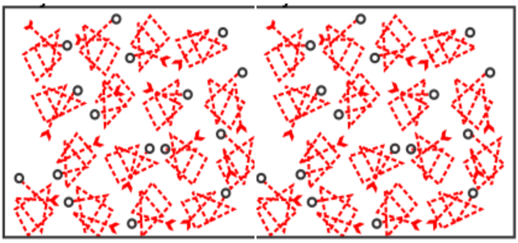
The Space-sci Sherlocks Deduce



How Rocket Fuel Causes Things to Move

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 stop to explore an asteroid and perform experiments with rockets, fuel, and motion.
> —Excerpted from *Murdered Energy Mysteries*, Part 1, Chapter 4, by Du-Ane Du, (Amazon, Kindle, ebook 2018, paperback 2021).

"What does one packet of fuel **always** give to **any** toy rocket?" appeared on Chip's main screen after Pico tapped the icon titled, *Secrets of Murdered Energia… Greatest Conundrum*.

“Are the Space-sci Sherlocks about to tackle a riddle or an experiment?” Pico said, as Tera and Hectii glided into the room. Earlier in the day, the girls had highlighted Hectii’s intentionally straightened hair, so her thick French braid was a mixture of dark brown and honey blonde.

“That sounds like both a riddle and an experiment,” Tera answered. “The words ‘always’ and ‘any’ are in bold print.”

“Something very consistent must happen when you use a specific amount of fuel with a wide variety of rockets,” Hectii postulated.

“Can we take some toy rockets along when we explore today’s asteroid?” Pico said.

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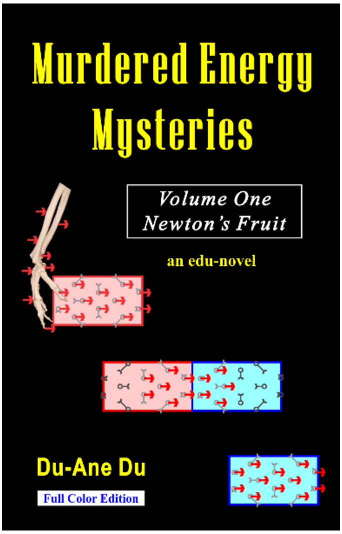

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“Why don’t you girls start out now?” Tera graciously suggested. “I’ll join you after I finish cleaning the dishes.”

“We’ll need some toy rockets, and fuel packets,” Pico said, as she and Hectii began putting on their spacesuits.

“Motion detectors, too,” Hectii said. “And a fishing rod and string to pull the rockets back after we launch them.”

Their spaceship was resting next to the sunny side of a large, oblong asteroid. The asteroid was about five times the length of the ship, and it appeared to be made of pink and gray granite, with periodic patches of sea-green deposits of copper minerals.

Hectii carried a box lined with sticky cloth, and their rockets and other equipment were attached inside the box by sticky tags. Pico skillfully attached a metal launch platform and motion detector to a small stone outcropping.

"We'll start by launching three different size rockets," Pico proposed. "And we'll use one packet of fuel in each high-efficiency rocket engine."

"How about a 1.0 kg rocket, a 2.0 kg rocket, and a 3.0 kg rocket?" Hectii said. "Do all these rockets have identical engines?"

"Identical high-efficiency H-1 engines and identical 12 gram fuel packets," Pico said. She attached a fishing line to the 1.0 kg rocket, placed it on the launch pad, focused the motion detector, and hit the launch button.

"Sweet," Hectii appraised, as the rocket sped away. She lifted the fishing rod and reeled the toy rocket back in.

"The fuel burned for 1.0 s," Pico said, reading off her visor display. "The 1.0 kg rocket had a starting speed of 0 m/s, and after the engine finished burning, the rocket had a final speed of 12 m/s."

"Now let's try the 2.0 kg rocket," Hectii said.

Pico launched the 2.0 kg rocket, and the smoke began to gather around their feet.

“That one didn’t accelerate as much,” Hectii said, as she reeled it back in.

“Once again, the fuel burned for 1.0 s,” Pico reported. “The starting velocity was 0 m/s, and the final velocity was 6.0 m/s.”

