

FULL REVIEW

Full Review — Position, Displacement, and Velocity — Calculus-Based

Review the essential ideas, relationships, and problem-solving tools for Position, Displacement, and Velocity.

 TIME 45–60 minutes	 BEST FOR A complete topic review	 FINISH WITH A readiness check
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After this full review, you'll be able to...

recall the essential ideas, apply them to representative problems, and determine what to study next.

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 45–60 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 One Dimension here →](#)

RESOURCE: Physics Sensei Topic Review
TOPIC ID: MEC-U03-T01
TOPIC: Position, Displacement, and Velocity
PARENT UNIT: MEC-U03 — Motion in One Dimension
COURSE LEVEL: Calculus-Based introductory physics

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 stages in order. Each stage builds on the previous one and prepares you for the final readiness check.

6 stages • Approximately 45–60 minutes

1 Warm-Up Check Activate prior knowledge.	2 Core Concepts Review the essential ideas.	3 Guided Practice Apply what you learned.
4 Confidence Check Confirm your understanding.	5 Summary Review the key ideas.	6 Next Step Continue your learning.

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 moment to see what you already remember. Do not worry about getting everything right. This is only a starting point.

ACTIVITY 1**Recall Activity 1**

Connect displacement to a function.

Write displacement from t_1 to t_2 when position is $x(t)$.

ACTIVITY 2**Recall Activity 2**

Differentiate a polynomial.

If $x(t) = 2t^3 - 5t$, find $v(t)$.

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Interpret derivative sign.

What does $v(t) < 0$ imply about $x(t)$ at that instant?

Ready to strengthen your understanding?

You've refreshed what you already know. Next, reinforce the essential concepts that will help you solve problems with confidence.

Continue to Core Concepts →

FR-05 • STAGE 2 OF 6

Core Concepts

Let's rebuild the key ideas one step at a time. Focus on understanding the relationships before worrying about solving problems.

KEY CONCEPT 1

Position functions and displacement

A differentiable position function $x(t)$ specifies the coordinate of the particle at each time. Displacement over an interval depends only on the two endpoint values of $x(t)$, not on the detailed path between them.

$$\Delta x = x(t_2) - x(t_1)$$

EXAMPLE For $x(t) = t^2 - 4t$, from 0 s to 5 s the displacement is $x(5) - x(0) = 5$ m.

SENSEI NOTE Do not integrate $|v|$ when the question asks only for displacement; endpoint positions are sufficient.

KEY CONCEPT 2

Average velocity is the secant slope

Average velocity over $[t_1, t_2]$ is the ratio of the finite position change to the finite time change. Geometrically it is the slope of the secant line connecting the two points on the x - t curve.

$$\bar{v} = [x(t_2) - x(t_1)] / (t_2 - t_1)$$

EXAMPLE For $x(t) = t^2$, from 2 s to 5 s: $\bar{v} = (25 - 4)/3 = 7$ m/s.

SENSEI NOTE For nonlinear $x(t)$, average velocity generally differs from the instantaneous velocity at either endpoint.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3**Instantaneous velocity is the derivative**

Instantaneous velocity is the limiting slope of the position curve as the time interval shrinks to zero. The derivative $v(t) = dx/dt$ gives both local rate and signed direction. Zeros of v correspond to horizontal tangents of $x(t)$.

$$v(t) = dx/dt$$

EXAMPLE If $x(t) = t^3 - 6t^2 + 9t$, then $v(t) = 3t^2 - 12t + 9$.

SENSEI NOTE A point where $v = 0$ is a candidate turning point; confirm a direction change by checking the sign of v on each side.

Ready to apply these ideas?

You've reinforced the essential concepts. Now put them into practice by working through guided examples and building your problem-solving confidence.

[Continue to Guided Practice →](#)

FR-06 • STAGE 3 OF 6

Guided Practice

Now it's time to apply what you've reviewed. Work through each activity in order. The examples become gradually more challenging, and each prepares you for the final readiness check.

PRACTICE 1**Worked Example**

Compute a finite-interval velocity.

For $x(t) = 2t^2 - 3t + 1$, find displacement and average velocity from $t = 1$ s to $t = 4$ s.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Compare average and instantaneous velocity.

For $x(t) = t^3 - 3t$, find $\bar{v}$ from 0 s to 2 s and v at $t = 2$ s.

PRACTICE 3

Independent Problem

Find and classify direction changes.

