The Names and Symbols of Physics

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Abstract:

Some of the symbols in physics can be very non-intuitive, wouldn't it be nice to know from where they came? The goal of this study was two-fold. First, to research the etymology of the names and symbols of physcis to better understand how they were named. Also, to determine how much interest there is on the subject in various levels of physics education, which was accomplished via a survey and multiple interviews.

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1 Introduction

Have you ever wondered why something in physics was given the name it was? Or why a particular physical quantity has been given the symbol it has? It always bothered me when I got introduced to a new symbol which apparently had no connection to the quantity it was describing. Like B for magnetic field, or I for current, or any number of the Greek letters which appear to be chosen at random to represent what they do. As I found out, I'm not alone in this puzzlement. There are many others who have wondered too. This paper will explore some of the units, symbols, and names of physics. As well as the amount of interest that the physics community, from high school students at Noble High School (my old high school), to undergraduates and college professors here at Worcester Polytechnic Institute, has in regards to why the names and symbols are what they are. Interest in the meaning behind symbols was investigated via a survey, which I gave to high school and undergraduate students. I also interviewed the professors to get a deeper understanding of what they were thinking.

Understanding why things have been named the way that they have helps students remember the symbols and quantities themselves. For example it may be hard for a freshman student to remember what a Farad is all by itself. However if that student knew a little bit about the history of the Farad, how it is named after a famous physicist who conducted a lot of experiments relating to electromagnetism, they may more easily make the connection that a Farad is the unit for capacitance. The more ideas and facts you can associate to something the more likely you are to be able to remember it clearly, learning through repetition has been shown though research time and time again to be effective.[1]

2 Famous People – Units

Some of the units in physics, many of them learned in the introductory and intermediate levels of undergraduate physics, are named after a famous physicist who made a big contribution to physics in the field of study surrounding that unit. It is important that we honor people who make ground breaking discoveries so that we do not forget from where the wealth of knowledge we have came.

The unit for electrical current, the ampere (often abbreviated as amp) is named after the French physicist André-Marie Ampére. Ampére was one of the founding people of the study of electrodynamics. He discovered that in the presence of current flowing through a wire, the needle of a compass would deflect. He practically ...laid the foundation of the science of electrodynamics. Most of his work was in the early 1800's, and he died in 1836 at the age is 61. It wasn't until 1881 that the Paris Conference of Electricians honored his memory by naming the unit for electrical current the Ampére.[2] It is worth noting that somewhere between then and now, the é became an e, at least in the English use of the unit. We use Ohm's law to connect current with another quantity, voltage. But why is the unit for electric potential named volt?

How many devices have you used today that have a battery? By in large you can thank the Italian physicist Count Alessandro Volta. He is credited with inventing the first battery, aptly named the voltaic battery. This was a far cry from the batteries in use today, but it was Volta's invention that set the whole thing into motion. At the first International Electrical Conference in 1881 the unit for a potential difference was named the Volt, in honor of Volta.[3]

Also in 1881 a newly defined quantity for capacitance was named the Farad, after the great British physicist Michael Faraday.[4] Faraday made countless contributions to the study of electricity and magnetism, and is perhaps most well known for his law of magnetic inductance. A very important thing in modern life that is based off this law is the electric generator. Without Faraday's law of induction many of the ways we generate electricity would not have come to existence. 1881 was a busy year it seems, for there was another unit named that year.

The French physicist Charles-Augustin de Coulomb showed us the fundamental law of electrostatic repulsion and attraction. This is known as Coulomb's law. This allows us to predict how any two charged objects will interact with each other as a function of the sign and magnitude of their charges, and the charge separation. Again in 1881, the unit for charge was named the Coulomb in his honor.[5] This change solidified a name for a unit which didn't have a well defined named before (that I know of).

