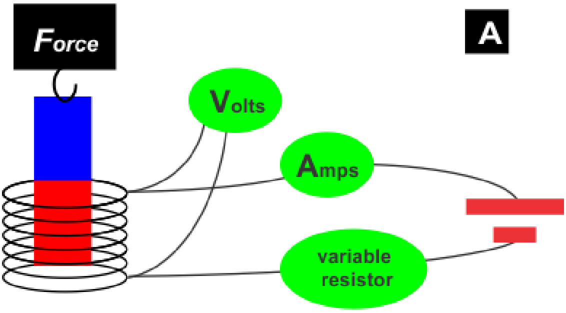
Labs Professors Fear



3. Magnetically Calibrating Voltage: Impulse Per Coulomb

Professor Du-Ane Du

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

The force between a strong permanent magnet and a weak solenoid is tested at a variety of voltages. This easily reproduced school lab shows that electric joules are a scaler multiple of impulse, where 1 Volt = 1.185 ρ/C, and 1 standard-linearized electric joule is always equivalent to 1.185 ρ of mechanical impulse.

—By Du-Ane Du, Author of *Murdered Energy Mysteries*, (Amazon, Kindle, ebook 2018, paperback 2021).

This is the third of three experiments on the relationship between impulse (momentum-transfer), calories, and electric joules. Here, Experiment #3 is a sample permanent-magnet/

electromagnet voltage-calibration experiment that can be repeated in a school or home lab. Experiment #1 is an analysis of Joule's original heat-is-work experiment, while the mechanical-vs-electric heat Experiment #2 can once again be duplicated and verified in a school or home lab. As one would expect, Labs Professors Fear produce results that are eye-opening, revolutionary, and controversial. *They are a must-perform for every aspiring engineer and physicist.*

Labs Professors Fear #3:

A detailed sample experiment using permanent and electromagnets to calibrate voltage, was done by Mr. Du in Part 4, Chapter 11 of *Murdered Energy Mysteries*. This sample lab will begin with a lab-friendly excerpt of that dialogue, and will finish up with final observations and conclusions:

"If electron currents involve forces," Hectii said, "then it seems like you should be able to use a magnet to measure how much impulse is being used to move the electrons that make up an electron current."

“It sounds like the Space-sci Sherlocks want to calibrate electricity,” Kief deduced. “Calibrating an electron current involves problems that have plagued scientists for hundreds of years.”

“Why?”

“Electron currents behave very consistently,” Kief said. “But it’s very difficult to measure exactly how much force it takes to produce electricity.”

“Why?”

Kief chuckled, “I like your inquisitiveness. When electron currents move along a wire, they generate heat and they generate a magnetic field that surrounds the wire. In some situations, an electron current generates a lot of heat and a little magnetism, and in some situations the electron current generates a little heat and a lot of magnetism.”

“Then how do you calibrate what’s pushing an electron current?” Hectii said.

Introduction

“One way to calibrate electron currents, is to compare electric heat to mechanical heat,” Kief clarified. “If you put an electric heating coil into some oil in a calorimeter,

Symbols

$im\Delta\rho$ – impulse

10 ρ = 10 kgm/s

10 ρ = 10 N*s

5 ρ/s = 5 N

the electric-magnetism and the electric heat will work together to heat the oil."

"Hectii discovered that Joule's experiment also involved ρ of impulse [momentum transfer]," Tera recognized.

"Using Joule's data," Hectii said, "we estimated that 4.958 $\pm$0.04 ρ of mechanical impulse is equivalent to a calorie of heat. Is there a way to compare that to electric heat?"

"In the 20th century, electric heat was measured in a unit we can call a volt-amp-sec, or a standard linearized joule$_{[1.2]}$," Kief explained. "That's the same thing as 1.0 volt of pressure pushing 1.0 ampere of electron current for 1.0 second. According to 20th century standards, a heat-calorie is equal to 4.184 volt-amp-sec, or 4.184 standard linearized joules$_{[1.2]}$."

