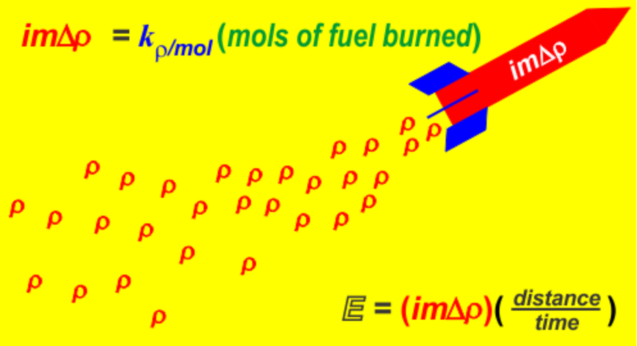
Atomic Heat-Behavior: Impulse vs. Energy



1. Chemically Stored Impulse, Energy, or Both?

Professor Du-Ane Du

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

Abstract: Analysis of black powder rocketry demonstrates that chemical bonds release Chemically Bonded Impulse in accordance with the equation, $im\Delta\rho = k(mols\ of\ fuel\ burned)$. The same analysis shows the derived equations, $\Delta E = im\Delta\rho(d/t)$, and $\Delta E = k(mols\ of\ fuel\ burned)(distance/time)$, suggest the Chemical Potential Energy theory may contain a mathematical fallacy involving the role of velocity.

The purpose of this advanced article is to use well-established model rocketry data to examine the relationship between the chemical bonds in fuel and the production of momentum, impulse, kinetic energy, work energy, and work done. It will be shown that the breaking of chemical bonds produces an impulse that transfers momentum from a trapped or bonded state to mechanical momentum. It will be further shown that the breaking of chemical bonds often has little to do with the alleged production of mechanical energy. (This is an advanced article, simpler discussions of these topics can be found at www.Wacky1301SCI.com.)

"On a related note," Devil's Advocate says, "A thorough examination of the transfer of momentum and energy from one form to another was recently done by Du-Ane Du in his edu-novel *Murdered Energy Mysteries*. References to that work will be based on chapter numbers rather than page numbers as the print version has not yet been released.

"Now, approach this essay like you were looking at new sports cars," Devil's Advocate says, "open a door, slip inside, keep an open mind, turn the key, and allow your imagination to enjoy the ride!"

Model Rocketry

The Estes model rocket company's data shows that its C-11 engines have 11 grams of black powder, they produce a maximum thrust of 22.1 N, an average thrust of 12.5 N, for 0.8 s, resulting in an impulse of 10 Ns, or 10 kgm/s, and a momentum increase of 10 ρ, or 10 kgm/s.

"There is no established singular unit for momentum," Devil's Advocate says, "so *Murdered Energy Mysteries* codified the symbol rho (ρ) for use in a variety of momentum related concepts (ρ is read as 'momentums')."

That is both logical and convenient, so this article will follow that convention. Based on this, the Estes C-11 engine produces an impulse of 10 ρ and a momentum increase of 10 ρ, or ten momentums of impulse and ten momentums of momentum.

In terms of molar mass, black powder is usually about 75% KNO_3, so there is 1 mol of KNO_3 in 134 g of black powder. Therefore, one C-11 engine contains 0.08 mol of KNO_3, as well as proportional amounts of carbon and sulfur.

Next, points of comparison need to be established for heat-energy and heat-impulse. Black powder has a variety of values for heat-energy, this article will use the value 2861.8 J/g. For the 11 gram C-11 engine, that would be a total heat-energy of 31,480 J per engine.

"In *Murdered Energy Mysteries*, Chapter 302, *Joule's Double Meaning*, Mr. Du notes that Joule's most accurate published experiment involved heating water by turning a hand crank with a force of 1 pound for 900 s," Devil's Advocate says. "That's an impulse of 900 pound-seconds. Joule then divided by the speed of 1 ft/s to produce a work value of 900 foot-pounds."

Excellent, and using Joule's data, the modern values for heat-impulse and heat-energy are:

1 cal of heat = 4.958 ±0.04 ρ of heat-impulse
1 J of heat = 1.185 ±0.009 ρ of heat-impulse

Applying this to the C-11 engine heat-energy data above, produces the base-line data points:

1 engine produces 31480 J of heat-energy
1 engine produces 37300 ρ of heat-impulse

"Note that heat-impulse has a higher value," Devil's Advocate says. "This is because James Prescott Joule used a crank-speed of 1 ft/s for 900 s, producing his heat-impulse finding of 900 pound-seconds, which was numerically higher than his heat-energy goal of 778 foot-pounds."

