

FOCUSED REVIEW

Focused Review: Thermodynamic Processes and PV Diagrams — 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-U09
TOPIC: Thermodynamic Processes and PV Diagrams
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 constraints.

State the constraint for isochoric, isobaric, isothermal, and adiabatic processes using differentials or heat transfer.

WARM-UP 2**Common Mistakes**

Recall the P–V work integral and its sign.

Write W for a quasistatic path from V_1 to V_2 . What sign results for expansion?

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

Connect cycle geometry to a closed integral.

What integral represents net work over a complete P – V cycle?

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

Process constraints in differential form

A process constraint restricts the allowed changes of the state variables. For a simple compressible system, the differential first law can be written $dU = \delta Q - P dV$ when W is work done by the gas. Isochoric, isobaric, isothermal, and adiabatic constraints then simplify different terms or relations.

$$dU = \delta Q - P dV \cdot \text{isochoric: } dV = 0 \cdot \text{isobaric: } dP = 0 \cdot \text{isothermal: } dT = 0 \cdot \text{adiabatic: } \delta Q = 0$$

EXAMPLE For an isochoric process, $dV = 0$, so the $P dV$ work term vanishes.

SENSEI NOTE Heat δQ and work $P dV$ are path-dependent transfers, not state-function differentials like dU .

KEY CONCEPT 2

P–V work as a path integral

For a quasistatic path, work by the gas is obtained by integrating pressure over volume. The integral is geometrically the signed area under the curve. For a complete cycle, the closed integral gives the signed enclosed area.

$$W = \int \text{from } V_1 \text{ to } V_2 P(V) dV \cdot W_{\text{cycle}} = \oint P dV$$

EXAMPLE If P changes linearly from 3.0×10^5 Pa to 2.0×10^5 Pa while V changes from 2.0 L to 4.0 L, $W = 500$ J.

SENSEI NOTE Endpoint data alone are not enough unless the process equation $P(V)$ is known.

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**

Integrate a linear P–V path.

Pressure decreases linearly from $3.0 \times 10^5 \text{ Pa}$ at 2.0 L to $2.0 \times 10^5 \text{ Pa}$ at 4.0 L . Evaluate W .

PRACTICE 2**Independent Check**

Use the ideal-gas isothermal path.

One mole of ideal gas expands isothermally at 300 K from 10 L to 20 L . Find W using $R = 8.314 \text{ J/(mol}\cdot\text{K)}$.

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

Compression sign

Use the integration limits.

For an isothermal ideal-gas compression from V_1 to $V_2 = V_1/2$, is W by the gas positive or negative?

CONFIDENCE CHECK 2

Closed-path work

Interpret the closed integral.

A P - V loop is clockwise. What is the sign of $\oint P \, dV$?

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

Constraints define the path

Use $dV = 0$, $dP = 0$, $dT = 0$, or $\delta Q = 0$ to identify how the process is restricted.

KEY TAKEAWAY 2

Integrate pressure over volume

For quasistatic work, $W = \int P dV$; for a cycle, $\oint P dV$ gives the signed enclosed area.

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. Focus on the essential explanation behind each result.

WARM-UP • ACTIVITY 1

Key Ideas

Isochoric: $dV = 0$. Isobaric: $dP = 0$. Isothermal: $dT = 0$. Adiabatic: $\delta Q = 0$.

WHY IT WORKS These are local statements of the process constraints.

WARM-UP • ACTIVITY 2

Common Mistakes

$W = \int \text{from } V_1 \text{ to } V_2 P(V) dV$. With positive pressure, expansion $V_2 > V_1$ gives $W > 0$.

WHY IT WORKS The integration direction follows the change in volume.

WARM-UP • ACTIVITY 3

Quick Application

$W_{\text{cycle}} = \oint P dV$.

WHY IT WORKS A closed path accumulates the signed area enclosed by the loop.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

For a linear path, $W = P_{\text{avg}}\Delta V = [(3.0 + 2.0)/2 \times 10^5](2.0 \times 10^{-3}) = 500 \text{ J}$.

WHY IT WORKS The integral is the trapezoid area under the straight-line $P(V)$ path.

PRACTICE 2

Independent Check

$W = nRT \ln(V_2/V_1) = (1)(8.314)(300)\ln 2 \approx 1.73 \text{ kJ}$.

WHY IT WORKS For an isothermal ideal gas, $P = nRT/V$, so the P – V integral produces a logarithm.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Compression sign

Negative: $W = nRT \ln(1/2) < 0$.

WHY IT WORKS Compression has $V_2 < V_1$, making the logarithm and the work by the gas negative.

CONFIDENCE CHECK 2

Closed-path work

Positive.

WHY IT WORKS The clockwise orientation gives positive signed enclosed area for work by the gas.

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