

FOCUSED REVIEW

Focused Review: Kinetic Theory of Gases — 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...

After this review, you'll be able to derive the kinetic pressure relation from momentum flux and use the Maxwell distribution to compare characteristic molecular speeds.

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 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: THM-U07
TOPIC: Kinetic Theory of Gases
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**Collision Geometry**

For a molecule striking a wall normally, write its momentum change.

For an elastic reversal of v_x , the molecule's $\Delta p_x = -2mv_x$; the wall receives $+2mv_x$.

WARM-UP 2**Isotropy**

State the component-average identity.

For an isotropic gas, $\langle x\text{-component of velocity squared} \rangle = \langle y\text{-component of velocity squared} \rangle = \langle z\text{-component of velocity squared} \rangle = \text{mean-square speed}/3$.

FR-04 • WARM-UP CHECK CONTINUED

WARM-UP 3

Distribution Check

Order the characteristic speeds.

At fixed T and m , order most probable speed, mean speed, and rms speed from smallest to largest.

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

Pressure as Momentum Flux

For a molecule in a box, collision frequency with one wall scales as x-component of velocity/(2L), while momentum delivered per collision is 2mx-component of velocity. Summing over molecules gives $P = (Nm/V)\langle x\text{-component of velocity squared} \rangle$ and isotropy supplies the factor 1/3.

$$P = (1/3)(N/V)m\langle v^2 \rangle$$

EXAMPLE The appearance of x-component of velocity squared reflects one factor of velocity from impulse and one from collision frequency.

SENSEI NOTE Keep the component average until isotropy is invoked; replacing x-component of velocity squared by speed squared too early loses the 1/3 factor.

KEY CONCEPT 2

Maxwell Speed Distribution and Moments

The normalized Maxwell speed distribution weights the number of molecules found near each speed. Its maximum gives most probable speed, its first moment gives mean speed, and its second moment gives rms speed.

$$v_{mp} = \sqrt{2k_B T/m} < v_{avg} = \sqrt{8k_B T/\pi m} < v_{rms} = \sqrt{3k_B T/m}$$

EXAMPLE All three characteristic speeds scale as $\sqrt{T/m}$, but their numerical coefficients differ.

SENSEI NOTE The mean speed $\langle v \rangle$ and rms speed $\sqrt{\text{mean-square speed}}$ are not interchangeable.

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

Recover the One-Third Factor

Complete the final step of the pressure derivation.

Starting from $P = (Nm/V)(x\text{-component of velocity squared})$, use isotropy to express P in terms of mean-square speed.

PRACTICE 2

Most Probable Speed

Use the Maxwell distribution.

Differentiate $\ln f(v)$ for $f(v) \propto \text{speed squared} \exp[-m\text{speed squared}/(2\text{Boltzmann constant}T)]$ and solve for the speed at the maximum.

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

Collision-Rate Dependence

Identify the second velocity factor.

Why does pressure depend on x-component of velocity squared rather than only on x-component of velocity?

CONFIDENCE CHECK 2

Characteristic Speeds

Compare exact forms.

Which is largest: most probable speed, mean speed, or rms speed?

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

Pressure is a momentum flux

Impulse $\times$ collision rate produces a second moment of velocity.

KEY TAKEAWAY 2

Maxwell statistics separates characteristic speeds

most probable speed, mean speed, and rms speed are distinct quantities obtained from the same speed distribution.

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

The molecule changes momentum by $-2m_x$ -component of velocity; the wall receives $+2m_x$ -component of velocity.

WHY IT WORKS Elastic reflection reverses the normal component while leaving tangential components unchanged.

WARM-UP • ACTIVITY 2

Common Mistakes

Each component contributes one-third of mean-square speed.

WHY IT WORKS No spatial direction is preferred in an equilibrium isotropic gas.

WARM-UP • ACTIVITY 3

Quick Application

most probable speed < mean speed < rms speed.

WHY IT WORKS The distribution is skewed toward higher speeds, so these characteristic values are not equal.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1

Guided Example

$$P = (Nm/V)(\text{mean-square speed}/3) = (1/3)(N/V)m\text{mean-square speed}.$$

WHY IT WORKS Isotropy converts the normal-component second moment into one-third of the total second moment.

PRACTICE 2

Independent Check

$d/dv[2 \ln v - m\text{speed squared}/(2\text{Boltzmann constant}T)] = 2/v - mv/(\text{Boltzmann constant}T) = 0$, giving most probable speed $= \sqrt{(2\text{Boltzmann constant}T/m)}$.

WHY IT WORKS Maximizing $\ln f(v)$ is algebraically simpler and gives the same location as maximizing $f(v)$.

SOLUTIONS • CONFIDENCE CHECK

CONFIDENCE CHECK 1

Collision-Rate Dependence

One factor x-component of velocity comes from impulse magnitude and the other from how frequently the molecule reaches the wall.

WHY IT WORKS Faster normal motion both transfers more momentum per collision and produces collisions more often.

CONFIDENCE CHECK 2

Characteristic Speeds

rms speed is largest, then mean speed, then most probable speed.

WHY IT WORKS Their coefficients are $\sqrt{3}$, $\sqrt{8/\pi}$, and $\sqrt{2}$, respectively, times $\sqrt{(\text{Boltzmann constant } T/m)}$.

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.

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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