What if someone tried to change the name of an already existing quantity to something else? The unit used today for frequency, Hertz, is named in honor of German physicist Heinrich Hertz.[6] Hertz made many contributions to the field of electromagnetism, including expanding on Maxwell's theory of how electromagnetism applies to light, and being the first to prove the existence of electromagnetic waves. The International Electrotechnical Commission established the unit Hertz in 1930, and was adopted by the General Conference on Weights and Measures in 1960. This replaced the former (and in my opinion rather clunky) term for frequency, cycles-per-second. It took a little while for the new term to work its way into practice however. It wasn't until the 1970's when the term hertz had largely replaced the old cycles-per-second.

Ten years before the adoption of hertz for frequency, we have the naming of the unit for magnetic field, which was named the Telsa in honor of physicist Nikola Tesla at the at the Conférence Gnérale des Poids et Mesures, Paris, 1960.[7] Tesla is to thank for an array of discoveries in electromagnetism, including the very important alternating current which is the form of current in use today when transporting electricity along wires. All that electricity is used as energy to power everything we use on the modern world.

Connecting power to enegry, the English physicist James Joule made it his life's work to study the nature of heat and energy. His discoveries of the connection between heat and mechanical work led to the theory of conservation of energy, and later to the formulation of the first law of thermodynamics. The unit of energy is named the Joule in his honor.[8] He also worked with Lord Kelvin, who ended up predicting an "absolute zero" temperature, which is the coldest temperature possible (perhaps a barrier that can never truly be reached, we have come painstakingly close, but have never gotten there). The temperature scale which starts at absolute zero (and therefor has no possible negative values) is named degrees Kelvin, after Lord Kelvin.[9] A body giving off heat is usually exerting some sort of force as well.

Last but not least there is a physicist who needs little introduction, for anyone who has taken even the most basic of physics classes known his name, Sir Isaac Newton. Newton built the foundation of classical mechanics, so it only makes sense that the unit for force be named the Newton in his honor.

There are certainly other units that have been named after people, what I have above is just a minute sampling of the vast world of symbols in physics. Nonetheless it is an important section, which covers many of the basic units seen in undergraduate physics.

3 The Symbols

3.1 Some Just Make Sense

There are some symbols in physics where the connection between the symbol used and the name used is quite obvious. For example, we use m for meters. m is the first letter of the word meter, the reason why m was chosen is so obvious anyone could make the connection. Some might ask, why not use this method for all symbols? At first glance it seems like a wonderful way to eliminate confusion. A problem arises from using this method however.

There are only 26 letters in the alphabet. If we only used the first letter of a quantity as its symbol, we would soon be racking up many duplicates. There are many duplicates in the system we use, ex. m for mass and m for meters, however they aren't to the point where you cannot distinguish which is which from the context. Now imagine if an equation had 4 different 'm's in it, which no way if keeping them apart other than labeling them m_1, m_2, M, etc. You probably could do it, but it seems rather cumbersome.

3.2 And Some Just Don't

Whenever a new quantity is discovered, it must be given a name, and in most cases, a symbol. Some names get symbols that don't *appear* to be associated with the physical quantity in question, like B for magnetic field. Some symbols get Greek letters. I was unable to find any information on why we started using Greek letters in physics, however it is very prevalent. There has to be a rhyme and reason to the seeming randomly distributed symbols, doesn't there?

3.3 A, B, C, D... H!

Three symbols that seem to make no sense are A for magnetic vector potential, B for magnetic induction, and H for the magnetic field. All these symbols can be traced back to Maxwell's *Treatise on Electricity and Magnetism*. In article 618 he displays a table of all his important electrical and magnetic quantities. If one reads the table from top to bottom in the symbol column, one notices it reads, A, B, C, D, E, F, G, H![10] Thats right, they are in *alphabetical order*! Maxwell must have noticed that most of the quantities lined up with the beginning of the alphabet, C for current, D for displacement vector, E for electromotive force, etc. The ones that didn't have any phonetic relevance, he just started filling in from the beginning of the alphabet. Moreover, his choice for magnetic vector potential being A might not be an arbitrary one, taken from article 540:

