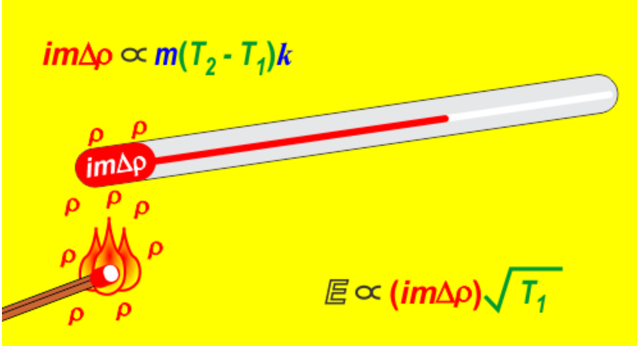
Atomic Heat-Behavior: Impulse vs. Energy



3. Calorimetric-Energy's Disappearing ΔT Fallacy

Professor Du-Ane Du

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

Abstract: The equation for the transfer of molecular kinetic energy contains a disappearing Δv fallacy that becomes apparent when written as, $\Delta E = (im\Delta\rho)(v_i + \frac{\Delta v}{2})$. In most calorimetric situations, this is equivalent to, $\Delta E \propto k_{\rho/mol}(mols\ of\ fuel\ burned)(\sqrt{T_{initial}})$. Thus the energy allegedly produced when something burns is not exclusively related to ΔT. This supports the use of impulse based calorimetry, where there is no disappearing ΔT fallacy.

This advanced article will focus on several fallacies inadvertently imbedded in the kinetic energy equations, and their relationship to calorimetry. Including, 1) the $(v_{initial} +$

$\frac{\Delta v}{2}$) disappearing delta fallacy, 2) conservation incompatibility, 3) the impulse/energy duality, 4) calorimetric energy's disappearing ΔT. (This is an advanced article, simpler discussions of these topics can be found at www.Wacky1301SCI.com)

Devil's Advocate says, "Approach this essay like you were looking at a new home, appreciate the neighborhood, explore the hallways, rooms and crevices, admire the architecture… consider new possibilities and validate new perspectives."

FALLACY #1: Kinetic Energy's Disappearing Δ*v*

The law of conservation of momentum was developed by Descartes around 1650. Galilei's, Descartes', and Newton's concept of the effect of an impulse can be represented by the equations:

$$mv_i + im\Delta\rho = mv_f$$

Where

$$im\Delta\rho = m(\Delta v)$$

The first conclusion of Article 1, *Chemically Stored Impulse, Energy, or Both?*, stated: "It is likely that chemical bonds store mechanical impulse, and when chemical bonds break, the mechanical impulse is released to increase the momentum of surrounding atoms and to increase the momentum of receiving objects." The release of Chemically Bonded Impulse can be expressed as:

$$im\Delta\rho = k_{\rho/mol}(mol\ of\ fuel\ burned)$$

Therefore:

$$mv_i + k_{\rho/mol}(mol\ fuel\ burned) = mv_f$$

And:

$$k_{\rho/mol}(mol\ fuel\ burned) = m(\Delta v)$$

These equations suggest, burning a substance in a calorimeter will cause a change in the molecular momentum and molecular velocity of the calorimetric fluid. The customs of calorimetry also show that the amount of fuel burned always creates a change in temperature, related to the object's specific heat. As a result, burning fuel causes a change in velocity and a related change in temperature:

$$\Delta\sqrt{T} \propto \Delta v$$

The essence of the calorimetric fallacies lies in a derivation oversight hidden in von-Leibniz's original equations. In the late 1700's Leibniz merged some Aristotelian ideas with his personal philosophy of "conservation of *vis viva*" and justified the entire idea with the equation:

$$\Delta\ vis\text{-}viva = \frac{1}{2}mv_{final}^2 - \frac{1}{2}mv_{inital}^2$$

Using the difference of two squares rule, this equation can be rotated to isolate the derivation oversight as follows:

$$\Delta\ vis\text{-}viva = \frac{1}{2}[(\boldsymbol{mv_f})\boldsymbol{v_f} - (\boldsymbol{mv_i})\boldsymbol{v_i}]$$

$$\Delta\ vis\text{-}viva = \frac{1}{2}\boldsymbol{m}[(\boldsymbol{v_f})\boldsymbol{v_f} - (\boldsymbol{v_i})\boldsymbol{v_i}]$$