Thought Experiments 1-4

Next, a series of thought experiments are performed, using the C-11 thrust data.

To eliminate the effect of gravity, air resistance, and possible outside sources of mechanical energy, a collection of C-11 engines and test rockets is taken into deep space, far from any galaxy. The test rockets have different masses:

Rocket A, 0.2 kg
Rocket B, 1.0 kg
Rocket C, 4.0 kg

Three C-11 engines are placed on each rocket so they can be ignited one at a time, but not ejected. The starting velocities are 0.0 m/s, the first rocket engine is fired, and data is collected onto Table 1:

Effect of First 11 Grams,
0.08 Mols of Fuel
1

	Rocket A		**Rocket B**		**Rocket C**	
Mass	0.2	kg	1.0	kg	4.0	kg
Initial Velocity	0.0	m/s	0.0	m/s	0.0	m/s
Thrust	12.5	N	12.5	N	12.5	N
Duration	0.8	s	0.8	s	0.8	s
Impulse	10	*ρ*	10	*ρ*	10	*ρ*
Final Velocity	50.00	m/s	10.00	m/s	2.50	m/s
Rocket Δ Momentum	**10.00**	***ρ***	**10.00**	***ρ***	**10.00**	***ρ***
Fuel's Heat-Impulse	37300	*ρ*	37300	*ρ*	37300	*ρ*
Momentum Efficiency	0.027	%	0.027	%	0.027	%
Rocket KE increase	**250.00**	**J**	**50.00**	**J**	**12.50**	**J**
Fuel's Heat-Energy	31480	J	31480	J	31480	J
Energy Efficiency	**0.794**	**%**	**0.159**	**%**	**0.040**	**%**

(For explanations on how to do these calculations, see www.Wacky1301SCI.com, or *Murdered Energy Mysteries*.)

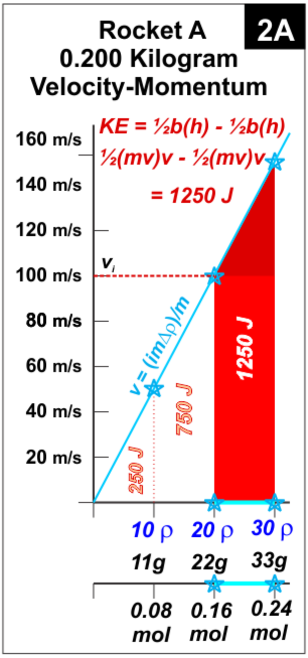
"The important data is highlighted and red," Devil's Advocate says. "The three test rockets experienced increases in forward momentum of 10 *ρ*, 10 *ρ*, and 10 *ρ*. However, they registered mechanical energy increases of 250 J, 50 J, and 12.5 J respectively."

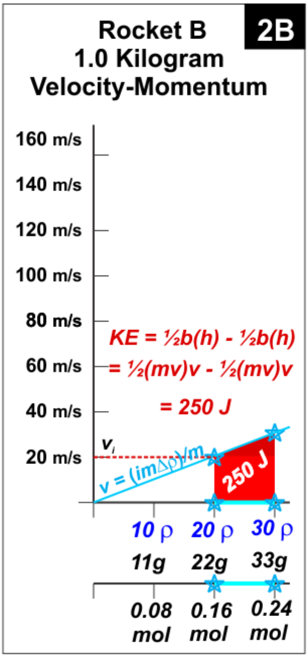
Next, the second engine on each rocket is ignited, and the three text rockets experience forward momentum increases of 10 ρ, 10 ρ, and 10 ρ (See Appendix, Table B). However, this time they allegedly experienced mechanical energy increases of 750 J, 150 J, and 37.5 J respectively.

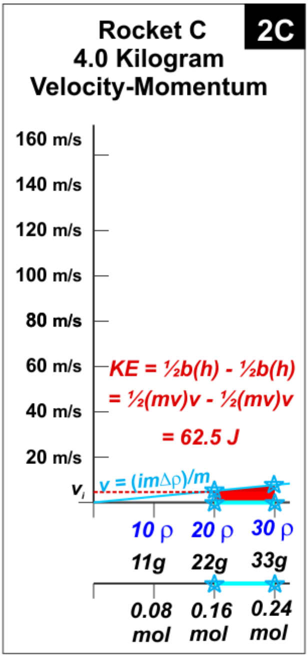
The amount of fuel is the same in all 6 experiments. Already it appears that there is a direct relationship between the chemical bonds in the fuel vs. the amount of forward momentum produced when those chemical bonds break.

