

FOCUSED REVIEW

Focused Review — Significant Figures and Measurement Uncertainty — Calculus-Based

Review the most important ideas, reinforce the essential skills, and confirm you're ready to move on.

 TIME 15–20 minutes	 BEST FOR Focused review	 FINISH WITH Greater confidence
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After this focused review, you'll be able to...

recognize the key concepts, reinforce your problem-solving skills, and continue with greater confidence.

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 15–20 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 [Units and Measurements here →](#)

RESOURCE: Physics Sensei Topic Review
TOPIC ID: MEC-U01-T02
TOPIC: Significant Figures and Measurement
Uncertainty
PARENT UNIT: MEC-U01 — Units and Measurements
COURSE LEVEL: Calculus-Based College Physics

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 focused stages in order. Each stage reinforces your understanding and prepares you for a final confidence check.

6 stages • Approximately 15–20 minutes

1 Warm-Up Check Refresh key ideas.	2 Core Concepts Reinforce the essentials.	3 Guided Practice Strengthen key skills.
4 Confidence Check Confirm your understanding.	5 Summary Remember the essentials.	6 Next Step Choose your next step.

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 minute to reactivate what you already know. This quick warm-up will help you focus on the most important ideas before moving on.

WARM-UP 1**Key Ideas**

Answer before revealing the response.

For $y = x^2$, does a fixed Δx create a larger or smaller Δy as x increases? Explain using the graph or slope.

WARM-UP 2**Common Mistakes**

Answer before revealing the response.

$A = \pi r^2$. Which mathematical quantity tells you how sensitive A is to a small change in r ?

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

Answer before revealing the response.

Why should a final numerical answer not display many more digits than its propagated uncertainty supports?

Ready to strengthen your understanding?

You've refreshed the most important ideas. Now reinforce the concepts you'll use most often.

Continue to Core Concepts →

FR-05 • STAGE 2 OF 6

Core Concepts

Let's reinforce the most important concepts you'll need to solve problems with confidence. Focus on the ideas that appear most often in homework, quizzes, and exams.

KEY CONCEPT 1

First-Order Propagation with a Derivative

For a derived quantity depending on one measured variable, the derivative estimates how a small input uncertainty maps into an output uncertainty. This is a local linear approximation and is most appropriate when the uncertainty is small compared with the scale over which the function changes strongly.

$$\text{For } y = f(x), \Delta y \approx |dy/dx| \Delta x$$

EXAMPLE For $A = \pi r^2$ at $r = 2.00 \pm 0.01$ m, the radius uncertainty produces an area uncertainty controlled by the local slope of $A(r)$.

SENSEI NOTE The derivative determines sensitivity; the number of calculator digits does not.

KEY CONCEPT 2

Independent Uncertainties in Several Variables

When a result depends on several independently measured variables, each variable contributes through its own sensitivity. Independent random contributions are commonly combined in quadrature rather than simply added.

$$\Delta f \approx \sqrt{[(\partial f / \partial x) \Delta x]^2 + (\partial f / \partial y) \Delta y]^2}$$

EXAMPLE For $f = xy$, uncertainty contributions come from uncertainty in x and uncertainty in y , weighted by the corresponding partial derivatives.

SENSEI NOTE Use linear addition only when the stated model or worst-case analysis calls for it; independent random uncertainties are usually combined differently.

Ready to apply these ideas?

You've reinforced the essential concepts. Now strengthen your problem-solving skills by working through a few guided examples.

[Continue to Guided Practice →](#)

FR-06 • STAGE 3 OF 6

Guided Practice

Now apply the key concepts you've just reviewed. Work through these focused practice activities to reinforce your problem-solving skills before the final confidence check.

PRACTICE 1**Guided Example**

Propagate through a Square

For $y = x^2$ with $x = 4.00 \pm 0.03$, estimate y and its uncertainty.

PRACTICE 2**Independent Check**

Two-Variable Estimate

For $f = xy$ with $x = 2.00 \pm 0.02$ and $y = 5.00 \pm 0.05$, estimate the independent combined uncertainty using partial-derivative contributions.

Ready for a confidence check?

You've reinforced the essential skills through focused practice. Now confirm your understanding with two short questions.

Continue to Confidence Check →

FR-07 • STAGE 4 OF 6

Confidence Check

You've reinforced the key concepts and practiced the essential skills. Now confirm you're ready to move forward by completing these short confidence checks.

CONFIDENCE CHECK 1

Sensitivity Direction

Interpret the derivative.

If $|df/dx|$ doubles while Δx is unchanged, what happens to the first-order contribution to Δf ?

CONFIDENCE CHECK 2

Report Consistently

Match digits to uncertainty.

If a computed value is 3.141592 with uncertainty about 0.03, which report is more sensible: 3.141592 ± 0.03 or 3.14 ± 0.03 ?

HOW DID IT GO?

I answered ____ of 2 questions correctly.

Use the Solutions section to check your reasoning, then take one final look at the essential ideas.

You've confirmed your understanding.

Take one final look at the essential ideas before choosing your next step.

[Continue to Summary →](#)

FR-08 • STAGE 5 OF 6

Summary

Before moving on, take one final look at the essential ideas you'll want to remember.

KEY TAKEAWAY 1**Derivatives Measure Sensitivity**

Use derivatives or partial derivatives to determine how input uncertainty influences a derived quantity.

KEY TAKEAWAY 2**Uncertainty Controls Reporting**

After propagation, round the uncertainty sensibly and report the central value to a matching decimal place.

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

Key Ideas

Larger, because the slope magnitude of x^2 grows as x increases.

WHY IT WORKS The same horizontal uncertainty spans a larger vertical interval where the function is steeper.

WARM-UP • ACTIVITY 2

Common Mistakes

The derivative dA/dr .

WHY IT WORKS It gives the local change in area per unit change in radius.

WARM-UP • ACTIVITY 3

Quick Application

Because those digits suggest precision that the measurement model does not support.

WHY IT WORKS Propagated uncertainty sets the meaningful reporting scale.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Guided Example**

$y = 16.00$. The local sensitivity magnitude is 8.00, giving $\Delta y \approx 0.24$, so report about 16.00 ± 0.24 .

WHY IT WORKS The result follows the reporting rule emphasized in the corresponding practice item.

PRACTICE 2**Independent Check**

The contributions are $5.00(0.02)=0.10$ and $2.00(0.05)=0.10$; quadrature gives about 0.14, so $f \approx 10.00 \pm 0.14$.

WHY IT WORKS The result follows the reporting rule emphasized in the corresponding practice item.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Sensitivity Direction

It doubles.

WHY IT WORKS This check tests whether the stated precision matches the measurement or calculation rule being used.

CONFIDENCE CHECK 2

Report Consistently

3.14 ± 0.03 is consistent; the extra digits are not supported by the uncertainty.

WHY IT WORKS This check tests whether the stated precision matches the measurement or calculation rule being used.

READINESS GUIDE

2 correct: You're ready to continue. • 1 correct: Review the missed idea, then continue. • 0 correct: Revisit Core Concepts or choose more practice.

FR-09 • STAGE 6 OF 6

Next Step: Continue Learning

Great work! You've completed this focused review. Choose the next resource that best matches how confident you feel.

? I'm Still Unsure Review the focused review again to strengthen the essential concepts. Review Again →	🎯 I Need More Practice Build confidence with additional practice problems. Go to Practice →	✓ I'm Ready Continue to the next topic or learning 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