$$\Delta\ vis\text{-}viva = \frac{1}{2}\boldsymbol{m}(\boldsymbol{v_f} - \boldsymbol{v_i})(\boldsymbol{v_f} + \boldsymbol{v_i})$$

$$\Delta\ vis\text{-}viva = (\boldsymbol{mv_f} - \boldsymbol{mv_i})\frac{1}{2}(\boldsymbol{v_f} + \boldsymbol{v_i})$$

$$\boldsymbol{mv_f} - \boldsymbol{mv_i} = \boldsymbol{im\Delta\rho}$$

$$(\boldsymbol{v_f}) + \boldsymbol{v_i} = (\boldsymbol{v_i} + \boldsymbol{\Delta v}) + \boldsymbol{v_i}$$

$$\Delta\ vis\text{-}viva = (\boldsymbol{im\Delta\rho})\frac{1}{2}(\boldsymbol{2v_i} + \boldsymbol{\Delta v})$$

$$\Delta\ vis\text{-}viva = (\boldsymbol{im\Delta\rho})\left(\boldsymbol{v_i} + \frac{\boldsymbol{\Delta v}}{\boldsymbol{2}}\right)$$

Which means,

$$\Delta E = (\boldsymbol{im\Delta\rho})\left(\boldsymbol{v_i} + \frac{\boldsymbol{\Delta v}}{\boldsymbol{2}}\right)$$

Note that the $(\boldsymbol{v_i} + \frac{\boldsymbol{\Delta v}}{\boldsymbol{2}})$ component includes a calculus-like disappearing delta. *That is the derivation oversight that this article will investigate*.

The disappearing delta creates a kinetic and calorimetric fallacy caused by the fact that when $v_{initial}$ is notably greater than Δv, then:

$$\Delta vis\text{-}viva = (\boldsymbol{im\Delta\rho})(\boldsymbol{v_i})$$

$$\Delta E = \boldsymbol{k_{\rho/mol}}(\boldsymbol{mol\ of\ fuel\ burned})(\boldsymbol{v_i})$$

Now it is obvious that the energy produced by the "CPE" is primarily dependent on the starting velocity, rather than on the change in velocity!

"Perhaps more importantly," Devil's Advocate says, "Δv is related to ΔT. So if Δv has disappeared, then ΔT becomes equally irrelevant!"

In fact, at most temperatures,

$$\Delta E \propto (\boldsymbol{im\Delta\rho})\sqrt{\boldsymbol{T_i}}$$

$$\Delta E \propto \boldsymbol{k_{\rho/mol}}(\boldsymbol{mol\ of\ fuel\ burned})\sqrt{\boldsymbol{T_i}}$$

$$\Delta E \propto \boldsymbol{k_{\rho/g}}(\boldsymbol{grams\ of\ fuel\ burned})\sqrt{\boldsymbol{T_i}}$$

This fallacy has a significant impact on the very meaning of calorimetry.

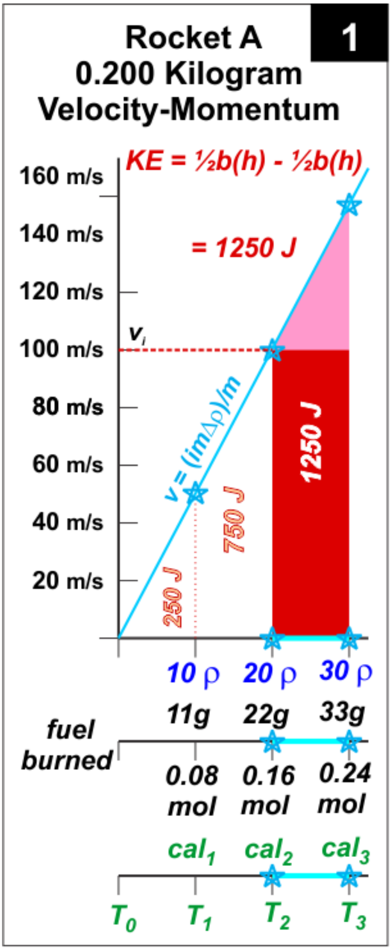
FALLACY #2: Conservation Incompatibility

The impact of the disappearing delta can be seen in the following velocity-momentum graph, Illustration 1 taken from Article 1, *Chemically Stored Impulse, Energy, or Both?* It is important to note that all energy equations have their origin in this graph.