"If we divide the heat-impulse value that we found using Joule's original data, by the volt-amp-sec value," Hectii said, as she began keying data into her phone:

$$1\ V = \frac{4.958\,\frac{\rho}{C}}{4.184}$$

1 V = 1.185 ρ/Coulomb

was written on the screen.

"Joule's prediction of electric impulse looks very good," Kief endorsed, as they entered the classroom. "Your conversion shows that Joule's experiment tells us that 1.0 volt is equal to 1.185^{-} momentums per coulomb of electrons. Often the value is written as a positive number, even though electrons are negative."

"That's the value Pico and I kept coming up with the other day," Hectii said buoyantly. "And we do tend to forget the negative sign."

"Everyone knows electrons are negative, so the sign is optional," Kief's eyes twinkled secretively. "Earlier, you said that you used Joule's experimental data to estimated that 4.958 $\pm$0.04 ρ of mechanical impulse is equivalent to one calorie of heat. Did you ever try to verify that number?"

"Actually, yes," Tera unabashedly interjected. "Chip helped me do some secret experiments, that Hectii doesn't know about. I placed oil in a calorimeter, and I put a mixer and an electric heater in the oil. It took 666 cal of electric heat to raise the temperature of the system by 1°C. Using the hand mixer, it took 3305.5 ρ of impulse to raise the temperature of the system by 1°. When I divided the two values, I found 4.96 ρ of mechanical impulse are equal to 1.0 cal." [See Labs Professors Fear #2, www.Wacky1301SCI.com]

"Wow, that's awesome! Let me compare that to the value for volt-amp-sec," Hectii said, as she keyed the following:

$$1\ V = \frac{4.96\,\frac{\rho}{Cmol}}{4.184}$$

$1\ V = 1.185^{-}\ \rho/\text{Coulomb}$

appeared on the screen.

“Your numbers are very consistent,” Kief judged, as he walked to a cabinet that contained electric equipment. He paused and held his hand next to his ear. “I’ll be there in a few minutes,” He said to an invisible microphone.

Kief smiled warmly and began selecting equipment. “I’ll set this up for you, and then I must go to a meeting.”

Materials Needed

Loggerpro or equivalent
Batteries or DC source
Variable resistor
Ammeter
Voltmeter
Force sensor
Solenoid, 400 windings (or 600, or 800)
Ring stand
Cow magnet—*very* strong
Connecting wires

Setup and Equations

“We’ll start with three batteries placed end-to-end,” Kief said. “The batteries will push electrons along the surface of the wire. The wire is attached to a control device called a variable resister. It'll enable you to adjust how much voltage is pushing on the electron current.

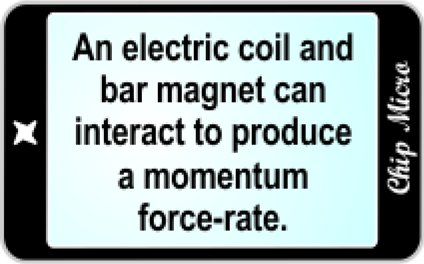
"Next, we will attach a switch, and a computerized ammeter. The ammeter will tell the computer how many coulombs of electrons are traveling along the wire. Then we'll attach a coil made of 400 wrappings of copper wire. The coil is called a solenoid. When the electron current goes around the coil, the coil will generate a small magnetic field. Finally, before and after the coil, we'll attach a computerized voltmeter. The voltmeter will tell the computer how much voltage is pushing the electron current through the wire."

"This looks simple, but very precise," Hectii articulated.

"Last year I did some experiments with equipment like this," Tera said. "This setup will allow us to regulate how much electricity is used, and the computer will measure the voltage and the amperage of the electron current."

"And the coil/solenoid will create a magnetic field," Hectii said. "What would happen if we suspended a magnet in the solenoid?"

