FOCUSED REVIEW

Focused Review: Projectile Motion — Calculus-Based

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

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

After this focused review, you'll be able to…
use component methods for projectile motion, interpret circular acceleration, and combine frame-labeled velocities.

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 bundle is designed to complement the chapter listed below. Use it to reinforce key concepts, prepare for homework, or review before a quiz or exam.

TEXTBOOK: Independent Physics Sensei Unit Review **CHAPTER: MEC-U15** **TOPIC: MEC-U15 — Projectile Motion** **COURSE LEVEL: Calculus-based introductory university physics**	**BEST USED** ✓ After reading the chapter ✓ Before starting homework ✓ Before a quiz or exam

Visit Physics Sensei →

Physics Sensei is an independent educational resource for college physics review and practice.

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 — page 4** Refresh key ideas.	2 **Core Concepts — page 6** Reinforce the essentials.	3 **Guided Practice — page 7** Strengthen key skills.
4 **Confidence Check — page 8** Confirm your understanding.	5 **Summary — page 10** Remember the essentials.	6 **Next Step — page 14** 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

Write the vector solution from constant acceleration.

Given a = <0, −g> and v(0) = <v_0x, v_0y>, write v(t).

WARM-UP 2

Common Mistakes

Use a derivative to identify the apex.

What condition on y(t) locates maximum height?

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

Connect the parameterized path to its Cartesian form.

Why does eliminating t from x(t) and y(t) give a parabola?

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

Integrate the Vector Equation of Motion

Start from $d^2r/dt^2 = \langle 0, -g \rangle$. Integrate with initial conditions to obtain v(t) and r(t). This exposes component independence and the shared time parameter without relying on memorized kinematic formulas.

$$v(t) = \langle v_0 \cos\theta, v_0 \sin\theta - gt \rangle;\ r(t) = \langle x_0 + v_0 \cos\theta \cdot t, y_0 + v_0 \sin\theta \cdot t - \tfrac{1}{2}gt^2 \rangle.$$

EXAMPLE For 24.0 m/s at 40.0° from $y_0 = 1.50$ m: $r(t) = \langle 18.4t, 1.50 + 15.4t - 4.90t^2 \rangle$ m.

SENSEI NOTE The common parameter t links the independently integrated components.

KEY CONCEPT 2

Eliminate Time and Use Derivatives

Eliminate t to obtain y(x), use dy/dt = 0 or dy/dx = 0 to locate the apex, and use landing roots to determine range. The second derivative establishes the downward concavity of the ideal trajectory.

$$y(x) = y_0 + x \tan\theta - g x^2/(2v_0^2 \cos^2\theta);\ t\_top = v_0 \sin\theta/g.$$

EXAMPLE For a level 28.0 m/s, 35.0° launch, the nonzero landing root gives T = 3.28 s and R = 75.2 m.

SENSEI NOTE The Cartesian parabola is derived from the parametric equations and the constant-acceleration assumptions.

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

Guided Example

Integrate and apply initial conditions.

Given a = <0, −9.80> m/s², r(0) = <0,2.00> m, v(0) = <14.0,12.0> m/s, find r(t).

PRACTICE 2

Independent Check

Eliminate t.

Derive y(x) for a projectile launched from the origin with speed v_0 at angle θ.

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

Slope of the Trajectory

Use the chain rule for a parameterized curve.

What is dy/dx for a projectile path in terms of velocity components?

CONFIDENCE CHECK 2

Apex Classification

Use the second derivative.

Why is the point where $v_y = 0$ a maximum of y(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

Integrate Components

The full projectile solution follows from integrating the constant acceleration vector with initial conditions.

KEY TAKEAWAY 2

Use the Parametric Geometry

The common time parameter determines the tangent velocity, apex, landing roots, and parabolic y(x) trajectory.

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

WARM-UP • ACTIVITY 1

Key Ideas

$v(t) = \langle v_0x, v_0y - gt \rangle$.

WHY IT WORKS Integrate each acceleration component and apply the initial velocity.

WARM-UP • ACTIVITY 2

Common Mistakes

$dy/dt = v_\gamma = 0$, with $d^2y/dt^2 = -g < 0$ confirming a maximum.

WHY IT WORKS The apex is a stationary point of y(t) and the negative second derivative classifies it.

WARM-UP • ACTIVITY 3

Quick Application

x is linear in t while y is quadratic in t, so substituting $t \propto x$ produces an x^2 term.

WHY IT WORKS The parabola follows directly from zero horizontal acceleration and constant vertical acceleration.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

$r(t) = <14.0t, 2.00 + 12.0t - 4.90t^2> \text{ m}$.

WHY IT WORKS Integrate a to get v, integrate again to get r, and use the initial conditions for the integration constants.

PRACTICE 2

Independent Check

$y = x \tan\theta - g x^2/(2v_0^2 \cos^2\theta)$.

WHY IT WORKS Solve $x = v_0 \cos\theta \cdot t$ for t and substitute into y(t).

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Slope of the Trajectory

$dy/dx = v_y/v_x$ when $v_x \neq 0$.

WHY IT WORKS $dy/dx = (dy/dt)/(dx/dt)$.

CONFIDENCE CHECK 2

Apex Classification

Because $d^2y/dt^2 = -g < 0$.

WHY IT WORKS The negative second derivative means $y(t)$ is concave downward.

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.	Build confidence with additional practice problems.	Continue to the next topic or learning 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