The graph for a rocket is the same as the velocity-momentum graph for a molecule, and this graph has several important features relating to calorimetry.

First, the order of dependency begins with the middle X-axis (fuel), and works its way up and down. The number of mols of fuel determines the number of grams of fuel, the number of grams of fuel determines the amount of impulse produced. Mols of fuel burned also determines the calories produced and temperature change—bottom axis.

Molecular impulse is the horizontal difference between two momentum values (top X-axis).



The sloped data line represents the equation $v = (im\Delta\rho)/m$, which determines the molecular velocity value on the Y-axis.

Finally, the change in molecular momentum (X-axis) and the molecular velocity data (Y-axis) interact to determine the total area under the data-line (red trapezoid). This is the molecule's ΔKE, or more properly work energy.

Notice the lower red box corresponds to the energy produced mainly by $v_{initial}$, (which becomes dominant at higher velocities).

Above the red box is a small pink triangle depicting the energy produced exclusively by the disappearing $\Delta v/2$, (which becomes irrelevant at higher velocities).

It is likely that the followers of Sir Newton and von-Leibniz would have argued forcefully over the fact that the graph shows that momentum and energy can never have a one-to-one relationship.

"Followers of Newton would likely have noted that momentum is linear, while energy is multi-parabolic," Devil's Advocate says. "This means momentum is conserved, but kinetic energy is created as the object's momentum increases."

Good, and The behavior of $v_{initial}$ and the disappearing delta matches the Newtonian view.

Followers of Leibniz would likely have converted this into a graph that portrays momentum as the first derivative of energy. That would imply that energy is conserved, but momentum gradually disappears as energy expands. (The problem with that approach is that it ignores the role of fuel, the role of calories, and the role of ΔT, which is what calorimetry is supposed to be about.)

Fallacy #3: The Impulse-Energy Duality

Either energy is the anti-derivative of momentum, or momentum is the derivative of energy. With every experiment one must always ask, "Are we measuring energy and calling it momentum, or are we measuring impulse and calling it energy?"

"The important thing at this point is to recognize the inexorable nature of the mathematical duality," Devil's Advocate says. "Human beings cannot interact with energy/work without also interacting with momentum/impulse."

In *Murdered Energy Mysteries*, Chapter 302, "Joule's Double Meaning," Joule's most accurate published experiment was examined with respect to the impulse-energy duality.

Joule turned a hand-crank with a force of 1 pound, at a rate of 1 ft/s, for 900 s. This resulted in an impulse of 900 pound-seconds, which Joule mathematically expressed as 900 foot-pounds of work done. Joule's goal was 778 foot-pounds of work done.

Murdered Energy Mysteries uses Joule's data to develop the following equivalencies:

1 calorie = 4.958 ±0.04 ρ of heat-impulse

1 J of heat-energy = 1.185 ρ of heat-impulse

1 J of electric energy = 1.185 ρ of electric impulse

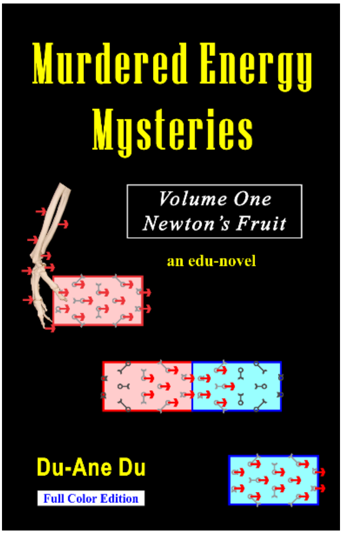
1 J of CPE = 1.185 ρ of Chemically Bonded Impulse

"Notice that these include equivalencies for electric units," Devil's Advocate says. "Going a step further, in nuclear chemistry, the ultimate duality involves Einstein's $E = mc^2$ which has the impulse equivalency equation:"

$$energy \propto mc^2$$
$$E = kmc^2$$

$$im\Delta\rho \propto mc$$
$$\boldsymbol{im\Delta\rho = kmc}$$
$$im\Delta\rho = 1.185\frac{\rho}{J}(E)$$
$$kmc = 1.185\frac{\rho}{J}(mc^2)$$
$$k = 1.185(c)$$
$$k = (1.185)(3.00\ E8\ )$$
$$k = 3.56\ E8$$

$$\boldsymbol{im\Delta\rho = (3.56\ E8)mc}$$



[Examine or purchase at Amazon.com]