"In contrast," Devil's Advocate says, "it appears that the amount of kinetic energy allegedly produced by the 'chemical potential energy' may be the result of a mathematical phenomenon that is not related to the chemical bonds."

The third engine on each rocket is ignited, and data is recorded. Only this time, the focus is on the three velocity-momentum graphs, Illustrations 2A – 2C. In these graphs, impulse and momentum are on the X-axis, while mechanical energy is the integral of momentum with respect to velocity.







On the momentum X-axes, the blue stars indicate the three rockets have experienced a momentum increase of 10 *ρ*, 10 *ρ*, and 10 *ρ*, respectively. However, in this third experiment, the area below the data line shows the rockets are allegedly experiencing mechanical energy increases of 1250 J, 250 J, and 62.5 J —all from the same amount of fuel!

“A quick glance at the graphs shows that in all 9 experiments, the 0.08 mol of fuel always produces a momentum increase of 10 *ρ*,” Devil’s Advocate says. “This is a clear indication of a direct relationship between fuel and impulse.”

However, the mechanical energy allegedly produced by the 0.08 mol of fuel has varied from 12.5 J, to 200 J, to 1250 J—a phenomenon not directly related to the mols of fuel.

Jumping ahead in the thought experiment, the scientists ignite more and more engines, eventually causing the rockets to accelerate to a speed of 1000 m/s.

As they fly through deep space at 1000 m/s, another engine is attached to each of the three rockets, the engines are fired, and the three test rockets once again experienced an increase in forward momentum of 10 ρ, 10 ρ, and 10 ρ (See Appendix, Table C). The efficiency with respect to heat-impulse, or Chemically Bonded Impulse is 0.027%, 0.027% and 0.027%, respectively. This consistency suggests that heat-impulse and Chemically Bonded Impulse both exist in nature.

“Unfortunately,” Devil’s Advocate says, “with a starting velocity of 1000 m/s, the data for mechanical energy grows to 10,250 J, 10,050 J, and 10,012.5 J respectively. The energy efficiency data of 32.56%, 31.93%, and 31.8% is also significantly higher than earlier experiments (See Appendix, Table C).”

Good point, superficially, it appears that the engines are becoming more efficient with respect to energy. However, if the engines are becoming more efficient, then the momentum data would also have increased. The fact that the momentum data is not changing suggests that something else is affecting the energy data—*something not related to the chemical bonds*.

The fluctuation in the energy data is actually quite ominous. To demonstrate why, the thought experiment is moved to an imaginary lab on the earth's equator, at midnight.

This time, the rockets are positioned on frictionless horizontal test tracks, so their forward motion is eastward, at midnight. In this position, each rocket will have three different simultaneous forward velocities.

With respect to the floor, the rockets will have a starting velocity of 0.0 m/s. With respect to the center of the Earth's rotation, the rockets will have a tangential starting velocity of almost 2,000 m/s. And with respect to the center of the Sun, the rockets will have a tangential starting velocity of almost 30,000 m/s.

"Some physicists may feel the need to use relativity equations at this point," Devil's Advocate says. "However, that complexity can be avoided by using 10,000 m/s to represent the solar orbital velocity."

Excellent, and with that in mind, the rocket engines are ignited, and the data is collected onto Table 3, (See full table, Appendix, Table D):

