FULL REVIEW

Full Review: Friction, Inclines, and Connected Objects — Foundational

Review the essential ideas, relationships, and problem-solving tools for Friction, Inclines, and Connected Objects.

◷ TIME	◎ BEST FOR	✓ FINISH WITH
45–60 minutes	A complete topic review	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 • TOPIC ALIGNMENT

Topic Alignment

This bundle is aligned to the approved Physics Sensei topic specification below. Use it to recover the topic structure, reinforce key decisions, and confirm readiness for the next study task.

TEXTBOOK: Independent Physics Sensei Unit Review **CHAPTER: Mechanics • MEC-U17** **TOPIC: Friction, Inclines, and Connected Objects** **COURSE LEVEL: Foundational**	**BEST USED** **✓ After reading the chapter** **✓ Before starting homework** **✓ Before a quiz or exam**

Review Prerequisites →

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 — 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

Classify the friction model before calculating.

A box rests on a rough horizontal floor while a small horizontal push is applied and the box does not move. Is the friction static or kinetic?

ACTIVITY 2

Recall Activity 2

Choose incline components and the normal force.

A block rests on a fixed incline. Which component of weight pulls it down the slope?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Identify the shared constraint in a connected system.

Two blocks are joined by one taut ideal rope over a pulley. If one block speeds up by moving 0.20 m, how far does the other end of the rope move?

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

Friction is a contact response, not a preset force

Friction acts along the contact surface and opposes relative sliding or the tendency to slide. Static friction adjusts as needed up to a limiting value; kinetic friction models sliding contact.

Static: friction adjusts up to a maximum. Sliding: kinetic friction acts opposite relative motion.

EXAMPLE A 15 N push on a box that remains at rest can be balanced by 15 N of static friction even if the maximum static friction is much larger.

SENSEI NOTE Ask first: is the contact sticking or sliding? Then compute the normal force. Only after those decisions should you choose a friction equation.

KEY CONCEPT 2

Inclines are Newton’s laws in rotated axes

Choose one axis along the incline and one perpendicular to it. Gravity then separates naturally into a down-slope component and a into-the-surface component. Friction acts along the surface.

Down slope: part of weight = $mg\sin\theta$. Into slope: part of weight = $mg\cos\theta$.

EXAMPLE On a steeper incline, the down-slope part of gravity grows while the perpendicular part decreases.

SENSEI NOTE Draw the weight vector straight down first. Components are mathematical projections of weight, not additional forces.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Connected objects require separate dynamics plus one constraint

Draw a separate free-body diagram for every object. A taut ideal rope links their motions, so one object's motion determines the other's. Tension is a real force on each attached object.

Separate FBDs + shared rope motion.

EXAMPLE If a hanging mass pulls a block across a rough table, friction acts on the table block while weight drives the hanging mass.

SENSEI NOTE Do not write one giant force equation before isolating the objects. Separate free-body diagrams prevent missing friction, weight, or tension terms.

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

Test static friction first; if it cannot hold, switch to kinetic friction and solve the motion.

A box on a 25° rough incline remains at rest. Which direction does static friction act if gravity alone would make the box slide down?

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Resolve forces on the incline and keep normal and tangential equations separate.

A student pulls a sled up an incline at constant speed. Is the net force along the incline zero or nonzero?

PRACTICE 3

Independent Problem

Draw both free-body diagrams, define one positive system direction, and solve with the rope constraint.

A hanging mass pulls a block to the right across a rough table. Which forces belong on the table block's free-body diagram?

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

Static or kinetic friction check

Answer and justify briefly.

A box is motionless while a horizontal push increases from 5 N to 10 N and remains below the slipping threshold. What happens to static friction?

QUICK CHECK 2

Incline setup check

Choose the correct component or relation.

Which weight component points down a simple incline: $mg \sin\theta$ or $mg \cos\theta$?

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Connected-system check

Identify the valid statement.

Do two blocks connected by one taut ideal rope necessarily have equal net forces?

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

Friction must be classified before it is calculated

Use static friction as an adjustable force satisfying $|f_s| \le \mu_s N$. Use $\mu_s N$ only at impending slip. For sliding, use the kinetic-friction model with direction opposite relative tangential motion.

KEY TAKEAWAY 2

Rotate the axes, not the physics

On a simple incline, resolve weight into $mg \sin\theta$ along the surface and $mg \cos\theta$ perpendicular to it. Determine N from the normal equation, then write the tangential Newton's-law equation.

KEY TAKEAWAY 3

Connected systems combine separate free-body diagrams with one constraint

Write one dynamics equation per object, choose a consistent positive direction, and apply the rope-length acceleration relation. Equal tension requires the ideal single-rope model; equal acceleration does not imply equal net force.

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

WARM-UP • ACTIVITY 1

Recall Activity 1

Static friction.

WHY IT WORKS Static friction supplies only the amount needed to prevent relative slipping, up to its limiting value. Do not set $f_s=\mu_s N$ unless the contact is at impending motion.

WARM-UP • ACTIVITY 2

Recall Activity 2

The component parallel to the incline, mg sinθ.

WHY IT WORKS For a simple fixed incline, resolving weight into parallel and perpendicular components reduces the force equations to the natural directions of motion and constraint.

WARM-UP • ACTIVITY 3

Recall Activity 3

0.20 m in the corresponding constrained direction.

WHY IT WORKS The rope geometry creates the kinematic constraint. Equal acceleration magnitudes come from constant rope length, not from equal forces.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

Up the incline, opposing the tendency to slide down.

WHY IT WORKS Static friction is a feasibility test: compare the friction required for zero acceleration with the maximum available. Only after failure do you use kinetic friction.

PRACTICE 2

Guided Problem

Zero along the incline because constant speed means zero acceleration.

WHY IT WORKS Incline problems become straightforward when weight is resolved once, N is obtained from the normal equation, and friction is then placed opposite sliding.

PRACTICE 3

Independent Problem

Weight downward, normal force upward, tension toward the pulley, and kinetic friction opposite the block's sliding direction.

WHY IT WORKS The two-body equations and the one-coordinate system equation are equivalent. The advantage of separate free-body diagrams is that they also reveal the internal tension.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Static or kinetic friction check

It increases from 5 N to 10 N in the opposite direction.

WHY IT WORKS Static friction is a constraint reaction that adjusts to satisfy no-slip dynamics until the limiting value is reached.

QUICK CHECK 2

Incline setup check

$mg \sin\theta$.

WHY IT WORKS The parallel component drives sliding; the perpendicular component determines the normal force in the simple fixed-incline model.

QUICK CHECK 3

Connected-system check

No. Their accelerations are constrained, but their masses and net forces can differ.

WHY IT WORKS The rope sets a kinematic relation; Newton's second law still applies separately to each mass.

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 topic.	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.

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