

FULL REVIEW

Full Review: Thermal Expansion

Review thermal expansion from physical meaning through representative calculations and applications.

 TIME 45–60 minutes	 BEST FOR A complete topic review	 FINISH WITH A readiness check
---	---	--

After this full review, you'll be able to...

After this full review, you'll be able to...

explain thermal expansion, select and apply linear, area, and volume models, and analyze constrained expansion.

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: THM-U02
TOPIC: Thermal Expansion
COURSE LEVEL: Foundational 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

Expansion or contraction

For each case, state whether the object expands or contracts: heating a steel beam; cooling a glass jar.

ACTIVITY 2

Symbols

Match ΔT , α , L_0 , and ΔL with temperature change, expansion coefficient, original length, and length change.

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3**Direction**

A 2.0 m rod is heated. Predict the sign of ΔT and ΔL before calculating.

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

Temperature Change and Size

Most materials expand when heated and contract when cooled. The temperature change is $\Delta T = T_{\text{final}} - T_{\text{initial}}$. A positive ΔT usually gives a positive change in size; a negative ΔT gives contraction.

$$\Delta L = \alpha L_0 \Delta T$$

The change is small, but it matters in bridges, railroad tracks, glassware, pipes, and thermometers.

EXAMPLE A metal lid often loosens under warm water because its diameter increases slightly.

SENSEI NOTE Use the temperature change, not the final temperature.

KEY CONCEPT 2

Linear Expansion

For a rod, wire, or other long object, $\Delta L = \alpha L_0 \Delta T$. The coefficient α describes how strongly the material expands. The new length is $L = L_0 + \Delta L$.

$$\Delta A \approx 2\alpha A_0 \Delta T; \quad \Delta V \approx 3\alpha V_0 \Delta T$$

EXAMPLE A longer rail changes length more than a shorter rail made of the same material for the same ΔT .

SENSEI NOTE Heating a hole in a metal plate makes the hole larger, as if the missing material expanded too.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Area, Volume, and Constraints

Expansion occurs in every dimension. For an isotropic solid, $\Delta A \approx 2\alpha A_0 \Delta T$ and $\Delta V \approx 3\alpha V_0 \Delta T$. Liquids are commonly described with $\Delta V = \beta V_0 \Delta T$. If expansion is blocked, thermal stress can develop.

If constrained: thermal stress develops

EXAMPLE Expansion joints give structures room to change size without buckling.

SENSEI NOTE Do not assume a rigid support eliminates expansion; it replaces free expansion with stress.

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**Bridge joint**

A 12.0 m steel section has $\alpha = 12 \times 10^{-6}/^{\circ}\text{C}$ and warms by 30°C . Find its increase in length.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2**Cooling wire**

A 5.0 m aluminum wire with $\alpha = 23 \times 10^{-6}/^{\circ}\text{C}$ cools by 40°C . Find ΔL and describe the change.

PRACTICE 3**Hole in a plate**

A circular hole is cut into a metal plate. What happens to the hole when the plate is heated uniformly?

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

Signs

A rod cools from 80°C to 20°C . What are the signs of ΔT and ΔL ?

QUICK CHECK 2

Compare materials

Two equal rods experience the same ΔT . Rod A has twice the α of rod B. Compare their length changes.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Expansion gap

Why is a gap left between sections of a bridge or railway?

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

Temperature Change and Size

Most materials expand when heated and contract when cooled. The temperature change is $\Delta T = T_{\text{final}} - T_{\text{initial}}$. A positive ΔT usually gives a positive change in size; a negative ΔT gives contraction.

KEY TAKEAWAY 2

Linear Expansion

For a rod, wire, or other long object, $\Delta L = \alpha L_0 \Delta T$. The coefficient α describes how strongly the material expands. The new length is $L = L_0 + \Delta L$.

KEY TAKEAWAY 3

Area, Volume, and Constraints

Expansion occurs in every dimension. For an isotropic solid, $\Delta A \approx 2\alpha A_0 \Delta T$ and $\Delta V \approx 3\alpha V_0 \Delta T$. Liquids are commonly described with $\Delta V = \beta V_0 \Delta T$. If expansion is blocked, thermal stress can develop.

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**Expansion or contraction**

Use the definitions and relationships from the review.

WHY IT WORKS Identify the dimension, temperature change, and coefficient before calculating.

WARM-UP • ACTIVITY 2**Symbols**

Use the definitions and relationships from the review.

WHY IT WORKS Identify the dimension, temperature change, and coefficient before calculating.

WARM-UP • ACTIVITY 3**Direction**

Use the definitions and relationships from the review.

WHY IT WORKS Identify the dimension, temperature change, and coefficient before calculating.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Bridge joint**

$$\Delta L = \alpha L_0 \Delta T = (12 \times 10^{-6}/^{\circ}\text{C})(12.0 \text{ m})(30^{\circ}\text{C}) = 0.00432 \text{ m} = 4.32 \text{ mm}.$$

WHY IT WORKS The model connects fractional size change to temperature change.

PRACTICE 2**Cooling wire**

$$\Delta T = -40^{\circ}\text{C}, \text{ so } \Delta L = (23 \times 10^{-6})(5.0)(-40) \text{ m} = -0.0046 \text{ m}. \text{ The wire contracts by 4.6 mm}.$$

WHY IT WORKS The model connects fractional size change to temperature change.

PRACTICE 3**Hole in a plate**

The hole expands. Imagine the hole filled with the same material: that material would expand outward, so the boundary of the hole moves outward.

WHY IT WORKS The model connects fractional size change to temperature change.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Signs

Both are negative: $\Delta T = -60^\circ\text{C}$ and the rod contracts, so $\Delta L < 0$.

WHY IT WORKS Apply the stated approximation and interpret the sign physically.

QUICK CHECK 2

Compare materials

Rod A changes length twice as much because ΔL is proportional to α .

WHY IT WORKS Apply the stated approximation and interpret the sign physically.

QUICK CHECK 3

Expansion gap

The gap allows thermal expansion and reduces the risk of buckling or damaging stress.

WHY IT WORKS Apply the stated approximation and interpret the sign physically.

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 →
--	---	---

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