"The whole history of this idea in the mind of Faraday, as shown in his published Researches, *is well worthy of study* [my italics]. By a course of experiments, guided by intense application of thought, but without the aid of mathematical calculations, he was led to recognize the existence of something which we now know to be a mathematical quantity, *and which may even be called the fundamental quantity in the theory of electromagnetism* [my italics]."[10]

So we see that perhaps he regarded the magnetic vector potential as being a more fundamental quantity than the others, since it was discovered and the mathematics were molded to fit that discovery, rather than being derived and then confirmed experimentally, and therefore deserving of having the letter A, the beginning of the alphabet.[11]

3.4 Current and Light

Sometimes the connection between symbol and name is not obvious to us because it is derived from a different language. The person who did founding work with electrical current was a french physicist, André-Marie Ampére. The notion of current was first introduced by Ampére, who called it "intensite' du courant", translated, "the intensity of the flow". We got the English word 'current' from the latter part of the French term, 'courant'. The use of the letter I was the first symbol given to this quantity, and is still the one we use today despite some attempts to start using the letter C for current through the 1800's, for example by Maxwell. One interesting thought is that this may be due to English disdain for the French at this time.[13]

The speed of light was once thought to be infinite. You can see why this might not sound so absurd a few hundred years ago. Light moves so fast that any distance it travels within our normal sight *appears* to be instant. The answer was first pondered by Galileo, who proposed an experiment involving two lanterns on hilltops a mile apart. However the findings of that experiment were that light is indeed instantaneous, they didn't have any equipment with which to measure, and the human eye is not sensitive enough to detect the time difference, even a full mile apart, which is on the order of a few micro seconds. Some years later a physicist named Roemer predicted that the sighting of a moon of Jupiter, Io, coming into view would be about twelve minutes late due to the fact that light had to travel some extra distance, and it has a finite speed. He ended up being right, but his superiors didn't believe him. Everyone *knew* from Galileo's experiment that light instantaneous, and everyone also *knew* that Io couldn't be predicted accurately because of "a distorting haze; or maybe the high angle of it's orbit". It wasn't until fifty years later when people took a closer look at the calculations, and observed the same twelve minute delay happening again, that light was finally accepted to have a finite speed.[12]

Now one might think that the speed of light is denoted as c due to the fact that it is a **c**onstant. However this is not the case. This is another example of not seeing the connection in a different language. During the time period when all these things were happening, Italy was the scientific capitol of the world, and Latin was the language of choice. The speed of light is named after the Latin word *celeritas*, meaning swiftness. After all, nothing is swifter than the speed of light. As an interesting sidenote, it is also the root word for the English *celerity*, where we get the word acceleration from.[12]

3.5 Permittivity, Permeability, and the Like

At one point there were two different terms for each of these quantities. Lord Kelvin was first to coin the term permeability. He used the same term in two different ways, magnetic permeability and electric permeability. What he called magnetic permeability is what we call today permeability, μ_0. The word permeability comes from the Latin words "per", (through), "meare", "to glide. flow. or pass) and "mittere", (to send). Kelvin thought this word could explain a range of different things, including magnetic, electric, hydrokinetic, and thermal.[14]

The first person to come up with permittivity was Oliver Heaviside. He used the terms permittivity, "indicating the capacity for permitting electric displacement" and inductivity, "indicating capacity for supporting magnetic induction" What he called permittivity is also today what we call permittivity, ϵ_0. We took Heaviside's word permittivity, and Kelvin's word permeability, as the two to use in our modern usage.[15]

I have my own little theory as to why we use μ_0 and ϵ_0 for the magnetic and electric constants. Several professors I talked to also came up with this same guess, though my discussion of the speed of light proves that just because many people tends towards one answer, doesn't mean it's right. We use μ_0 because thats the magnetic constant, starting with the letter m. The subscript o indicates that it is a fundamental, non-changing, constant. Similar story for ϵ_0 being the electric constant. It's an explanation that certainly makes logical sense, however it is still only an educated guess.