According to this impulse parallel of Einstein's equation, when the fuel rods in a nuclear reactor lose 0.001 kg of mass, the conversion will generate an impulse of:

$$im\Delta\rho = (3.56\ E8)mc$$
$$im\Delta\rho = (3.56\ E8)(0.001kg)(3.00\ E8\frac{m}{s})$$
$$im\Delta\rho = 3.56\ E14\ \rho$$

The impulse-energy equivalencies involve every aspect of science. The question remains, "Are scientists measuring energy and calling it momentum, *or are scientists measuring impulse and calling it energy?*"

Fallacy #4: Calorimetric Energy's Disappearing Δ*T*

In 1850, several things happened that resulted in the development of the kinetic theory of heat. Probably the most influential was the discovery of Graham's law, which relates the effusion velocity of a gas, at a constant temperature, to the square root of its molecular mass. Versions of the Graham's equations include:

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

In the 1850's this was probably seen as strong evidence that molecular kinetic energy was somehow related to the transfer of heat from one place to another.

"Is this a fact," Devil's Advocate says, "or a mathematical coincidence?"

Good question. To resolve this issue, a series of thought experiments involving calorimetry will be performed to determine the exact amount of kinetic energy produced during the explosive combustion of 1 g of black powder. At the same time, the role of the Δ*T*-Δ*v* fallacy will be examined with respect to the alleged transfer of energy from the black powder to three different noble gases. The equations investigated include:

$$E\ produced = \frac{1}{2}mv_{final}^2 - \frac{1}{2}mv_{initial}^2$$
$$E\ produced = k_{\rho/mol}(mol\ of\ fuel)\left(\boldsymbol{v_{initial}} + \frac{\boldsymbol{\Delta v}}{\boldsymbol{2}}\right)$$

$$\boldsymbol{E\ produced} = (\boldsymbol{im}\Delta\boldsymbol{\rho})\left(\boldsymbol{v_{initial}} + \frac{\Delta \boldsymbol{v}}{\mathbf{2}}\right)$$

The thought experiments will involve three identical noble-gas calorimeters, one containing 10 mol radon-222, one containing 10 mol xenon-131, and one containing 10 mol neon-4. The starting temperature is 300 K, and the traditional equation:

$$v = \sqrt{\frac{24403(\text{Kelvins})}{m_{amu}}}$$

where $v \propto \sqrt{T}$

This can be used to estimate the initial velocities of each of the three noble gases, prior to igniting the black powder, Table F1.

Initial Velocity at 300 K						F1
	Radon-222		Xenon-131		Helium-4	
Starting Temp	300.0	K	300.0	K	300.0	K
Atomic Mass	222	amu	131	amu	4	amu
Velocity Initial	**182**	**m/s**	**236**	**m/s**	**1353**	**m/s**

As one would expect, the noble gas with the highest atomic mass also has the lowest initial velocity (182 m/s), while the noble gas with the lowest atomic mass has the highest initial velocity (1353 m/s).

Note that calorimetry involves the relationships:

$$\sqrt{T_{initial}} \propto v_{initial}$$
$$\Delta\sqrt{T} \propto \Delta v$$

Because of the calculus-like disappearing delta, the energy associated with $T_{initial}$ and $v_{initial}$ can be found using the [first] calorimetry equations:

$$\boldsymbol{E\ produced\ by\ T_{initial} = m(\Delta v)(v_{initial})}$$
$$E\ produced\ by\ \boldsymbol{T_{initial}} = (im\Delta\rho)(\boldsymbol{v_{initial}})$$
$$E\ produced\ by\ \boldsymbol{T_{initial}} = (im\Delta\rho)(\sqrt{\boldsymbol{T_{initial}}})$$

Similarly, the energy produced exclusively by ΔT and Δv can be found using the calorimetry equations:

$$\boldsymbol{E\ produced\ by\ \Delta T = m(\Delta v)(\frac{\Delta v}{2})}$$
$$E\ produced\ by\ \Delta\boldsymbol{T} = (im\Delta\rho)(\frac{\Delta \boldsymbol{v}}{\boldsymbol{2}})$$
$$E\ produced\ by\ \Delta\boldsymbol{T} = (im\Delta\rho)(\frac{\Delta\sqrt{\boldsymbol{T}}}{\boldsymbol{2}})$$

Returning to the thought experiment, 1.0 g of black powder is placed inside each calorimeter, and ignited. The final temperature of the gas is measured, the final velocity is calculated, and the change in velocity is used to calculate the amount of energy produced, in Table F2.

