

FOCUSED REVIEW

Focused Review: Heat Transfer

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
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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-U05
TOPIC: Heat Transfer
COURSE LEVEL: Calculus-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 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**

Identify the mechanism and the quantity that controls each heat-transfer mode.

Match: conduction—temperature gradient/contact; convection—bulk fluid motion; radiation—electromagnetic waves.

WARM-UP 2**Common Mistakes**

Decide whether each statement is true: radiation needs air; convection occurs in solids; conduction can occur through a wall.

Correct responses: false, false, true.

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

Classify the dominant mode for a hot pan handle, rising warm air, and sunlight warming pavement.

Conduction; convection; radiation.

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

Conduction and Thermal Resistance

Model heat transfer with gradients, boundary conditions, and fluxes. Conduction follows Fourier's law; convection is a boundary law; radiation is nonlinear in absolute temperature.

$$\text{Heat flux: } \mathbf{q} = -k\nabla T. \text{ 1-D conduction: } \dot{Q} = -kA(dT/dx). \text{ Convection: } \dot{Q} = hA(T_{\text{surface}} - T_{\text{fluid}}). \text{ Radiation: } \dot{Q} = \epsilon\sigma A(T_{\text{surface}}^4 - T_{\text{surroundings}}^4).$$

EXAMPLE For steady 1-D conduction with constant k , integrating Fourier's law gives $\dot{Q} = kA(T_{\text{hot}} - T_{\text{cold}})/L$.

SENSEI NOTE Keep the sign convention consistent: heat flows down the temperature gradient.

KEY CONCEPT 2

Convection and Thermal Radiation

Convection transfers energy with moving fluid; thermal radiation transfers energy by electromagnetic waves and can cross a vacuum.

$$\text{Heat flux: } \mathbf{q} = -k\nabla T. \text{ 1-D conduction: } \dot{Q} = -kA(dT/dx). \text{ Convection: } \dot{Q} = hA(T_{\text{surface}} - T_{\text{fluid}}). \text{ Radiation: } \dot{Q} = \epsilon\sigma A(T_{\text{surface}}^4 - T_{\text{surroundings}}^4).$$

EXAMPLE Linearizing radiation near T_m gives an effective $h_r \approx 4\epsilon\sigma T_m^3$.

SENSEI NOTE Keep the sign convention consistent: heat flows down the temperature gradient.

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

Work through one representative heat-transfer application and identify the governing mode first.

Integrate steady 1-D Fourier conduction through a plane wall of thickness L with constant k . Solution: $\dot{Q} = -kA(dT/dx) = \text{constant}$; integration gives $\dot{Q} = kA(T_1 - T_2)/L$ for $T_1 > T_2$.

PRACTICE 2

Independent Check

Solve a second application without looking at the solution.

Linearize net radiation about a mean absolute temperature T_m for a small ΔT .

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

Conduction Check

Answer briefly.

What direction does $-\nabla T$ point?

CONFIDENCE CHECK 2

Radiation/Convection Check

Answer briefly.

Give the linearized radiation coefficient near T_m .

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

Conduction depends on a temperature difference or gradient and material/geometry.

Identify the physical mechanism before choosing a model.

KEY TAKEAWAY 2

Convection uses fluid motion; radiation uses electromagnetic emission and needs no medium.

Heat-transfer rate depends on both the mechanism and the system properties.

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

Key Ideas

$\vec{q} = -k\nabla T$; the minus sign means heat flux points toward lower temperature.

WHY IT WORKS The temperature gradient points toward increasing T , opposite spontaneous heat flow.

WARM-UP • ACTIVITY 2

Common Mistakes

Conduction relates flux to an internal temperature gradient; convection relates surface flux to a fluid-surface temperature difference.

WHY IT WORKS The two equations apply in different physical regions.

WARM-UP • ACTIVITY 3

Quick Application

$$\dot{Q} = \epsilon \sigma A (T_s^4 - T_{\text{sur}}^4).$$

WHY IT WORKS Net exchange is emitted minus absorbed environmental radiation in the gray-body model.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

$\dot{Q} = -kA(dT/dx) = \text{constant}$; integration gives $\dot{Q} = kA(T_1 - T_2)/L$ for $T_1 > T_2$.

WHY IT WORKS Steady energy conservation makes the 1-D heat rate constant through the slab.

PRACTICE 2

Independent Check

$T_{\text{surface}}^4 - T_{\text{surroundings}}^4 \approx 4T_m^3(T_{\text{surface}} - T_{\text{surroundings}})$, so $\dot{Q} \approx h_r A \Delta T$ with $h_r = 4\epsilon\sigma T_m^3$.

WHY IT WORKS A first-order Taylor expansion converts the nonlinear radiation law to a local linear form.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Conduction Check

Toward decreasing temperature.

WHY IT WORKS Heat flows down the temperature field.

CONFIDENCE CHECK 2

Radiation/Convection Check

$$R = L1/(k1A) + L2/(k2A).$$

WHY IT WORKS Steady series resistances add because the same heat rate crosses each layer.

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 →
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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