4 Research Process

I started out very ambitious, making a list of all the symbols I could think of that I would be interested in researching. I quickly realized that this would be very impractical, and started narrowing the list down to what you see above. My first trip was to my favorite site for basic information, Wikipedia. This yielded some good information about the units named after famous physicists. I was able to go to the articles relating to each unit and the corresponding articles about the physicists, as well as follow the citations to other sources, and come to fairly good conclusions about why each unit had been named in honor of the physicist. Wikipedia proved useless however in finding any information about anything not directly related to the name of a famous physicist.

My next stop was an internet search engine, some might say the internet search engine, google.com. However after a while I realized that Google was going to be almost useless for my research. This isn't the kind of thing that is well-known enough to have web pages dedicated to it. In fact I was beginning to get the feeling that maybe I was the first one to research why the symbols are what they are. This couldn't be totally true though, someone had to have written down some reason for some of the symbols, even if it goes all the way back to the person who did the ground-breaking research for that particular quantity.

At this point I was pretty much stumped so I requested some help from the library. I had a research consultation with Librarian Laura Hanlan who really set me straight on where to look for my information. She gave me the site of the Oxford English Dictionary. This is different than other dictionaries in that it gives you the history of a word, back to the first known time that it was mentioned. For example putting in Magnetic Field refers all the way back to Faraday. It was through the Oxford English Dictionary that I was able to track some symbols back to the original authors. It was also around this time that I stumbled on the American Journal of Physics and did some searches on their website, leading to the articles that I cited in this paper. I will admit there was a bit of serendipity involved in finding some of my information. A lot of it came from looking at sources of sources of sources.

Not everything I came across panned out of course, there were a lot of setbacks and dead ends. In particular I tried to contact the person who had written the response to why we use I for current. This is what he wrote, taken verbatim from the list serve[13]:

"The term we call 'current' was first introduced in the writings of Ampere, who called it 'the intensity of the flow', 'intensite' du courant" in French. Gauss and the Germans used terminology like 'die Stromstaerke' to describe the intensity of 'der elektrische Strom', but adopted the French symbol 'I'. So the symbol "I" comes from the French word 'intensite". The word 'current' comes from the Anglicization of the French word 'courant'."

I didn't get a response from the e-mail listed, and a look at the school's website where he worked revealed he was no longer a teacher there. I did come across another e-mail listed by him (or at least someone with the same name), but that one turned out to no longer be in use either. However there were several other responses by different people giving the same answer, which gives me some comfort that it's right.

5 Are people interested?

My other task was to figure out whether or not there is an interest of learning more about from where symbols come. I came up with a hypothesis that as you progress your knowledge of physics your interest in knowing more about the names and symbols of physics would be higher. The idea being that the more you already know about physics, the more that you have to question, and the more you'll wonder about why symbols and names are what they are.

5.1 Back to High School

I felt it was important to first get the opinions of students who are just starting their study of physics. Many of whom will probably never learn anything more than the most basic of basic laws of physics. The first step was to get in contact with my AP physics teacher from Noble High School, Mr. John Nowacki. He was only teaching regular physics classes this year, which go over the most basic of concepts from classical mechanics, at a pace the average high school student can handle. I asked if I could administer a survey to his classes. He said he was more than happy to have me join his classes for a day, and after getting my survey approved by the principal, we set a date.

I gave a short talk about who I was and what my project was about, with the help of Mr. Nowacki. A lot of the students remembered me from when I was a senior there and they were freshmen. When I was a senior in high school I was the photo guy. One day I was invited to take a picture of the '09 class standing in a giant 09 (as i side note i got to ride up in a boom lift to get high enough to take the picture, which was awesome).

As I handed out my survey I informed the classes that I would also be handing out candy. This is enough to make almost anyone's day, let alone high school seniors. They were all very thankful, and I got the feeling that they took the survey more serious somehow. There has been plenty of research done showing that giving an incentive to fill out a survey increases both the response rate and the quality of the data gathered.[16] There was a concern among a lot of students that they weren't being very helpful. Some of them simply filled out the whole survey with "No" and question marks. I kept reassuring them that even if they knew nothing or weren't interested at all, they were indeed helping me. After all I am trying to confirm my hypothesis that as you advance your knowledge in physics you become more interested in and wonder about why symbols are what they are.

