

FULL REVIEW

Full Review — Two-Dimensional Kinematics with Components — Calculus-Based

Review the essential ideas, relationships, and problem-solving tools for Two-Dimensional Kinematics with Components.

 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 Two Dimensions here →](#)

RESOURCE: Physics Sensei Topic Review
TOPIC ID: MEC-U04-T01
TOPIC: Two-Dimensional Kinematics with Components
PARENT UNIT: MEC-U04 — Motion in Two Dimensions
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**

Answer before revealing the response.

An 18 m/s velocity is directed 40° above $+x$. Write expressions for its horizontal and vertical components.

ACTIVITY 2**Recall Activity 2**

Answer before revealing the response.

Why must the same elapsed time be used when integrating or solving the x- and y-components of one motion?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Answer before revealing the response.

A velocity has components -5 m/s and 12 m/s. What is its speed?

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

Resolving vectors into component functions

Two-dimensional kinematics begins by expressing vectors in components along chosen axes. When θ is measured from $+x$, $v_x = v \cos \theta$ and $v_y = v \sin \theta$, with signs assigned from the actual directions. In calculus-based form, the same components become the entries of $\mathbf{v}(t) = d\mathbf{r}/dt = \langle dx/dt, dy/dt \rangle$.

$$\mathbf{v}_x = v \cos \theta; \quad \mathbf{v}_y = v \sin \theta; \quad \mathbf{v}(t) = d\mathbf{r}/dt = \langle dx/dt, dy/dt \rangle$$

EXAMPLE A 20 m/s velocity at 30° above $+x$ has components (17.3, 10.0) m/s; these are the instantaneous component rates dx/dt and dy/dt .

SENSEI NOTE Resolve the geometry before differentiating or integrating. Calculus does not change which physical components the vector has.

KEY CONCEPT 2

Component kinematics from derivatives and integrals

Velocity and acceleration are component derivatives: $\mathbf{v} = d\mathbf{r}/dt$ and $\mathbf{a} = d\mathbf{v}/dt$. Solve or integrate x and y independently over the same elapsed time. When a component acceleration is constant, integration gives the familiar constant-acceleration equations on that axis, so the calculus and algebraic descriptions are the same physics.

$$\mathbf{v}_i(t) = \mathbf{v}_i(0) + \int_0^t \mathbf{a}_i(\tau) d\tau; \quad \Delta \mathbf{r}_i(t) = \int_0^t \mathbf{v}_i(\tau) d\tau; \quad \text{if } \mathbf{a}_i \text{ is constant: } \Delta \mathbf{r}_i(t) = \mathbf{v}_i(0)t + \frac{1}{2}\mathbf{a}_i t^2$$

EXAMPLE With $v_x(0)=6$ m/s and $a_x=2$ m/s², integrating over 4 s gives $\Delta x=40$ m.

SENSEI NOTE Use component values in component equations or integrals; never substitute the total speed for an axis velocity.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Reconstructing magnitude, direction, and tangent motion

After solving velocity or displacement components, recombine them to describe the overall vector. Magnitude comes from the perpendicular components and direction comes from their signs and ratio. When $\mathbf{v} = d\mathbf{r}/dt$, that reconstructed velocity vector is tangent to the trajectory at that instant.

$$|\mathbf{v}| = \sqrt{v_x^2 + v_y^2}; \quad \tan \theta = v_y / v_x; \quad \mathbf{v} = d\mathbf{r}/dt$$

EXAMPLE Velocity components $(-6, 8)$ m/s give speed 10 m/s and a direction in quadrant II; the vector is the tangent velocity at that instant.

SENSEI NOTE An inverse-tangent value alone does not encode the quadrant. Check component signs, then interpret the vector geometrically.

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**

Resolve the initial velocity before writing the component motion.

An object starts with speed 16 m/s at 30° above $+x$. Find $\mathbf{v}(0) = (v_x(0), v_y(0))$.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Integrate each constant acceleration component over the same 3 s interval.

Given $v(0) = \langle 4, 6 \rangle$ m/s and $a = \langle 3, -2 \rangle$ m/s², find the displacement vector Δr after 3 s.