“Strange,” Hectii said puzzlingly. “The only thing that was the same was the length of time that the fuel burned.

“If this is a riddle, the answer can’t be that simple.”

“Try the 3.0 kg rocket.”

“The 3.0 kg rocket is accelerating even slower,” Pico said, as the rocket left the launch pad.

“My visor display says, the 3.0 kg rocket had a final speed of only 4.0 m/s,” Hectii said.

“Chip, please put our information in the form of a data chart,” Pico said, “and give us a looksee.”

Chip placed the following on their visor displays:

1 kg rocket	starting speed: $0 \frac{m}{s}$	final speed: **12** $\frac{m}{s}$	**A**
2 kg rocket	starting speed: $0 \frac{m}{s}$	final speed: **6** $\frac{m}{s}$	
3 kg rocket	starting speed: $0 \frac{m}{s}$	final speed: **4** $\frac{m}{s}$	

"I see a pattern," Pico said triumphantly. "If you multiply the kilograms (on the left) by the final velocity (on the right), you always arrive at the same answer!"

"Wonderful observation," Hectii congratulated.

"Ok," Pico said has her fingertips began keying information into her data-input gloves. "Our 2.0 kg rocket had a starting speed-momentum of 0 ρ, and a final s-momentum of:"

$s\text{-}momentum = |mv|$

$s\text{-}momentum = (2\ kg)(6\ \frac{m}{s})$

$\boldsymbol{s\text{-}momentum = 12\ kgm/s\ or\ 12\ \rho}$

appeared on their visor displays. (For a full explanation of the difference between speed-momentum and velocity-momentum see *Murdered Energy Mysteries*, Chapter 103.)

"And," Pico continued, "the calculations for impulse become:"

$impulse/momentum\text{-}transfer = \rho_{final} - \rho_{initial}$

$im\Delta\rho = 12\ \rho - 0\ \rho$

$\boldsymbol{im\Delta\rho = 12\ \rho}$

"That gives us 12 momentums of impulse during the acceleration of the 1.0 kg rocket," Pico finished.

"Impulse is easy to calculate," Hectii said, "we're getting really good at it!"

As Hectii keyed data into her data-input glove, the numbers appeared on both of their visor displays. But Tera's phone was not currently linked to their activities, so the information did not display on her phone.

"While the 3.0 kg rocket was accelerating," Hectii said, "it experienced an impulse of:"

$$impulse/momentum\text{-}transfer = mv_{final} - mv_{initial}$$

$$im\Delta\rho = (3\ kg)(4\ m/s) - (3\ kg)(0\ m/s)$$

$$\mathbf{im\Delta\rho = 12\ kgm/s\ or\ 12\ \rho}$$

appeared on their visor displays.

"Notice that when we use one packet of fuel, the impulse is always 12 ρ," Pico prophesized. "That suggests the impulse may be coming from the fuel."

"Wait," Hectii said cautiously. "Is this amount of impulse the same in every situation?"

"Let's try different amounts of fuel," Pico said. "And we can also try throwing the rockets before we hit the launch button."

"Let's put the results in a table."

"Not only that," Pico said with a snicker. "We can leave some of the information blank. When we arrive back to the ship, we'll give the table to Tera and see if she can fill in the missing numbers."

"Sneaky, Sister," Hectii said, as she energetically prepared to launch the first rocket. "We'll tell Tera it's a *Secrets of Murdered Energia… Greatest Conundrum* homework assignment."

After five launches, Chip placed a combined table on their visor displays. "There's a lot of data here," Chip said. "You launched five rockets, each with a different mass. And you used one packet of fuel in each rocket engine.

