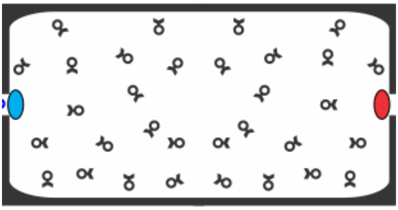
The Space-sci Sherlocks Deduce



Enclosed Atomic Momentum Produces Every Gas Law Equation

Professor Du-Ane Du

www.Wacky1301SCI.com, *"Looking at serious science, sideways!"*

Three sisters, Pico, Hectii, and Tera, the "Space-sci Sherlocks," are traveling through the Asteroid Belt. They explore the nature of enclosed atomic momentum and use it to derive all of the Gas Law Equations!
—Excerpted from *Murdered Energy Mysteries*, Part 3, Chapter 9, by Du-Ane Du, (Amazon, Kindle, ebook 2018, paperback 2021).

"Perhaps there are some missing laws, or rules of enclosed atomic momentum," Chip wrote on all three of their phones. "Analyzing that may help you better determine if a calorie is equal to 4.958 $\pm 0.04\ \rho$ of heat-impulse, or if a calorie is equal to 4.18 J[1.2] of energy (speed infused impulse)."

"Perfect," Pico said, as she handed her medical ID card to the attendant. "Good luck, Sisters."

"We'll need it," Tera whispered as she and Hectii walked to a bench that looked out a window. On the wall beside them, a large display screen showed hundreds of colorful fish swimming around a coral reef.

"I wonder why an enclosed atom and not an enclosed molecule?" Hectii pondered. "This is a curious puzzle. Let's brainstorm it."

"We'll record everything we can think of," Tera said. "Then we'll come back later and clarify any odd ideas we come up with."

"I'll write down our ideas," Hectii said. "Let's start by defining what enclosed means."

"We've been focusing on laws," Tera said. "If the atom broke the law, perhaps the atom is in jail. Why don't we start by saying the atom is inside a balloon-like jail?"

"Are there other options?" Hectii said. "Do all containers have walls? Are there other types of prisons?"

"Yes," Tera said radiantly. "On Earth, Grandpa Proge keeps his dog on a tether. I once read that thousands of years ago they kept prisoners from running away by chaining their legs to a post."

"Good thought," Hectii congratulated. "Atoms often bond together into molecules. The enclosure could be a wall, or a tether—"

"—or both, like a rope tied to a wall," Tera said, a ring of interest in her voice. "Let's call it a tether-wall cell."

"Ok, let's say we have one atom with a mass of 1.0 g," Hectii said. "And it's trapped in a tether-wall cell."

"Why don't we say the atom has a mass of *m*," Tera said. "That way our conclusions will be true for all atoms of any size."

"Excellent, Hectii said with a nod. "And our atom is moving, so it has a velocity of *v*."

"That'll give it a momentum of *mv*, and a kinetic energy of $\frac{1}{2}mv^2$," Tera added.

"What'll happen when our atom contacts the wall of its container?" Hectii said.

"It'll forward some of its momentum to the wall," Tera said. "And the atom will absorb momentum from the wall."

"I like this approach," Hectii said approvingly. "Let's brainstorm about momentum first. Then we'll repeat the process and look at how energy behaves."

"How do we make certain the atom keeps moving after it hits the wall?" Tera said.

"We'll need a condition of heat-impulse equilibrium," Hectii said, as she began tapping information into her phone:

FIRST PRINCIPLE OF ENCLOSED ATOMIC/MOLECULAR MOMENTUM:

A condition of ***equilibrium*** can only occur when the contac-ρ-force-rate, momentums per second, of the atom/molecule is equal to the force-rate of the walls of the container (or tether-wall cell).

[* This rule will change slightly in future chapters.]

"I like that," Tera said encouragingly. "We'll begin by assuming the walls are in equilibrium with the atom, that way the atom will always fly the same speed. It won't suddenly speed up or slow down when it bounces off the wall."

