FULL REVIEW

Full Review: Fluid Mechanics — Algebra-Based

Review the essential ideas, relationships, and problem-solving tools for Fluid Mechanics.

◷ TIME	◎ BEST FOR	✓ FINISH WITH
45–60 minutes	A complete topic review	A readiness check

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 • 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: Algebra-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 stages in order. Each stage builds on the previous one and prepares you for the final readiness check.

6 stages • Approximately 45–60 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 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

Use proportional reasoning.

If the depth below the surface doubles in the same liquid, what happens to the gauge pressure?

ACTIVITY 2

Recall Activity 2

Compare buoyant force and weight.

A fully submerged object displaces 0.020 m^3 of water. What determines the magnitude of the buoyant force?

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Recall Activity 3

Use continuity before Bernoulli.

For incompressible steady flow, if area decreases to one-third, how does speed change?

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 — page 6 →

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

Pressure, density, and hydrostatic equilibrium

Use $\rho = m/V$ and $p = F_\perp/A$. For a constant-density fluid open to atmosphere, $p = p_{atm} + \rho gh$ and $\rho g = \rho gh$. Pressure differences transmit through a confined fluid, which underlies hydraulic devices.

$$p = F_\perp/A;\ p = p_0 + \rho gh;\ F_2/F_1 = A_2/A_1 \text{ for an ideal hydraulic system.}$$

EXAMPLE In water, 3.0 m below an open surface gives $\rho g \approx (1000)(9.8)(3.0) = 2.94\times10^4$ Pa.

SENSEI NOTE Pressure is a scalar field. Do not draw a "pressure vector"; draw pressure forces normal to surfaces and use pressure differences to determine net force.

KEY CONCEPT 2

Buoyancy, floating, and apparent weight

Use $F_B = \rho_{fluid} V_{disp}\, g$. For static vertical equilibrium, compare F_B with mg and any support force or tension. A floating object displaces enough fluid so F_B = mg; the submerged fraction equals $\rho_{object}/\rho_{fluid}$ when densities are uniform.

$$F_B = \rho_{fluid} V_{disp}\, g;\ \text{floating: } \rho_{fluid} V_{disp}\, g = mg.$$

EXAMPLE A 600 kg/m³ block floating in water has 60% of its volume submerged.

SENSEI NOTE Archimedes gives the buoyant force. It does not by itself say whether the object accelerates; compare all forces on the object.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

Flow rate, continuity, Bernoulli, and ideal-flow limits

Use $Q = Av$ and $A_1v_1=A_2v_2$ for steady incompressible flow. Along a streamline in steady, incompressible, nonviscous flow with no pump/turbine work, $p + \frac{1}{2}\rho v^2 + \rho gy$ is constant.

$$Q = Av;\ A_1v_1=A_2v_2;\ p_1+\tfrac{1}{2}\rho v_1^2+\rho gy_1 = p_2+\tfrac{1}{2}\rho v_2^2+\rho gy_2.$$

EXAMPLE If $A_2=A_1/4$, then $v_2=4v_1$. At equal height, the faster section has lower static pressure in the ideal Bernoulli model.

SENSEI NOTE Do not use “faster flow means lower pressure” as a universal slogan. First verify the two points are connected by a valid Bernoulli model and account for height, pumps, and losses.

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 — page 8 →

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

Identify the pressure reference, choose gauge or absolute pressure, and solve with units.

Find the gauge pressure 5.0 m below fresh water using $\rho=1000\ kg/m^3$ and $g=9.8\ m/s^2$.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2

Guided Problem

Draw the object free-body diagram and identify displaced fluid volume.

A 0.030 m^3 object is fully submerged in water. Find the buoyant force using $g=9.8\ m/s^2$.

PRACTICE 3

Independent Problem

Apply continuity first, then decide whether Bernoulli is valid.

Water flows horizontally from area 4.0 cm^2 at 2.0 m/s into area 1.0 cm^2. Find the second speed. If ideal Bernoulli applies, which section has lower pressure?

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 — page 10 →

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

Pressure model check

Answer and justify in one sentence.

A hydraulic lift has $A_2=20A_1$. Ideally, what output force results from an input force F_1?

QUICK CHECK 2

Buoyancy check

Classify the statement.

An object is fully submerged and held by a string from above. Write the equilibrium relation among T, F_B, and mg.

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Continuity and Bernoulli check

Choose the valid relationship.

Can Bernoulli's simple constant be applied across a pump or a strongly dissipative pipe section without adding energy/loss terms?

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 — page 12 →

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

Pressure comes from force per area and hydrostatic balance

Use p, not a pressure vector. Distinguish gauge from absolute pressure, choose the correct depth/elevation reference, and use $p = p_0 + \rho g h$ only when density is effectively constant.

KEY TAKEAWAY 2

Buoyancy is displaced-fluid weight

Find V_{disp} and ρ_{fluid}, then compare F_B with weight, tension, or support forces. Floating equilibrium is a force balance, not a disappearance of weight.

KEY TAKEAWAY 3

Continuity first; Bernoulli only under valid assumptions

Use mass conservation to connect area and speed. Then use Bernoulli only for the appropriate steady, incompressible, nonviscous model along a streamline unless additional energy/loss terms are included.

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 16 →

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

Recall Activity 1

It doubles.

WHY IT WORKS For constant density, gauge pressure is proportional to depth: $p_g = \rho g h$.

WARM-UP • ACTIVITY 2

Recall Activity 2

The fluid density, displaced volume, and g: $F_B = \rho_{fluid} V_{disp} g$.

WHY IT WORKS Buoyant force equals the weight of displaced fluid, not the object's weight by definition.

WARM-UP • ACTIVITY 3

Recall Activity 3

The speed triples.

WHY IT WORKS $A_1 v_1 = A_2 v_2$, so speed varies inversely with area.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Worked Example

$p_g = \rho g h = 4.90 \times 10^4$ Pa.

WHY IT WORKS Gauge pressure excludes atmospheric pressure. Absolute pressure would be $p_{atm} + p_g$.

PRACTICE 2

Guided Problem

$F_B = (1000)(0.030)(9.8) = 294$ N upward.

WHY IT WORKS Archimedes' principle uses the fluid density and displaced volume.

PRACTICE 3

Independent Problem

$v_2 = 8.0$ m/s; the narrower, faster section has lower pressure at the same height.

WHY IT WORKS Continuity gives $v_2 = (A_1/A_2)v_1 = 8.0$ m/s; Bernoulli then compares pressure at equal elevation.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

Pressure model check

$F_2=20F_1$.

WHY IT WORKS Equal pressure transmission gives $F_1/A_1=F_2/A_2$.

QUICK CHECK 2

Buoyancy check

$T+F_B=mg$ if the string tension and buoyancy act upward.

WHY IT WORKS The free-body diagram determines the signs.

QUICK CHECK 3

Continuity and Bernoulli check

No.

WHY IT WORKS Pumps add mechanical energy and viscosity/turbulence dissipate it; the simple ideal form omits those effects.

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	**I Need More Practice**	**I'm Ready**
Review the key ideas and examples again.	Continue with additional practice for this topic.	Continue to the next recommended 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