Flying jewels
net v-momentum = 0 kgm/s

The Unusual Powers of Speed-Momentum

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 asteroids, observe virtual experiments, and deduce the unusual powers of speed-momentum.
> —Excerpted from *Murdered Energy Mysteries*, Part 1, Chapter 2, by Du-Ane Du, (Amazon, Kindle, ebook 2018, paperback 2021).

Dear Grandma Aaret,

It was wonderful of Grandpa Proge to call today. We always enjoy talking with him. I think Grandpa is the smartest man in the universe.

Grandpa and Pico did some experiments in Pico's 3D exercise-game. It's like a cross between a 3D virtual game and a bicycle-exercise program.

Anyway, Pico reached a new level, and that made her very happy. Even better, she and Grandpa explored the differences between net v-momentum and total s-momentum.

I should explain—better yet, I'll show you some of the notes that Pico, Hectii, and I developed when we discussed our latest deductions.

Excerpted from:

Murdered Energy Mysteries

*Volume One
Newton's Fruit*

an edu-novel

Du-Ane Du

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Net V- and Total S-

A negative symbol in front of a momentum value is never an indication of the size (magnitude) of the value. A negative symbol is always an indication of direction. As a result, the application of mathematical properties can sometimes be confusing—so be careful.

For example, east is often a positive direction, and west is often negative. Pico was riding a virtual speed boat on a virtual river, and some of her vector speeds were:
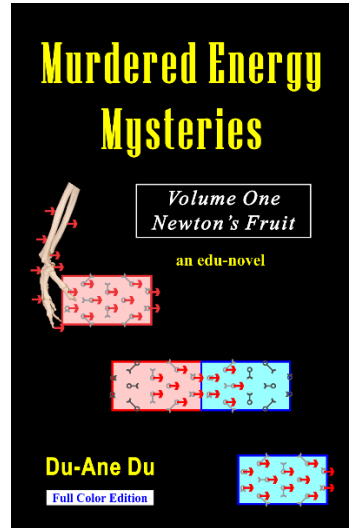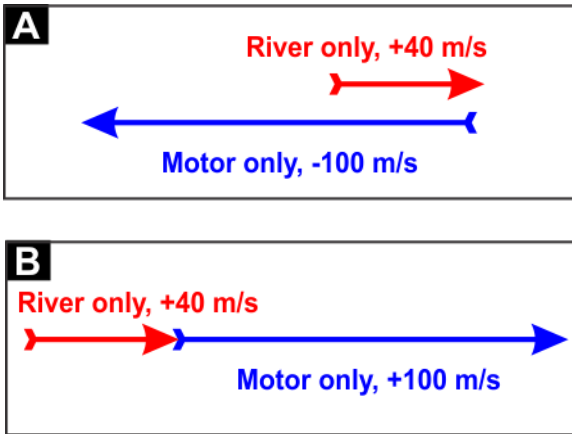
When three objects are interacting, the equations for net velocity and net v-momentum (velocity-based-momentum) become:

$$net\ velocity = {}^{\circ}v_1 + {}^{\circ}v_2 + {}^{\circ}v_3$$
$$net\ v\text{-}momentum = {}^{\circ}m_1v_1 + {}^{\circ}m_2v_2 + {}^{\circ}m_3v_3$$
(v-momentum is velocity- based momentum)

The direction symbol can be a positive sign (forward, east, etc.), a negative sign (backward, west, etc.), or direction can be an angle, or even a word (like *down*).

The preferred equations for the total speed and total s-momentum (speed-based-momentum) of three objects are:

$$\textbf{total speed} = |\textbf{s}_1| + |\textbf{s}_2| + |\textbf{s}_3|$$
$$total\ speed = |v_1| + |v_2| + |v_3|$$
$$\textbf{total s-momentum} = |\textbf{ms}|_1 + |\textbf{ms}|_2 + |\textbf{ms}|_3$$
$$total\ s\text{-}momentum = |mv|_1 + |mv|_2 + |mv|_3$$
(s-momentum is speed- based momentum)

Similarly, the preferred equations for the average speed and average s-momentum of three objects are:

