

FOCUSED REVIEW

Focused Review: Entropy and the Second Law — Calculus-Based

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-U11
TOPIC: Entropy and the Second Law
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**

Write the differential definition $dS = \delta Q_{\text{rev}}/T$ and distinguish dS from the path-dependent heat differential δQ .

Write a concise response and identify the governing entropy idea.

WARM-UP 2**Common Mistakes**

Write the finite entropy change as an integral between equilibrium states.

Write a concise response and identify the governing entropy idea.

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

State the Clausius inequality for a cycle and connect strict inequality with irreversibility.

Write a concise response and identify the governing entropy idea.

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

Entropy as a state differential

Entropy is a state function with differential $dS = \delta Q_{\text{rev}}/T$ along a reversible path. For any two equilibrium states, $\Delta S = \int_1^2 \delta Q_{\text{rev}}/T$ evaluated along a convenient reversible path.

$$dS = \delta Q_{\text{rev}}/T; \quad \Delta S = \int_1^2 \delta Q_{\text{rev}}/T$$

Even if the actual process is irreversible, ΔS can be computed using any reversible path connecting the same end states.

Do not replace δQ by dQ conceptually: heat is path dependent, while entropy has an exact differential.

KEY CONCEPT 2

Entropy generation and the second law

A useful balance is $dS = \delta Q/T_b + dS_{\text{gen}}$, where T_b is the boundary temperature for heat transfer and $dS_{\text{gen}} \geq 0$. Reversible processes have $dS_{\text{gen}} = 0$.

$$dS = \delta Q/T_b + dS_{\text{gen}}, \text{ with } dS_{\text{gen}} \geq 0$$

For an isolated system $\delta Q = 0$, so $dS = dS_{\text{gen}} \geq 0$.

Entropy generation is a diagnostic of irreversibility, not an entropy "flow" across the boundary.

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**

For one mole of an ideal gas heated reversibly at constant volume from T_1 to T_2 with constant C_V , evaluate $\Delta S = \int nC_V dT/T$.

Show your reasoning clearly and include units where applicable.

PRACTICE 2**Independent Check**

A reversible isothermal ideal-gas expansion goes from V_1 to V_2 . Starting with $\delta Q_{\text{rev}} = nRT dV/V$, evaluate ΔS .

Show your reasoning clearly and include units where applicable.

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

Entropy Check

Solve or explain briefly.

Evaluate $\int$ from T_1 to T_2 of $nC_V dT/T$ for constant C_V .

CONFIDENCE CHECK 2

Entropy Check

Solve or explain briefly.

For a reversible isothermal expansion, express ΔS in terms of n , R , V_1 , and V_2 .

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

Integrate $dS = \delta Q_{\text{rev}}/T$

Entropy is a state function with differential $dS = \delta Q_{\text{rev}}/T$ along a reversible path.

KEY TAKEAWAY 2

Track entropy generation

A useful balance is $dS = \delta Q/T_b + dS_{\text{gen}}$, where T_b is the boundary temperature for heat transfer and $dS_{\text{gen}} \geq 0$.

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

$dS = \delta Q_{\text{rev}}/T$; integrating along a reversible path gives $\Delta S = \int_1^2 \delta Q_{\text{rev}}/T$.

This follows from the definition of entropy and the second-law direction criterion.

WARM-UP • ACTIVITY 2

Common Mistakes

For an isolated system, $dS = dS_{\text{gen}} \geq 0$. Reversible means $dS_{\text{gen}} = 0$.

This follows from the definition of entropy and the second-law direction criterion.

WARM-UP • ACTIVITY 3

Quick Application

The Clausius inequality is $\oint \delta Q/T \leq 0$; equality applies to a reversible cycle.

This follows from the definition of entropy and the second-law direction criterion.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Guided Example**

$$\Delta S = nC_V \int (dT/T) = nC_V \ln(T_2/T_1).$$

Check signs, absolute temperature, and whether the process is reversible or irreversible.

PRACTICE 2**Independent Check**

$$\Delta S = \int nR \, dV/V = nR \ln(V_2/V_1).$$

Check signs, absolute temperature, and whether the process is reversible or irreversible.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Entropy Check

For an isolated system, $dS = dS_{\text{gen}} \geq 0$. Reversible means $dS_{\text{gen}} = 0$.

Use the total-entropy criterion to justify the result.

CONFIDENCE CHECK 2

Entropy Check

The Clausius inequality is $\oint \delta Q/T \leq 0$; equality applies to a reversible cycle.

Use the total-entropy criterion to justify the result.

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