FULL REVIEW

Full Review: Motion in Two Dimensions

Review the essential ideas, relationships, graphs, and algebra-based problem-solving tools for motion in two dimensions.

TIME	BEST FOR	FINISH WITH
60 minutes	A complete unit review	A readiness check

After this full review, you'll be able to…

interpret two-dimensional motion, apply algebra-based kinematics 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 60 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: Algebra-Based	BEST USED ✓ Before homework on two-dimensional kinematics ✓ Before a quiz or exam ✓ When components, launch angles, or relative velocity feel uncertain

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

6 stages • Approximately 60 minutes

1 **Warm-Up Check — page 4** Activate prior knowledge.	2 **Core Concepts — page 6** Review the essential ideas.	3 **Guided Practice — page 8** Apply what you learned.
4 **Confidence Check — page 10** Confirm your understanding.	5 **Summary — page 12** Review the key ideas.	6 **Next Step — page 16** 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

Use vector displacement to calculate average velocity.

A drone moves 12 m east and 5.0 m north in 4.0 s. Find the magnitude and direction of its average velocity.

ACTIVITY 2

Recall Activity 2

Subtract velocity vectors component by component.

Velocity changes from ⟨8.0,2.0⟩ m/s to ⟨2.0,8.0⟩ m/s in 3.0 s. Find average acceleration.

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Use independent horizontal and vertical equations.

A ball launches horizontally at 10.0 m/s from a 19.6 m ledge. Find flight time and range.

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 — page 6 →

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

Vectors, components, velocity, and acceleration

Choose x and y axes first. Resolve vectors into components, analyze components independently, then recombine them for magnitude and direction.

$$\Delta x = x_2 - x_1 \quad \bullet \quad v\_avg = \Delta x/\Delta t$$

EXAMPLE $\Delta\vec{r}=\langle\Delta x,\Delta y\rangle$ and $\vec{v}avg=\Delta\vec{r}/\Delta t$. A vector $\langle 6,8\rangle$ has magnitude 10 and angle 53.1°.

SENSEI NOTE Component signs describe axis directions; vector magnitudes are nonnegative.

KEY CONCEPT 2

Constant acceleration applies component by component

Apply constant-acceleration equations separately to x and y. One shared time connects the component motions.

$$v = v_0 + at \quad \bullet \quad \Delta x = v_0 t + \tfrac{1}{2}at^2$$

EXAMPLE $x=x_0+v_{0x}t+\frac{1}{2}a_xt^2$ and $y=y_0+v_{0y}t+\frac{1}{2}a_yt^2$. For projectiles, $a_x=0$ and $a_y=-g$.

SENSEI NOTE Do not assign separate times to the horizontal and vertical parts of one motion.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Projectile motion and relative velocity use the same vector rules

In ideal projectile motion, horizontal velocity is constant while vertical velocity changes under gravity. Relative velocities add as vectors.

slope(x–t) → v • slope(v–t) → a • area(v–t) → Δx

EXAMPLE $v_{0x}=v_0\cos\theta$, $v_{0y}=v_0\sin\theta$; $v_y=v_{0y}-gt$ For a boat, $\vec{v}_{shore}=\vec{v}_{boat/water}+\vec{v}_{water/shore}$.

SENSEI NOTE At a projectile's top, only v_y is zero; v_x and downward acceleration remain.

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 — page 8 →

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

Resolve the launch velocity, then use the shared flight time.

A projectile launches at 20.0 m/s, 30.0° above horizontal from level ground. Find flight time, maximum height, and range.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Add perpendicular relative-velocity vectors.

A boat moves north at 4.0 m/s relative to water while the river flows east at 3.0 m/s. Find velocity relative to shore.

PRACTICE 3

Independent Problem

Use vertical motion for time, then horizontal motion for range.

A ball launches horizontally at 15.0 m/s from a 44.1 m cliff. Find impact time, range, and impact speed.

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 — page 10 →

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

Identify the constant component

Use the acceleration components.

Which velocity component stays constant in ideal projectile motion, and why?

QUICK CHECK 2

Recombine components

Use magnitude and direction.

A vector has components ⟨6.0,8.0⟩ m. Find magnitude and direction above +x.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Resolve a launch vector

Use sine and cosine with the launch angle.

A projectile launches at 14.0 m/s at 45°. Find its initial velocity components.

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 — page 12 →

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

Define both axes before the algebra

Resolve all vectors in one coordinate system before substituting numbers.

KEY TAKEAWAY 2

Match each component equation to the model

Use one time variable and the correct acceleration component in each axis.

KEY TAKEAWAY 3

Use trajectories and vector checks

Check component signs, vector magnitude, direction, units, and trajectory shape.

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 16 →

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

3.25 m/s at 22.6° north of east.

WHY IT WORKS $\vec{v}_{avg}=\langle 12,5\rangle/4=\langle 3.0,1.25\rangle$ m/s, with magnitude 3.25 m/s and angle 22.6°.

WARM-UP • ACTIVITY 2

Recall Activity 2

$\langle -2.0,2.0\rangle$ m/s².

WHY IT WORKS $\vec{a}_{avg}=(\langle 2,8\rangle-\langle 8,2\rangle)/3=\langle -2,2\rangle$ m/s².

WARM-UP • ACTIVITY 3

Recall Activity 3

2.00 s; 20.0 m.

WHY IT WORKS $19.6=\frac{1}{2}gt^2$ gives $t=2.00$ s; range $=(10.0)(2.00)=20.0$ m.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

Time 2.04 s; height 5.10 m; range 35.3 m.

WHY IT WORKS $v_{0x}=17.3$ and $v_{0y}=10.0$ m/s. $T=2v_{0y}/g=2.04$ s, $H=v_{0y}^2/(2g)=5.10$ m, $R=v_{0x}T=35.3$ m.

PRACTICE 2

Guided Problem

5.0 m/s at 53.1° north of east.

WHY IT WORKS $\vec{v}_{shore}=\langle 3,4\rangle$ m/s; magnitude 5.0 m/s and angle $\tan^{-1}(4/3)=53.1°$.

PRACTICE 3

Independent Problem

3.00 s; 45.0 m; 33.0 m/s.

WHY IT WORKS $44.1=\frac{1}{2}gt^2$ gives $t=3.00$ s and $x=45.0$ m. Impact components are $\langle 15.0,-29.4\rangle$ m/s, so speed is 33.0 m/s.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Identify the constant component

v_x; because $a_x=0$.

WHY IT WORKS Zero horizontal acceleration means the horizontal velocity component is constant.

QUICK CHECK 2

Recombine components

10.0 m at 53.1°.

WHY IT WORKS Magnitude $\sqrt{(6^2+8^2)}=10.0$ m; angle $\tan^{-1}(8/6)=53.1°$.

QUICK CHECK 3

Resolve a launch vector

$v_{0x}=v_{0y}=9.90$ m/s.

WHY IT WORKS $v_0\cos45°=v_0\sin45°=9.90$ m/s.

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	**I Need More Practice**	**I'm Ready**
Review the key ideas and examples again.	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