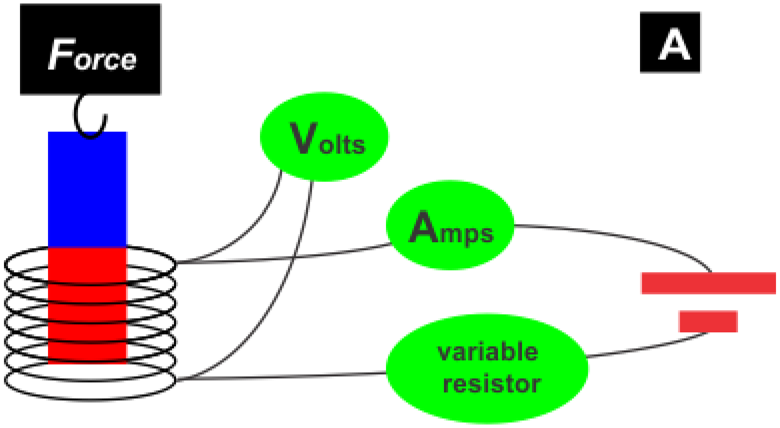
"That's actually the next step," Kief validated. "The solenoid is being powered by less than three batteries. Your equipment won't work if the current is higher than 0.6 amps, so the solenoid is going to produce an extremely weak magnetic field."



"Can we measure how strong it is?" Hectii said. "Or better yet, can we use a magnet to measure the force-rate produced by the electron current?"

Kief lifted an eyebrow as he attached a long-thin magnet to a force sensor. "This is what you call a true experiment. I'm only guessing that it might work. Then again it might not. You may have to test a larger or smaller solenoid, too."

"What do we do, first?" Tera said rhetorically.



"We're going to suspend a very powerful magnet inside the coil," Kief elaborated. "I think ¾ the way in will be best—

but maybe ½ way in will be best, maybe $^4/_4$, test several and see. When you turn on the electricity, the coil will create a small magnetic field that'll pull down on the permanent magnet. The permanent magnet is attached to a computerized force sensor. The computer will tell you how strong the force-rate is."

"What equation do I use?" Hectii said.

"Force-rates are measured in momentums per second [where 5 N = 5 ρ/s]," Kief said, "and amperage is a measure of coulombs per second. Which means, if the voltmeter reads 1.0 V, then you calculate, force divided by amps."

"But what do we do if the voltmeter has a different reading?" Tera said respectfully.

"In that case, you also divide by the volt reading," Kief said, as he keyed the following into the computer that the equipment was attached to:

$$1.0\ V = \frac{(force)/(amps)}{\#volts}$$

appeared on the screen.

"In fact," Kief kindly offered. "I'm programming the computer to run the calculations for you. I suggest you start with a low voltage, and then slowly increase the voltage until the ammeter stops working—remember, the ammeter won't work if the electron current is faster than 0.6 C/s."

"I think I understand," Hectii said positively, as she adjusted some of the controls.

"Before you go," Tera interrupted. "Is there some reason why the experiment might fail?"

"Your data may be highly inconsistent," Kief posed. "The main problem is the comparison between a weak electron-stimulated magnetic-field and a strong permanent-magnet. You see, the force meter can't tell which one is doing the pulling. Is the force data being caused by the permanent magnet or by the electron current?"

"Which means, there's no guarantee that we will produce useful results," Tera concluded.

"But we might," Hectii said hopefully. "And the possibility of learning something new is what experiments are all about."

"Great attitude, Girls," Kief said. "I need to head to my meeting. I'm looking forward to seeing your results."

"Thanks, Uncle Kief! You're the greatest uncle in the world," the girls said appreciatively.

"Ok, where do we start?" Tera said, as Kief stepped out the door.

First Data Set

Hectii adjusted the voltage control, "If we're lucky… I'll set the reading for about 1 V."

"Zero the equipment first," Tera said. "That's what my physical science teacher always told us to do."

Hectii zeroed the equipment, pressed start, and then she turned on the electron current. The computer collected numbers, graphs appeared, and after a couple of seconds, Hectii pressed 'stop'.

