

FULL REVIEW

Full Review: First Law of Thermodynamics — Algebra-Based

Review the essential ideas, relationships, and problem-solving tools for First Law of Thermodynamics.

 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-U08
TOPIC: First Law of Thermodynamics
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**

Apply the sign convention

For W defined as work done by the system, assign signs when a gas absorbs 420 J and is compressed with 160 J of work done on it.

ACTIVITY 2**Recall Activity 2**

Rearrange the first law

Rearrange $\Delta U = Q - W$ to solve for Q .

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

PV work units

Show that $\text{Pa}\cdot\text{m}^3$ has units of joules.

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**First-Law Energy Balance**

Use $\Delta U = Q - W$ with W as work done by the system. $Q > 0$ for heat absorbed, $Q < 0$ for heat released, $W > 0$ for expansion work, and $W < 0$ when work is done on the system.

$$\Delta U = Q - W$$

EXAMPLE If $Q = 900 \text{ J}$ and $W = 350 \text{ J}$, $\Delta U = 550 \text{ J}$.

SENSEI NOTE Write the signs before inserting numbers.

KEY CONCEPT 2**State Function vs. Path Transfers**

Internal energy U is a state function: ΔU depends only on initial and final states. Q and W depend on the process path, even though $Q - W$ must equal the same ΔU between fixed endpoints.

$$\Delta U = U_2 - U_1 \quad (\text{path independent})$$

EXAMPLE Two paths can have different Q and W but the same ΔU .

SENSEI NOTE Do not treat Q or W as properties of a state.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Pressure-Volume Work

For constant external pressure, $W = P \Delta V$. More generally, work is associated with the area under a P-V path. Expansion gives positive work by the gas.

$$W = P\Delta V \quad (\text{constant pressure})$$

EXAMPLE At 2.5×10^5 Pa, an expansion of 3.0×10^{-3} m³ gives $W = 750$ J.

SENSEI NOTE Convert liters to cubic meters before multiplying by pressure.

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**

A gas absorbs 1.20 kJ and does 450 J of work. Calculate ΔU .

Convert 1.20 kJ to 1200 J and apply $\Delta U = Q - W$.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

A gas is compressed at constant pressure 1.8×10^5 Pa from 6.0 L to 3.5 L while 220 J of heat leaves the gas. Find ΔU .

Compute $\Delta V = -2.5 \text{ L} = -2.5 \times 10^{-3} \text{ m}^3$, then $W = P \Delta V$.

PRACTICE 3

Independent Problem

A process raises internal energy by 500 J while the gas expands from 2.0 L to 5.0 L at 1.0×10^5 Pa. Find Q.

Find $W = P \Delta V$, then use $Q = \Delta U + W$.

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

Compression balance

Solve using the first law and the stated sign convention.

$Q = -100 \text{ J}$ and $W = -350 \text{ J}$. Find ΔU .

QUICK CHECK 2

Solve for work

Solve using the first law and the stated sign convention.

$Q = 700 \text{ J}$ and $\Delta U = 480 \text{ J}$. Find W .

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

PV work

Solve using the first law and the stated sign convention.

A gas expands 4.0 L at 2.0×10^5 Pa. Find W .

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**First-law equation**

$\Delta U = Q - W$ with W defined as work done by the system.

KEY TAKEAWAY 2**State and path**

ΔU is state-dependent only; Q and W depend on the process.

KEY TAKEAWAY 3**PV calculations**

Use $W = P \Delta V$ at constant pressure and track the sign of ΔV .

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

Recall Activity 1

$$Q = +420 \text{ J and } W = -160 \text{ J.}$$

WHY IT WORKS Work done on the system corresponds to negative work done by the system.

WARM-UP • ACTIVITY 2

Recall Activity 2

$$Q = \Delta U + W.$$

WHY IT WORKS Move $-W$ to the other side.

WARM-UP • ACTIVITY 3

Recall Activity 3

$$\text{Pa} \cdot \text{m}^3 = (\text{N}/\text{m}^2)\text{m}^3 = \text{N} \cdot \text{m} = \text{J.}$$

WHY IT WORKS Pressure-volume work is an energy.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Worked Example**

$$\Delta U = 1200 \text{ J} - 450 \text{ J} = 750 \text{ J}.$$

WHY IT WORKS Keep all energy quantities in the same unit.

PRACTICE 2**Guided Problem**

$$W = -450 \text{ J}; Q = -220 \text{ J}; \Delta U = -220 - (-450) = 230 \text{ J}.$$

WHY IT WORKS Compression makes W negative in the work-by-system convention.

PRACTICE 3**Independent Problem**

$$W = 300 \text{ J}; Q = 800 \text{ J}.$$

WHY IT WORKS Heat input supplies both the internal-energy increase and expansion work.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Compression balance

$$\Delta U = 250 \text{ J.}$$

WHY IT WORKS $\Delta U = -100 - (-350).$

QUICK CHECK 2

Solve for work

$$W = 220 \text{ J.}$$

WHY IT WORKS $W = Q - \Delta U.$

QUICK CHECK 3

PV work

$$W = 800 \text{ J.}$$

WHY IT WORKS $4.0 \text{ L} = 4.0 \times 10^{-3} \text{ m}^3$, so $W = P \Delta V.$

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