FOCUSED REVIEW

Focused Review: Torque and Rotational Dynamics — Calculus-Based

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

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

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 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: MEC-U20** **TOPIC: Torque and Rotational Dynamics** **COURSE LEVEL: Calculus-Based**	**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 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

Write $\vec{\tau} = \vec{r} \times \vec{F}$, $I = \int r^2\,dm$, and $\sum\tau = I\alpha$. State the right-hand-rule direction for $\vec{r}$ along $+x$ and $\vec{F}$ along $+y$.

Write your response in the space below.

WARM-UP 2

Common Mistakes

Explain why these are wrong: replacing $\vec{r} \times \vec{F}$ with ordinary multiplication, and computing I without specifying an axis.

Write your response in the space below.

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

If a constant net torque acts on a rigid body with constant I, describe $\omega(t)$ qualitatively using $\alpha = d\omega/dt$.

Write your response in the space below.

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

Torque as a Cross Product

The torque of a force about an origin is $\vec{\tau} = \vec{r} \times \vec{F}$. The cross product captures both the perpendicular geometry and the axis direction. For planar rotation, the axial component can be treated with signs.

$$\vec{\tau} = \vec{r} \times \vec{F} \quad \bullet \quad I = \int r^2\,dm \quad \bullet \quad \sum\tau = dL/dt$$

EXAMPLE $\vec{r} = (0.30\text{ m})\hat{\imath}$ and $\vec{F} = (20\text{ N})\hat{\jmath}$ gives $\vec{\tau} = (6.0\text{ N·m})\hat{k}$.

SENSEI NOTE The position vector begins at the chosen origin/axis and ends at the force application point.

KEY CONCEPT 2

Moment of Inertia and Dynamics

For a continuous mass distribution, $I = \int r^2\,dm$ about a specified axis. Once I is known, fixed-axis dynamics follows $\sum\tau = I\alpha$ with $\alpha = d\omega/dt$.

$$\vec{\tau} = \vec{r} \times \vec{F} \quad \bullet \quad I = \int r^2\,dm \quad \bullet \quad \sum\tau = dL/dt$$

EXAMPLE A larger contribution of dm at large r increases I strongly because of the r^2 weighting.

SENSEI NOTE State the integration variable and geometry clearly when deriving I.

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

Given $\vec{r} = 0.20\hat{\imath}$ m and $\vec{F} = 30\hat{\jmath}$ N, compute $\vec{\tau}$.

Show your setup and reasoning in the space below.

PRACTICE 2

Independent Check

A body with constant $I = 2.0$ kg·m^2 experiences $\tau = 6.0$ N·m for 4.0 s starting from $\omega_0 = 1.0$ rad/s. Find ω.

Show your setup and reasoning in the space below.

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

Cross-Product Direction

Answer without looking back.

$\vec{r}$ points $+x$ and $\vec{F}$ points $-y$. What direction is $\vec{\tau}$?

CONFIDENCE CHECK 2

Continuous Inertia

Answer without looking back.

Why does dm located farther from the axis contribute more to I?

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

Torque Is a Vector

Use $\vec{\tau} = \vec{r} \times \vec{F}$ to capture both magnitude and axis direction.

KEY TAKEAWAY 2

I Encodes Mass Distribution

For continuous bodies, $I = \int r^2\, dm$ about the specified rotation axis.

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

Torque/rotation relationships recalled correctly. Use the unit's core definitions and equations appropriate to this treatment.

WHY IT WORKS These are the minimum ideas needed for the rest of the review.

WARM-UP • ACTIVITY 2

Common Mistakes

Correct the misconception by checking force geometry, torque sign, and the chosen rotation axis.

WHY IT WORKS Most rotational-dynamics errors begin in the setup, before any arithmetic.

WARM-UP • ACTIVITY 3

Quick Application

The more effective lever arm or cross-product geometry produces the larger torque.

WHY IT WORKS The torque definition determines the rotational effectiveness of the force.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

$\vec{\tau} = \vec{r} \times \vec{F} = (0.20)(30)(\hat{\imath}\times\hat{\jmath}) = 6.0\hat{k}$ N·m.

WHY IT WORKS The solution applies the current Unit 20 torque/rotational-dynamics relationships consistently.

PRACTICE 2

Independent Check

$\alpha = \tau/I = 3.0$ rad/s^2. Since α is constant, $\omega = \omega_0 + \alpha t = 1.0 + (3.0)(4.0) = 13$ rad/s.

WHY IT WORKS The solution applies the current Unit 20 torque/rotational-dynamics relationships consistently.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Cross-Product Direction

$-z$.

WHY IT WORKS $\hat{\imath} \times (-\hat{\jmath}) = -\hat{k}$ by the right-hand rule.

CONFIDENCE CHECK 2

Continuous Inertia

Its contribution is $dI = r^2 dm$, so it grows with the square of distance from the axis.

WHY IT WORKS The r^2 weighting makes mass distribution central to rotational inertia.

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 →	**Go to Practice →**	**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