FULL REVIEW

Full Review — Unit Conversions and Dimensional Analysis — Calculus-Based

Review the essential ideas, relationships, and problem-solving tools for Unit Conversions and Dimensional Analysis.

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

Related Unit Review: If you need to review the complete unit material, review Units and Measurements here →

RESOURCE: Physics Sensei Topic Review TOPIC ID: MEC-U01-T01 TOPIC: Unit Conversions and Dimensional Analysis PARENT UNIT: MEC-U01 — Units and Measurements COURSE LEVEL: Calculus-Based	BEST USED ✓ After learning the topic ✓ 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

State the dimensions of velocity, acceleration, momentum, and force.

ACTIVITY 2

Recall Activity 2

Classify as dimensionally valid or invalid: $d x/dt$, $\sin(\omega t)$, $\exp(-t/\tau)$. State required parameter dimensions.

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Find the dimensions of $\int F\,dt$.

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

Factor-Label Conversion for Derived Units

Unit conversion remains algebraic even for derived quantities. Convert every base-unit factor explicitly and preserve powers in compound units.

$$1\ \text{N} = 1\ \text{kg}\cdot\text{m/s}^2$$

EXAMPLE 1 N = 1 kg·m/s²; derived-unit conversions can be expanded to base units when helpful.

SENSEI NOTE Keep dimensions and chosen units conceptually separate.

KEY CONCEPT 2

Dimensions of Derivatives and Integrals

If Q has dimensions [Q] and t has [T], then dQ/dt has [Q]/[T] and ∫Q dt has [Q][T]. This provides fast checks for rates, fluxes, impulses, and accumulated quantities.

$$[dQ/dt] = [Q]/[T] \quad \text{and} \quad [\textstyle\int Q\,dt] = [Q][T]$$

EXAMPLE F = dp/dt: [ML/T]/[T] = [ML/T²].

SENSEI NOTE The differential symbol carries the dimension of its variable.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Dimensionless Arguments and Scaling

Transcendental functions require dimensionless arguments. Dimensional reasoning can constrain the form of a relationship and the dimensions of constants, but cannot determine dimensionless coefficients.

$$[\omega t] = 1 \quad \text{and} \quad [t/\tau] = 1$$

EXAMPLE x=Ae^(–t/τ) requires [A]=[L] and [τ]=[T].

SENSEI NOTE Dimensional analysis alone cannot determine constants such as 2π.

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

Worked example: find the dimensions of $J = \int F\,dt$.

$[J]=[F][T]=[ML/T^2][T]=[ML/T]$, so impulse has momentum dimensions.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Guided problem: for $x=A\cos(\omega t+\varphi)$, determine the dimensions of A, ω, and φ.

x sets [A]=[L]. Both ωt and φ must be dimensionless, so $[\omega]=[T^{-1}]$ and [φ]=1.

PRACTICE 3

Independent Problem

Independent problem: power is $P=dE/dt$. Derive its dimensions from $[E]=[ML^2/T^2]$.

Show the dimensional algebra and state a compatible SI derived unit.

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

Impulse Dimension

Answer and justify with units or dimensions.

What are the dimensions of ∫F dt?

QUICK CHECK 2

Rate Constant

Answer and justify with units or dimensions.

For e^(–kt), what dimensions must k have?

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Power Dimension

Answer and justify with units or dimensions.

What are the dimensions of dE/dt?

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

Derived Units

Convert derived units by tracking every base-unit factor and power.

KEY TAKEAWAY 2

Calculus Dimensions

Differentiate by dividing dimensions; integrate by multiplying dimensions.

KEY TAKEAWAY 3

Dimensionless Arguments

Exponential, logarithmic, and trigonometric arguments must carry no physical dimension.

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

Recall Activity 1

[L/T], [L/T^2], [ML/T], [ML/T^2].

WHY IT WORKS The definitions and factors provide the basic vocabulary for the topic.

WARM-UP • ACTIVITY 2

Recall Activity 2

dx/dt has [L/T]; sin(ωt) and exp(–t/τ) are valid when [ω]=[T^{-1}] and [τ]=[T].

WHY IT WORKS Dimensions identify the physical type of each quantity.

WARM-UP • ACTIVITY 3

Recall Activity 3

[ML/T], matching momentum.

WHY IT WORKS The unit or dimensional algebra produces the stated result.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

[J]=[F][T]=[ML/T²][T]=[ML/T], so impulse has momentum dimensions.

WHY IT WORKS A complete setup makes every conversion or dimensional step visible.

PRACTICE 2

Guided Problem

x sets [A]=[L]. Both ωt and φ must be dimensionless, so [ω]=[T^{-1}] and [φ]=1.

WHY IT WORKS The checkpoints preserve consistency through the solution.

PRACTICE 3

Independent Problem

Show the dimensional algebra and state a compatible SI derived unit.

WHY IT WORKS The independent problem uses the same approved principles without scaffolding.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Impulse Dimension

[ML/T].

WHY IT WORKS This follows directly from the conversion or dimensional rule used in the review.

QUICK CHECK 2

Rate Constant

$[T^{-1}]$.

WHY IT WORKS The required dimensions make the expression physically meaningful.

QUICK CHECK 3

Power Dimension

$[ML^2/T^3]$.

WHY IT WORKS The dimensions of each term determine whether the expression is consistent.

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