After I was done with my survey, I was enlisted by Mr. Nowacki to help with an activity he had planed for the day. Around the room he had setup motion detectors, the kind that can sense an object in front of them, tell how far away it is, how fast it's going, and how quickly it's accelerating. He also had a program which could plot the object's displacement and velocity on a graph with respect to time. In the program he had drawn a graph, which the students were to match by physically moving their bodies the right distances and speeds relative to the detector. I helped by going around and demonstrating how to use the equipment, and signing off on student's papers once they had matched the graphs. Overall I had a blast spending the day with my former teacher, and I feel the survey process was a success. Almost all the students I observed appeared to be making a good attempt at answering the surveys, and I got to know them a little bit through my interactions with their experiment.

In all, 52 students completed a survey. Of those, 21 students (40%) indicated they had wondered about the reason a unit or symbol had been assigned to a quantity in physics, whereas 31 students (60%) indicated they had not. I had to lump the two questions on symbols and names together due to some confusion in the difference between them (for example, students answering with symbols they've wondered about in the name question). There was a considerable jump in the percentage of of students who said they would be interested in learning more about the symbols and units of physics, with 26 students (60%) saying they would, and only 17 students (40%) saying they would not. Note that the numbers do not match up because some students left the question blank, or wrote down an indefinite answer (i.e. ”maybe”, or ”not sure”) which could not be counted as an affirmation.

5.2 Fellow Undergraduates

My next step was to go to my peers, undergraduate students, and give the same survey to them. I was hoping to see that more students had already wondered about symbols and units, and that there would be more interest as well. Luckily for me (or maybe...because it was setup...hey, don't look at me like that!) the person who is advising my project, Professor Carolann Koleci, was teaching a rather large class at the time, PH1121, the introductory calculu- based electromagnetism class. She volunteered to give my survey to her class. She asked her conference instructors to distribute the surveys for PH1121, and even gave the students a small incentive to fill them out in the form of extra credit (a good thing!)[16]

After the surveys were in I found a whopping 113 out of 139 students (81%) had thought about symbols or unit names before, and only 26 out of 139 students (18.7%) had not. This is a large leap from the percentages of high school students. More than double the percentage of students had thought about the meaning of symbols or units before. Something between high school physics and introductory college physics made people think more about the symbols and units. 100 out of 139 students (71.9%) said they would be interested in learning more about the symbols and units, whereas 39 out of 139 (28%) said they would not. This isn't as big of a difference, but still 11.9% more students would be interested.

It is worth to note that this class is a self-selected group of students who opted to take the more difficult calculus based version of introductory electromagnetism. These are students who most likely have a higher interest in physics to begin with than people taking the regular introductory electromagnetism. They also are more likely to be physics majors (most of the physics majors I know have taken 1121), though still the majority of them are not. They also have a professor who is very interested in the origins of symbols and names, who could have passed on some of that interest through her lectures.

I also surveyed another class, the intermediate mechanics class, which in contrast to the introductory electromagnetism class, the majority of students were physics majors. I was the grader for that class, and the instructor, Professor Nancy Burnham, was happy to let me administer my IQP survey to her class. Of 22 students who filled out the survey, 19 students (86%) said they had thought about symbols or unit names before, and only 3 students (14%) said they had not. There were 20 people who have an answer to the question on whether they would be interested in learning more about the symbols and names. Of those 17 (85%) said they would, and only 3 (15%) said they would not. These numbers are higher than the introductory class, though I am not sure whether this is more actual interest or just an artifact from only having 22 students. The smaller the sample size the less accurate any conclusion you draw from the data is. A small sample size of 22 isn't a *terribly* small, but it is certainly much smaller than 139.