On the display screen, a data box read:

Average force-rate: 0.5196 ρ/s or 0.5196 N
Average amperage: 0.4380 C/s
Average voltage: 0.9816 V

"That was very close to 1.0 V," Tera said.

"Next, we divide the force-rate by the amperage to find the amount of impulse per coulomb," Hectii said as she slipped her fingers into the data-input ball and began keying. "Like this:"

$$\#\ volt = \frac{force}{amps}$$

$$0.9816\ V = \frac{0.5196\ \rho/s}{0.438\ C/s}$$

$$0.9816\ V = 1.1863\ \rho/C$$

$$1.0\ V = \frac{1.1863\ \rho/C}{0.9816}$$

$$\mathbf{1.0\ V = 1.209^{-}\ \rho/C}$$

appeared on the screen.

"1.209^{-} is great!" Tera commended. "The value we calculated based on Joule's experimental data was 1.185^{-} ρ/C, and my electricity-to-heat experiment also produced a value of 1.185^{-} ρ/C. Our first experiment was amazingly close!"

Second Data Set

"I'll move the control knob a tiny bit," Hectii said. She clicked the start button on the computer and turned the electron current on. When the experiment was complete, the computer displayed the following:

Average force-rate: 0.5683 ρ/s or 0.5683 N
Average amperage: 0.4773 C/s
Average voltage: 1.070 V

"And here's what the calculations will look like:"

$$\# \text{ volt} = \frac{force}{amps}$$

$$1.070\ V = \frac{0.5683\ \rho/s}{0.4773\ C/s}$$

$$1.070\ V = 1.1907\ \rho/C$$

$$1.0\ V = \frac{1.1907\ \rho/C}{1.070}$$

$$\mathbf{1.0\ V = 1.113^{-}\ \rho/C}$$

appeared on the screen.

"That's very close to our earlier measurements, too," Tera said. "Adjust the dial again, and we'll average the results."

After a third experiment, the computer screen showed the following data:

Average force-rate: 0.5117 ρ/s or 0.5117 N

Average amperage: 0.4311 C/s

Average voltage: 0.9675 V

"And here's what the calculations will look like:"

$$\# \text{ volt} = \frac{force}{amps}$$

$$0.9675\ V = \frac{0.5117\ \rho/s}{0.4311\ C/s}$$

$$0.9675\ V = 1.1870\ \rho/C$$

$$1.0\ V = \frac{1.1879\ \rho/C}{0.9675}$$

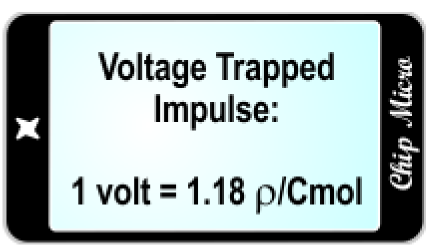
$$\mathbf{1.0\ V = 1.227^{-}\ \rho/C}$$

appeared on the screen.

"I'll average the three values," Tera said, as she eagerly keyed the following into her phone:

$$1.0\ V = \frac{1.209+1.113+1.1879\ \rho/C}{3}$$

$$\mathbf{1.0\ V = 1.183^{-}\ \rho/C}$$



"We're all around the value that we first estimated," Tera said excitedly. "Joule's was 1.185^{-}, Mine was 1.185^{-}, and now ours is 1.183^{-} ρ/C."

"This method of calibrating electricity seems to work," Hectii realized. "When you divide the force-rate in ρ/s by the electron flow rate in C/s, the result is momentums per coulomb. ρ/C is a measure of the inter-electron pressure, it's a measure of the battery voltage, and it's equivalent to the voltage/potential-difference."

"And," Tera said decidedly, "our experiments seem to verify that 1.0 V is equal to 1.185^{-} $\pm$0.009 ρ/C, and that means a calorie is equal to 4.958 $\pm$0.04 ρ of heat-impulse."

