

FULL REVIEW

Full Review: Rolling Motion

Review the essential ideas, relationships, and problem-solving tools for rolling motion.

 TIME 45–60 minutes	 BEST FOR A complete topic review	 FINISH WITH A readiness check
---	---	--

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 Unit Review is an independent learning resource. Use it to reinforce key concepts, prepare for homework, or review before a quiz or exam.

RESOURCE: Physics Sensei Unit Review **UNIT ID:** MEC-U22
TOPIC: Rolling Motion **COURSE LEVEL:** Algebra-Based

BEST USED

- ✓ After learning the unit
- ✓ 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**Key Ideas**

Write the no-slip relations for speed and tangential acceleration.

Write a short response: Write the no-slip relations for speed and tangential acceleration.

ACTIVITY 2**Common Mistakes**

What kinetic-energy term is often forgotten in rolling problems?

Write a short response: What kinetic-energy term is often forgotten in rolling problems?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Quick Application

A wheel has $R = 0.25 \text{ m}$ and $\omega = 8.0 \text{ rad/s}$. Find v_{cm} .

Write a short response: A wheel has $R = 0.25 \text{ m}$ and $\omega = 8.0 \text{ rad/s}$. Find v_{cm} .

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

No-Slip Kinematics

Pure rolling imposes $v_{cm} = \omega R$ and $a_{cm} = \alpha R$. These equations let you convert between linear and angular variables.

$$v_{cm} = \omega R \quad ; \quad a_{cm} = \alpha R$$

EXAMPLE If $R = 0.30 \text{ m}$ and $\omega = 10 \text{ rad/s}$, then $v_{cm} = 3.0 \text{ m/s}$.

SENSEI NOTE Use the same radius that connects the center to the contact point.

KEY CONCEPT 2

Energy and Rolling Acceleration

With $I = kMR^2$, energy and dynamics depend on k . For an object rolling down an incline without slipping, $a = g \sin\theta / (1 + k)$.

$$I = kMR^2 \quad ; \quad a = g \sin\theta / (1 + k)$$

EXAMPLE Solid cylinder: $k = 1/2$, so $a = (2/3)g \sin\theta$.

SENSEI NOTE Do not cancel rotational inertia; it is what distinguishes shapes.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Force and Torque Method

On an incline, use $Mg \sin\theta - f = Ma$ and $fR = I\alpha$ together with $a = \alpha R$. With $I = kMR^2$, these equations give $a = g \sin\theta / (1+k)$ and the required static friction magnitude.

$$Mg \sin\theta - f = Ma \quad ; \quad fR = I\alpha \quad ; \quad a = \alpha R$$

EXAMPLE For a solid cylinder, $f = (1/3)Mg \sin\theta$ uphill and $a = (2/3)g \sin\theta$.

SENSEI NOTE The sign of friction follows from your chosen axis and the tendency to slip; solve consistently rather than memorizing a direction.

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**Guided Example**

A solid sphere ($k = 2/5$) rolls down a 30° incline. Find a .

A solid sphere ($k = 2/5$) rolls down a 30° incline. Find a .

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Independent Check

A hoop rolls from rest through a vertical drop h . Find its speed in terms of g and h .

A hoop rolls from rest through a vertical drop h . Find its speed in terms of g and h .

PRACTICE 3

Independent Problem

A solid cylinder rolls without slipping down a 30° incline. Find a and the static-friction magnitude.

A solid cylinder rolls without slipping down a 30° incline. Find a and the static-friction magnitude.

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**Cylinder Speed**

Solve or explain without looking back.

A solid cylinder starts from rest and drops through height h . Write v at the bottom.

QUICK CHECK 2**Incline Acceleration**

Solve or explain without looking back.

For $I = kMR^2$, write the no-slip acceleration down an incline.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Friction Magnitude

Solve or explain without looking back.

For a solid cylinder on an incline, what fraction of $Mg \sin\theta$ is the static-friction magnitude?

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

Constraint

Use $v_{cm} = \omega R$ and $a_{cm} = \alpha R$ to connect translation and rotation.

KEY TAKEAWAY 2

Shape Factor

The factor k in $I = kMR^2$ controls the energy split and acceleration.

KEY TAKEAWAY 3

Force and Torque Method

On an incline, use $Mg \sin\theta - f = Ma$ and $fR = I\alpha$ together with $a = \alpha R$.

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. Replace each placeholder with a concise answer and the essential explanation.

WARM-UP • ACTIVITY 1

Key Ideas

$v_{cm} = \omega R$ and $a_{cm} = \alpha R$.

WHY IT WORKS $v_{cm} = \omega R$ and $a_{cm} = \alpha R$.

WARM-UP • ACTIVITY 2

Common Mistakes

The rotational term $\frac{1}{2} I \omega^2$.

WHY IT WORKS The rotational term $\frac{1}{2} I \omega^2$.

WARM-UP • ACTIVITY 3

Quick Application

2.0 m/s.

WHY IT WORKS 2.0 m/s.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

$$a = g \sin 30^\circ / (1 + 2/5) = 4.9/1.4 = 3.5 \text{ m/s}^2.$$

WHY IT WORKS $a = g \sin 30^\circ / (1 + 2/5) = 4.9/1.4 = 3.5 \text{ m/s}^2.$

PRACTICE 2

Independent Check

$$mgh = 1/2 Mv^2 + 1/2(MR^2)(v^2/R^2) = Mv^2, \text{ so } v = \sqrt{(gh)}.$$

WHY IT WORKS $mgh = 1/2 Mv^2 + 1/2(MR^2)(v^2/R^2) = Mv^2, \text{ so } v = \sqrt{(gh)}.$

PRACTICE 3

Independent Problem

$$a = (2/3)g \sin 30^\circ = 3.27 \text{ m/s}^2. \text{ Using } fR = I\alpha \text{ gives } f = (1/3)Mg \sin 30^\circ = Mg/6, \text{ directed uphill.}$$

WHY IT WORKS $a = (2/3)g \sin 30^\circ = 3.27 \text{ m/s}^2. \text{ Using } fR = I\alpha \text{ gives } f = (1/3)Mg \sin 30^\circ = Mg/6, \text{ directed uphill.}$

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Cylinder Speed

$$v = \sqrt{(4gh/3)}.$$

WHY IT WORKS $v = \sqrt{(4gh/3)}.$

QUICK CHECK 2

Incline Acceleration

$$a = g \sin\theta / (1 + k).$$

WHY IT WORKS $a = g \sin\theta / (1 + k).$

QUICK CHECK 3

Friction Magnitude

$$\text{One third: } f = (1/3)Mg \sin\theta.$$

WHY IT WORKS One third: $f = (1/3)Mg \sin\theta.$

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 →
--	---	---

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](https://www.physicssensei.com)