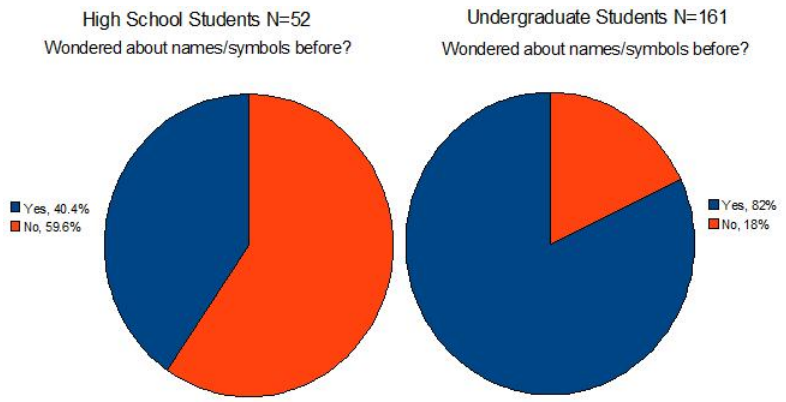

Figure 1: High School vs Undergraduate, wondered about names/symbols before?

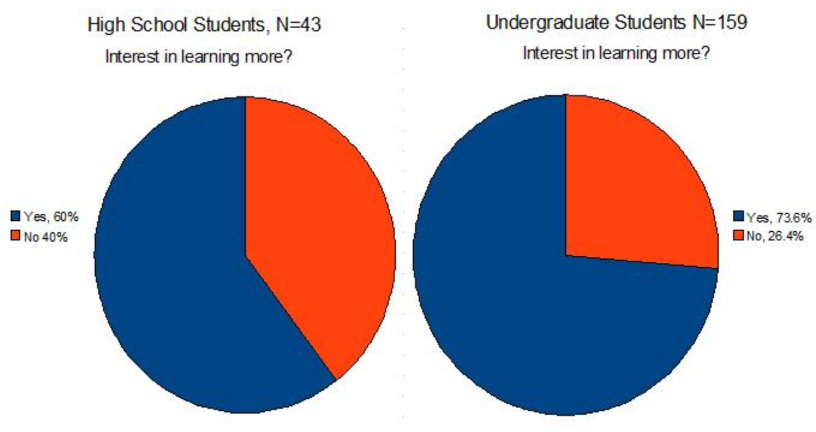

Figure 2: High School vs Undergraduate, interested in learning more about the names/symbols?

When the undergraduate numbers are combined, 82% of students have thought about symbols or names before. This is much higher than the high school percentage of 40% (figure 1).

The combined percentage for undergraduates who would like to learn more about the names and symbols is 74%. This is considerably higher than the high school percentage of 60% (figure 2).

There is an interesting discrepancy here between the two data sets for college undergraduates. More people have wondered about the names and symbols than would be interested in learning more. This seems rather odd to me, and I have no explanation for this strange result.

5.3 Professor's Interest

The last piece of the puzzle was to get the input of the physics professors here at WPI. I decided to get in contact with all the professors, sixteen in total, and interview them instead of giving a survey. In total nine of the sixteen professors I asked to interview accepted. Of the seven I didn't interview, one responded saying they weren't interested, one didn't have time, one was out of the country, and four didn't respond. Interviews would allow me to get much more information, and the small number of professors made interviews possible (it would be very time consuming for one person to interview 150 undergrads). I took notes during the interviews, but also voice recorded the conversations incase I missed anything. I based my interviews loosely off a list of questions (attached in Appendix A), but the conversations often took shape on their own, with my questions coming out in a different order. Most of the interviews had a very laid-back setting, and played out more like a conversation than an interview. A few professors were a little anxious about the voice recorder at first, but seemed to forget about it as we got talking. If my hypothesis was correct, virtually all of the professors would be very interested. Instead I got a varied spectrum of interest ranging from absolutely no interest to very interested.

On one end, there were some professors who had no interest what-so-ever. One professors turned down my interview, outright saying he/she had no interest, and two had little to no interest during the interviews. One that I interviewed took only about ten minutes to interview because his/her answers were all very short and negative. He/she said that there was no value in doing something like this, and that it was only knowing how to apply the symbols to solve problems that was important. To me this is kind-of like saying that if you have a television remote, it's only important to know which buttons to press rather than knowing how it actually works.