3

Starting at 10,000 m/s

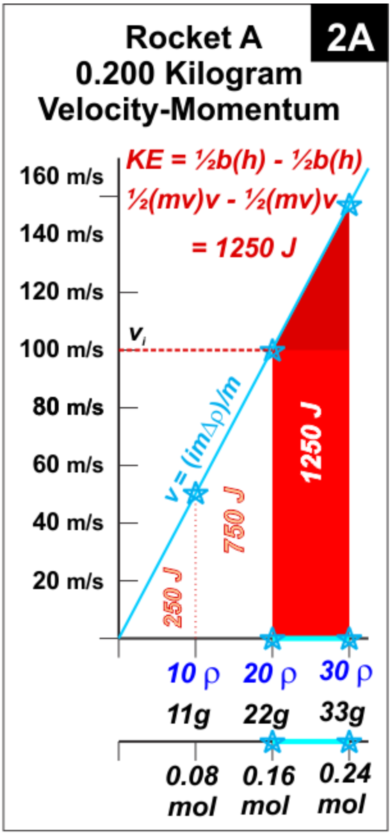
Effect of 11 Grams, 0.08 Mols of Fuel

	Rocket A		**Rocket B**		**Rocket C**	
Final Velocity	10050.00	m/s	10010.00	m/s	10002.50	m/s
Rocket Δ Momentum	**10.00**	**ρ**	**10.00**	**ρ**	**10.00**	**ρ**
Fuel's Heat-Impulse	37300	ρ	37300	ρ	37300	ρ
Momentum Efficiency	0.027	%	0.027	%	0.027	%
Rocket KE increase	**100,250**	**J**	**100,050**	**J**	**100,013**	**J**
Fuel's Heat-Energy	31480	J	31480	J	31480	J
Energy Efficiency	**318.5**	**%**	**317.8**	**%**	**317.7**	**%**

Amazing how energy efficient a solid-fuel rocket engine can be when the motion is measured with respect to the sun, 318.5%, 317.8%, and 317.7% energy efficient!

“That’s why,” Devil’s Advocate says, “,n *Murdered Energy Mysteries*, Mr. Du identifies this phenomenon as being caused by ‘multi-parabolic’ values, or multi-parabolic joules.”

Precisely, and how this multi-parabolic energy phenomena relates to chemical bonds is easily ascertained by returning to the velocity-momentum graph, Illustration 2A.



Focusing on the two X-axes. For a given motor, production of impulse is directly proportional to the amount of fuel burned.

The heat-impulse of explosive combustion for black powder is approximately 3391 ρ/g or 456,700 ρ/mol. Ideally the impulse-to-mol ratio ($k_{\rho/mol}$) for a given black powder engine would be:

$$black\ powder,$$

$$k_{\rho/mol} = 456{,}700\ \rho/mol$$

However, Estes's data shows that the C-11 engine has an impulse-to-mol ratio of:

$$C\text{-}11\ engine,\ \ k_{\rho/mol} = 122\ \rho/mol$$

Based on the relationship between impulse and fuel, the equations to calculate the impulse (momentum-increase) produced by a given amount of fuel becomes:

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

“Pausing here,” Devil’s Advocate says, “note that mols of fuel burned is related to the number of chemical bonds that will break during the burning process. These equations clearly indicate that chemical bonds store mechanical momentum. In *Murdered Energy Mysteries* this is called “trapped impulse,” or Chemically Bonded Impulse. When the bonds break, the released momentum creates an impulse, and the impulse causes the receiving object to experience a momentum increase.”

Wonderful, but how chemical bonds store impulse/trapped momentum is outside the parameters of this article.

Turning now to the energy portion of Illustration 2A. All forms of mechanical energy involve the area under a curve. Energy integration often uses the first of two possible trapezoid equations:

$$1)\ \Delta E = \frac{b_f(h_f) - b_i(h_i)}{2}$$

$$2)\ \Delta E = (b_f - b_i)\frac{(h_f + h_i)}{2}$$

Since the mols X-axis and the momentum X-axis are parallel, the length of the **mols** axis can be substituted into the first, traditional energy equation as follows:

$$\Delta E = \frac{(k_{\rho/mol}\boldsymbol{(mol)}_f)h_f - (k_{\rho/mol}\boldsymbol{(mol)}_i)h_i}{2}$$

$$\Delta E = \frac{(k_{\rho/mol}(\boldsymbol{mol})_f)\boldsymbol{v_f} - (k_{\rho/mol}(\boldsymbol{mol})_i)\boldsymbol{v_i}}{2}$$

Trapezoid substitution of equation 2 can be used to isolate concepts:

$$\Delta E = k_{\rho/mol}(\boldsymbol{mol_f} - \boldsymbol{mol_i})\,\frac{(\boldsymbol{v_f} + \boldsymbol{v_i})}{2}$$

The equation for the amount of fuel burned is:

$$(\boldsymbol{mol\ fuel\ burned}) = (\boldsymbol{mol_f} - \boldsymbol{mol_i})$$

Substitute to make:

$$\Delta E = k_{\rho/mol}(\boldsymbol{mol\ fuel\ burned})(\frac{\boldsymbol{v_f} + \boldsymbol{v_i}}{\boldsymbol{2}})$$

The three main ways to calculate average velocity are:

$$\boldsymbol{average\ velocity} = (\frac{\boldsymbol{v_f} + \boldsymbol{v_i}}{\boldsymbol{2}})$$
$$\boldsymbol{average\ velocity} = (\frac{\boldsymbol{distance}}{\boldsymbol{time}})$$
$$\boldsymbol{average\ velocity} = (\boldsymbol{v_{initial}} + \frac{\boldsymbol{\Delta v}}{\boldsymbol{2}})$$

