FULL REVIEW

Full Review: Springs and Elastic Potential Energy

Review the essential ideas, relationships, and problem-solving tools for springs and elastic potential energy using the Foundational treatment.

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

After this full review, you'll be able to…

explain restoring-force direction, compare spring stiffness, track elastic potential energy, and reason about energy changes between turning points and equilibrium.

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

Use this independent Physics Sensei Unit Review to reinforce key concepts, prepare for homework, or review before a quiz or exam.

RESOURCE: Physics Sensei Unit Review **UNIT: MEC-U18** **TOPIC: Springs and Elastic Potential Energy** **COURSE LEVEL: College introductory physics • Foundational**	**BEST USED** ✓ **After learning the topic** ✓ Before starting homework ✓ Before a quiz or exam

Explore Physics Sensei Reviews →

Physics Sensei is an independent educational resource. This Unit Review uses Physics Sensei-owned organization, examples, explanations, and practice.

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 — page 4** Activate prior knowledge.	2 **Core Concepts — page 6** Review the essential ideas.	3 **Guided Practice — page 8** Apply what you learned.
4 **Confidence Check — page 10** Confirm your understanding.	5 **Summary — page 12** Review the key ideas.	6 **Next Step — page 16** 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

Restoring Force Direction

Use equilibrium as the reference.

A spring is stretched to the right of equilibrium. Which direction does the spring force point?

ACTIVITY 2

Force and Energy

Separate direction from stored energy.

A spring is compressed and then stretched by the same distance. Which case stores more elastic potential energy?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Turning Points

Connect motion and energy.

At maximum compression of an ideal horizontal spring system, what is the object's instantaneous speed?

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 — page 6 →

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

Restoring Force and Spring Stiffness

An ideal spring exerts a restoring force toward equilibrium. The magnitude grows with deformation, and a larger spring constant k means a stiffer spring. At equilibrium, x = 0 and the spring force is zero.

Fs = -kx; |Fs| = k|x|; at equilibrium x = 0, so Fs = 0.

EXAMPLE A spring stretched to the right pulls left; compressed to the left, it pushes right.

SENSEI NOTE The negative sign describes direction, not a force that is always numerically negative.

KEY CONCEPT 2

Elastic Potential Energy

A deformed ideal spring stores elastic potential energy. Stretching and compressing by the same magnitude store the same energy. Because the energy depends on x^2, doubling deformation quadruples the stored energy.

Us = (1/2)kx^2; equal |x| gives equal stored energy; doubling |x| quadruples Us.

EXAMPLE If a deformation doubles from x to 2x, the stored spring energy becomes four times larger.

SENSEI NOTE Do not give spring potential energy the sign of x. Energy is a scalar.

KEY CONCEPT 3

Energy Transformations and Turning Points

In an ideal horizontal spring system, elastic potential energy and kinetic energy trade back and forth while total mechanical energy remains constant. At maximum deformation, speed is zero; at equilibrium, spring energy is minimum and speed can be maximum.

$K_i + U_{s,i} = K_f + U_{s,f}$ for an ideal horizontal spring system; at a turning point $v = 0$.

EXAMPLE A released compressed spring transfers stored elastic energy into kinetic energy as it moves toward equilibrium.

SENSEI NOTE Zero spring force at equilibrium does not mean zero speed.

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 — page 8 →

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

Identify direction before magnitude.

A spring is stretched 0.080 m to the right. Without calculating, state the spring-force direction and explain how the force changes if the stretch is doubled.

PRACTICE 2

Guided Problem

Compare spring energy using proportional reasoning.

Two identical springs are deformed by x and 2x. Compare their stored elastic potential energies.

PRACTICE 3

Independent Problem

Track energy at special positions.

For a frictionless horizontal spring-block system, compare kinetic and spring potential energy at maximum extension and at equilibrium.

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 — page 10 →

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

Restoring Direction

State the physical direction.

A spring is compressed to the left of equilibrium. Where does the spring force point?

QUICK CHECK 2

Energy Scaling

Use the squared dependence.

A spring's deformation triples. By what factor does its elastic potential energy change?

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Equilibrium vs. Turning Point

Distinguish force, speed, and energy.

Which is zero at equilibrium: spring force, speed, or total mechanical energy?

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 — page 12 →

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

Force Points Toward Equilibrium

The spring force opposes displacement and increases in magnitude with deformation.

KEY TAKEAWAY 2

Energy Depends on Deformation Squared

Elastic potential energy is $\frac{1}{2}kx^2$, so equal stretch and compression store equal energy.

KEY TAKEAWAY 3

Turning Points and Equilibrium Are Different

At maximum deformation speed is zero; at equilibrium spring force and spring energy are minimum.

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 — page 16 →

ANSWER KEY • CHECK AFTER ATTEMPTING

Solutions and Explanations

Use these solutions to check your reasoning—not only your final answer. Use each answer and explanation to identify the step that supports the result.

WARM-UP • ACTIVITY 1

Recall Activity 1

Left, toward equilibrium.

WHY IT WORKS The spring force is restoring: it points opposite the displacement.

WARM-UP • ACTIVITY 2

Recall Activity 2

They store the same elastic potential energy.

WHY IT WORKS Elastic potential energy depends on x^2, so equal-magnitude compression and extension store equal energy.

WARM-UP • ACTIVITY 3

Recall Activity 3

Zero.

WHY IT WORKS Maximum compression is a turning point, so the object is momentarily at rest.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

The force points left; doubling the stretch doubles the force magnitude.

WHY IT WORKS Hooke's law is linear in displacement magnitude, and the force always points toward equilibrium.

PRACTICE 2

Guided Problem

The second spring stores four times as much energy.

WHY IT WORKS Because $U_s \propto x^2$, $(2x)^2/x^2 = 4$.

PRACTICE 3

Independent Problem

At maximum extension: $K = 0$ and U_s is maximum. At equilibrium: U_s is minimum and K is maximum.

WHY IT WORKS Mechanical energy is transferred between kinetic and elastic forms while the total remains constant.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Equilibrium vs. Turning Point

To the right, toward equilibrium.

WHY IT WORKS The restoring force always opposes displacement.

QUICK CHECK 2

Check Spring Energy Reasoning

It increases by a factor of 9.

WHY IT WORKS $U_s \propto x^2$, so $3^2 = 9$.

QUICK CHECK 3

Equilibrium vs. Turning Point

The spring force is zero; speed need not be zero.

WHY IT WORKS At equilibrium $x = 0$, so $F_s = 0$ and U_s is minimum. In ideal motion, speed can be maximum.

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	**I Need More Practice**	**I'm Ready**
Review the key ideas and examples again.	Continue with additional practice for this topic.	Continue to the next recommended resource.
Review again: return to Warm-Up Check on page 4.	**Go to Practice →**	**Continue →**

RECOMMENDED LINKS

Review again: return to Warm-Up Check on page 4.

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