"What would happen if the wall didn't have the same force-rate?" Tera said.

"That makes an entire set of principles," Hectii declared, as she keyed the following:

FIRST PRINCIPLE OF ENCLOSED ATOMIC/MOLECULAR MOMENTUM:

B) If the container walls have a *lower* contac- ρ-force-rate than the enclosed atom/molecule, then the momentum of the molecule will *decrease* as it bounces off the container wall, and the container wall's molecular momentum will *increase*.

C) If the container walls have a *higher* contac- ρ-force-rate than the enclosed molecule, then the momentum of the molecule will *increase* as it bounces off the container wall, and the container wall's molecular momentum will *decrease*.

D) If the average molecular momentum inside the container is higher than the average molecular momentum outside, the molecular momentum will migrate from the region of high momentum to the region of low momentum.

"That's a long group of principles," Tera said admiringly. "And that last part about molecular momentum migrating from one place to another seems familiar."

Hectii smiled knowingly. "For now, we just need to remember that the walls are in equilibrium with the momentum of the enclosed atom."

"But the enclosed atom won't hit the container walls just one time," Tera said. "You know what I mean? If the atom is inside a balloon, it's going to bounce back and forth from one side to another."

"Which means, we need to know how often the atom will hit the sides," Hectii said.

"It's not going to be a specific number," Tera noted. "If the atom flies faster, it'll collide with the walls more often."

"Which means, the ρ-force-rate will be an equation," Hectii said thoughtfully. "If we assume the container, or the tether-wall cell, is a sphere with radius r, then the atom will travel $2r$ between collisions with the walls."

"What if the container is shaped like a cylinder?"

"Then one direction will be longer than $2r$, and one direction will be less than $2r$," Hectii said. "Tell you what, we'll use the letter *k* to represent an unknown multiple of the radius. It's not perfect, but *kr* would be a good general estimate of the distance between walls. We can look at the issue of angled flight paths later."

"You and Pico can brainstorm that when I'm not around," Tera said hopefully. "How does the distance between collisions relate to the velocity of our atom?"

"The equation for the number of collisions per second would be the velocity divided by the distance between walls, or *v/kr*," Hectii said, as she tapped on her phone screen. "That means a basic equation for the force-rate of an enclosed atom or molecule will look like this:"

$$\rho\text{-}force\text{-}rate\ (per\ collision) = mv$$

$$\rho\text{-}force\text{-}rate\ (per\ second) = mv\left(\frac{velocity}{k(radius)}\right)$$

$$\rho\text{-}force\text{-}rate\ (per\ second) = mv\left(\frac{v}{kr}\right)$$

was written on her phone.

"Hectii," Chip wrote in red lettering.

"What's that Chip?" Hectii replied.

"If I may," Chip wrote, "the number represented by your letter 'k' is not always a constant."

"It seems like it would be constant," Tera said.

"That number behaves like a constant if both the pressure and the volume don't change," Chip wrote. "But if either the pressure or the volume changes, then the number changes."

"If we change the letter 'k' to a variable, what variable should we use?" Hectii said.

"But don't give away the answer, Chip," Tera said hurriedly. "We want to discover this for ourselves."

"Maybe we should use a question mark," Hectii proposed. "Like this:"

$$\rho\text{-}force\text{-}rate\ (per\ second) = mv\left(\frac{v}{[?]r}\right)$$

was written on her phone.

"We'll define the question mark as being a constant when the pressure and the volume are constant," Hectii said.

"But the question mark is a variable when either the pressure or the volume changes." Tera reminded.

"Excellent," Chip wrote.

"Back to our question-mark variable," Hectii said. "It's going to represent a semi-variable, that's a constant when the pressure and volume are constant, but a variable when one of them is changing."

"The atomic momentum is enclosed in a container," Tera recollected. "How does the surface area effect our equation for enclosed atomic momentum? If the moving atom is in a container, or a tether-wall cell, the container must have a surface area."