Substituting these in will result in four equations for the amount of mechanical energy allegedly produced when fuel is burned. There are four names for mechanical energy, which can randomly be assigned to the four equations:

$$\boldsymbol{\Delta KE\ produced} = k_{\rho/mol}(mol\ fuel\ burned)(\frac{\boldsymbol{v_f} + \boldsymbol{v_i}}{\boldsymbol{2}})$$

$$\boldsymbol{WE\ produced} = k_{\rho/mol}(mol\ burned)(\boldsymbol{average\ velocity})$$

$$\boldsymbol{Work\ done\ by} = k_{\rho/mol}(mol\ fuel\ burned)\left(\frac{\boldsymbol{distance}}{\boldsymbol{time}}\right)$$

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

$$\Delta E = im\Delta\rho\left(\frac{\boldsymbol{distance}}{\boldsymbol{time}}\right)$$

"By now," Devil's Advocate says, "every chemist reading this article should be staring at the words "average velocity", "initial velocity", etc. Everyone knows, chemical bonds do not store velocity."

Very good, and the equation clearly claims that chemical bonds store initial velocity, distance, time, and/or average velocity. This is impossible. The only thing that could possibly be stored inside the chemical bonds is the impulse implied in the relationship, $k_{\rho/mol}(mols\ of\ fuel\ burned) = im\Delta\rho$.

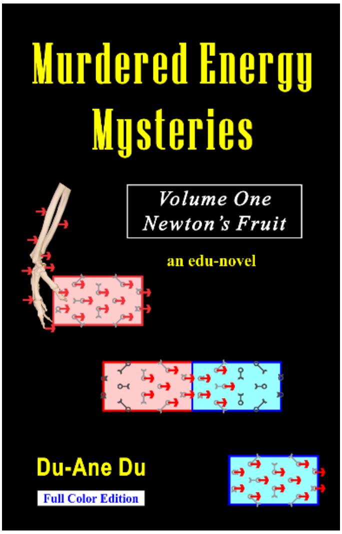
CONCLUSION 1: It is likely that chemical bonds store heat-impulse, and when chemical bonds break, the heat-impulse is released to increase the momentum of surrounding atoms and to increase the momentum of receiving objects.

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

CONCLUSION 2: Chemical bonds are not directly related to the alleged production of mechanical energy. Mathematically, mechanical energy is a joint function of an object's average velocity and its change in momentum, and ME is dependent on the object's starting velocity, $\Delta E =$

$(im\Delta\rho)(\frac{distance}{time})$. Work done, work energy, and changes in kinetic energy are all joint functions of the object's average velocity and momentum change, and they are dependent on the object's starting velocity and mass.

Chemical bonds do not store average velocity. Therefore the breaking of chemical bonds does not directly produce kinetic energy, it does not directly produce work energy, and it does not directly produce work done. All three of these are functions of the object's average velocity, not the fuel.



Examine or purchase at Amazon.com

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.)

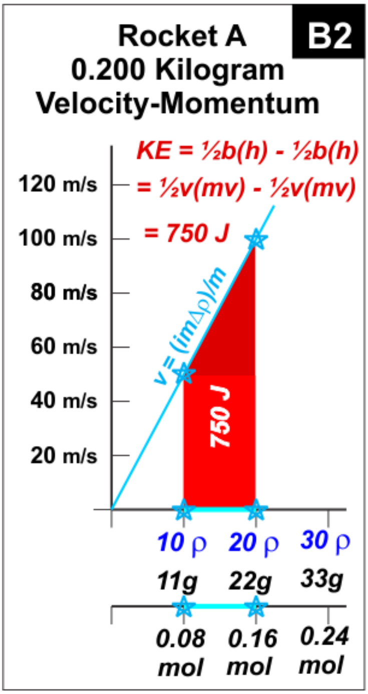
More information, see:

Murdered Energy Mysteries, an edu-novel, Amazon.
Atomic Heat-Behavior: Impulse vs. Energy
Article 2. *Foundations for a Heat-Impulse Theory*
Article 3. *Cal-Energy's Disappearing ΔT Fallacy*
Available at: www.Wacky1301SCI.com

