time.

SENSEI NOTE Write object/observer labels before using numbers.

KEY CONCEPT 2

Subtract instantaneous components

Subtract the instantaneous velocity components measured in one common frame. Equivalently, differentiate each component of relative position with respect to time.

$$v_{x,A/B}(t) = \frac{dx_{A/B}(t)}{dt}, v_{y,A/B}(t) = \frac{dy_{A/B}(t)}{dt}$$

EXAMPLE With t in numerical seconds, positions A: (3t, 2t²) m and B: (t, t²) m give A/B velocity (2, 2t) m/s.

SENSEI NOTE Subtract signed components from the same frame.

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 →](#)

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**

Two moving objects: work with labeled frames.

Given ground positions A: $(5t, t^2)$ m and B: $(t, -t)$ m, with t measured numerically in seconds, find A/B velocity and evaluate it at $t = 1$ s.

PRACTICE 2**Independent Check**

Boat and current: work with labeled frames.

The boat/water velocity is $(0, 4)$ m/s and water/shore position is $(3t, 0)$ m, with t in seconds. Find boat/shore velocity.

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 →

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

Component difference

Find the signed vector before interpreting it.

Find A/B if $A = (7, -1)$ m/s and $B = (2, 3)$ m/s relative to ground.

CONFIDENCE CHECK 2

Observer reversal

Find the signed vector before interpreting it.

If $A/B = (-3, 4)$ m/s, give B/A and the common relative speed.

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 →

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

Name the observer

The second object in A/B is the observer; use a common reference frame.

KEY TAKEAWAY 2

Subtract signed components

Relative velocity is a vector difference in x and y.

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 →

ANSWER KEY • CHECK AFTER ATTEMPTING

Solutions and Explanations

Use these solutions to check your reasoning—not only your final answer. Read the reasoning for each response and revisit any step that was unclear.

WARM-UP • ACTIVITY 1

Key Ideas

B is the observer measuring A's changing position.

WHY IT WORKS The second object after "relative to" names the observer.

WARM-UP • ACTIVITY 2

Common Mistakes

A moves east at 4 m/s relative to B.

WHY IT WORKS Subtracting the observer's eastward 2 m/s leaves 4 m/s east.

WARM-UP • ACTIVITY 3

Quick Application

B/A is $(-3, 2)$ m/s.

WHY IT WORKS Swapping object and observer reverses the relative vector.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

A/B position is $(4t, t^2 + t)$ m; A/B velocity is $(4, 2t + 1)$ m/s. At 1 s: $(4, 3)$ m/s.

WHY IT WORKS Differentiate the relative position component by component in the same frame.

PRACTICE 2

Independent Check

Differentiating water/shore position gives $(3, 0)$ m/s. Boat/shore velocity is $(3, 4)$ m/s, speed 5 m/s.

WHY IT WORKS The time derivative supplies current velocity; then the velocity chain adds vectors.

SOLUTIONS • CONFIDENCE CHECK**CONFIDENCE CHECK 1**

Component difference

$$A/B = (5, -4) \text{ m/s.}$$

WHY IT WORKS Subtract matching components: $7 - 2 = 5$ and $-1 - 3 = -4$.

CONFIDENCE CHECK 2

Observer reversal

$$B/A = (3, -4) \text{ m/s; speed } 5 \text{ m/s.}$$

WHY IT WORKS The vector reverses, while its magnitude remains unchanged.

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 Review the focused review again to strengthen the essential concepts. Review Again →	 I Need More Practice Build confidence with additional practice problems. Go to Practice →	 I'm Ready Continue to the next topic or learning resource. Continue →
---	---	---

RECOMMENDED LINKS

[Review this topic again →](#)[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