"A tether-wall cell may not have a defined surface area," Hectii said.

"Then we should divide this into two separate investigations," Tera said. "For now, let's focus on what happens when enclosed momentum is inside a container."

"Good point," Hectii agreed. "Tether-wall cells is a description of atoms that are inside a molecule, or maybe atoms inside a crystal or inside a piece of metal."

"We'll make note to investigate those issues later," Tera said. "Now let's focus on molecules in a container—you know like carbon dioxide, or helium gas."

"Good, the issue at hand is how surface area affects the transfer of momentum through a container wall," Hectii said as she keyed. "That means we'll need to divide by the surface area. If the molecule is in a container, the equation becomes:

$$\rho\text{-}force\text{-}rate\ (per\ second) = mv\left(\frac{v}{[?]r}\right)\left(\frac{1}{\mathbf{Area}}\right)$$

"The equation for the surface area of a sphere is:"

$$area = 4\pi r^2$$

was written on her phone.

Tera nodded. "Can you put that into our equation?"

"If I substitute the area equation into our equation, the force-rate becomes:

$$\rho\text{-}force\text{-}rate\ (per\ second) = mv\left(\frac{v}{[?]r}\right)\left(\frac{1}{4\pi r^2}\right)$$

"Is this equation only for atoms?" Tera wondered aloud, "or will it also work for molecules?"

"Mainly it's for molecules, unless it's a single-atom molecule, like helium," Hectii said. "I need to clarify how… This is interesting, Tera do you know the equation for the volume of a sphere?"

"Of course," Tera said with a smirk. "I memorized it, along with the exact diameter of the solar system and the precise volume of the galaxy."

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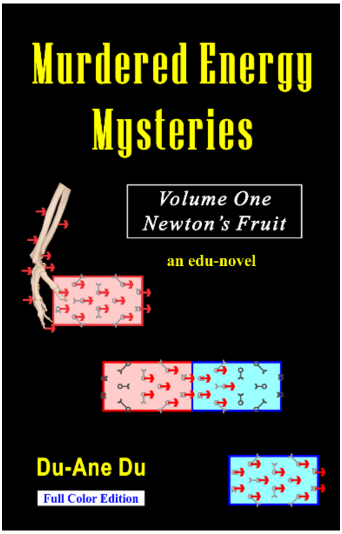

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"Sorry," Hectii said, as she tapped her touch screen. "The equation for the volume (*V*) of a sphere looks like this:"

$$volume = \frac{4\pi}{3}(radius)^3$$

$$volume = \frac{4\pi}{3}r^3$$

$$or\text{: } \mathbf{3V = 4\pi r^3}$$

was written on her phone.

"And that's an interesting coincidence," Hectii absent-mindedly remarked. "Because now we can merge the radius symbols and substitute the volume equation into our force-rate equation like this:"

$$\rho\text{-}force\text{-}rate\ (per\ second) = mv\left(\frac{v}{[?]\boldsymbol{r}}\right)\left(\frac{1}{\boldsymbol{4\pi r^2}}\right)$$

$$\rho\text{-}force\text{-}rate\ (per\ second) = mv\left(\frac{v}{[?]}\right)\left(\frac{1}{\boldsymbol{4\pi r^3}}\right)$$

$$\rho\text{-}force\text{-}rate\ (per\ second) = mv\left(\frac{v}{[?]}\right)\frac{1}{\boldsymbol{3Volume}}$$

$$\rho\text{-}force\text{-}rate = Kmv\left(\frac{v}{[?]}\right)\frac{1}{Volume}$$

was written on her phone.

"That does involve fewer letters," Tera approved. 'But why'd you change to a capital *K*?"

"The letter *K* stands for the constant of proportionality," Hectii said. "Technically, you include it when you use equal signs in a derivation. It lumps together the unit conversions that you're using—you know, meters, grams, etc."

"The mysterious magic of mathematics," Tera said with an unenthusiastic sigh. "But does our new equation involve atoms or molecules?"

