

FULL REVIEW

Full Review — Work and the Work–Energy Theorem — Calculus-Based

Review the essential ideas, relationships, and problem-solving tools for Work and the Work–Energy Theorem.

 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 Topic Review is an independent learning resource. Use it to reinforce key concepts, prepare for homework, or review before a quiz or exam.

Related Unit Review: If you need to review the complete unit material, review [Work, Energy, and Power here →](#)

RESOURCE: Physics Sensei Topic Review
TOPIC ID: MEC-U06-T01
TOPIC: Work and the Work–Energy Theorem
PARENT UNIT: MEC-U06 — Work, Energy, and Power
COURSE LEVEL: Calculus-Based

BEST USED

- ✓ After learning the topic
- ✓ 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**

Answer before revealing the response.

Write the differential form of work and the corresponding path integral for total work.

ACTIVITY 2**Recall Activity 2**

Answer before revealing the response.

What does a negative contribution to the integral of $F(x) dx$ mean physically?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Answer before revealing the response.

Evaluate the setup, not the arithmetic: what integral gives the work for $F(x) = kx$ from $x = 0$ to $x = A$?

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**Work from a Force Field**

Infinitesimal work is the dot product of force with an infinitesimal displacement. Integrating along the actual path accumulates the signed energy transfer. In one dimension, the line integral reduces to a definite integral over position.

$$W = \int F \cdot dr$$

EXAMPLE For $F(x) = ax$, work from 0 to L is one-half aL^2 .

SENSEI NOTE The path and limits are part of the physics; write them before integrating.

KEY CONCEPT 2**The Work–Energy Theorem**

Integrating the net force along the path gives the net work, and that net work equals the change in kinetic energy. This is the integral energy form of Newton's second-law dynamics.

$$W_{net} = \Delta K$$

EXAMPLE If the net-work integral is +18 J, the final kinetic energy is 18 J greater than the initial value.

SENSEI NOTE The theorem requires net work, so include every force that contributes along the path.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Kinetic Energy as the Endpoint Quantity

Kinetic energy depends only on the endpoint speed and mass. The work–energy theorem therefore converts a potentially position-dependent force problem into a relation between an integral along the path and endpoint kinetic energies.

$$K = \frac{1}{2} m v^2$$

EXAMPLE After finding the final kinetic energy, solve the kinetic-energy expression for the endpoint speed.

SENSEI NOTE Do not confuse a force-position integral with an impulse, which integrates force over time.

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**

Integrate a variable force over position.

A force is $F(x) = 4x^3$ N from $x = 0$ to $x = 2$ m. Find the work done.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Use the net-force integral to update kinetic energy.

A 1.5 kg particle begins with 12 J of kinetic energy. The net force is $F(x) = 2x + 1$ N from $x = 0$ to $x = 3$ m. Find the final kinetic energy.

PRACTICE 3

Independent Problem

Solve for final speed after evaluating the work integral.

Using the final kinetic energy from the previous problem, find the particle's final speed.

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**Signed Work Integral**

Solve independently before checking the solution.

Find the work done by $F(x) = 10 - 2x$ N from $x = 0$ to $x = 4$ m.

QUICK CHECK 2**Net Work and Kinetic Energy**

Solve independently before checking the solution.

A particle starts with 6 J of kinetic energy and receives +14 J of net work. What is its final kinetic energy?

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Endpoint Speed

Solve independently before checking the solution.

A 4.0 kg particle has 32 J of kinetic energy. What is its speed?

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**Work Is a Path Integral**

Integrate the force component along the actual displacement path to calculate work for variable forces.

KEY TAKEAWAY 2**Net Work Equals the Kinetic-Energy Change**

The net-work integral equals the change in kinetic energy, making the theorem valid beyond constant-force cases.

KEY TAKEAWAY 3**Kinetic Energy Connects the Integral to Speed**

Once the work integral is evaluated, kinetic energy provides the direct link to the endpoint speed.

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

Differential work is force dotted with differential displacement; total work is its line integral along the path.

WHY IT WORKS The dot product and path integral define work for a general force along motion.

WARM-UP • ACTIVITY 2

Recall Activity 2

It means that force component removes kinetic energy over that part of the path.

WHY IT WORKS A negative integrand contributes negative work and removes energy.

WARM-UP • ACTIVITY 3

Recall Activity 3

Integrate $kx \, dx$ from 0 to A.

WHY IT WORKS The position dependence determines the integrand and the endpoints determine the limits.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Worked Example**

16 J.

WHY IT WORKS Integrating $4x^3$ gives x^4 , evaluated from 0 to 2.

PRACTICE 2**Guided Problem**

The work is 12 J, so the final kinetic energy is 24 J.

WHY IT WORKS Integrate the net force over position, then add that work to the initial kinetic energy.

PRACTICE 3**Independent Problem**

About 5.66 m/s.

WHY IT WORKS Solve the kinetic-energy expression for speed using the final energy.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Signed Work Integral

24 J.

WHY IT WORKS The definite integral of $10 - 2x$ from 0 to 4 gives 24 J.

QUICK CHECK 2

Net Work and Kinetic Energy

20 J.

WHY IT WORKS Positive net work increases kinetic energy by the same amount.

QUICK CHECK 3

Endpoint Speed

4.0 m/s.

WHY IT WORKS Rearrange kinetic energy to solve for speed.

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