"Focus on the right column," Chip continued. "You can check the calculations if you want, but the most important information is the final answers—and the final answer for impulse produced is shown in the right column:"

B	**Tera's *Secrets of Murdered Energia* Homework** These experiments always used 1 packet (12 g) of fuel.			
Mass	**Velocities**		**Calculations**	**Impulse**
m	$v_{initial}$	v_{final}	$im\Delta\rho = mo_{ve} - mv_i$	$im\Delta\rho$ = _?_ ρ or _?_ $\frac{kgm}{s}$
$1\ kg$	$0\ \frac{m}{s}$	$12\frac{m}{s}$	$(1\ kg)(12\frac{m}{s}) - (1\ kg)(0)$	$im\Delta\rho$ = 12 ρ or 12 $\frac{kgm}{s}$
$2\ kg$	$0\ \frac{m}{s}$	$6\ \frac{m}{s}$	$(2\ kg)(6\ \frac{m}{s}) - (2\ kg)(0)$	$im\Delta\rho$ = 12 ρ or 12 $\frac{kgm}{s}$
$3\ kg$	$0\ \frac{m}{s}$	$4\ \frac{m}{s}$	$(3\ kg)(4\ \frac{m}{s}) - (3\ kg)(0)$	$im\Delta\rho$ = 12 ρ or 12 $\frac{kgm}{s}$

$4\,kg$	$0\,\frac{m}{s}$	$3\,\frac{m}{s}$	$(4\,kg)(3\,\frac{m}{s}) - (4\,kg)(0)$	$im\Delta\rho$ = ____ ρ or ____ $\frac{kgm}{s}$
$6\,kg$	$0\,\frac{m}{s}$	$2\,\frac{m}{s}$	$(6\,kg)(2\,\frac{m}{s}) - (6\,kg)(0)$	$im\Delta\rho$ = ____ ρ or ____ $\frac{kgm}{s}$
In every case, 1 packet of fuel produced __________ ρ of impulse/momentum-transfer ($im\Delta\rho$). [1 packet = 12 g fuel]				

"Different rockets, one packet of fuel each time… the results look fabulous," Hectii said after reviewing the calculations. "The pattern in the right column is obvious."

"One packet of fuel always produces 12 momentums of impulse," Pico analyzed.

"The same amount of momentum transfer, no matter how much mass the rocket has," Hectii said. "The mass of the rocket doesn't matter—it's all about the amount of fuel used. That means the impulse must be coming from the fuel."

"Now let's try using three packets of fuel," Pico said. "More fuel means the rockets should fly even faster!"

"Sounds great!"

"But we need to move to a different area," Pico said, impulsively disconnecting the launch pad. "There's no atmosphere on this asteroid, and no wind to blow the smoke away."

Hectii retrieved the box of rocket equipment, and the two girls moved past a low granite ridge and attached their materials to a new outcropping on the edge of a small valley.

"What's the next table look like, Chip?" Hectii requested after five more launches, each with a different size rocket.

"Here," Chip said, as he placed the next table on their visor displays. "This time there were three packets of fuel in each rocket engine. And notice that the final amount of impulse produced is shown in the right column. Check the calculations if you wish, but focus mainly on the right column:"

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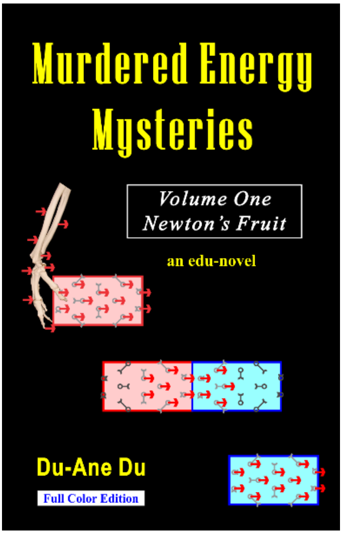