"This one involves molecules and solo atoms," Hectii said. "That means… Here, I'll record these new rules, so Pico can study our conclusions:"

SECOND PRINCIPLE OF ENCLOSED ATOMIC/MOLECULAR MOMENTUM:

When a molecule is in a container (gas, liquid, or solid) the molecule will forward its momentum to the sides of the container as it collides with the sides of the container.

The contac- ρ-force-rate, momentums per second, of the molecule is directly related to the momentum of the molecule, the velocity of the molecule, and it is inversely related to the volume of the container:

$$\underline{\boldsymbol{F}} \propto (\boldsymbol{m_{molecule}v})(\frac{velocity}{[?]})(\frac{\mathbf{1}}{\mathbf{3Volume}})$$

or: $\underline{\boldsymbol{F}} = \boldsymbol{K}\frac{\boldsymbol{m_{molecule}\ v}}{\boldsymbol{Volume}}(\frac{\boldsymbol{v}}{[?]})$

“What do you think, Chip?” Hectii said.

“Nice addition to the equation,” Chip wrote. “You’re wise to focus on molecules first. Inside the molecule, the amount of momentum transferred between the molecules is also related to the amount of attraction between the atoms and molecules.”

“Wait, you said, sometimes there’s an attraction between molecules,” Hectii repeated excitedly. “Is that what the question mark is?”

“Partially,” Chip wrote. “Attraction is one of the factors that the question mark represents, but there are other factors as well. Just remember, the question mark is a constant when both the pressure and the volume are constant, but the question mark is a variable when either the pressure or the volume changes. So, it's a good symbol to keep for now."

"Do my principles make sense to you, Tera?" Hectii said.

"I'm starting to understand the principals, but what do these equations mean?" Tera said. "Put some numbers into one of the equations, so I can see what's going on."

"I'll use one molecule with a mass of 0.002 kg, flying at a speed of 1 000 m/s, inside a spherical balloon with a radius of 0.1 m, and a question-mark variable of 2," Hectii said as she rapidly keyed. "In that case our equation will look like this:"

$$\rho\text{-}force\text{-}rate = mv\left(\frac{v}{2r}\right)\left(\frac{1}{4\pi r^2}\right)$$

$$\rho\text{-}force\text{-}rate = (0.002kg)(1\ 000\,\frac{m}{s})\left(\frac{(1\ 000\ m/s)}{2(0.1m)}\right)\left(\frac{1}{4\pi(0.1m)^2}\right)$$

appeared on her phone.

"Go ahead and reduce that, Chip," Hectii said.

"Done," Chip wrote as he placed the following information on the display:

$$\rho\text{-}force\text{-}rate = \left(\frac{1\ 000\ 000\ \rho}{s}\right)\left(\frac{1}{4\pi m^2}\right)$$

$$\boldsymbol{\rho\text{-}force\text{-}rate = 79\ 600\,\frac{\rho/s}{m^2}}$$

$$\boldsymbol{\rho\text{-}force\text{-}rate = 79\ 600\ pascals}$$

appeared on her phone.

"That seems like a lot of pascals. Chip, what's a pascal?" Tera asked.

"A pascal is the metric unit for measuring the surface pressure of a gas in a container," Chip wrote.

"If 1 molecule produces 79 600 pascals of pressure," Tera said. "How much pressure would 2 molecules produce?"

"Careful," Hectii cautioned. "Our single molecule had a mass of 0.002 kg, which is absurdly high."

"Ok, but what if we had 2 molecules, each with a mass of 0.001 kg?"

Hectii began tapping her handled, stopped, and smiled at Tera. "Brilliant observation, Sis, our equation doesn't have a variable for the number of molecules in the container."

"Let's use the letter *n* to represent the number of molecules," Tera suggested.

"Good idea," Hectii said as she keyed the following:

$$\rho\text{-}force\text{-}rate = (number)K[mv\left(\frac{v}{[?]}\right)\frac{1}{Volume}]$$

$$\rho\text{-}force\text{-}rate = nK[mv\left(\frac{v}{[?]}\right)\frac{1}{Volume}]$$

appeared on her phone.

