

FULL REVIEW

Full Review: Phase Changes and Latent Heat

Review the essential ideas, relationships, and problem-solving tools for phase changes and latent heat.

 TIME 45–60 minutes	 BEST FOR A complete topic review	 FINISH WITH A readiness check
---	---	--

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-U04
TOPIC: Phase Changes and Latent Heat
COURSE LEVEL: Calculus-based introductory physics

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 phase change to an energy function.

At a first-order phase transition at fixed pressure, why can added energy fail to increase T ?

ACTIVITY 2**Recall Activity 2**

Distinguish sensible and latent contributions.

Write a general expression for heating a mass through a temperature interval when c may depend on T , and the expression for a phase change.

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Interpret a heating curve as a piecewise energy relation.

What does $dT/dQ = 0$ indicate on an idealized heating-curve plateau?

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

Latent Heat as a Discrete Energy Contribution

For a mass crossing a phase boundary at fixed transition conditions, the phase-change contribution is $Q = mL$. In a thermodynamic description at fixed pressure, the latent heat corresponds to an enthalpy change per unit mass between coexisting phases. The reverse transition has the opposite heat-transfer sign for the system.

$$Q_{\text{phase}} = mL; \text{ at fixed } p, L = \Delta h \text{ per unit mass}$$

EXAMPLE For 0.050 kg vapor condensing with $L_v = 2260 \text{ kJ/kg}$, $Q_{\text{system}} = -113 \text{ kJ}$ if heat into the system is positive.

SENSEI NOTE Keep the system sign convention separate from the positive tabulated magnitude L .

KEY CONCEPT 2

Piecewise Heating Paths

A path that remains within one phase has $Q = m \int c(T) dT$ when c varies with temperature. Crossing a phase boundary adds mL . A complete heating path is therefore a sum of continuous sensible-heat integrals and discrete latent-heat terms.

$$Q_{\text{total}} = m \sum \int c_i(T) dT + m \sum L_j$$

EXAMPLE Solid below $T_m \rightarrow$ melt at $T_m \rightarrow$ heat liquid: $Q = m \int_{\text{solid}} c(T) dT + mL_f + m \int_{\text{liquid}} c(T) dT$.

SENSEI NOTE Do not integrate through the phase transition with a single smooth $c(T)$ model unless the model explicitly includes two-phase behavior.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Phase Boundaries and Pressure Dependence

A phase diagram represents coexistence curves in state space. Crossing a coexistence curve changes the stable phase. Transition temperatures depend on pressure, so the latent-heat event occurs at the boundary appropriate to the imposed pressure. The triple point marks three-phase coexistence, while the critical point ends the liquid–vapor coexistence curve.

At coexistence, the two phases share the same T and p ; the transition path is constrained by the phase boundary.

EXAMPLE Changing pressure shifts where a constant-pressure heating path intersects the liquid–vapor boundary.

SENSEI NOTE Do not confuse a heating curve (energy path) with a phase diagram (state stability map).

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**

Evaluate a latent-heat term with a sign convention.

A 0.040 kg liquid sample vaporizes with $L_v = 2.26 \times 10^6$ J/kg. Find Q_{system} if heat into the system is positive.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Set up a piecewise integral-plus-latent calculation.

Write the expression for heating mass m from $T_1 < T_m$ to $T_2 > T_m$ when $c_s(T)$ and $c_l(T)$ may vary with T and the sample melts at T_m .

PRACTICE 3

Independent Problem

Solve a mixed sensible/latent path.

A 0.100 kg solid is heated from 250 K to its melting point 300 K with constant $c_s = 500\text{ J}/(\text{kg}\cdot\text{K})$, melted with $L_f = 1.50 \times 10^5\text{ J/kg}$, then heated as a liquid to 320 K with $c_l = 700\text{ J}/(\text{kg}\cdot\text{K})$. Find Q_{total} .

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**Latent-Heat Sign**

Use the system sign convention.

If a vapor condenses at constant pressure, what is the sign of Q_{system} when heat into the system is positive?

QUICK CHECK 2**General Piecewise Form**

Write the symbolic expression.

Write Q for heating from T_1 to T_2 across one melting transition when c is constant within each phase.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Plateau Interpretation

Explain in thermodynamic terms.

What changes microscopically during an idealized phase-change plateau while T remains constant?

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

Latent heat is a discrete phase-transition term

Use $Q = mL$ at the phase boundary, with the sign set by the system energy-transfer convention.

KEY TAKEAWAY 2

General heating paths are piecewise

Combine $m\int c(T)dT$ within phases with mL at phase transitions.

KEY TAKEAWAY 3

State path and phase map answer different questions

A heating curve tracks energy along a path; a phase diagram identifies stable phases and boundaries in T - p space.

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

The energy changes phase fraction and intermolecular potential energy; enthalpy changes while temperature remains at the transition value.

WHY IT WORKS At coexistence, energy can convert one phase into the other rather than raise kinetic temperature.

WARM-UP • ACTIVITY 2

Recall Activity 2

$$Q_{\text{sensible}} = m \int c(T) dT; Q_{\text{latent}} = mL.$$

WHY IT WORKS Integration handles temperature-dependent heat capacity; latent heat is a discrete phase-transition contribution.

WARM-UP • ACTIVITY 3

Recall Activity 3

Energy is being added without changing temperature, indicating a phase transition in the idealized model.

WHY IT WORKS The plateau is the latent-heat interval of the path.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

$$Q_{\text{system}} = mL_v = (0.040)(2.26 \times 10^6) = 9.04 \times 10^4 \text{ J} = 90.4 \text{ kJ}.$$

WHY IT WORKS Vaporization requires energy input, so Q_{system} is positive with this convention.

PRACTICE 2

Guided Problem

$$Q = m \int [T_1 \rightarrow T_m] c_s(T) dT + mL_f + m \int [T_m \rightarrow T_2] c_l(T) dT.$$

WHY IT WORKS The phase transition is a discrete energy term between two single-phase integrals.

PRACTICE 3

Independent Problem

$$Q_1 = 0.100(500)(50) = 2500 \text{ J}; Q_2 = 0.100(1.50 \times 10^5) = 15000 \text{ J}; Q_3 = 0.100(700)(20) = 1400 \text{ J}; Q_{\text{total}} = 18900 \text{ J} = 18.9 \text{ kJ}.$$

WHY IT WORKS The process has three distinct physical stages that must be summed.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Latent-Heat Sign

Q_{system} is negative; the system releases the latent heat.

WHY IT WORKS Condensation is the reverse of vaporization.

QUICK CHECK 2

General Piecewise Form

$$Q = mc_s(T_m - T_1) + mL_f + mc_l(T_2 - T_m).$$

WHY IT WORKS The path contains solid heating, melting, and liquid heating.

QUICK CHECK 3

Plateau Interpretation

The phase fraction and intermolecular potential-energy structure change while average kinetic temperature remains fixed.

WHY IT WORKS Latent heat drives the reorganization between phases.

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 →
--	---	---

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