Energy Produced by 1g of Black Powder						F2
	Radon-222		**Xenon-131**		**Helium-4**	
Starting Temp	300.0	K	300.0	K	300.0	K
Atomic Mass	222	amu	131	amu	4	amu
# mol	10	mol	10	mol	10	mol
Total Mass	2.22	kg	1.31	kg	0.04	kg
Sp Heat	0.09	cal/g/K	0.0377	cal/g/K	0.746	cal/g/K
Black Powder Cal	684	cal+	684	cal+	684	cal+
Final Temp	303.42	K	313.8	K	322.9	K
Velocity Initial	181.6	m/s	236.4	m/s	1352.9	m/s
Velocity Final	182.6	m/s	241.8	m/s	1403.6	m/s
KE produced by T1, v1	**417**	**J/g**	**1671**	**J/g**	**2745**	**J/g**
KE produced by ΔT, Δv	**1**	**J/g**	**19**	**J/g**	**51**	**J/g**
Total ΔKE	**418**	**J/g**	**1690**	**J/g**	**2797**	**J/g**
J/cal	0.611	J/cal	2.471	J/cal	4.089	J/cal

"This data clearly indicates that the determining factor in the alleged production of energy is not the chemical bonds!" Devil's Advocate says, "rather the determining factor is the starting velocity and starting temperature of the atoms receiving the impulse-energy!"

Note that radon had a starting velocity of 182 m/s, but a Δv of only 1 m/s. The amount of energy allegedly produced by $T_{initial}$ was 417 J, while the amount of energy produced by ΔT was only 1 J.

Similarly, the helium had a starting velocity of 1353 m/s, but a Δv of 50 m/s. The amount of energy allegedly produced by $T_{initial}$ was 2745 J, while the amount of energy produced by ΔT was only 51 J.

"In all three cases," Devil's Advocates says, "the energy allegedly produced during calorimetry is not directly related to ΔT."

If energy produced is not directly related to ΔT, then the heat that causes ΔT cannot be related to energy.

Could the relationship between impulse and calorimetry be closer?

Consider, the equations noted earlier can also be written as:

$$im\Delta\rho = m(\Delta v)$$
$$im\Delta\rho \ produced \ by \ T_{initial} = 0$$
$$im\Delta\rho \ produced \ by \ \Delta T = (m)(\Delta v)$$

Recall that $v_{initial}$ is related to $T_{initial}$, and Δv is related to ΔT. As a result, the temperature components can be substituted into the equations to reveal the relationships:

$$im\Delta\rho \ total = (m)(\Delta T)k$$
$$im\Delta\rho \ produced \ by \ T_{initial} = (0)k$$
$$\boldsymbol{im\Delta\rho \ produced \ by \ \Delta T = (m)(\Delta T)k}$$

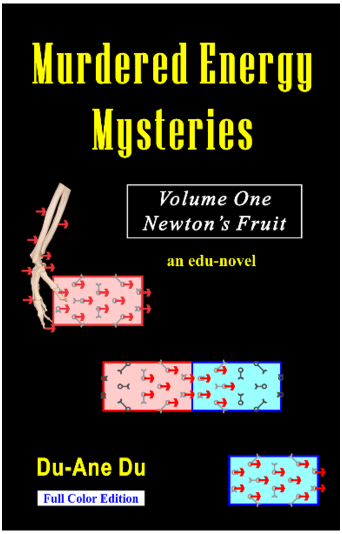
Note the direct correlation with the standard calorimetry equation:

$$\boldsymbol{calories \ total = (m)(\Delta T)(C_P)}$$

Fallacy #5: Determining a Value for *J/cal*

"If energy exists," Devil's Advocate says, "then the amount of energy produced by the impulse stored in 1 gram of fuel must be the highest possible estimate (See Appendix). When measured from the galactic view, there must be at least 400 J/cal. This means the commonly used estimate of 4.184 J/cal cannot be scientifically valid."

For more on Fallacy #5, see the Appendix of Supplemental Material.



