

FULL REVIEW

Full Review — Acceleration and Constant-Acceleration Motion — Calculus-Based

Review the essential ideas, relationships, and problem-solving tools for Acceleration and Constant-Acceleration Motion.

 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-T02
TOPIC: Acceleration and Constant-Acceleration Motion
PARENT UNIT: MEC-U03 — Motion in One Dimension
COURSE LEVEL: Calculus-Based

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 the graph to the derivative.

What does the slope of a v -versus- t graph represent at a given time?

ACTIVITY 2**Recall Activity 2**

Distinguish an instantaneous value from a rate.

Can $v = 0$ while $a \neq 0$? Give a one-dimensional example.

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Use an integral interpretation.

What does the signed area under an a -versus- t graph represent?

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**Differential Definition of Acceleration**

Instantaneous acceleration is the derivative of velocity. Equivalently, it is the second derivative of position, so curvature in $x(t)$ is tied directly to acceleration.

$$\mathbf{a = dv/dt = d^2x/dt^2}$$

EXAMPLE For $x(t) = 2 + 5t - t^2$, $v(t) = 5 - 2t$ and $a(t) = -2 \text{ m/s}^2$.

SENSEI NOTE A zero slope in $x(t)$ means $v = 0$, not necessarily $a = 0$.

KEY CONCEPT 2**Integrating Constant Acceleration**

When a is constant, integrate acceleration over time to obtain velocity, then integrate velocity to obtain position. Initial conditions determine the integration constants.

$$\mathbf{v(t) = v_0 + at}$$

EXAMPLE Integrating constant a from 0 to t gives $v - v_0 = at$.

SENSEI NOTE Initial conditions are essential; integration does not determine them automatically.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Graphical and Integral Consistency

Derivative and integral views are complementary. The slope of $v(t)$ is $a(t)$, while the signed area under $a(t)$ gives Δv . Likewise, the signed area under $v(t)$ gives displacement.

$$\Delta v = \int_{t_1}^{t_2} a(t) \, dt$$

EXAMPLE For constant a , the integral reduces to $a(t_2 - t_1)$, reproducing the linear velocity relation.

SENSEI NOTE Signed area matters: portions below the time axis contribute negatively.

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**

Differentiate the position function.

A particle has $x(t) = 1 + 4t + 1.5t^2$ in SI units. Find $v(2 \text{ s})$ and a .

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Use initial conditions after integrating.

A particle has $v_0 = -3$ m/s and constant $a = +2$ m/s². Find the time when it reverses direction and the displacement up to that instant.

PRACTICE 3

Independent Problem

Connect the graph area to velocity change.

Acceleration is $+4$ m/s² from $t = 0$ to 2 s, then -2 m/s² from $t = 2$ to 5 s. If $v(0) = +1$ m/s, find $v(5$ 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

Second Derivative

Differentiate twice.

For $x(t) = 6 - 2t + 4t^2$, what are $v(t)$ and $a(t)$?

QUICK CHECK 2

Area under Acceleration

Use $\Delta v = \int a \, dt$ for constant a .

If $a = -5 \, \text{m/s}^2$ for $0.60 \, \text{s}$, what is the change in velocity?

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Piecewise Acceleration

Add signed acceleration–time areas.

Starting from $v = +2 \text{ m/s}$, acceleration is $+3 \text{ m/s}^2$ for 1 s and then -1 m/s^2 for 4 s. What is the final velocity?

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**Derivative View**

Acceleration is the local derivative dv/dt and also d^2x/dt^2 . Graph slopes encode these derivative relationships.

KEY TAKEAWAY 2**Integral View**

Integrating acceleration gives velocity change; integrating velocity gives displacement. Constant acceleration yields linear $v(t)$ and quadratic $x(t)$.

KEY TAKEAWAY 3**Slope and Area Must Agree**

Use derivatives for local rates and integrals for accumulated changes. Constant acceleration is the simplest case where both views reduce to the familiar kinematic equations.

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.

WARM-UP • ACTIVITY 1**Recall Activity 1**

Instantaneous acceleration.

WHY IT WORKS The derivative dv/dt is the slope of $v(t)$.

WARM-UP • ACTIVITY 2**Recall Activity 2**

Yes. At the top of a vertical throw, $v = 0$ momentarily while acceleration remains downward.

WHY IT WORKS Velocity can pass through zero while its derivative remains finite.

WARM-UP • ACTIVITY 3**Recall Activity 3**

The change in velocity, Δv .

WHY IT WORKS Integrating acceleration over time accumulates velocity change.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Worked Example**

$v(t) = 4 + 3t$, so $v(2) = 10 \text{ m/s}$; $a = 3 \text{ m/s}^2$.

WHY IT WORKS Differentiation converts position to velocity and then to acceleration.

PRACTICE 2**Guided Problem**

Set $0 = -3 + 2t$, so $t = 1.5 \text{ s}$. Then $\Delta x = (-3)(1.5) + \frac{1}{2}(2)(1.5^2) = -2.25 \text{ m}$.

WHY IT WORKS The reversal occurs at $v = 0$; the signed displacement follows from the integrated constant-acceleration motion.

PRACTICE 3**Independent Problem**

$\Delta v_1 = (+4)(2) = +8 \text{ m/s}$; $\Delta v_2 = (-2)(3) = -6 \text{ m/s}$. Therefore $v(5) = 1 + 8 - 6 = +3 \text{ m/s}$.

WHY IT WORKS Velocity change is the signed area under $a(t)$, so piecewise-constant intervals add algebraically.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Second Derivative

$$v(t) = -2 + 8t \text{ and } a(t) = +8 \text{ m/s}^2.$$

WHY IT WORKS The first derivative gives velocity; the second derivative gives acceleration.

QUICK CHECK 2

Area under Acceleration

$$\Delta v = (-5)(0.60) = -3.0 \text{ m/s}.$$

WHY IT WORKS For constant acceleration, the acceleration–time area is simply $a\Delta t$.

QUICK CHECK 3

Piecewise Acceleration

$$v = 2 + (3)(1) + (-1)(4) = +1 \text{ m/s}.$$

WHY IT WORKS Each interval contributes a signed Δv equal to its acceleration–time area.

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