"The value, 1.185, once again suggests that a standard linearized joule$_{[1.2]}$ is really a form of impulse."

Largest Data Set

Tera left to visit a new classmate, and Hectii decided to test a large variety of voltages. Uncle Kief had warned she might find some strange data, and for a while it seemed that he was correct. Here is a table of the voltages and ***VTI*** that Hectii developed:

A		Electron-stored	
Voltage		**Voltage Trapped Impulse**	
0.4563	volts	**2.636**	Impulse/Coulomb
0.4972	volts	**2.409**	ρ/C
0.5325	volts	**2.248**	ρ/C
0.5728	volts	**2.085**	ρ/C
0.6231	volts	**1.909**	ρ/C

0.8148	volts	**1.462**	ρ/C
0.8168	volts	**1.457**	ρ/C
0.8193	volts	**1.455**	ρ/C
0.8603	volts	**1.377**	ρ/C
0.8608	volts	**1.383**	ρ/C
0.8654	volts	**1.367**	ρ/C
0.9179	volts	**1.291**	ρ/C
0.9196	volts	**1.288**	ρ/C
0.9197	volts	**1.289**	ρ/C
0.9643	volts	**1.227**	ρ/C
0.9675	volts	**1.227**	ρ/C
0.9816	volts	**1.209**	ρ/C
1.07	volts	**1.113**	ρ/C
1.07	volts	**1.107**	ρ/C
1.071	volts	**1.111**	ρ/C
1.093	volts	**1.087**	ρ/C
1.12	volts	**1.059**	ρ/C
1.121	volts	**1.060**	ρ/C
1.209	volts	**0.995**	ρ/C
1.245	volts	**0.953**	ρ/C
1.247	volts	**0.951**	ρ/C
1.366	volts	**0.851**	ρ/C
1.371	volts	**0.848**	ρ/C
1.372	volts	**0.847**	ρ/C

At first, the data looked very inconsistent. Then Hectii realized that when she used a low voltage, the coil/solenoid generated a tiny magnetic field, and the strong permanent magnet caused the efficiency to increase to 150% or even

200%. As she decreased the voltage, the efficiency rose faster and faster.

The opposite thing happened when Hecctii raised the voltage above 1.0 V.

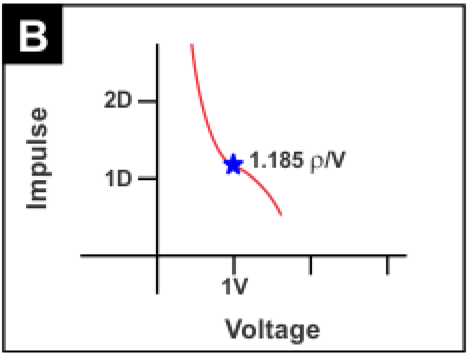
Uncle Kief stopped by the classroom and looked at Hectii's data. He said: "Hectii, it looks as if when you used higher voltages, the solenoid generated a magnetic field that was too large for the permanent magnet to interact with. As a result, the efficiency of the equipment dropped rapidly."

Uncle Kief and Hectii put the data into a graphing program, and they created a graph with voltage on the X-axis and ρ/C on the Y-axis. It was a cubic function!!!

Hectii had the computer generate the equation for the cubic function, and it produced the following:

$$\rho/C = -1.98492738V^3 + 7.3673265V^2 - 9.9412763V + 5.743952$$

And the graph looks like this:



“When you look at the graph, it becomes apparent that low voltages involve impulse efficiencies above 100% (caused by the large permanent magnet),” Hectii said, “while high voltages involve efficiencies far below 100% (caused by excess heat and magnetic fields that were overly large and wasteful).”

“It looks like the ideal data is occurring at the inflection point,” Kief said, “which is at 1.0 V on the X-axis.”

“Chip,” Hectii said, “Evaluate our equation for 1.0 V.”

