

FULL REVIEW

Full Review: First Law of Thermodynamics — Foundational

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: Foundational

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**

Energy-transfer signs

Use the convention W = work done by the system. If 200 J of heat enters a gas and the gas does 50 J of work, is Q positive or negative? Is W positive or negative?

ACTIVITY 2**Recall Activity 2**

Internal energy change

A system receives 300 J of heat and does no work. What happens to its internal energy?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Compression intuition

A gas is compressed while no heat is exchanged. Does its internal energy tend to increase or decrease?

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**The First Law**

Energy conservation for a thermodynamic system is $\Delta U = Q - W$, where W is work done by the system. Heat added to the system is positive Q ; heat leaving is negative Q .

$$\Delta U = Q - W$$

EXAMPLE If $Q = 500 \text{ J}$ and $W = 120 \text{ J}$, then $\Delta U = 380 \text{ J}$.

SENSEI NOTE Choose and state one sign convention before calculating; most sign mistakes come from switching conventions.

KEY CONCEPT 2**Heat and Work Are Transfers**

Internal energy is a property of the system. Heat and work are ways energy crosses the system boundary; a system does not "contain heat" or "contain work."

$$\Delta U = U_2 - U_1$$

EXAMPLE A hot object can have high internal energy, but heat refers to energy transferred because of a temperature difference.

SENSEI NOTE Ask what crosses the boundary and in which direction.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Work and Volume Change

For a simple expansion at constant pressure, work done by the gas is $W = P \Delta V$. Expansion gives positive W ; compression gives negative W .

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

EXAMPLE At $P = 2.0 \times 10^5 \text{ Pa}$ and $\Delta V = 0.0010 \text{ m}^3$, $W = 200 \text{ J}$.

SENSEI NOTE A pressure-volume product has units of joules.

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 650 J of heat and does 180 J of work. Find ΔU .

Use $\Delta U = Q - W$. Substitute $Q = 650 \text{ J}$ and $W = 180 \text{ J}$.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

A gas releases 150 J of heat while it is compressed. The work done by the gas is -400 J. Find ΔU .

Assign signs first, then apply the first law.

PRACTICE 3

Independent Problem

The internal energy increases by 600 J while the gas does 200 J of work. Find Q.

Rearrange $\Delta U = Q - W$ to $Q = \Delta U + W$.

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

Sign of compression

Solve using the first law and the stated sign convention.

An adiabatic compression has $Q = 0$ and $W = -90 \text{ J}$. Find ΔU .

QUICK CHECK 2

Heat needed

Solve using the first law and the stated sign convention.

A system has $\Delta U = 250 \text{ J}$ and does 75 J of work. Find Q .

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Constant-pressure work

Solve using the first law and the stated sign convention.

A gas expands by 0.0020 m^3 at $1.5 \times 10^5 \text{ Pa}$. 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**Energy accounting**

Use $\Delta U = Q - W$ with a declared sign convention.

KEY TAKEAWAY 2**Boundary transfers**

Heat and work describe energy crossing the boundary, not stored quantities.

KEY TAKEAWAY 3**Expansion work**

At constant pressure, $W = P \Delta V$; expansion is positive and compression negative for work by the system.

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 is positive and W is positive.

WHY IT WORKS Energy entering as heat makes $Q > 0$; expansion work done by the system makes $W > 0$.

WARM-UP • ACTIVITY 2

Recall Activity 2

The internal energy increases by 300 J.

WHY IT WORKS With $W = 0$, the first law gives $\Delta U = Q$.

WARM-UP • ACTIVITY 3

Recall Activity 3

Increase.

WHY IT WORKS Compression means work is done on the gas, so W by the system is negative and $\Delta U = -W$ is positive.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Worked Example**

$$\Delta U = 650 \text{ J} - 180 \text{ J} = 470 \text{ J}.$$

WHY IT WORKS Energy entered as heat, but some left as work.

PRACTICE 2**Guided Problem**

$$\Delta U = -150 \text{ J} - (-400 \text{ J}) = 250 \text{ J}.$$

WHY IT WORKS Compression transfers more energy into the gas than the heat loss removes.

PRACTICE 3**Independent Problem**

$$Q = 600 \text{ J} + 200 \text{ J} = 800 \text{ J}.$$

WHY IT WORKS The incoming heat must supply both the internal-energy increase and the work output.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Sign of compression

$$\Delta U = 90 \text{ J.}$$

WHY IT WORKS $\Delta U = 0 - (-90 \text{ J}).$

QUICK CHECK 2

Heat needed

$$Q = 325 \text{ J.}$$

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

QUICK CHECK 3

Constant-pressure work

$$W = 300 \text{ J.}$$

WHY IT WORKS $W = P \Delta V = (1.5 \times 10^5)(0.0020).$

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