Appendix of
Supplemental Material

Effect of Second 11 Grams, 0.08 Mols of Fuel						**B**
	Rocket A		**Rocket B**		**Rocket C**	
Mass	0.2	kg	1.0	kg	4.0	kg
Initial Velocity	50.0	m/s	10.0	m/s	2.5	m/s
Thrust	12.5	N	12.5	N	12.5	N
Duration	0.8	s	0.8	s	0.8	s
Impulse	10	ρ	10	ρ	10	ρ
Final Velocity	100.00	m/s	20.00	m/s	5.00	m/s
Rocket Δ Momentum	**10.00**	**ρ**	**10.00**	**ρ**	**10.00**	**ρ**
Fuel's Heat-Impulse	37300	ρ	37300	ρ	37300	ρ
Momentum Efficiency	0.027	%	0.027	%	0.027	%
Rocket KE increase	**750.00**	**J**	**150.00**	**J**	**37.50**	**J**
Fuel's Heat-Energy	31480	J	31480	J	31480	J
Energy Efficiency	**2.382**	**%**	**0.476**	**%**	**0.119**	**%**

The role of this mathematical phenomenon can be better seen by examining one of the velocity-momentum graphs, Illustration B2.



This graph for Rocket A has several important features. There are two X-axes, one for mols and grams of fuel burned, and one for the amount of momentum produced. Note that these are parallel concepts.

On the momentum X-axis, the distance between the two blue stars represents the change in momentum of the rocket, an increase of 10 *ρ*. This also indicates that the rocket engine produced 10 *ρ* of impulse.

The red area below the graph is the integral of the change in momentum with respect to the change in velocity. This is more commonly referred to as ΔKE, or work energy.

In fact, one of the classic definitions of mechanical energy is “the area below the line.” Kinetic energy is an integral, work energy is an integral, and work done is an integral. The graphs may be different, but the integrals are always equivalent when working with pendulums, springs, etc. This integral equivalency is one of the factors that underlies the “law of conservation for mechanical energy.”

But do they always match?

Starting at 1,000 m/s

Effect of 11 Grams, 0.08 Mols of Fuel

C

	Rocket A		**Rocket B**		**Rocket C**	
Mass	0.2	kg	1.0	kg	4.0	kg
Initial Velocity	1000.0	m/s	1000.0	m/s	1000.0	m/s
Thrust	12.5	N	12.5	N	12.5	N
Duration	0.8	s	0.8	s	0.8	s
Impulse	10	ρ	10	ρ	10	ρ
Final Velocity	1050.00	m/s	1010.00	m/s	1002.50	m/s
Rocket Δ Momentum	**10.00**	ρ	**10.00**	ρ	**10.00**	ρ
Fuel's Heat-Impulse	37300	ρ	37300	ρ	37300	ρ
Momentum Efficiency	**0.027**	**%**	**0.027**	**%**	**0.027**	**%**
Rocket KE increase	**10,250**	**J**	**10,050**	**J**	**10,013**	**J**
Fuel's Heat-Energy	31480	J	31480	J	31480	J
Energy Efficiency	**32.560**	**%**	**31.925**	**%**	**31.806**	**%**

Starting at 10,000 m/s

Effect of 11 Grams, 0.08 Mols of Fuel

D

	Rocket A		**Rocket B**		**Rocket C**	
Mass	0.2	kg	1.0	kg	4.0	kg
Initial Velocity	10000.0	m/s	10000.0	m/s	10000.0	m/s
Thrust	12.5	N	12.5	N	12.5	N
Duration	0.8	s	0.8	s	0.8	s
Impulse	10	ρ	10	ρ	10	ρ
Final Velocity	10050.00	m/s	10010.00	m/s	10002.50	m/s
Rocket Δ Momentum	**10.00**	**ρ**	**10.00**	**ρ**	**10.00**	**ρ**
Fuel's Heat-Impulse	37300	ρ	37300	ρ	37300	ρ
Momentum Efficiency	0.027	%	0.027	%	0.027	%
Δρ From 0m/s Start	**10.00**	**ρ**	**10.00**	**ρ**	**10.00**	**ρ**
Efficiency	0.027	%	0.027	%	0.027	%
Rocket KE increase	**100,250**	**J**	**100,050**	**J**	**100,013**	**J**
Fuel's Heat-Energy	31480	J	31480	J	31480	J
Energy Efficiency	**318.456**	**%**	**317.821**	**%**	**317.702**	**%**
WE From 0m/s Start	**250.00**	**J**	**50.00**	**J**	**12.50**	**J**
Efficiency	0.794	%	0.159	%	0.040	%