"Would *n* have to be the exact number of molecules?" Tera said. "Or could it also represent clusters like moles?"

"Currently, our equation is independent of units," Hectii said. "The volume, mass, and number of molecules can be measured in any unit the scientist wants. The units chosen will determine the nature of the constant *K*."

"That actually makes sense," Tera said. "And the unit used to measure the surface pressure produced by the force-rate could also vary."

"That's right!" Hectii said insightfully, as she hurriedly tapped her phone. "The force-rate is producing a surface pressure. That means we've discovered another principle:"

THIRD PRINCIPLE OF ENCLOSED ATOMIC/MOLECULAR MOMENTUM:

In a container with a fixed volume (*V*), the pressure (*P*) of a gas against the side of the container is directly proportional to the contac-ρ-force-rate of the molecules/atoms of the enclosed gas.

$$(1)\ P \propto n\left[\frac{m_{molecule}\,v}{Volume}\left(\frac{v}{[?]}\right)\right]$$

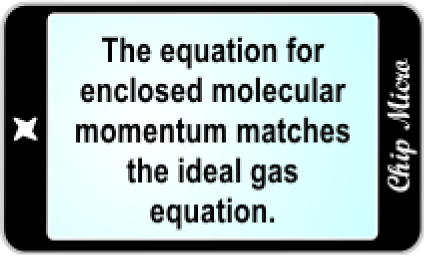
$$(2)\ P = nK\left[\frac{m_{molecule}\,v}{Volume}\left(\frac{v}{[?]}\right)\right]$$

$$(3)\ PV = nK\left[m_{molecule}\,v\left(\frac{v}{[?]}\right)\right]$$

$$(4)\ \frac{P_1V_1}{n_1\left[m_m v\left(\frac{v}{[?]}\right)\right]_1} = \frac{P_2V_2}{n_2\left[m_m v\left(\frac{v}{[?]}\right)\right]_2}$$

"Wow, that's an intense brainstorm," Tera admired, as she pointed to the undersea display. The sting-ray family had departed, and the colorful coral reef was once again filled with hundreds of beautiful fish. "Let's take it one equation at a time."

"The first equation tells us the pressure is proportional to the force-rate," Hectii clarified with a nod. "And the rules of proportionality tell us we can change a proportion into an equality if also we add the constant *k*."



"That's why the second equation has a new constant?"

"Yes."

"I see," Tera said halfheartedly. "But, what would happen if there were two different size molecules in the container?"

"That sounds more complicated. Let's brainstorm it," Hectii said, as she considered for a moment. "If the walls of the container and the molecules are all in a condition of equalized momentum, and the volume is constant, then the enclosed momentum of the two molecules will follow this relationship:"

$$(PV)_A = (PV)_B$$

$$\left(m_{molecule} v\left(\frac{v}{[?]}\right)\right)_A = \left(m_{molecule} v\left(\frac{v}{[?]}\right)\right)_B$$

appeared on her phone.

"Hectii, you're suggesting the pressure and volume are constant, right?" Tera said as her countenance brightened. She sat up, touched the screen with a finger, and altered the equations. "Chip said, the question mark is a constant when the pressure and volume don't change. That means we can cancel out the question mark. Our new equation is much simpler. See?"

Tera pointed to her phone screen:

$$(m_{molecule}v^2)_A = (m_{molecule}v^2)_B$$

"Explo!" Hectii said. "You uncovered another principle of enclosed molecular momentum! Check this out. First, I'll cross multiply backwards, like this:"

$$(m_{molecule}v^2)_A = (m_{molecule}v^2)_B$$

$$\frac{v_A^2}{v_B^2} = \frac{m_B}{m_A}$$

appeared on her phone.

