FOCUSED REVIEW

Focused Review: Motion in One Dimension

Reinforce the essential derivative, integral, and motion-model connections used in calculus-based one-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-U02 — Motion in One Dimension SCOPE: Unit Review PHYSICS LEVEL: Calculus-Based	BEST USED ✓ Before calculus-based kinematics homework ✓ Before a quiz or exam ✓ When derivative, integral, or variable-acceleration models 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 position once for velocity and twice for acceleration.

If $x(t) = 2t^3 - 5t^2 + 4$, write $v(t)$ and $a(t)$.

WARM-UP 2

Recall Activity 2

Use a definite integral to accumulate signed displacement.

If $v(t)$ is known, what definite integral gives the displacement from t_1 to t_2?

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Recall Activity 3

Use the derivative condition, then check whether the sign changes.

For a differentiable x(t), what condition identifies a possible turning point?

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 derivatives

Instantaneous velocity is the first derivative of position. Acceleration is the derivative of velocity and the second derivative of position.

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

EXAMPLE $v = dx/dt$; $a = dv/dt = d^2x/dt^2$. Example: $x = 2t^3 - 5t^2 + 4t$ gives $v = 6t^2 - 10t + 4$ and $a = 12t - 10$.

SENSEI NOTE A point where $v = 0$ is a candidate turning point. Inspect the sign of v on both sides to determine whether the direction actually reverses.

KEY CONCEPT 2

Integrals reconstruct displacement and velocity change

Integrating velocity gives displacement; integrating acceleration gives velocity change. Definite integrals naturally handle motion whose rate changes continuously.

$$\Sigma\tau\_O = 0 \quad \cdot \quad \tau = Fd\perp$$

EXAMPLE $x(t_2) - x(t_1) = \int[t_1,t_2]\ v(t)dt$; $v(t_2) - v(t_1) = \int[t_1,t_2]\ a(t)dt$. If $a(t)=3t$ and $v(0)=2$, then $v(t)=2+1.5t^2$.

SENSEI NOTE The integral of signed velocity gives displacement. The integral of speed gives total distance.

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 position function and solve $v(t)=0$ to identify rest times.

A particle has $x(t)=t^3-6t^2+9t$ meters. Find $v(t)$, $a(t)$, and the times from 0 to 5 s when it is instantaneously at rest.

PRACTICE 2

Guided Problem

Integrate acceleration, use the initial condition, then integrate velocity.

A particle has $a(t)=6t-4$ m/s², $v(0)=3$ m/s, and $x(0)=2$ m. Find $v(t)$ and $x(t)$.

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 before substituting

Find the instantaneous velocity from x(t).

For $x(t)=4t^2-t^3$, find v at t = 2 s.

CONFIDENCE CHECK 2

Integrate acceleration

Use the initial velocity as the constant of integration.

If $a(t)=2t$ and $v(0)=-1$ m/s, find v(3 s).

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

Derivatives convert x → v → a

Local slopes are calculus statements: differentiate position for velocity and velocity for acceleration.

KEY TAKEAWAY 2

Integrals reconstruct motion

Signed areas under v(t) and a(t) accumulate 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

$v(t) = 6t^2 - 10t$; $a(t) = 12t - 10$.

WHY IT WORKS Instantaneous velocity is dx/dt and acceleration is d^2x/dt^2.

WARM-UP • ACTIVITY 2

Recall Activity 2

$\Delta x = \int[t_1,t_2]\ v(t)\ dt$.

WHY IT WORKS Integrating the instantaneous velocity over time accumulates the signed changes in position.

WARM-UP • ACTIVITY 3

Recall Activity 3

$v(t) = dx/dt = 0$, followed by a sign change in v for a true reversal.

WHY IT WORKS A zero derivative marks an instantaneous horizontal tangent, but the direction reverses only if velocity changes sign.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

$v = 3t^2 - 12t + 9 = 3(t-1)(t-3)$; $a = 6t - 12$; rest at $t = 1$ s and 3 s.

WHY IT WORKS Differentiate $x(t)$ to get $v(t)$, differentiate again for $a(t)$, then solve the quadratic $v(t)=0$.

PRACTICE 2

Guided Problem

$v(t)=3+3t^2-4t$; $x(t)=2+3t+t^3-2t^2$.

WHY IT WORKS Integrating $a(t)$ gives $v(t)=3t^2-4t+C$; $v(0)=3$ sets $C=3$. Integrating again and using $x(0)=2$ gives $x(t)$.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Differentiate before substituting

4 m/s.

WHY IT WORKS $v = dx/dt = 8t - 3t^2$. At $t = 2$ s, $v = 16 - 12 = 4$ m/s.

CONFIDENCE CHECK 2

Integrate acceleration

8 m/s.

WHY IT WORKS $v(3) = -1 + \int_0^3 2t\,dt = -1 + 9 = 8$ m/s.

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