FOCUSED REVIEW

Focused Review: Gravitation — Calculus-Based

Review the most important ideas, reinforce the essential skills, and confirm you're ready to move on.

◷	◎	✓
TIME	**BEST FOR**	**FINISH WITH**
15–20 minutes	Focused review	Greater confidence

> **After this focused review, you'll be able to…**
> recognize the key concepts, reinforce your problem-solving skills, and continue with greater confidence.

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 15–20 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-U13** **TOPIC: Gravitation** **COURSE LEVEL: Calculus-Based**	**BEST USED** ✓ After reading the chapter ✓ Before starting homework ✓ Before a quiz or exam

Review Prerequisites →

Physics Sensei is an independent educational resource designed to complement independently authored Physics Sensei materials. Physics Sensei content is independently authored and organized under the approved topic architecture.

FR-03 • YOUR REVIEW PLAN

Your Review Plan

Complete these six focused stages in order. Each stage reinforces your understanding and prepares you for a final confidence check.

6 stages • Approximately 15–20 minutes

1 **Warm-Up Check — page 4** Refresh key ideas.	2 **Core Concepts — page 6** Reinforce the essentials.	3 **Guided Practice — page 7** Strengthen key skills.
4 **Confidence Check — page 8** Confirm your understanding.	5 **Summary — page 10** Remember the essentials.	6 **Next Step — page 14** Choose your next step.

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 minute to reactivate what you already know. This quick warm-up will help you focus on the most important ideas before moving on.

WARM-UP 1

Key Ideas

Recall the distance rule.

State the radial dependence of point-source field and potential.

WARM-UP 2

Common Mistakes

Separate field from force.

Write the calculus connection between V and $\vec{g}$.

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

Check the orbit model.

What conservation law underlies equal areas in equal times?

Ready to strengthen your understanding?

You've refreshed the most important ideas. Now reinforce the concepts you'll use most often.

Continue to Core Concepts — page 6 →

FR-05 • STAGE 2 OF 6

Core Concepts

Let's reinforce the most important concepts you'll need to solve problems with confidence. Focus on the ideas that appear most often in homework, quizzes, and exams.

KEY CONCEPT 1

Force and field: model, distance, direction

Use $\vec{g} = -GM\,\vec{r}/r^3$ for point sources and integrate contributions for continuous mass distributions; exploit symmetry first.

$$\vec{g} = -G\int(\vec{r}-\vec{r}')/|\vec{r}-\vec{r}'|^3\,dm.$$

EXAMPLE Far from any finite spherical or symmetric distribution, the leading field behaves like GM/r^2.

SENSEI NOTE Before calculation, mark the center, define positive direction, and draw each field or force vector.

KEY CONCEPT 2

Energy selects the orbit or escape model

Use $\vec{g} = -\nabla V$, $\varepsilon = v^2/2 - GM/r$, and $\varepsilon = -GM/(2a)$ for bound Kepler orbits. Central force conserves angular momentum.

$$\vec{g} = -\nabla V;\ \varepsilon = -GM/(2a);\ dA/dt = \text{constant}.$$

EXAMPLE For a circular orbit $a = r$, so $\varepsilon = -GM/(2r)$ and $v^2 = GM/r$.

SENSEI NOTE Use mgh only when the height change is small compared with the planet's radius. Use the general $U = -GMm/r$ otherwise.

Ready to apply these ideas?

You've reinforced the essential concepts. Now strengthen your problem-solving skills by working through a few guided examples.

Continue to Guided Practice — page 7 →

FR-06 • STAGE 3 OF 6

Guided Practice

Now apply the key concepts you've just reviewed. Work through these focused practice activities to reinforce your problem-solving skills before the final confidence check.

PRACTICE 1

Guided Example

Set up the field before calculating.

A ring has $M = 2.0\times10^{10}$ kg, $a = 3.0$ m, and point $x = 4.0$ m. Use $g_x = GMx/(x^2+a^2)^{(3/2)}$.

PRACTICE 2

Independent Check

Use the correct orbit or energy relationship.

Show that the total energy of a circular orbit is $-GMm/(2r)$.

Ready for a confidence check?

You've reinforced the essential skills through focused practice. Now confirm your understanding with two short questions.

Continue to Confidence Check — page 8 →

FR-07 • STAGE 4 OF 6

Confidence Check

You've reinforced the key concepts and practiced the essential skills. Now confirm you're ready to move forward by completing these short confidence checks.

CONFIDENCE CHECK 1

Distance and direction check

Answer without a calculator.

Why must $\vec{g}$ be zero at the exact center of a uniform ring?

CONFIDENCE CHECK 2

Energy and orbit check

Identify the valid statement.

What sign of total specific energy identifies a bound Kepler orbit?

HOW DID IT GO?

I answered ____ of 2 questions correctly.

Use the Solutions section to check your reasoning, then take one final look at the essential ideas.

You've confirmed your understanding.

Take one final look at the essential ideas before choosing your next step.

Continue to Summary — page 10 →

FR-08 • STAGE 5 OF 6

Summary

Before moving on, take one final look at the essential ideas you'll want to remember.

KEY TAKEAWAY 1

Distance, source, direction

Use center-to-center r. Field depends on the source; force also depends on the test mass. Superpose vectors.

KEY TAKEAWAY 2

Energy and orbit selection

Use U = -GMm/r for large distance changes. In circular orbit gravity is the net inward force; use energy for escape and general bound motion.

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 14 →

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

$g_r = -GM/r^2$ and $V = -GM/r$.

WHY IT WORKS Distance is center-to-center and field follows an inverse-square rule.

WARM-UP • ACTIVITY 2

Common Mistakes

$\vec{g} = -\nabla V$.

WHY IT WORKS The source sets the field; the test mass converts field to force through $\mathbf{F} = m\,\vec{g}$.

WARM-UP • ACTIVITY 3

Quick Application

Angular momentum conservation.

WHY IT WORKS Gravity remains substantial in orbit; the support force is nearly absent.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

0.0427 N/kg toward the ring plane.

WHY IT WORKS Substitution gives magnitude 0.042688 N/kg; direction is inward toward x = 0.

PRACTICE 2

Independent Check

K = GMm/(2r), U = -GMm/r, so E = K+U = -GMm/(2r).

WHY IT WORKS The circular condition $v^2 = GM/r$ determines K.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Distance and direction check

Symmetry cancels every contribution with one from the opposite side.

WHY IT WORKS Apply inverse-square scaling and vector—not scalar—addition.

CONFIDENCE CHECK 2

Energy and orbit check

Negative.

WHY IT WORKS The zero is at infinity; circular and escape results follow from force and energy respectively.

READINESS GUIDE

2 correct: You're ready to continue. • 1 correct: Review the missed idea, then continue. • 0 correct: Revisit Core Concepts or choose more practice.

FR-09 • STAGE 6 OF 6

Next Step: Continue Learning

Great work! You've completed this focused 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 focused review again to strengthen the essential concepts.	Build confidence with additional practice problems.	Continue to the next topic or learning 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