“Certainly,” Chip said, “the impulse value for voltage is:

$$1.0\ V = 1.185^{-}\ \rho/Coulomb$$

“That seems definitive,” Hectii said. “What’s important is that our original estimate of, 1.0 V = $1.185^{-} \pm 0.009\ \rho$/C, was wonderful!”

Observations and Conclusions

This experiment is a bit trickier than it first appears. If a smaller coil had been used, it would’ve created a high-efficiency error similar to the one that occurred when the voltage was too low. Likewise, a coil with too many wrappings or a weaker magnet would have caused an abnormally low efficiency—like when we used higher voltages.

Students/teachers who wish to reproduce this experiment will need to test a variety of solenoids to see which produce the most reliable results for the given magnet.

The strength of the permanent magnet is particularly critical. A brand-new cow magnet was used, but as the magnet deteriorated over a period of months, the experimental data became useless. The permanent magnet cannot be too strong, but a weak magnet will not produce reliable data.

This experiment may not be the best way to calibrate electron currents. Labs Professors Fear Experiment #2 used a calorimeter to compare mechanical impulse to electric voltage. That approach is easier to reproduce in the lab because it isn’t dependent on magnetic fields that can deteriorate over time.

In the sample of LPF Experiment #2, Tera found that:

$$1.0\ V = 1.185^{-}\ \rho/C.$$

In LPF Experiment #1, data from Joule’s original experiments produces a value of:

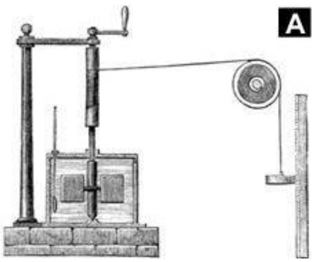
$$1.0\ V = 1.185^{-} \pm 0.009\ \rho/C.$$

As crazy as it sounds, this all suggests that a standard linearized joule[1.2] is actually the same thing as 1.185 ρ of impulse!

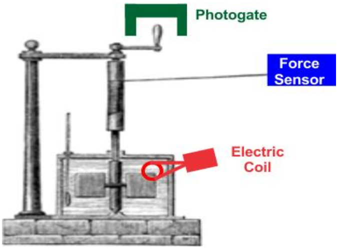
Conclusion

In this experiment, the force between a strong permanent magnet and a weak solenoid is tested at a variety of voltages. This easily reproduced school lab shows that electric joules are a scaler multiple of impulse, where 1 Volt = 1.185 ρ/C, and 1 standard-linearized electric joule is always equivalent to 1.185 ρ of mechanical impulse. These findings correspond to the findings in mechanical-vs-electric heat Experiment #2, and to the analysis of Joule's original experimental data presented in Experiment #1.

To discover more, explore:



Labs Professors Fear #1: a detailed analysis of James Prescott Joule's Heat-is-Work experiment. Using Joule's data, it can be shown that 1 cal of heat is equivalent to 4.95 ρ of mechanical impulse. *This lab should be reviewed by all students prior to doing Experiment #2*. (www.Wacky1301Sci.com)



Labs Professors Fear #2: a repeatable amplification of Joule's experiment that uses calories as the intermediate step in comparing mechanical heat and electric heat. (www.Wacky1301SCI.com)

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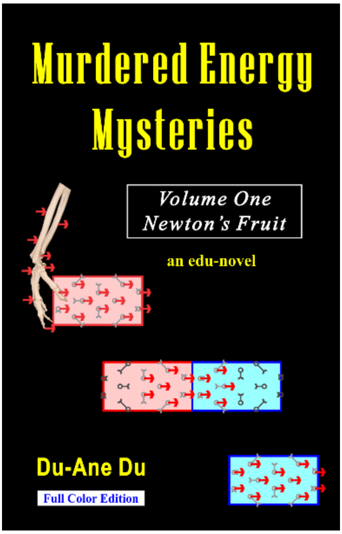

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Murdered Energy Mysteries seeks to increase understanding of the various forms of momentum and momentum transfer, as well as the various forms of energy and energy transfer. The lack of understanding on the part of the scientific community is substantial,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