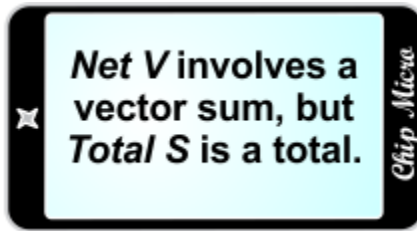$$\text{\textit{average speed}} = \frac{|s_1| + |s_2| + |s_3|}{3}$$

$$\text{\textit{average speed}} = \frac{|v_1| + |v_2| + |v_3|}{3}$$

$$\text{\textbf{\textit{average s-momentum}}} = \frac{|ms|_1 + |ms|_2 + |ms|_3}{3}$$

$$\text{\textit{average s-momentum}} = \frac{|mv|_1 + |mv|_2 + |mv|_3}{3}$$

The use of negative symbols for motion values is very common, therefore it's strongly recommended that absolute value symbols be included every time these equations are used.

Net *V* involves a vector sum, but *Total S* is a total.

Chip Micra

If angles are used, then the Pythagorean theorem and/or trigonometry must be used to find the net resultant vector. (A **net resultant** is like a vector sum.)
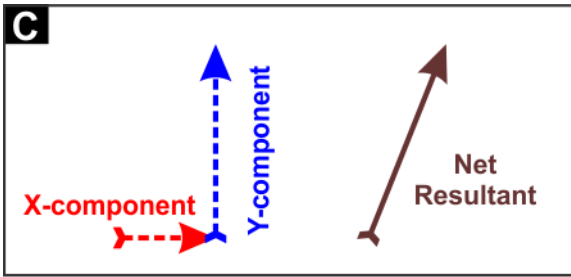
Why is this important? Sometimes calculations of v-momentum can cause the amount of s-momentum in a system to suddenly appear to "decrease". Here is Chip's transcript of an experiment Pico accidentally did as she played a virtual reality game with Hectii and Grandpa Proge:

"Let's jump to the first diamond," Pico said, as she deactivated her data-input gloves, peddled fast, and pressed the jump command. Her avatar jumped to a nearby diamond that was traveling rightward. She glanced around the room and quickly jumped her avatar from diamond, to ruby, to emerald, to diamond, to emerald… until she ran out of gems.

Pico paused to watch the other avatars following behind her.

"Look out!" Hectii shouted as her avatar pointed to Pico's right.

A large red meteoroid was rapidly approaching Pico from the right, and a lavender meteoroid was approaching her from the left.

Pico squealed and hit the jump button. She tried to grab a glass ledge that was suspended in the air, missed, and began falling. "Reset!" Pico yelled.

Instantly all three avatars were sitting on one of the original diamonds, watching the gems glide past in different directions.

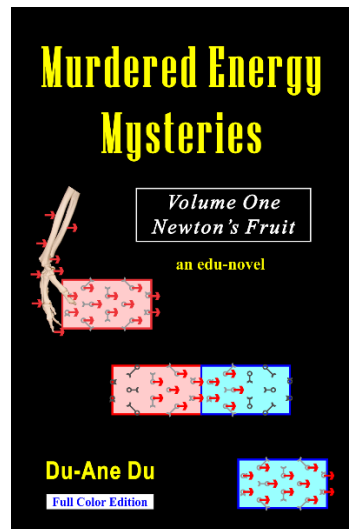"That was close," Pico said breathlessly.

"But we arrived back safely," Proge said, suppressing a laugh.

"And what would've happened to me if I hadn't jumped?" Pico said.

"You would've experienced an impulse," Hectii said, stifling a smirk.

"But how much impulse?" Pico said. "Chip, what was the mass and velocity of the two meteoroids?"

"The red-right meteoroid had a mass of 1 000 kg, a speed of 30 m/s, and a velocity of –30 m/s, because it was traveling leftward," Chip said. "The lavender-left meteoroid also had a mass of 1 000 kg, and a speed of 30 m/s, but it had a velocity of +30 m/s, because it was traveling rightward."

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"That seems easy," Pico said. "But should we use the equation for net v-momentum, or the equation for total s-momentum?"

"Why don't you try both?" Proge suggested.