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C	**Tera's *Secrets of Murdered Energia* Homework** These experiments always used 3 packets of fuel.			
Mass	**Velocities**		**Calculations**	**Impulse**
m	***v*initial**	***v*final**	***imΔρ = mv*f – *mv*i**	$im\Delta\rho$ = _?_ ρ or _?_ $\frac{kgm}{s}$
$1\ kg$	$0\ \frac{m}{s}$	$36\frac{m}{s}$	$(1\ kg)(36\frac{m}{s}) - (1\ kg)(0)$	$im\Delta\rho$ = **36** ρ or 36 $\frac{kgm}{s}$
$2\ kg$	$0\ \frac{m}{s}$	$18\frac{m}{s}$	$(2\ kg)(18\frac{m}{s}) - (2\ kg)(0)$	$im\Delta\rho$ = **36** ρ or 36 $\frac{kgm}{s}$
$3\ kg$	$0\ \frac{m}{s}$	$12\ \frac{m}{s}$	$(3\ kg)(12\frac{m}{s}) - (3\ kg)(0)$	$im\Delta\rho$ = **36** ρ or 36 $\frac{kgm}{s}$
$4\ kg$	$0\ \frac{m}{s}$	$9\ \frac{m}{s}$	$(4\ kg)(9\ \frac{m}{s}) - (4\ kg)(0)$	$im\Delta\rho$ = ____ ρ or ___ $\frac{kgm}{s}$
$6\ kg$	$0\ \frac{m}{s}$	$6\ \frac{m}{s}$	$(6\ kg)(6\ \frac{m}{s}) - (6\ kg)(0)$	$im\Delta\rho$ = ____ ρ or ___ $\frac{kgm}{s}$
In every case, 3 packets of fuel (36 g) produced __________ ρ of impulse/momentum-transfer ($im\Delta\rho$).				

That means, 1 packet of fuel (12 g) produced ____12___ ρ of impulse/momentum-transfer (*im*$\Delta\rho$).

"The first rocket started with 0 ρ of s-momentum," Hectii said. "In the right column, when the engine burned, the rocket's s-momentum increased by 36 ρ."

"The same thing happened with the 6.0 kg rocket," Pico evaluated. "It started with 0 ρ of momentum, and it ended with 36 ρ of momentum. That means it experienced 36 ρ of impulse from the three packets of fuel—that's 12 momentums per packet."

"You know, Pico, it seems like we may be dancing around another science fact," Hectii said suggestively.

"Impulse involves the transfer of momentum from one object to another," Pico said. "This experiment must have something to do with Descartes's conservation facts—you know, the r-s-t momentum facts. Maybe we should start there."

"Chip," Hectii said. "What is the most accurate version of the Cartesian conservation facts?

"Rene Descartes was a mathematician and philosopher who lived in the 1600's," Chip said. "The term *Cartesian* is used to indicate a teaching of Descartes—because he often went by the name Carte."

"That's very logical," Pico said with a touch of impatience. "And *very* enlightening, but what about the facts of momentum?"

"I can give you the first one, which we developed a few days ago," Hectii said. "**Cartesian #1 conservation fact of momentum** tells us, the total amount of motion/momentum in the universe never changes, therefore Object A cannot speed up unless a second object slows down, likewise Object B cannot slow down unless one or more other objects speeds up."

"But we expanded that to include radian/rotational momentum," Pico said. "Right Chip?"

"Your **Cartesian #2 clarified conservation fact of r-s-t momentum**," Chip said, "tells us radian/speed/trapped momentum can change forms (radian, speed, or trapped), r-s-t momentum can change natures (linear, multidirectional, or omnidirectional), and r-s-t momentum can be transferred from one object to another, but the total amount of r-s-t momentum in the universe never changes."

"That's wonderfully descriptive," Hectii said. "But this experiment involves impulse [momentum transfer]. We'll need to reorganize conservation fact #2 so it emphasizes impulse."

"Before the launch, our rockets had an s-momentum of 0 ρ," Pico said. "But after the launch their velocities ranged from 1.0 m/s to more than 12 m/s."

"In each case, the s-momentum increased," Hectii said. "And Cartesian conservation fact #2 states, for the s-momentum to increase, a second object must experience a decrease in its r-momentum, or the second object could experience a decrease in its s-momentum, or the second object could experience a decrease in its t-momentum/t-impulse.

"And that's what an impulse/momentum-transfer does," Pico added. "The impulse is occurring because the momentum is being transferred from one object to another and/or from one form to another."

