FOCUSED REVIEW

Focused Review: Damping, Driving, and Resonance — Algebra-Based

Review the highest-leverage ideas about damping, driving, and resonance using the Algebra-Based treatment.

◷ TIME	◎ BEST FOR	✓ FINISH WITH
15–20 minutes	Focused review	Greater confidence

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

calculate damping and response quantities, compare driving and natural frequencies, and interpret resonance quantitatively.

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 Unit Review supports MEC-U10 — Damping, Driving, and Resonance. Use it to reinforce concepts, prepare for homework, or review before a quiz or exam.

UNIT: MEC-U10 **TOPIC: Damping, Driving, and Resonance** **TREATMENT: Algebra-Based** **RESOURCE: Physics Sensei Unit Review**	**BEST USED** ✓ After reading the chapter ✓ Before starting homework ✓ Before a quiz or exam

Explore Physics Sensei →

Physics Sensei is an independent physics learning resource. This review uses original Physics Sensei organization, explanations, examples, and practice.

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

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

Compute the natural angular frequency.

A 2.0 kg mass is attached to a 50 N/m spring. Find ω_0.

WARM-UP 2

Common Mistakes

Compare b with critical damping.

For the same system, find b_c and classify b = 8.0 N·s/m.

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

Use amplitude decay.

If amplitude follows $A = A_0e^{\wedge}(-\gamma t)$ with $\gamma = 0.40\ s^{-1}$, what fraction remains after 2.0 s?

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 — page 6 →

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

Free Damping: ω_0, b_c, and Decay

For a mass-spring oscillator, $\omega_0 = \sqrt{(k/m)}$. With viscous damping Fd = -bv, critical damping is b_c = $2\sqrt{(km)}$. In the underdamped regime the amplitude envelope decays exponentially with $\gamma = b/(2m)$, while mechanical energy decays twice as fast in the exponent.

$$v = dr/dt;\ a = dv/dt;\ v_{0x} = v_0 \cos(\theta);\ v_{0y} = v_0 \sin(\theta);\ x = x_0 + v_{0x} t;\ y = y_0 + v_{0y} t - (1/2)gt^2.$$

EXAMPLE For m = 2.0 kg, k = 50 N/m, b = 4.0 N·s/m: ω_0 = 5.0 rad/s, b_c = 20 N·s/m, and γ = 1.0 s^{-1}.

SENSEI NOTE Do not use the amplitude decay factor for energy; energy is proportional to amplitude squared.

KEY CONCEPT 2

Driven Response and Resonance

For F = $F_0 \cos(\omega t)$, the steady-state displacement amplitude is $A = F_0/\sqrt{[(k - m\omega^2)^2 + (b\omega)^2]}$. The response is largest near the natural frequency when damping is weak. Larger damping lowers and broadens the peak. For weak damping, $Q \approx m\omega_0/b$.

$$a_{rad} = v^2/r;\ a_{tan} = dv/dt;\ |a| = \sqrt{(a_{rad}^2 + a_{tan}^2)};\ v_{A/C} = v_{A/B} + v_{B/C}.$$

EXAMPLE With m = 1.0 kg, k = 100 N/m, b = 2.0 N·s/m, Q ≈ (1×10)/2 = 5.

SENSEI NOTE The displacement-resonance frequency of a damped system is generally slightly below ω_0.

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 — page 7 →

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

Calculate the damping regime and decay.

A 1.5 kg oscillator has k = 96 N/m and b = 6.0 N·s/m. Find ω_0, b_c, γ, and the amplitude fraction after 1.0 s.

PRACTICE 2

Independent Check

Evaluate a driven amplitude.

For m = 1.0 kg, k = 100 N/m, b = 4.0 N·s/m, F_0 = 10 N, find A at ω = 10 rad/s.

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 — page 8 →

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

Critical Damping

Compute and classify.

A 0.50 kg oscillator has k = 200 N/m and b = 12 N·s/m. Find b_c and classify the motion.

CONFIDENCE CHECK 2

Quality Factor

Interpret Q.

If m = 2.0 kg, ω_0 = 6.0 rad/s, and b = 3.0 N·s/m, estimate Q.

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 — page 10 →

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

Compare Damping With the Critical Scale

Use $b_c = 2\sqrt{(km)}$ and $\gamma = b/(2m)$ to classify and quantify free decay.

KEY TAKEAWAY 2

Driven Amplitude Depends on Frequency and Damping

The response becomes resonant near ω_0 when damping is weak; Q summarizes the sharpness of that response.

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 14 →

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 check both the setup and the physical interpretation.

WARM-UP • ACTIVITY 1

Key Ideas

$\omega_0 = \sqrt{(50/2.0)} = 5.0$ rad/s.

WHY IT WORKS The natural angular frequency depends only on k/m for the ideal mass-spring model.

WARM-UP • ACTIVITY 2

Common Mistakes

$b\_c = 2\sqrt{(km)} = 20$ N·s/m; $8.0 < 20$, so it is underdamped.

WHY IT WORKS The damping regime follows from comparing b to b_c.

WARM-UP • ACTIVITY 3

Quick Application

$e^{(-0.80)} = 0.449$, about 45%.

WHY IT WORKS Exponential amplitude decay is set by the damping rate γ.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

ω_0 = 8.00 rad/s; b_c = 24.0 N·s/m; γ = 2.00 s^{-1}; $A/A_0 = e^{-2}$ = 0.135.

WHY IT WORKS Compute $\omega_0 = \sqrt{(96/1.5)}$, b_c = $2\sqrt{(1.5\times96)}$, and $\gamma = 6/(2\times1.5)$.

PRACTICE 2

Independent Check

$A = 10/\sqrt{[(100-100)^2+(40)^2]}$ = 0.250 m.

WHY IT WORKS At $\omega = \omega_0$, the spring-inertia terms cancel in the amplitude denominator, leaving $b\omega$.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Critical Damping

$b_c = 2\sqrt{(0.50 \times 200)} = 20$ N·s/m; since $12 < 20$, it is underdamped.

WHY IT WORKS The comparison b/b_c identifies the regime.

CONFIDENCE CHECK 2

Quality Factor

$Q \approx m\omega_0/b = 4.0$.

WHY IT WORKS Higher Q corresponds to weaker relative damping and a sharper resonance.

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	◎ I Need More Practice	✓ I'm Ready
Review the focused review again to strengthen the essential concepts.	Build confidence with additional practice problems.	Continue to the next topic or learning 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