

FULL REVIEW

Full Review: Stress, Strain, and Elasticity

Review the essential ideas, relationships, and problem-solving tools for stress, strain, and elasticity.

 TIME 45–60 minutes	 BEST FOR A complete topic review	 FINISH WITH A readiness check
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After this full review, you'll be able to...

explain the key elastic relationships, solve representative deformation problems, and interpret what the results mean physically.

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: MEC-U24
TOPIC: Stress, Strain, and Elasticity
COURSE LEVEL: Algebra-Based

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**Key Equations**

Write the axial loading relationships.

State σ , ϵ , Y , and the combined extension relation for a uniform rod.

ACTIVITY 2**Common Mistakes**

Identify the incorrect setup.

A student uses total force instead of F/A for stress and uses ΔL instead of $\Delta L/L_0$ for strain. What must be corrected?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Quick Application

Predict a design change.

For the same material, force, and length, how does doubling area affect extension?

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**Axial Stress and Strain**

Normal stress is $\sigma = F/A$ and longitudinal strain is $\epsilon = \Delta L/L_0$. In SI, σ is in pascals and ϵ is dimensionless.

$$\sigma = F/A \quad \epsilon = \Delta L/L_0$$

EXAMPLE A 1.0 kN load on $5.0 \times 10^{-4} \text{ m}^2$ gives $\sigma = 2.0 \text{ MPa}$.

SENSEI NOTE Area must be perpendicular to the axial force.

KEY CONCEPT 2**Young's Modulus and Extension**

In the linear elastic regime, $\sigma = Y\epsilon$. Combining the definitions gives $\Delta L = FL_0/(AY)$.

$$\Delta L = FL_0/(AY)$$

EXAMPLE This equation predicts how geometry and material stiffness affect elongation.

SENSEI NOTE The relation applies only while the material remains approximately linear elastic.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Shear and Bulk Response

Elastic deformation can also involve shape change and volume change. Shear modulus G links shear stress to shear strain; bulk modulus B links pressure change to fractional volume change.

$$\text{Shear: } \tau = G\gamma \quad \text{Bulk: } B = -\Delta P/(\Delta V/V)$$

EXAMPLE Large G resists shape change; large B resists compression.

SENSEI NOTE Choose Y , G , or B according to the type of deformation.

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**Guided Example**

Calculate an extension.

A steel rod has $L_0 = 2.0\text{ m}$, $A = 3.0 \times 10^{-4}\text{ m}^2$, $Y = 2.0 \times 10^{11}\text{ Pa}$, and $F = 1.2 \times 10^4\text{ N}$. Find ΔL .

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Independent Check

Find Young's modulus from measurements.

A sample has stress 6.0×10^7 Pa and strain 3.0×10^{-4} . Find Y .

PRACTICE 3

Independent Problem

Use bulk modulus.

A liquid has bulk modulus $B = 2.0 \times 10^9$ Pa. A pressure increase of 4.0×10^6 Pa is applied. Find the magnitude of the fractional volume change.

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**Rod Geometry**

Use proportional reasoning.

Keeping F and Y fixed, a rod is twice as long and has twice the area. How does ΔL compare with the original?

QUICK CHECK 2**Elastic Limit**

Interpret the model.

Why should $\sigma = Y\epsilon$ not be used beyond the linear part of a stress-strain graph?

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Shear Response

Use the correct modulus.

A block changes shape at nearly constant volume under a tangential force. Which elastic modulus is most directly relevant?

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**Axial relationships**

$\sigma = F/A$ and $\epsilon = \Delta L/L_0$ describe loading and deformation.

KEY TAKEAWAY 2**Linear elastic response**

$\sigma = Y\epsilon$ leads to $\Delta L = FL_0/(AY)$ for a uniform rod.

KEY TAKEAWAY 3**Choose the modulus**

Young's modulus describes axial stretching, shear modulus shape change, and bulk modulus volume change.

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.

WARM-UP • ACTIVITY 1

Key Equations

$$\sigma = F/A; \epsilon = \Delta L/L_0; Y = \sigma/\epsilon; \Delta L = FL_0/(AY).$$

WHY IT WORKS The combined relation follows directly from the definitions and Hooke-like linear behavior.

WARM-UP • ACTIVITY 2

Common Mistakes

Use F/A for stress and $\Delta L/L_0$ for strain.

WHY IT WORKS Both quantities normalize by geometry.

WARM-UP • ACTIVITY 3

Quick Application

Extension is halved.

WHY IT WORKS $\Delta L \propto 1/A$ for fixed F , L_0 , and Y .

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Guided Example**

$$\Delta L = 4.0 \times 10^{-4} \text{ m} = 0.40 \text{ mm.}$$

WHY IT WORKS Substitute SI values into $FL_0/(AY)$.

PRACTICE 2**Independent Check**

$$Y = 2.0 \times 10^{11} \text{ Pa.}$$

WHY IT WORKS Y is the ratio σ/ϵ in the linear region.

PRACTICE 3**Independent Problem**

$$|\Delta V|/V = \Delta P/B = 2.0 \times 10^{-3}.$$

WHY IT WORKS Bulk modulus converts pressure loading into fractional volume change.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Rod Geometry

It is unchanged.

WHY IT WORKS Doubling L_0 and A produces equal factors in numerator and denominator.

QUICK CHECK 2

Elastic Limit

The stress-strain relation is no longer proportional there.

WHY IT WORKS Y is the slope of the linear elastic portion, not a universal constant across plastic deformation.

QUICK CHECK 3

Shear Response

The shear modulus G .

WHY IT WORKS Shear loading primarily changes shape rather than length or volume.

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 Review the key ideas and examples again. Review Again →	 I Need More Practice Continue with additional practice for this topic. Go to Practice →	 I'm Ready Continue to the next recommended resource. Continue →
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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