"How's this," Hectii recommended after pausing for several swallows of carbonated orange-drink. "We'll call this the **Cartesian #3 conservation impulse corollary**. And it states, Object A's motion/momentum will not change unless (1) an impulse transfers momentum from Object B to A, usually causing A to speed up, or (2) the impulse could transfer momentum from Object A to B, usually causing A to slow down, or (3) the impulse could transfer momentum out of a trapped or multidirectional state, usually causing A to speed up, or (4) momentum could be transferred away from A and into a trapped or multidirectional state, usually causing A to slow."

“That’s fabulous,” Pico said. “This new corollary relates impulse to conservation fact #2, and it also relates impulse to the dual atomic motion fact that we learned in our last series of experiments. Very clever, Hectii!”

“But how does this new impulse corollary relate to our rocket launches?” Hectii said quizzically. “In the last set of launches, all of the rockets experienced 36 ρ of impulse.”

“We used three packets of fuel each time,” Pico said. “That means one packet of fuel always gives each rocket 12 ρ of impulse. The consistency of the results suggests that the 12 ρ of impulse is coming from the fuel itself—that coordinates well with our new impulse corollary.”

“And calculating impulse is easy,” Hectii said. “I think Tera will answer these questions without too much trouble.”

“Then we’ll make the next questions harder,” Pico said. “We’ll use one packet of fuel each time, but we’ll throw the rockets before we hit the launch button!”

“Excellent idea,” Hectii said approvingly. “Data from moving rockets should also enable us to determine for certain how the experiments relate to our new Cartesian #3 conservation impulse corollary.”

The girls performed seven experiments, each with a different starting velocity.

“How’s the data look, Chip? Pico said as she rapidly cranked the fishing reel and pulled the final rocket back in.

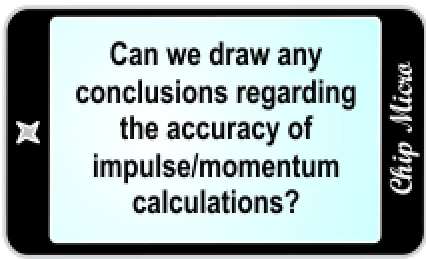
"Here's a table of the experiments involving launching moving rockets," Chip said.

D	**Tera's *Secrets of Murdered Energia* Homework** These experiments always used 1 packet (12 g) of fuel. (But we threw the rockets to make different starting velocities.)			
Mass	**Velocities**		**Calculations**	**Impulse**
m	$v_{initial}$	v_{final}	$im\Delta\rho = mv_f - mv_i$	$im\Delta\rho$ = _?_ ρ or _?_ $\frac{kgm}{s}$
$6\ kg$	$4\frac{m}{s}$	$6\frac{m}{s}$	$(6\ kg)(6\frac{m}{s}) - (6\ kg)(4\frac{m}{s})$	$im\Delta\rho$ = 12 ρ or 12 $\frac{kgm}{s}$
$6\ kg$	$8\frac{m}{s}$	$10\frac{m}{s}$	$(6\ kg)(10\frac{m}{s}) - (6\ kg)(8\frac{m}{s})$	$im\Delta\rho$ = 12 ρ or 12 $\frac{kgm}{s}$
$3\ kg$	$6\frac{m}{s}$	$10\frac{m}{s}$	$(3\ kg)(10\frac{m}{s}) - (3\ kg)(6\frac{m}{s})$	$im\Delta\rho$ = 12 ρ or 12 $\frac{kgm}{s}$
$3\ kg$	$18\frac{m}{s}$	$22\frac{m}{s}$	$(3kg)(22\frac{m}{s}) - (3kg)(18\frac{m}{s})$	$im\Delta\rho$ = ____ ρ or ___ $\frac{kgm}{s}$
$1\ kg$	$15\frac{m}{s}$	$27\frac{m}{s}$	$(1kg)(27\frac{m}{s}) - (1kg)(15\frac{m}{s})$	$im\Delta\rho$ = 12 ρ or 12 $\frac{kgm}{s}$
$1\ kg$	$30\frac{m}{s}$	$42\frac{m}{s}$	$(1kg)(42\frac{m}{s}) - (1kg)(30\frac{m}{s})$	$im\Delta\rho$ = ____ ρ or ___ $\frac{kgm}{s}$
$1\ kg$	$60\frac{m}{s}$	$72\frac{m}{s}$	$(1kg)(72\frac{m}{s}) - (1kg)(60\frac{m}{s})$	$im\Delta\rho$ = ____ ρ or ___ $\frac{kgm}{s}$
In every case, 1 packet (12 g) of fuel produced ___________ ρ of impulse/momentum-transfer ($im\Delta\rho$).				

