Gas in Motion

Use simulation data to connect temperature and particle energy.

PHY.3.9 "Explore the kinetic theory in terms of kinetic energy of ideal gases using digital resources."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two quantities the digital model can display, then circle the variable you would change to test how temperature affects mean kinetic energy.

Watching an Ideal Gas

1. Imagine opening a digital model of an ideal gas in a sealed container. Its particles move in straight paths between collisions, which are treated as perfectly elastic. The model lets you set temperature in kelvins and read the mean kinetic energy per particle. Kinetic energy is energy of motion, so the display connects an invisible process to a measurable quantity.

2. For an ideal gas, mean kinetic energy per particle depends only on absolute temperature. In a simulation, increasing temperature makes the speed distribution shift toward faster motion. Individual particles still have different speeds at any moment. A lighter gas generally moves faster than a heavier gas at the same temperature, but both have the same mean kinetic energy per particle.

3. A digital readout can show the pattern more precisely than the animation alone. The table gives ideal-gas values rounded to two decimal places. Its energy column is measured in units of 10^{-21} joule. To test the pattern, change the temperature while keeping the gas and particle count fixed, then compare the readout with the speed display.

IDEAL-GAS SIMULATION READOUT

Temperature (K)	Mean kinetic energy per particle (10^{-21} J)
200	4.14
300	6.21
400	8.28
600	12.42

2 ANSWER WITH EVIDENCE

Use the passage

1. From 200 K to 400 K, by what factor does the mean kinetic energy per particle change? Use the readout values as evidence.

2. At 400 K, how would a lighter gas compare with a heavier gas in mean kinetic energy per particle and typical particle speed?

3. Predict the mean kinetic energy per particle at 500 K. Explain how you used the table.

4. A speed display shows that a few particles at 600 K move more slowly than some particles at 300 K. Does this conflict with the table? Explain.

3 YOUR TURN

Your own words

Design a test in the digital model using two temperatures that are not in the table. State what you would keep the same, predict how mean kinetic energy would change, and explain what you would look for in the speed display.

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PART 1 · READ AND MARK

Underline two quantities the digital model can display, then circle the variable you would change to test how temperature affects mean kinetic energy. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	From 200 K to 400 K, by what factor does the mean kinetic energy per particle change? Use the readout values as evidence.	**It doubles: 8.28 ÷ 4.14 = 2.**
2	At 400 K, how would a lighter gas compare with a heavier gas in mean kinetic energy per particle and typical particle speed?	**Both have a mean kinetic energy of 8.28×10^{-21} J per particle. The lighter gas has a higher typical particle speed.**
3	Predict the mean kinetic energy per particle at 500 K. Explain how you used the table.	**About 10.35×10^{-21} J. Since 500 K is halfway between 400 K and 600 K, the energy is halfway between 8.28 and 12.42 in the table's units.**
4	A speed display shows that a few particles at 600 K move more slowly than some particles at 300 K. Does this conflict with the table? Explain.	**No. Individual speeds vary, while the table reports a mean. The higher temperature has greater mean kinetic energy even if some individual particles move slowly.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would compare 250 K with 500 K while keeping the gas and particle count the same. Because the temperature doubles, I predict the mean kinetic energy per particle will double. I would check whether the speed distribution shifts toward faster motion at 500 K.

Accept reasonable estimates for 500 K near 10.35×10^{-21} J. In the open task, students should choose two temperatures absent from the table and make a prediction consistent with mean kinetic energy being proportional to temperature in kelvins.