

FULL REVIEW

Full Review: Kinetic Theory of Gases — Algebra-Based

Review the essential ideas, relationships, and problem-solving tools for Kinetic Theory of Gases.

 TIME 45–60 minutes	 BEST FOR A complete topic review	 FINISH WITH A readiness check
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After this full review, you'll be able to...

After this review, you'll be able to derive and apply the standard kinetic-theory relationships for pressure, molecular kinetic energy, rms speed, and monatomic internal energy.

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

6 stages • Approximately 45–60 minutes

1 Warm-Up Check Activate prior knowledge.	2 Core Concepts Review the essential ideas.	3 Guided Practice Apply what you learned.
4 Confidence Check Confirm your understanding.	5 Summary Review the key ideas.	6 Next Step Continue your learning.

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**Microscopic-to-Macroscopic Map**

Write the equations connecting pressure, mean-square speed, and average kinetic energy.

Include $P = (1/3)(N/V)m\text{mean-square speed}$ and average translational kinetic energy = $(3/2)\text{Boltzmann constant } T$.

ACTIVITY 2**Mass Conventions**

Distinguish molecular mass from molar mass.

State when to use m with Boltzmann constant and M with R .

FR-04 • WARM-UP CHECK CONTINUED

ACTIVITY 3

Estimate Before Solving

Compare helium and nitrogen at 300 K.

Predict which has the larger rms speed and estimate whether the factor is closer to 1, 3, or 10.

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 →

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 from Momentum Transfer**

Elastic wall collisions reverse the normal molecular momentum. Averaging the impulse rate over many molecules and using isotropy gives the kinetic-theory pressure relation.

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

EXAMPLE At fixed number density, a 10% increase in rms speed produces a pressure factor 1.10 squared = 1.21.

SENSEI NOTE The one-third factor comes from isotropy: $\langle x\text{-component of velocity squared} \rangle = \langle y\text{-component of velocity squared} \rangle = \langle z\text{-component of velocity squared} \rangle = \text{mean-square speed}/3$.

KEY CONCEPT 2**Temperature and Translational Energy**

Equating the kinetic-theory pressure relation with the ideal-gas macroscopic temperature relation gives average translational kinetic energy per molecule proportional to T.

$$K_{\text{avg}} = 3/2 k_B T$$

EXAMPLE Raising T from 300 K to 450 K raises average translational kinetic energy by a factor 1.50.

SENSEI NOTE Temperature determines the average translational energy, not a single molecular energy.

FR-05 • CORE CONCEPTS CONTINUED

KEY CONCEPT 3

RMS Speed and Monatomic Internal Energy

Rms speed is $\sqrt{\text{mean-square speed}}$. For a monatomic ideal gas, total internal energy is the sum of translational energies of all molecules, giving $U = (3/2)nRT$.

$$v_{\text{rms}} = \sqrt{(3RT/M)}$$

EXAMPLE At 300 K, rms speed ≈ 1368 m/s for He and ≈ 517 m/s for nitrogen.

SENSEI NOTE Do not use $U = (3/2)nRT$ for gases whose relevant rotational or vibrational degrees of freedom must be included.

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 →

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**Helium RMS Speed**

Calculate directly from molar quantities.

Find rms speed for He at 300 K using $M = 0.0040 \text{ kg/mol}$.

FR-06 • GUIDED PRACTICE CONTINUED

PRACTICE 2**Pressure from Molecular Data**

Apply the microscopic pressure relation.

A gas has number density 2.0×10^{25} molecules per cubic meter, molecular mass 4.65×10^{-26} kg, and rms speed = 500 m/s. Calculate P .

PRACTICE 3**Monatomic Internal Energy**

Use the monatomic energy relation.

Find U for 2.0 mol of a monatomic ideal gas at 400 K.

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 →

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

One-Third Factor

Identify the origin.

Why does the pressure relation contain $1/3$ for an isotropic gas?

QUICK CHECK 2

Same Temperature

Compare two molecular species.

At equal T , which quantity is the same for He and nitrogen: average translational kinetic energy or rms speed?

FR-07 • CONFIDENCE CHECK CONTINUED

QUICK CHECK 3

Temperature and RMS Speed

Use proportional reasoning.

By what factor must T change to make rms speed three times larger for the same gas?

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 →

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 momentum flux

$P = (1/3)(N/V)m\text{mean-square speed}$ connects collisions to macroscopic pressure.

KEY TAKEAWAY 2

Temperature fixes average translational energy

average translational kinetic energy = $(3/2)\text{Boltzmann constant } T$ for an ideal gas.

KEY TAKEAWAY 3

RMS speed carries square-root scaling

rms speed = $\sqrt{(3RT/M)}$; for a monatomic gas, $U = (3/2)nRT$.

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

Recall Activity 1

$P = (1/3)(N/V)m\text{mean-square speed and average translational kinetic energy} = (1/2)m\text{mean-square speed} = (3/2)\text{Boltzmann constant } T.$

WHY IT WORKS The same mean-square motion appears in both pressure and energy relations.

WARM-UP • ACTIVITY 2

Recall Activity 2

Use molecular mass m with Boltzmann constant; use molar mass M with R .

WHY IT WORKS Since $R = \text{Avogadro constant Boltzmann constant}$ and $M = \text{Avogadro constant } m$, the molecular and molar forms are equivalent when units are consistent.

WARM-UP • ACTIVITY 3

Recall Activity 3

Helium is faster; $\sqrt{(\text{nitrogen molar mass/helium molar mass})} = \sqrt{(28/4)} \approx 2.65$, so the factor is closest to 3.

WHY IT WORKS At equal temperature, rms speed varies as $1/\sqrt{M}$.

SOLUTIONS • GUIDED PRACTICE

PRACTICE 1**Worked Example**

rms speed = $\sqrt{(3(8.314)(300)/0.0040)} \approx 1.37 \times 10^3 \text{ m/s}$.

WHY IT WORKS The very small molar mass of helium gives a large characteristic molecular speed.

PRACTICE 2**Guided Problem**

The pressure is about 77.5 kPa.

WHY IT WORKS The squared speed converts microscopic motion into momentum flux at the walls.

PRACTICE 3**Independent Problem**

$U = (3/2)(2.0)(8.314)(400) \approx 9.98 \times 10^3 \text{ J}$.

WHY IT WORKS For a monatomic ideal gas, translational energy supplies the internal energy in this model.

SOLUTIONS • CONFIDENCE CHECK

QUICK CHECK 1

One-Third Factor

Random isotropic motion shares mean-square speed equally among x, y, and z components.

WHY IT WORKS Only the component normal to a particular wall contributes to its momentum transfer.

QUICK CHECK 2

Same Temperature

average translational kinetic energy is the same; rms speed is larger for helium.

WHY IT WORKS Average translational kinetic energy depends only on T, while rms speed also depends on mass.

QUICK CHECK 3

Temperature and RMS Speed

T must increase by a factor of 9.

WHY IT WORKS For a fixed gas, rms speed $\propto \sqrt{T}$, so a speed factor 3 requires a temperature factor 3 squared.

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

[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