"Throwing the rockets meant they had different starting velocities," Pico observed. "And different starting velocities meant they also started with different amounts of s-momentum."

"The first rocket had 24 ρ of s-momentum when you fired the engine," Hectii said. "And after the fuel burned, it had 36 ρ of momentum. In the right column, as the fuel burned the rocket's s-momentum increased by 12 ρ."

“Look at the last launch,” Pico said. “We threw that 1.0 kg rocket very hard, so it had a starting s-momentum of 60 ρ. In the right column, after we fired the engine, it had a final momentum of 72 ρ.”



“That means the last rocket also experienced 12 ρ of impulse,” Hectii said conclusively. “In every situation, one packet of fuel always produces 12 ρ of impulse.”

“This is amazing,” Pico said with pride, as the girls gathered their equipment and began gliding toward their ship.

Hectii laughed, “I can’t wait to see how Tera does on her homework.”

“Let’s add one more question,” Pico suggested, as she keyed the following into her data-input glove:

> *Tera, fill in the blank. In a toy rocket of any size, the same amount of fuel always produces the same amount of ____________________!* [*hint, im*$\Delta\rho$]

“Chip, call Tera,” Pico said.

“How’s the experiment going?” Tera responded a few moments later.

“You missed the exciting part,” Hectii said.

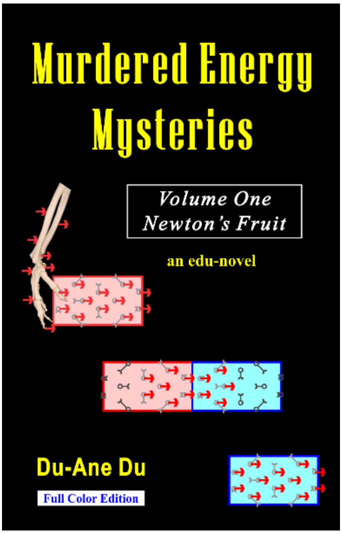
Pico grinned broadly. “Chip has a homework assignment for you.”

“You’ll probably complete it before we finish changing out of our spacesuits,” Hectii said.

“Ok,” Tera accepted, “it’s a race!”

“We don’t have a chance,” Pico said, as she pressed a control button. A spray of gas shot out the back of her spacesuit, increasing the speed of her glide home.

“I wish we could experiment with some more rockets,” Pico said a few hours later. The girls were back on their ship, sucking on tubes of frozen limeade, and watching a fashion show on their largest flat-screen display.



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“And calculating impulse was easy,” Tera said. “Now, what have the Space-sci Sherlocks deduced so far?”

“One packet of fuel always contains the same amount of trapped impulse,” Pico said.

“You said *contains*,” Tera said. “Didn’t you mean the fuel *produces* the same amount of impulse?

"You can't produce something from nothing," Hectii said. "It's a new scientific fact that we discovered."

"We call it the **Cartesian #3 conservation impulse corollary**," Pico said. "It says, Object A's motion/momentum will not change unless (1) an impulse transfers momentum from Object B to A, usually causing A to speed up, or (2) the impulse could transfer momentum from Object A to B, usually causing A to slow down, or (3) the impulse could transfer momentum out of a trapped or multidirectional state, usually causing A to speed up, or (4) momentum could be transferred away from A and into a trapped or multidirectional state, usually causing A to slow."

"This scientific fact tells us, an impulse moves momentum from one place to another," Hectii summarized.

"It's clear that the fuel produced an impulse," Tera said. "And I can see that the impulse was based on the amount of fuel used. But, was the fuel actually storing the impulse?"

