

FOCUSED REVIEW

Focused Review: Temperature and Thermal Equilibrium

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

 TIME 15–20 minutes	 BEST FOR Focused review	 FINISH WITH 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 • 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-U01
TOPIC: Temperature and Thermal Equilibrium
COURSE LEVEL: Calculus-Based University 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 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 Refresh key ideas.	2 Core Concepts Reinforce the essentials.	3 Guided Practice Strengthen key skills.
4 Confidence Check Confirm your understanding.	5 Summary Remember the essentials.	6 Next Step 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 temperature as a state variable and the equilibrium condition.

State what must be true of temperatures and net heat transfer at equilibrium.

WARM-UP 2**Common Mistakes**

Differentiate between a sensor value and its sensitivity.

For $X(T)$, identify the meanings of X , dX/dT , and ΔX .

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

Use a derivative to estimate a small temperature change.

If $dX/dT=4$ units/K and $\Delta X=12$ units, estimate ΔT .

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 →

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

Temperature as a State Variable

Temperature labels thermal state and determines the spontaneous direction of heat transfer. At equilibrium, a composite system has no temperature difference between interacting parts and therefore no net heat transfer.

At equilibrium: $T(A) = T(B)$ and net heat transfer is zero

EXAMPLE If two systems each equilibrate at 300 K with the same reference, they share the same thermal state variable.

SENSEI NOTE Zero net transfer is an equilibrium statement, not a claim that microscopic motion stops.

KEY CONCEPT 2

Thermometric Sensitivity and Linearization

A calibrated property $X(T)$ can serve as a thermometer. The derivative dX/dT is its local sensitivity. For sufficiently small changes, the tangent-line approximation converts ΔX into ΔT .

$$\Delta X \approx (dX/dT)\Delta T; \Delta T \approx \Delta X/(dX/dT)$$

EXAMPLE A resistance sensor with $dR/dT=0.385 \text{ } \Omega/\text{K}$ changes by $0.770 \text{ } \Omega$ for about a 2.00 K rise.

SENSEI NOTE Evaluate the derivative at the operating temperature when sensitivity varies with T .

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 →](#)

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**

Use a linear resistance model and its derivative.

For $R(T) = 100\ \Omega + (0.385\ \Omega/K)(T - 273.15\ K)$, find R at $293.15\ K$ and dR/dT .

PRACTICE 2**Independent Check**

Estimate uncertainty from local sensitivity.

A sensor has $dX/dT = 1.6\ \text{units/K}$ and measurement uncertainty $\pm 0.8\ \text{unit}$. Estimate the resulting temperature uncertainty.

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 →

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

Equilibrium Gradient

Interpret the derivative of temperature in space.

If T is uniform throughout an isolated object at equilibrium, what is dT/dx inside it?

CONFIDENCE CHECK 2

Nonlinear Sensitivity

Differentiate and evaluate.

For $X(T)=aT+bT^2$, write dX/dT at temperature T_0 .

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 →

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**Equilibrium Removes Temperature Differences**

A uniform equilibrium temperature gives no preferred direction for net thermal transfer within the system.

KEY TAKEAWAY 2**A Derivative Measures Local Sensor Response**

The local slope dX/dT connects a small thermometer-property change to a small temperature 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 Ideas

At equilibrium, interacting parts have equal temperature and no net heat transfer.

WHY IT WORKS Equal temperature eliminates the thermodynamic imbalance that drives net transfer.

WARM-UP • ACTIVITY 2

Common Mistakes

X is the measured property; dX/dT is its local sensitivity; ΔX is a finite measured change.

WHY IT WORKS A derivative is a rate of change evaluated locally, while ΔX is a finite change.

WARM-UP • ACTIVITY 3

Quick Application

$\Delta T \approx 12/4 = 3$ K.

WHY IT WORKS The tangent-line relation gives $\Delta T \approx \Delta X / (dX/dT)$.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

At 293.15 K, $R=107.70\ \Omega$, and $dR/dT=0.385\ \Omega/\text{K}$.

WHY IT WORKS The linear model has constant slope, and the 20 K rise adds $7.70\ \Omega$.

PRACTICE 2

Independent Check

The temperature uncertainty is approximately $\pm 0.8/1.6 = \pm 0.5\ \text{K}$.

WHY IT WORKS Uncertainty propagates inversely through the local sensitivity.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Equilibrium Gradient

$dT/dx=0$ for a uniform equilibrium temperature.

WHY IT WORKS A spatially constant temperature has zero spatial derivative.

CONFIDENCE CHECK 2

Nonlinear Sensitivity

dX/dT at T_0 is $a+2bT_0$.

WHY IT WORKS Differentiate term by term, then evaluate at the operating point.

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 Review the focused review again to strengthen the essential concepts. Review Again →	🎯 I Need More Practice Build confidence with additional practice problems. Go to Practice →	✓ I'm Ready Continue to the next topic or learning 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