PRACTICE 3

Independent Problem

Update the component velocity, then reconstruct its magnitude.

Given $v(0) = \langle 2, 10 \rangle$ m/s and $a = \langle 1, -3 \rangle$ m/s², find $v(2$ s) and the speed at $t=2$ 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**Component decomposition**

Resolve the vector before applying calculus.

A 25 m/s velocity has $\cos \theta = 0.80$ and $\sin \theta = 0.60$. Find its components.

QUICK CHECK 2**Shared-time component displacement**

Integrate the constant component accelerations over one interval.

$v(0) = \langle 3, -1 \rangle$ m/s and $a = \langle 2, 4 \rangle$ m/s². Find Δr after 2 s.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Magnitude and quadrant

Recombine the instantaneous components.

A velocity is $v = (-9, 12)$ m/s. Find the speed and identify the quadrant of its direction.

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

Resolve and represent components first

A magnitude-angle vector becomes signed x- and y-components; vector functions use those same components.

KEY TAKEAWAY 2

Differentiate or integrate each axis with one shared time

$\mathbf{v} = d\mathbf{r}/dt$ and $\mathbf{a} = d\mathbf{v}/dt$ act componentwise; constant acceleration integrates to the usual one-dimensional equations on each axis.

KEY TAKEAWAY 3

Recombine for magnitude, direction, and physical meaning

After solving the components, recover the overall vector; an instantaneous velocity obtained from $d\mathbf{r}/dt$ is tangent to the 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 →

ANSWER KEY • CHECK AFTER ATTEMPTING

Solutions and Explanations

Use these solutions to check your reasoning—not only your final answer. Compare your approach with the concise reasoning below.

WARM-UP • ACTIVITY 1

Recall Activity 1

Horizontal expression: $18 \cos 40^\circ$; vertical expression: $18 \sin 40^\circ$.

WHY IT WORKS Resolve the vector using trigonometric ratios defined by the angle from +x; the resulting components are the entries used by $\mathbf{v}(t)$.

WARM-UP • ACTIVITY 2

Recall Activity 2

Elapsed time must be the same for both component equations or integrals describing the same event interval.

WHY IT WORKS One physical motion has one time parameter t , even though its x - and y -components evolve independently.

WARM-UP • ACTIVITY 3

Recall Activity 3

Speed = $\sqrt{(-5)^2 + 12^2} = 13 \text{ m/s}$.

WHY IT WORKS The speed is the magnitude of the instantaneous velocity vector formed from perpendicular components.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Worked Example** $v(0) = (13.9, 8.0) \text{ m/s}$.

WHY IT WORKS Resolve the 16 m/s vector before writing any derivative or integral relation for the component motion.

PRACTICE 2**Guided Problem** $\Delta r = (25.5, 9.0) \text{ m}$.WHY IT WORKS For constant acceleration, component integration gives $\Delta r = v(0)t + \frac{1}{2}at^2$ over the same 3 s interval.**PRACTICE 3****Independent Problem** $v(2) = (4, 4) \text{ m/s}$; speed = $\sqrt{4^2 + 4^2} \approx 5.66 \text{ m/s}$.WHY IT WORKS Integrate a over 2 s to update each velocity component, then take the vector magnitude.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1**Component decomposition**

Components are $\langle 20, 15 \rangle$ m/s.

WHY IT WORKS Use the supplied cosine and sine values to resolve the 25 m/s vector before any component calculus.

QUICK CHECK 2**Shared-time component displacement**

$\Delta r = \langle 10, 6 \rangle$ m.

WHY IT WORKS Integrating constant acceleration yields $\Delta r = v(0)t + \frac{1}{2}at^2$ component by component, using the same 2 s interval.

QUICK CHECK 3**Magnitude and quadrant**

Speed = 15 m/s; the direction lies in quadrant II.

WHY IT WORKS Magnitude comes from $\sqrt{v_x^2 + v_y^2}$; the negative x- and positive y-components determine quadrant II.

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.

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