[*Examine or purchase at Amazon.com*]

CONCLUSION 1: One of the most important aspects of calorimetry is Δ*T*. Burning fuel in a calorimeter causes a corresponding increase in the molecular momentum, molecular velocity, and overall temperature. Yet derivations show, in most calorimetric situations the production of molecular kinetic energy is not exclusively a function of Δ*T*. If energy produced is not related to Δ*T*, then the heat that causes Δ*T* may not be related to energy. This calls into question the wisdom of using joules as a unit of heat.

CONCLUSION 2: Note the relationships between the equations:

$$\boldsymbol{im\Delta\rho} = (m)(\Delta v)$$
$$\boldsymbol{im\Delta\rho\ produced\ by\ \Delta T} = (m)(\Delta T)k$$
$$\boldsymbol{calories\ total} = (m)(\Delta T)(C_P)$$

It is likely that chemical bonds store heat-impulse, and when chemical bonds break, the heat-impulse is released to increase the momentum of surrounding atoms and to increase the momentum of receiving objects. (See Article 1. *Chemically Stored Impulse, Energy, or Both?*)

CONCLUSION 3: 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 is an edu-novel which 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.

—Du-Ane Du, author of the edu-novel *Murdered Energy Mysteries* (Amazon, Kindle, e-book 2018, paperback 2020.)

More information, see:

Murdered Energy Mysteries, an edu-novel

Atomic Heat-Behavior: Impulse vs. Energy

Article 1. *Chemically Stored Impulse, Energy, or Both?*

Article 2. *Foundations for a Heat-Impulse Theory*

Available at: www.Wacky1301SCI.com

Appendix of Supplemental Material

Fallacy #5: Determining a Value for *J/cal*

If energy exists, then the amount of energy produced by the impulse stored in 1 gram of fuel must be the highest possible estimate. All lesser values can then be explained away as some form of energy dissipation. Hence the 2nd law of thermodynamics. It is easy to explain away energy destruction, energy creation cannot be explained away.

Now the question becomes, is the helium estimate of 4.089 J/cal the highest possible estimate of the amount of energy produced by the impulse contained in 1 g of black powder?

Recall that the work done, kinetic energy, and work energy allegedly produced by breaking chemical bonds can be calculated using the generic equations:

$$\boldsymbol{E\ produced} = k_{\rho/mol}(mol\ fuel\ burned)\left(\boldsymbol{v_{initial}} + \frac{\boldsymbol{\Delta v}}{\mathbf{2}}\right)$$

$$\boldsymbol{E\ produced} = k_{\rho/g}(grams\ fuel\ burned)\left(\boldsymbol{v_{initial}} + \frac{\boldsymbol{\Delta v}}{\mathbf{2}}\right)$$

Because of the prominent role of $v_{initial}$, it is important to ask what the actual starting velocity of the noble gases was? Measured relative to where?

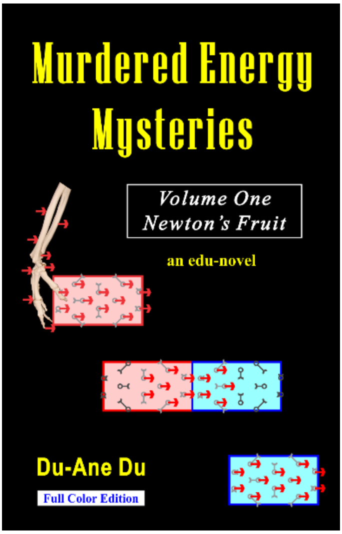
Atomic velocity involves the concept of root-mean-square averaging. As a result, direction is forward only. Therefore one can think of the 1 kg of neon-4 at 300 K as having an initial eastward velocity of 1353 m/s. This can be measured from five distinct perspectives, that can be approximated as:

1,353 m/s relative to the lab floor,
3,353 m/s relative to the center of the Earth,
31,353 m/s relative to the center of the Sun,
201,353 m/s relative to the center of the Milky Way,
651,353 m/s relative to the center of the Universe.

The issue now becomes one of controlling the parallax errors produced by calculations of molecular energy. In *Murdered Energy Mysteries*, Chapter 305, "Simple-Relativity Test of Unit Reliability," Mr. Du focuses extensively on how to control these energy calculations. In Chapter 306 he deals specifically with gas behavior by comparing a projectile to its effect on gases.

