FOCUSED REVIEW

Focused Review: Motion in Two Dimensions

Reinforce the essential derivative, integral, and motion-model connections used in calculus-based two-dimensional kinematics.

◷ TIME	◎ BEST FOR	✓ FINISH WITH
15–20 minutes	Focused review	Greater confidence

After this focused review, you'll be able to…
use the essential derivative and integral relationships and confirm readiness for calculus-based kinematics.

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 • UNIT ALIGNMENT

Unit Alignment

This bundle is aligned to the approved Physics Sensei unit specification below. Use it to recover the unit structure, reinforce key decisions, and confirm readiness for the next study task.

ARCHITECTURE: Physics Sensei Independent Mechanics UNIT: MEC-U03 — Motion in Two Dimensions SCOPE: Unit Review PHYSICS LEVEL: Calculus-Based	BEST USED ✓ Before calculus-based vector-motion homework ✓ Before a quiz or exam ✓ When vector derivatives, parametric motion, or component integrals need reinforcement

Review Prerequisites →

Physics Sensei is an independent educational resource. This review is independently authored and organized under the approved Physics Sensei mechanics architecture.

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

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

Recall Activity 1

Differentiate a vector position function component by component.

If $\vec{r}(t)=\langle 2t, 5t-4.9t^2\rangle$, write $\vec{v}(t)$ and $\vec{a}(t)$.

WARM-UP 2

Recall Activity 2

Use a vector integral to accumulate displacement.

If $\vec{v}(t)$ is known, what integral gives $\Delta\vec{r}$ from t_1 to t_2?

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Recall Activity 3

Use velocity components to identify a horizontal tangent.

What condition on v_y identifies the top of a projectile trajectory?

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

Velocity and acceleration are vector derivatives

For planar motion, differentiate each position component to obtain velocity and differentiate again for acceleration.

$$\Sigma F_x = 0 \quad \bullet \quad \Sigma F_y = 0$$

EXAMPLE $\vec{v}=d\vec{r}/dt$ and $\vec{a}=d^2\vec{r}/dt^2$. If $\vec{r}=\langle 2t,5t-4.9t^2\rangle$, then $\vec{v}=\langle 2,5-9.8t\rangle$ and $\vec{a}=\langle 0,-9.8\rangle$.

SENSEI NOTE Velocity is tangent to the trajectory; zero v_y does not imply zero vector velocity.

KEY CONCEPT 2

Vector integrals reconstruct displacement and velocity change

Integrate each vector component over the same time interval to reconstruct displacement or velocity change.

$$\Sigma\tau\_O = 0 \quad \bullet \quad \tau = Fd_\perp$$

EXAMPLE $\Delta\vec{r}=\int\vec{v}dt$ and $\Delta\vec{v}=\int\vec{a}dt$. Component integration preserves vector direction information.

SENSEI NOTE $\int|\vec{v}|dt$ gives path length; $|\int\vec{v}dt|$ gives displacement magnitude. They are generally different.

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

Worked Example

Differentiate a vector position function and evaluate speed and direction.

A particle has $\vec{r}(t)=\langle 3t^2,4t\rangle$ m. Find $\vec{v}(t)$, $\vec{a}(t)$, and its speed at $t=2$ s.

PRACTICE 2

Guided Problem

Integrate each acceleration component using vector initial conditions.

A particle has $\vec{a}(t)=\langle 2t,-4\rangle$, $\vec{v}(0)=\langle 1,3\rangle$, $\vec{r}(0)=\langle 0,2\rangle$. Find $\vec{v}(t)$ and $\vec{r}(t)$.

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 8 →

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

Differentiate the vector function

Find velocity from $\vec{r}(t)$.

For $\vec{r}(t)=\langle t^2,3t\rangle$, find $\vec{v}$ at $t=2$ s.

CONFIDENCE CHECK 2

Integrate vector acceleration

Apply both initial velocity components.

If $\vec{a}(t)=\langle 2t,-g\rangle$ and $\vec{v}(0)=\langle 1,5\rangle$, write $\vec{v}(t)$.

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

Vector derivatives convert $\vec{r} \to \vec{v} \to \vec{a}$

Differentiate component functions while preserving the vector basis.

KEY TAKEAWAY 2

Vector integrals reconstruct motion

Component integrals accumulate vector displacement and velocity change.

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. Compare your setup, signs, units, and interpretation with the explanations below.

WARM-UP • ACTIVITY 1

Recall Activity 1

$\vec{v}(t)=\langle 2,5-9.8t\rangle$; $\vec{a}(t)=\langle 0,-9.8\rangle$.

WHY IT WORKS Differentiate both vector components once and then twice.

WARM-UP • ACTIVITY 2

Recall Activity 2

$\Delta\vec{r}=\int[t_1,t_2]\vec{v}(t)dt$.

WHY IT WORKS Component integrals accumulate the vector change in position.

WARM-UP • ACTIVITY 3

Recall Activity 3

$v_y=0$; verify v_x and $\vec{a}$ separately.

WHY IT WORKS A horizontal trajectory tangent has $dy/dx=v_y/v_x=0$ when $v_y=0$ and $v_x\neq 0$.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

$\vec{v}=\langle 6t,4\rangle$; $\vec{a}=\langle 6,0\rangle$; speed at 2 s is $\sqrt{160}=4\sqrt{10}$ m/s.

WHY IT WORKS Differentiate each component and evaluate $|\vec{v}(2)|=\sqrt{(12^2+4^2)}$.

PRACTICE 2

Guided Problem

$\vec{v}=\langle 1+t^2,3-4t\rangle$; $\vec{r}=\langle t+t^3/3,2+3t-2t^2\rangle$.

WHY IT WORKS Integrate each component and apply the corresponding initial condition.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Differentiate the vector function

$\langle 4,3\rangle$ m/s.

WHY IT WORKS $\vec{v}=\langle 2t,3\rangle$, so $\vec{v}(2)=\langle 4,3\rangle$ m/s.

CONFIDENCE CHECK 2

Integrate vector acceleration

$\langle 1+t^2,5-gt\rangle$ m/s.

WHY IT WORKS Integrate each acceleration component and add $\vec{v}(0)$.

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.	Continue with additional practice for this unit.	Continue to the next recommended 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