For $x(t) = t^3 - 3t^2$, find the times when $v = 0$ and determine the direction of motion just before and after $t = 2$ s.

Ready to check your understanding?

You've practiced the essential skills with guidance. Now solve a few short problems on your own and confirm you're ready to move forward.

Continue to Confidence Check →

FR-07 • STAGE 4 OF 6

Confidence Check

You've rebuilt the key ideas and practiced them with guidance. Now try these short questions on your own to check your understanding before moving on.

QUICK CHECK 1**Endpoint displacement**

Use $x(t_2) - x(t_1)$.

For $x(t) = 5 - 2t$, find displacement from $t = 1$ s to $t = 4$ s.

QUICK CHECK 2**Differentiate for velocity**

Find the derivative.

For $x(t) = 2t^3 + t^2$, find v at $t = 1$ s.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Turning-point reasoning

Check the sign around the zero.

Suppose $v(t)$ changes from positive to negative as t passes through t_0 where $v(t_0) = 0$. What happens to $x(t)$?

HOW DID IT GO?

I answered ____ of 3 questions correctly.

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

You've checked your understanding.

Take one final look at the essential ideas before deciding what to do next.

Continue to Summary →

FR-08 • STAGE 5 OF 6

Summary

Before moving on, take one final look at the most important ideas from this review.

KEY TAKEAWAY 1**Displacement remains an endpoint difference**

Even for $x(t)$, use $\Delta x = x(t_2) - x(t_1)$.

KEY TAKEAWAY 2**Average velocity uses finite change**

The secant slope over an interval is $\bar{v} = \Delta x / \Delta t$.

KEY TAKEAWAY 3**Instantaneous velocity is local change**

Use $v(t) = dx/dt$; its sign gives direction and its zeros locate horizontal tangents.

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. Use each answer and explanation to check both the setup and the physical interpretation.

WARM-UP • ACTIVITY 1

Recall Activity 1

$$\Delta x = x(t_2) - x(t_1).$$

WHY IT WORKS Displacement is still final position minus initial position, even when position is given as a function.

WARM-UP • ACTIVITY 2

Recall Activity 2

$$v(t) = 6t^2 - 5.$$

WHY IT WORKS Instantaneous velocity is the derivative of position with respect to time.

WARM-UP • ACTIVITY 3

Recall Activity 3

$x(t)$ is decreasing with time; the tangent slope is negative.

WHY IT WORKS The derivative sign gives the instantaneous direction along the coordinate axis.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

$x(1) = 0 \text{ m}$, $x(4) = 21 \text{ m}$; $\Delta x = 21 \text{ m}$; $\bar{v} = 7 \text{ m/s}$.

WHY IT WORKS Evaluate position at both endpoints, subtract, then divide by the elapsed time.

PRACTICE 2

Guided Problem

$x(0) = 0 \text{ m}$, $x(2) = 2 \text{ m}$, so $\bar{v} = 1 \text{ m/s}$. $v(t) = 3t^2 - 3$, so $v(2) = 9 \text{ m/s}$.

WHY IT WORKS The secant slope over the interval and tangent slope at the endpoint describe different rates.

PRACTICE 3

Independent Problem

$v(t) = 3t(t - 2)$. Around $t = 2 \text{ s}$, v is negative just before and positive just after, so the particle reverses from negative to positive direction.

WHY IT WORKS A zero of v signals a horizontal tangent; the sign change confirms the reversal.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Endpoint displacement

$x(1) = 3 \text{ m}$, $x(4) = -3 \text{ m}$, so $\Delta x = -6 \text{ m}$.

WHY IT WORKS Displacement depends on endpoint positions, not on the form of the function between them.

QUICK CHECK 2

Differentiate for velocity

$v(t) = 6t^2 + 2t$, so $v(1) = 8 \text{ m/s}$.

WHY IT WORKS Instantaneous velocity is the derivative evaluated at the requested time.

QUICK CHECK 3

Turning-point reasoning

$x(t)$ has a local maximum at t_0 and the particle reverses from positive to negative direction.

WHY IT WORKS The derivative changes from positive slope to negative slope across the horizontal tangent.

READINESS GUIDE

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

FR-09 • STAGE 6 OF 6

Next Step: Continue Learning

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

 I'm Still Unsure Review the key ideas and examples again. Review Again →	 I Need More Practice Continue with additional practice for this topic. Go to Practice →	 I'm Ready Continue to the next recommended resource. Continue →
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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