This article will use a similar shortcut by viewing the rocket experiments from Article 1, as a parallax-free substitute for the final noble gas experiment.

In this final thought experiment, the lab is located at the equator, at midnight. A 4 kg rocket is placed on a friction free test track, so that it will travel eastward. There is no air in the room, and no source of friction. To eliminate the need for relativity equations, the initial velocities will be about half that normally estimated by astronomers.



[Examine or purchase at Amazon.com]

The C-11 engine will be repacked so it has only 1 gram of black powder, produces a force of 0.7 N for 0.12987 s, so the total impulse produced is 0.909 ρ.

When seen from the earth-centered view, the rocket engine will produce 684 cal of heat, an impulse and momentum-increase of 0.909 ρ, which is an average of 0.00133 ρ/cal. This is lower than Joule's data of 4.95 ρ/cal (See data in Article 1). The missing impulse is easily explained via the 2^{nd} law of thermodynamics, as witnessed by the rise in temperature, caused by the increase in disorganized atomic motion.

With respect to energy allegedly produced, the 684 cal will be associated with a work-energy increase of 909.2 J, which is an average of 1.33 J/cal. This is lower than the traditional value of 4.184 J/cal. This loss of energy is easily explained by the 2^{nd} law of thermodynamics.

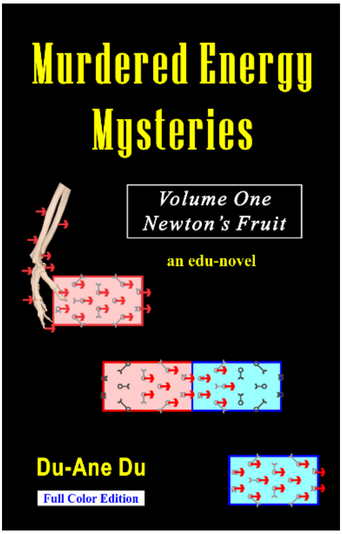
The raw data of the solar, galactic, and universe views of the experiment are in Table G:

4 kg Rocket, Effect of 1 Gram of Fuel						**G**
	Solar View		**Galactic View**		**Universe View**	
Mass	4	kg	4.0	kg	4.0	kg
Initial Velocity	15000.0	m/s	100000.0	m/s	300000.0	m/s
Thrust	7	N	7	N	7	N
Duration	0.130	s	0.130	s	0.130	s
Impulse	0.909	*ρ*	0.909	*ρ*	0.909	*ρ*
Final Velocity	15000.23	m/s	100000.23	m/s	300000.23	m/s
Rocket Δρ	**0.909**	***ρ*/g**	**0.909**	***ρ*/g**	**0.909**	***ρ*/g**
Cal Generated	684	cal/g	684	cal/g	684	cal/g
ImΔρ Per Cal	**0.00133**	***ρ*/cal**	**0.00133**	***ρ*/cal**	**0.00133**	***ρ*/cal**
Energy	**13,636**	**J/g**	**90,909**	**J/g**	**272,727**	**J/g**
J/cal	**19.9**	**J/cal**	**133**	**J/cal**	**399**	**J/cal**

Looking at the bottom line of the table, from the solar view the black powder allegedly produced 19.9 J/cal. This is more than the traditional value of 4.185 J/cal. The 2nd law of thermodynamics is only valid if the highest possible estimate is used. This means energy-to-calories ratio must be higher than 19.9 J/cal.

The bottom data line of Table G, shows the galactic view is 133 J/cal, and the universe view is 399 J/cal. And these are the lowest possible estimates! This means in order for the 2nd law of thermodynamics to be valid, if the kinetic theory of heat-energy is valid, there must be a minimum of 400 joules of heat-energy for every calorie of heat.

In 1850, scientists had little understanding of galactic motion or universe motion. Nevertheless, the universe does exist and it is well established that the Earth is moving through space very rapidly. Earth's velocity can no longer be ignored, and it must be taken into consideration whenever energy calculations are done. Energy is a relativistic measurement, and if calorimetry is a measure of energy, then it too is relativistic.



Note that the momentum data never varies. In every view, all rockets experience an impulse and momentum-increase of 0.909 ρ per gram of fuel, which is an average of 0.00133 ρ/cal. This is lower than Joule's estimate of 4.95 ρ/cal, so Joule's impulse data remains valid and usable in all forms of calorimetry.