"The momentum must've been stored inside the fuel," Pico feverishly argued. "The rocket wasn't moving, then the fuel burned and the rocket began moving. The more fuel we burned, the faster the rocket moved after the burn. The burning fuel caused the rocket's s-momentum to increase. It seems obvious, the impulse [momentum transfer] was caused by trapped momentum that was coming out of the fuel."

"If you ask me, it also matches up with the invo-atomic and exvo-atomic experiments we did the other day," Hectii calmly supported.

"Exactly," Pico said, releasing an exasperated sigh. "At this point it appears that the molecules and chemical bonds in the fuel were storing some type of trapped impulse."

"Wait, let's not go too fast," Tera said. "Let's store some notes in Chip's memory banks so we don't forget what we've deduced so far."

"How's this?" Hectii said, as she slipped her fingers into a data-input ball and began keying. She created a file called *Deductions About Murdered Energia*. As she keyed, the following appeared on their displays:

1) The conservation fact of r-s-t momentum tells us, r-s-t momentum cannot be created or destroyed. Only momentum can be added to momentum to produce more momentum, therefore:
    a. Impulse is the addition or subtraction of r-s-t momentum at the atomic level,
    b. Impulse involves the amount of atomic-momentum that is moving from one object to another, from one place to another, or from one form to another (from trapped to radian to speed, etc.).

2) It appears that the breaking of chemical bonds may release some type of bonded r-momentum, or trapped impulse (because burning fuel causes momentum increase, and the impulse must be coming from the fuel). For now, we're calling this theoretical concept **Chemically Bonded Impulse.**
3) You can add the released chemically bonded impulse to the initial s-momentum of the rocket to predict what the final s-momentum will be:

   Final momentum = $mv_{initial} + im\Delta\rho$ *from fuel*

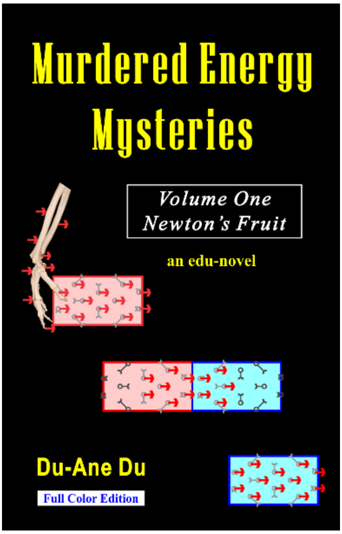
   (which also suggests that the impulse must be coming from the fuel).
4) The release of chemically bonded impulse can:
   a. Cause an increase or decrease in the invo-atomic average speed of the surrounding atoms—thereby increasing the temperature of the object, and/or
   b. Cause a change in the exvo-atomic net v-momentum of the object—thereby causing a change in the human-level v-momentum, and
   c. If the human-level v-momentum changes, then the exvo-atomic net velocity and human-level velocity will change accordingly. (*MEM*, Ch 103)
5) Chemically bonded impulse (or whatever is causing this phenomenon) obeys the **impulse fact #1 of dual atomic motions:** Applying an impulse to an object can either

cause an increase/decrease in the object's invo-atomic s-momentum, or the impulse can increase or decrease the object's exvo-atomic v-momentum, or both. (*MEM*, Ch 103)

6) "That looks great," Tera celebrated. "Did we discover anything else today?"

"Yes," Hectii said. "We also threw some of the rockets before we hit the launch button. No matter how we designed the experiment, the rockets always experienced 12 ρ of impulse for each packet of fuel burned."

"Then let's add this to our notes," Pico said, keying in the following:



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7) The equation for the impulse of a rocket produces the same answer regardless of the starting velocity,

8) Calculations involving impulse (*im*$\Delta\rho$) are 100% accurate in all situations.

"You're right, Tera," Hectii said. "The Space-sci Sherlocks deduced a lot today!"

"And those are wonderful conclusions," Tera said.

Pico nodded wildly, "Just imagine what we'll learn tomorrow!"

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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.

—Du-Ane Du, author of the edu-novel *Murdered Energy Mysteries* (Amazon, Kindle, e-book 2018, paperback 2021.)

More information, visit www.Wacky1301SCI.com