Hectii's eyes twinkled as she tapped her phone. "And when I take the square root of both sides, we end up with a fourth principle. It looks like this:"

FOURTH PRINCIPLE OF ENCLOSED MOLECULAR MOMENTUM:

A) When a mixture of two substances is in a condition of equalized molecular momentum, the overall contac- ρ-force-rates, momentums per second, will be in equilibrium. Therefore:

(Equalized $\underline{\boldsymbol{F}}$)$_A$ = (Equalized $\underline{\boldsymbol{F}}$)$_B$

and: $\left(\frac{m_{molecule}v^2}{|?|}\right)_A = \left(\frac{m_{molecule}v^2}{|?|}\right)_B$

and: $(m_{molecule}v^2)_A = (m_{molecule}v^2)_B$

and: $\frac{v_A^2}{v_B^2} = \frac{m_{B-amu}}{m_{A-amu}}$

B) When a closed system is in a condition of equalized molecular momentum, the average velocity of two different gas molecules is inversely proportional to the square root of their atomic masses [Graham's Law].

Relative velocities, controlled by the equalized molecular momentum:

$$\frac{v_A}{v_B} = \frac{\sqrt{m_{B-amu}}}{\sqrt{m_{A-amu}}}$$

[* This Graham's law equation is also the mathematical definition of equalized momentum exchange during molecular collisions!]

C) When gas is in a condition of equalized momentum, the average velocity of a single molecule is inversely proportional to the square root of its atomic mass [Graham's Law]:

$$v_A \propto \frac{1}{\sqrt{m_{A-amu}}}$$

"You mean you can tell how fast a molecule is traveling just by its mass?" Tera said quizzically.

"Not quite," Hectii said. "This tells us, when the momentum is equalized, a heavier molecule will fly only a little bit slower than a lighter molecule.

"Normally, you'd think that momentum-based velocity is related to a molecule's mass, without the square root. But in this case, the gas molecules are enclosed in a container."

Tera nodded. "It is an odd relationship…"

"The reason is a little difficult to explain," Hectii acquiesced. "But the math is indisputable. When the molecular momentum in a container of gas is fully equalized, the velocity of the molecules is dependent on the square root of the molecular mass."

"That's amazing," Tera professed. "Chip, are you following this?"

"Definitely," Chip wrote. "This equation correlates well with Graham's law. In 1848, Thomas Graham discovered that the rate of effusion of a gas (seeping through a tiny hole) is inversely proportional to the square root of the atomic masses. His equation looked like this:"

$$\frac{rate_A}{rate_B} = \frac{\sqrt{m_{B-amu}}}{\sqrt{m_{A-amu}}}$$

appeared on her phone.

"Notice the similarity to Hectii's equation?" Chip wrote. "The Graham's law equation appears in a variety of forms, all of which match the equations in your fourth principle of enclosed atomic momentum. In fact, the inverse proportion equation:"

$$v_A \propto \frac{1}{\sqrt{m_A}}$$

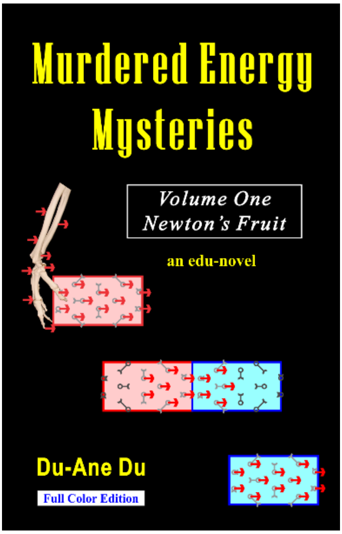
appeared on her phone.

"is used by chemists in a wide variety of situations."

*   *   *

CONCLUSION: More research needs to be done into the relationship between mechanical energy and other theoretical forms of energy. Many common beliefs may actually be philosophical myths.

Murdered Energy Mysteries seeks to increase understanding of the various forms of momentum and momentum transfer, as well as the various forms of energy and energy transfer. The lack of understanding on the part of the scientific community is substantial, and more research needs to be done.



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