FOCUSED REVIEW

Focused Review: Fluid Mechanics — Calculus-Based

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

◷ TIME	◎ BEST FOR	✓ FINISH WITH
15–20 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 15–20 minutes

FR-02 • TOPIC ALIGNMENT

Topic Alignment

This bundle is aligned to the approved Physics Sensei topic specification below. Use it to recover the topic structure, reinforce key decisions, and confirm readiness for the next study task.

TEXTBOOK: Independent Physics Sensei Unit Review **CHAPTER: Mechanics • MEC-U14** **TOPIC: Fluid Mechanics** **COURSE LEVEL: Calculus-Based**	**BEST USED** ✓ After reading the chapter ✓ Before starting homework ✓ Before a quiz or exam

Review Prerequisites →

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

Recall the hydrostatic rule.

State dp/dy for y upward.

WARM-UP 2

Common Mistakes

Check buoyancy.

State the surface-integral origin of buoyancy.

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Quick Application

Check flow selection.

Write the incompressible differential continuity condition.

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

Statics: pressure, hydrostatics, and buoyancy

Use $\nabla p=\rho\vec{g}$ and pressure-force integration for hydrostatics and buoyancy; reduce to the familiar constant-density equations when assumptions allow.

$$\nabla p=\rho\vec{g};\ \vec{F}_B=-\oint p\,\hat{n}\,dA.$$

EXAMPLE For constant ρ and g, integrating the pressure gradient over displaced volume gives Archimedes' principle.

SENSEI NOTE Keep three quantities separate: pressure p, pressure force on a surface, and net buoyant force on an object.

KEY CONCEPT 2

Dynamics: flow rate, continuity, and Bernoulli

Use the continuity equation for mass conservation and Euler/Bernoulli for inviscid flow. Recognize where viscosity, turbulence, pumps, or losses invalidate the simple Bernoulli constant.

$$\partial\rho/\partial t+\nabla\cdot(\rho\vec{v})=0;\ \text{steady incompressible: } \nabla\cdot\vec{v}=0.$$

EXAMPLE A large open tank gives ideal efflux $v\approx\sqrt{2g\Delta y}$ from Bernoulli when surface speed is negligible.

SENSEI NOTE Continuity is conservation of mass. Bernoulli is an energy relation with assumptions. Do not merge them into one rule.

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

Solve one statics model completely.

Use $\nabla p = \rho \vec{g}$ *to explain why the net pressure force is upward on a submerged body.*

PRACTICE 2

Independent Check

Use continuity, then Bernoulli if justified.

For steady incompressible flow, explain the physical meaning of $\nabla \cdot \vec{v} = 0$.

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

Statics readiness check

Answer without a calculator.

What vector equation replaces $p=p_0+\rho gh$ when density or direction varies?

CONFIDENCE CHECK 2

Flow readiness check

Identify the valid statement.

What mathematical condition expresses incompressibility for the velocity field?

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

Statics: depth, pressure, displacement

Use the correct pressure reference, distinguish pressure from force, and make buoyancy from displaced fluid volume plus a complete free-body diagram.

KEY TAKEAWAY 2

Flow: conserve mass, then test the energy model

Apply continuity first. Use Bernoulli only when its steady, incompressible, nonviscous assumptions and streamline connection are defensible.

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 concise answer and explanation to check the essential reasoning.

WARM-UP • ACTIVITY 1

Key Ideas

$dp/dy = -\rho g$.

WHY IT WORKS Hydrostatic pressure differences come from supporting the fluid above.

WARM-UP • ACTIVITY 2

Common Mistakes

$\vec{F}_B = -\oint p\,\hat{n}\,dA$.

WHY IT WORKS Buoyancy is the net effect of nonuniform hydrostatic pressure on the object surface.

WARM-UP • ACTIVITY 3

Quick Application

$\nabla\cdot\vec{v} = 0$.

WHY IT WORKS Conservation of mass comes before any Bernoulli comparison.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

Pressure increases downward, so lower-surface pressure forces exceed upper-surface pressure forces; the surface integral gives an upward resultant.

WHY IT WORKS Combine hydrostatics with the free-body diagram; do not infer acceleration from buoyancy alone.

PRACTICE 2

Independent Check

A small fluid volume has no net volumetric expansion from the velocity field; inflow equals outflow locally.

WHY IT WORKS Area-speed changes follow mass conservation. Pressure changes require a separate momentum/energy model.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Statics readiness check

$\nabla p=\rho\vec{g}$.

WHY IT WORKS Use hydrostatic balance and Archimedes' principle, with the model assumptions stated.

CONFIDENCE CHECK 2

Flow readiness check

$\nabla\cdot\vec{v}=0$.

WHY IT WORKS Continuity fixes the area-speed relationship; Bernoulli adds the ideal pressure-speed-height relation.

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