FULL REVIEW

Full Review: Newton's Laws and Free-Body Diagrams

Use free-body diagrams, vector components, Newton's laws, friction, tension, and connected-system algebra to solve college-physics force problems.

◷ TIME	◎ BEST FOR	✓ FINISH WITH
45–60 minutes	A complete unit review	A readiness check

After this full review, you'll be able to…
construct complete free-body diagrams, resolve forces into components, and solve Newton's-law problems with friction, tension, and connected objects.

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 • 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-U05 — Newton's Laws and Free-Body Diagrams SCOPE: Unit Review PHYSICS LEVEL: Algebra-Based	BEST USED ✓ Before force-and-friction homework ✓ When component equations are the main challenge ✓ Before a quiz on Newton's laws and FBDs

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

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

List only forces acting on the chosen object.

A crate is pulled across a rough horizontal floor by a rope angled upward. Which forces belong on the crate's free-body diagram?

ACTIVITY 2

Recall Activity 2

Translate the diagram into vector equations.

For a system accelerating horizontally with no vertical acceleration, what equations connect the force components to acceleration?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Do not pair forces that act on the same object.

A block rests on a table. Is the block's weight the Newton's-third-law partner of the table's normal force?

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

Resolve forces before solving

After choosing axes, resolve angled forces into components and write one Newton-second-law equation per axis. Signs come from the chosen axes, not from memorized formulas.

$$\Sigma F_x = ma_x \quad \bullet \quad \Sigma F_y = ma_y$$

EXAMPLE For a pull T at angle θ above horizontal: $T_x = T\cos\theta$ and $T_y = T\sin\theta$. If vertical acceleration is zero, $N + T\sin\theta - mg = 0$.

SENSEI NOTE An angled pull changes the normal force, which can change friction. Solve the normal direction before substituting $f = \mu N$ when that model applies.

KEY CONCEPT 2

Use force models with their conditions

Weight is mg near Earth; an ideal rope transmits one tension; kinetic friction has magnitude $\mu_k N$ and opposes sliding; static friction adjusts up to $\mu_s N$.

$$f_k = \mu_k N \quad \bullet \quad f_s \le \mu_s N$$

EXAMPLE Static friction is $f_s \le \mu_s N$, not always $f_s = \mu_s N$. Equality applies only at impending slip.

SENSEI NOTE Write the inequality for static friction before assuming the limiting value.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Connected systems share constraints

For connected objects, each object has its own free-body diagram. A massless inextensible rope gives linked accelerations, and internal tensions cancel if the connected objects are treated as one larger system.

overturning moment = restoring moment

EXAMPLE For two blocks of total mass 10 kg pulled by 30 N on a frictionless floor, the system acceleration is 3.0 m/s^2. Use one block afterward to find tension.

SENSEI NOTE System-level equations often find acceleration fastest; individual-object equations then recover internal forces such as tension.

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 angled pull and update the normal force first.

A 12 kg crate is pulled with 50 N at 30° above horizontal across a floor with $\mu_k = 0.20$. Find its acceleration. Use $g = 9.8\ m/s^2$.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Use the whole system for acceleration, then one block for tension.

Blocks of 4.0 kg and 6.0 kg are connected on a frictionless horizontal surface. A 30 N horizontal force pulls the 6.0 kg block. Find the acceleration and the tension.

PRACTICE 3

Independent Problem

Resolve gravity along and perpendicular to an incline.

A 5.0 kg block slides down a 25° incline with $\mu_k = 0.15$. Find its acceleration down the incline. Use $g = 9.8\ m/s^2$.

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

Net-force calculation

Apply $\Sigma F = ma$ with signs.

An 8.0 kg box has 28 N right and 12 N left. What is its horizontal acceleration?

QUICK CHECK 2

Elevator normal force

Use acceleration sign consistently.

A 70 kg person accelerates upward at 1.2 m/s^2 in an elevator. What normal force does the floor exert? Use $g = 9.8$ m/s^2.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Static friction

Let static friction match the needed value below its maximum.

A 10 kg crate on a level floor has $\mu_s = 0.40$. A 30 N horizontal push is applied and the crate remains at rest. What is the static-friction force? Use $g = 9.8\ m/s^2$.

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

Diagram first, components second

A disciplined FBD plus declared axes determines the signs and equations.

KEY TAKEAWAY 2

Use the correct force model

Normal force, friction, and tension depend on the interaction and constraints; they are not universal constants.

KEY TAKEAWAY 3

Choose system boundaries strategically

Whole-system equations simplify acceleration; individual diagrams recover internal forces.

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

Weight, normal force, rope tension, and friction.

WHY IT WORKS All four are external interactions on the crate. The crate's velocity or acceleration is not itself a force.

WARM-UP • ACTIVITY 2

Recall Activity 2

$\Sigma F_x = ma_x$ and $\Sigma F_y = 0$.

WHY IT WORKS Newton's second law is applied component by component. Zero vertical acceleration makes the vertical force sum zero even while horizontal acceleration is nonzero.

WARM-UP • ACTIVITY 3

Recall Activity 3

No.

WHY IT WORKS Weight and normal both act on the block. Their third-law partners act on Earth and on the table, respectively.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

2.06 m/s^2 horizontally in the pull direction.

WHY IT WORKS N = mg - 50 sin30° = 117.6 - 25 = 92.6 N. Then f_k = 0.20(92.6) = 18.52 N and T_x = 50 cos30° = 43.30 N. Thus F_net,x = 24.78 N and a = 24.78/12 = 2.065 m/s^2.

PRACTICE 2

Guided Problem

a = 3.0 m/s^2; T = 12 N.

WHY IT WORKS For both blocks, a = 30/(4+6) = 3.0 m/s^2. For the 4.0 kg block alone, the only horizontal force is tension, so T = (4.0)(3.0) = 12 N.

PRACTICE 3

Independent Problem

2.81 m/s^2 down the incline.

WHY IT WORKS mg sin25° = 20.71 N down the slope; N = mg cos25° = 44.41 N; f_k = 6.66 N up the slope. Net = 14.05 N down, so a = 14.05/5.0 = 2.81 m/s^2.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Net-force calculation

2.0 m/s^2 right.

WHY IT WORKS $F_{net} = 28 - 12 = 16$ N, so $a = 16/8.0 = 2.0$ m/s^2 right.

QUICK CHECK 2

Elevator normal force

770 N upward.

WHY IT WORKS With upward positive, $N - mg = ma$. Thus $N = m(g+a) = 70(11.0) = 770$ N.

QUICK CHECK 3

Static friction

30 N opposite the push.

WHY IT WORKS The maximum static friction is $\mu_s N = 0.40(98) = 39.2$ N. Because only 30 N is needed for equilibrium, static friction is 30 N, not 39.2 N.

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