

FULL REVIEW

Full Review: Thermodynamic Processes and PV Diagrams — Algebra-Based

Review the essential ideas, relationships, and problem-solving tools for Thermodynamic Processes and PV Diagrams.

 TIME 45–60 minutes	 BEST FOR A complete topic review	 FINISH WITH A readiness check
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After this full review, you'll be able to...

recall the essential ideas, apply them to representative problems, and determine what to study next.

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-U09
TOPIC: Thermodynamic Processes and PV Diagrams
COURSE LEVEL: Algebra-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 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**Recall Activity 1**

Connect each process name to its algebraic constraint.

State the defining condition for isochoric, isobaric, isothermal, and adiabatic processes.

ACTIVITY 2**Recall Activity 2**

Verify the work units you will use.

Show why $\text{Pa} \cdot \text{m}^3$ has units of joules, and state the conversion from liters to cubic meters.

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Read a rectangular cycle.

A P - V rectangle is traversed clockwise. Which horizontal segment contributes positive work, which contributes negative work, and what is the sign of the net work?

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

Process constraints determine useful equations

Classify the path before calculating. Constant volume makes boundary work zero. Constant pressure makes work a rectangle, $P\Delta V$. For an ideal gas at constant temperature, PV is constant. An adiabatic process has no heat transfer.

$$\text{Isochoric: } W = 0 \cdot \text{Isobaric: } W = P\Delta V \cdot \text{Isothermal ideal gas: } P_1V_1 = P_2V_2 \cdot \text{Adiabatic: } Q = 0$$

EXAMPLE An ideal gas expanding isothermally from 2.0 L to 6.0 L drops from 2.4×10^5 Pa to 8.0×10^4 Pa.

SENSEI NOTE A path can have changing pressure and changing volume; do not force a constant-pressure formula onto a curved path.

KEY CONCEPT 2

Calculate work from P–V geometry

Work by the gas is the signed area under the P–V path. For a constant-pressure path, $W = P\Delta V$. Vertical constant-volume segments have zero work. For simple piecewise paths, calculate the area of each segment and add with signs.

$$\text{Constant pressure: } W = P\Delta V \cdot \text{Expansion: } W > 0 \cdot \text{Compression: } W < 0$$

EXAMPLE At 1.5×10^5 Pa, expansion from 2.0 L to 5.0 L gives $W = 450$ J.

SENSEI NOTE Always convert L to m^3 before using pressure in pascals.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Use enclosed area for simple cycles

A closed cycle returns the gas to its starting state. For a rectangular cycle, the magnitude of net work is $\Delta P \Delta V$. The direction sets the sign: clockwise is positive work by the gas; counterclockwise is negative.

$$\text{Rectangular cycle: } |W_{\text{net}}| = \Delta P \Delta V; \text{ clockwise} \rightarrow W_{\text{net}} > 0$$

EXAMPLE A cycle spanning 1.0×10^5 to 3.0×10^5 Pa and 2.0 to 5.0 L has area 600 J; clockwise gives +600 J.

SENSEI NOTE The enclosed area is net work, not the work on every individual segment.

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**Worked Example**

Calculate one constant-pressure expansion completely.

A gas expands at $1.5 \times 10^5 \text{ Pa}$ from 2.0 L to 5.0 L . Find W .

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Compare two paths with the same volume change.

A gas expands by 3.0 L. Path A stays at 3.0×10^5 Pa; Path B stays at 1.0×10^5 Pa. Calculate both works and compare.

PRACTICE 3

Independent Problem

Calculate a simple cycle from its dimensions.

A clockwise rectangular cycle spans pressures 1.0×10^5 Pa to 3.0×10^5 Pa and volumes 2.0 L to 5.0 L. Find W_{net} .

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

Constant-pressure work

Calculate in SI units.

At $2.0 \times 10^5 \text{ Pa}$, a gas expands from 1.0 L to 4.0 L. Find W .

QUICK CHECK 2

Isothermal pressure

Use the ideal-gas isothermal relation.

$P_1 = 3.0 \times 10^5 \text{ Pa}$, $V_1 = 2.0 \text{ L}$, and $V_2 = 5.0 \text{ L}$. Find P_2 for an isothermal process.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Cycle sign

Use both area and direction.

A rectangular P - V cycle is traversed counterclockwise. What is the sign of W_{net} by the gas?

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**Process constraints simplify the model**

Classify the path first, then apply the relationship that matches the constraint.

KEY TAKEAWAY 2**P–V area has energy units**

Use SI units so pressure times volume gives joules; horizontal work is $P\Delta V$ and vertical work is zero.

KEY TAKEAWAY 3**Cycle area gives net work**

For a rectangular cycle, the magnitude is $\Delta P\Delta V$. Clockwise is positive work by the gas; counterclockwise is negative.

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

Recall Activity 1

Isochoric: $\Delta V = 0$. Isobaric: $\Delta P = 0$. Isothermal: $\Delta T = 0$. Adiabatic: $Q = 0$.

WHY IT WORKS The constraint determines which relationships simplify.

WARM-UP • ACTIVITY 2

Recall Activity 2

$\text{Pa} \cdot \text{m}^3 = (\text{N}/\text{m}^2)\text{m}^3 = \text{N} \cdot \text{m} = \text{J}$. Also, $1 \text{ L} = 10^{-3} \text{ m}^3$.

WHY IT WORKS P–V area is an energy only when consistent SI units are used.

WARM-UP • ACTIVITY 3

Recall Activity 3

The rightward high-pressure segment is positive, the leftward low-pressure segment is negative, and the net work is positive.

WHY IT WORKS The positive expansion area is larger than the negative compression area.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Worked Example**

$$\Delta V = 3.0 \times 10^{-3} \text{ m}^3. W = P\Delta V = (1.5 \times 10^5)(3.0 \times 10^{-3}) = 450 \text{ J}.$$

WHY IT WORKS A horizontal path has constant pressure, so its P–V area is a rectangle.

PRACTICE 2**Guided Problem**

Path A: 900 J. Path B: 300 J. Path A does 600 J more work.

WHY IT WORKS For the same ΔV , $W = P\Delta V$ is proportional to pressure.

PRACTICE 3**Independent Problem**

$$\Delta P = 2.0 \times 10^5 \text{ Pa and } \Delta V = 3.0 \times 10^{-3} \text{ m}^3. \text{ The area is 600 J, so } W_{\text{net}} = +600 \text{ J}.$$

WHY IT WORKS For a rectangle, the enclosed area is $\Delta P\Delta V$, and clockwise sets a positive sign.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Constant-pressure work

$$W = (2.0 \times 10^5)(3.0 \times 10^{-3}) = 600 \text{ J.}$$

WHY IT WORKS The volume increases by $3.0 \text{ L} = 3.0 \times 10^{-3} \text{ m}^3$.

QUICK CHECK 2

Isothermal pressure

$$P_2 = P_1 V_1 / V_2 = 1.2 \times 10^5 \text{ Pa.}$$

WHY IT WORKS At fixed temperature for a fixed amount of ideal gas, PV is constant.

QUICK CHECK 3

Cycle sign

Negative.

WHY IT WORKS Compression occurs at higher pressure than expansion, so the signed enclosed area is negative.

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 →
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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