"I'll start with net v-momentum," Pico said, as she activated her data-input gloves and began keying. "The calculations for net v-momentum are:"

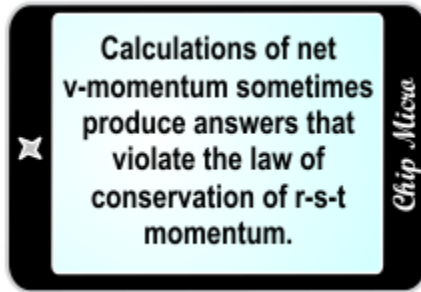$$net\ v\text{-}momentum = {}^{\circ}mv_{left} + {}^{\circ}mv_{right}$$

$$net\ v\text{-}momentum = (1000kg)(+30\tfrac{m}{s}) + (1000kg)(-30\tfrac{m}{s})$$

$$net\ v\text{-}momentum = (+30\,000\ kg\tfrac{m}{s}) + (-30\,000\ kgm/s)$$

$$\textbf{\textit{net v-momentum = 0 kgm/s}}$$

Pico stared at the textbox in amazement, "The net v-momentum is zero! Which means, next time I try this, if the two meteoroids hit me at the same time, I'll experience an impulse of zero. No effect! The rightward momentum will destroy the leftward momentum and I won't feel a thing!"

Hectii's avatar shook its head. "Pico, your conclusion involves a violation of the conservation fact for r-s-t momentum. Momentum can't be destroyed."

Calculations of net v-momentum sometimes produce answers that violate the law of conservation of r-s-t momentum.

Chip Micra

"Ignoring the fact that this is a virtual world," Proge said. "If one meteoroid hits you it will hurt."

"And if two meteoroids hit you from opposite directions at the same time," Hectii said logically, "it's going to hurt a lot."

"You see, Pico," Proge elaborated. "Vector mathematics is very useful. But sometimes vector mathematics produces false or misleading answers. The net v-momentum equation that you used simply tells us, the two meteoroids will come to a stop when they hit you. But the v-momentum equation can't be used to calculate the amount of impulse that you'll experience during the collision."

"In this case," Hectii interpreted, "the answer produced by the net v-momentum equation actually represents a violation of the conservation fact for r-s-t momentum. Rightward momentum can't cancel out leftward momentum!"

"Well, we don't want to violate the conservation facts," Pico said, as she resumed keying. "S-momentum

is speed-based, so the total amount of s-momentum in the two meteoroids is:"

$$total\ s\text{-}momentum = |ms|_{left} + |ms|_{right}$$

$$total\ s\text{-} = \left|(1\ 000\ kg)\left(30\frac{m}{s}\right)\right| + \left|(1000\ kg)\left(30\frac{m}{s}\right)\right|$$

total s-momentum = 60 000 kgm/s

"Ouch!" Pico declared painfully. "We know the two meteoroids will come to a stop when they hit me. This last calculation also tells us, I'll experience a total impulse of 60 000 kgm/s."

"Amazing! We've deduced that vector-based calculations of net v-momentum sometimes violate the facts of r-s-t momentum conservation," Hectii concluded. "Thanks, Grandpa Proge."

You see Grandma? Pico's experience shows rightward and leftward s-momentum can't destroy each other. Therefore, an apparent decrease in the amount of s-momentum or v-momentum in a system is a violation of the facts of r-s-t momentum conservation. In these situations, the s-momentum equations should be used.

(I think it is wise to always calculate both v-momentum and s-momentum, to make certain your math isn't violating the conservation facts.)

All this is quite fascinating. I smell chicken fajitas cooking. Time to go.

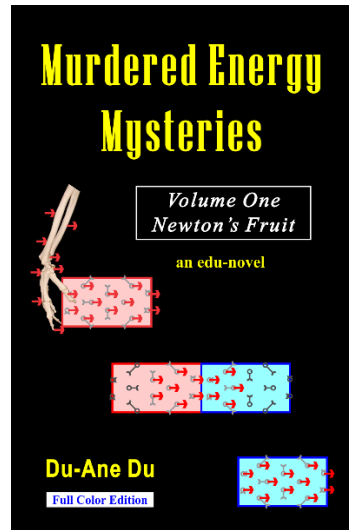Tell Grandpa Proge hello. All our love, Daddy, Pico, Hectii, and your Tera!

*   *   *

[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.)

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