FULL REVIEW

Full Review: Gauss's Law — Algebra-Based

Review the essential ideas, relationships, and problem-solving tools for Gauss's Law.

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 • 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: EME-U03** **TOPIC: Gauss's Law** **COURSE LEVEL: Algebra-Based College Physics**	**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

Recall Activity 1

Recall the definitions and symbols used in Gauss's law.

Define electric flux, Gaussian surface, Q_{enc}, ε_0, and area vector dA.

ACTIVITY 2

Recall Activity 2

Classify statements about flux and field.

For each statement, decide whether it describes electric field, electric flux, or enclosed charge.

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Apply the enclosed-charge idea.

A closed surface encloses +6 μC, −2 μC, and +1 μC. Find Q_{enc} and predict the sign of the net flux.

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

Electric Flux

Electric flux measures how the electric field passes through a surface. For a uniform field through a flat surface, $\Phi = E A \cos \theta$. The area vector is perpendicular to the surface, so the angle is measured between E and that area vector.

$$\oint \mathbf{E} \cdot d\mathbf{A} = Q_{enc} / \varepsilon_0$$

EXAMPLE Maximum positive flux occurs when E points along the outward area vector; zero flux occurs when E is tangent to the surface.

SENSEI NOTE Flux is a scalar. A large electric field does not automatically mean a large flux; orientation and area matter.

KEY CONCEPT 2

Gauss's Law

For any closed surface, electric flux through a closed surface = Q_{enc} / ε_0. Only net enclosed charge appears on the right side. Charges outside the surface can affect E locally but contribute zero net flux through the closed surface.

$$\text{Spherical symmetry: } E(4\pi r^2) = Q_{enc} / \varepsilon_0$$

EXAMPLE If a closed surface encloses +Q and –Q, its net flux is zero even though the electric field need not be zero.

SENSEI NOTE Zero net flux does not imply zero field.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Symmetry and Gaussian Surfaces

Gauss's law becomes a powerful field-solving method when the charge distribution has enough symmetry. Standard results include spherical symmetry: $E = (1 / 4\pi\varepsilon_0)(Q_{enc} / r^2)$; an infinite line: $E = \lambda / (2\pi\varepsilon_0 r)$; and an isolated infinite sheet: $E = \sigma / (2\varepsilon_0)$.

Infinite line: $E = \lambda / (2\pi\varepsilon_0 r)$

EXAMPLE Match the Gaussian surface to the symmetry: sphere for spherical symmetry, cylinder for line symmetry, pillbox for planar symmetry.

SENSEI NOTE If E is not constant over the chosen surface and its direction is not controlled by symmetry, you generally cannot simply pull E outside the integral.

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

Use spherical symmetry to find E outside a point charge Q.

Choose a sphere of radius r centered on Q. E is radial and constant. Thus $\oint E \cdot dA = E(4\pi r^2) = Q/\varepsilon_0$*, giving* $E = (1 / 4\pi\varepsilon_0)(Q_{enc}/ r^2)$.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Use cylindrical symmetry for an infinite line charge.

Choose a cylinder of radius r and length L. The end caps contribute zero flux; the curved side gives $E(2\pi rL)$. Set this equal to $\lambda L/\varepsilon_0$ and solve.

PRACTICE 3

Independent Problem

An infinite sheet has surface charge density σ. Find the magnitude of E on either side.

Choose a thin pillbox crossing the sheet. The side contributes zero flux and the two flat faces contribute 2EA. Use $Q_{enc} = \sigma A$ and solve for E.

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

Closed Surface with No Net Charge

Explain briefly and use the relevant Gauss's-law idea.

A closed surface encloses equal positive and negative charges. What is the net flux? Can E still be nonzero on the surface?

QUICK CHECK 2

Gaussian Surface Choice

Explain briefly and use the relevant Gauss's-law idea.

For a uniformly charged infinite line, which Gaussian surface makes the symmetry useful and why?

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Conductor in Electrostatic Equilibrium

Explain briefly and use the relevant Gauss's-law idea.

What is the electric field inside the conducting material of a conductor in electrostatic equilibrium? Where does excess charge reside?

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

Flux Depends on Enclosed Charge

For a closed surface, electric flux through a closed surface = Q_{enc} / ε_0. Outside charges do not enter Q_{enc}.

KEY TAKEAWAY 2

Symmetry Determines Usefulness

Choose Gaussian surfaces that make E constant on contributing portions and give a simple angle with dA.

KEY TAKEAWAY 3

Know the Standard Symmetries

Spherical: $E = (1 / 4\pi\varepsilon_0)(Q_{enc} / r^2)$; line: $E = \lambda / (2\pi\varepsilon_0 r)$; infinite sheet: $E = \sigma / (2\varepsilon_0)$.

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. Use each explanation to compare your reasoning with the representative solution.

WARM-UP • ACTIVITY 1

Recall Activity 1

Electric flux describes field through a surface; a Gaussian surface is imaginary and closed; Q_{enc} is net charge inside; ε_0 is the permittivity of free space; dA points normal to the surface.

WHY IT WORKS These are the quantities and geometry used in the flux integral and Gauss's law.

WARM-UP • ACTIVITY 2

Recall Activity 2

Field is a vector defined at points; flux is a scalar associated with a surface; enclosed charge is the algebraic sum of charge inside a closed surface.

WHY IT WORKS Keeping these quantities distinct prevents the most common conceptual errors.

WARM-UP • ACTIVITY 3

Recall Activity 3

$Q_{enc} = +5\ \mu C$, so the net flux is positive.

WHY IT WORKS Add enclosed charges algebraically before applying Gauss's law.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

$E = (1 / 4\pi\varepsilon_0)(Q_{enc} / r^2)$

WHY IT WORKS Spherical symmetry makes E radial and constant on the Gaussian sphere.

PRACTICE 2

Guided Problem

$E = \lambda / (2\pi\varepsilon_0 r)$

WHY IT WORKS Cylindrical symmetry makes the curved surface the only contributing part.

PRACTICE 3

Independent Problem

$E = \sigma / (2\varepsilon_0)$

WHY IT WORKS Planar symmetry gives equal flux through the two flat faces of the pillbox.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Closed Surface with No Net Charge

The net flux is zero. Yes, E can still be nonzero on the surface.

WHY IT WORKS Gauss's law constrains total flux, not the local value of E.

QUICK CHECK 2

Gaussian Surface Choice

A coaxial cylinder. E is radial and has constant magnitude on the curved side, while the end-cap flux is zero.

WHY IT WORKS The symmetry reduces the closed-surface integral to $E(2\pi rL)$.

QUICK CHECK 3

Conductor in Electrostatic Equilibrium

$E = 0$ inside the conducting material in electrostatic equilibrium; excess charge resides on the surface.

WHY IT WORKS A Gaussian surface entirely inside the conductor has zero flux, consistent with no net charge in the conducting bulk.

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 →	**Go to Practice →**	**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