Then there were four professors who were in the middle. They said that they would have some interest in learning more about symbols and names, but didn't seem very enthusiastic about it. One professor said that they wouldn't spend time researching this himself, but if someone were to do a presentation on it, they would probably come if they had the time. When asked question 1 they all remarked that they had, but mostly in passing, not a strong curiosity. Three of the four also answered question 10 that it was the interview and learning about my project that piqued their interest.

Then there were three professors who seemed really into my project, and would be very interested in learning more, I could hear the enthusiasm in their voices. These were the best interviews because it was more of them talking about things than me giving a static question and them giving an answer. For example on question 1, they clearly answered yes and gave multiple examples of symbols they had wondered about. They all said they were very excited about learning more about the symbols of physics, and would be looking forward to my presentation on my findings.

The interviews had differing times, from about 10 minutes on the short end, to an hour on the long end. Overall I noticed the longer the interview took, the more interest the professor had. It was from the professors with more interest that I gained the most insight for the sections below, such as duplicate symbols, the i/j discrepancy, and the Greek alphabet.

5.4 So How Much Interest Is There?

There is certainly a considerable amount of interest out there for learning more about why we've chosen certain symbols and names. Overall the majority of professors had at least some interest, however it definitely does not follow the trend setup by the high school student to college student progression of raising interest. If anything I would say that the college students had the most interest, followed by the professors, then the high school students. One explanation I have for how my data turned out is that as college students, many of us are in our "prime" of wanting to learn knowledge. We soak up knowledge every day; it is our *job* to learn. That is why we are here. The same is true of high school students, however the difference is everyone is forced to be a high school student, so those surveys were given to a whole range of people. The vast majority of students at WPI are a self-selected group of young adults who are working towards degrees in some type of a math or science related field. By self-selection I mean that students here at WPI have made a personal choice to be at a school where science is the main focus. I would make the analogy of asking a random group of people whether they are interested about how the rules of football are defined, and a group of sports fans if they are interested. The sports fans will most likely give you more affirmation than the random group, since they are a selected group of people who already have some connection to the subject.

Professors on the other hand, while still learning some things, already know a great deal about their subject area, and have many other things to worry about in their lives other than learning. Some of the curiosity may have faded in the transition between student and teacher. This isn't to say professors aren't interested, there were still a good amount of professors who are.

5.5 No One Knew About B or c!

Something that amazed me was that through the entire process, high school students, college students, and professors, not a single person knew why magnetic field is B or why the speed of light is c. A good number of people guessed that there was some connection between these two symbols and a foreign language, which is the closest anyone got to getting a correct answer to why the speed of light is c. No one was even in the ballpark when asked why magnetic field is B. By far the most repeated incorrect answer (besides "I don't know") was saying that the speed of light is c because it is a constant. Here's an example of an explanation which makes sound logical sense, but isn't the true meaning. This is why I have a disclaimer in my section on permeability and permittivity.

There are some pretty off the wall guesses about both B and c. There's no knowing whether or not they were all serious (I'm guessing some aren't), but they are funny nonetheless. One student thought that B was magnetic field because a capitol B looks kind of like magnetic field lines. One said the speed of light is c because light goes "crazy-fast". One high school student even wanted to know what "ohm's horseshoe" was. I used Ω for Ohms as my example of a symbol. The student thought that Ω looked like a horse shoe (which...yea I can see the similarity) and wanted to know what it was for.

5.6 Professor's Concerns and Comments

The most common response across the board to the question of disagreement with symbols or confusion was duplicate symbols. Students starting out with physics will often get confused if a symbol is used to represent more than one thing in their work. It is hard enough to have heads and tails of the content itself, without having the added confusion of trying to figure out which m the problem is talking about. One professor even said he goes out of his way to try to make sure students only see each symbol used for one thing at a time, to avoid confusion. Common examples included m for mass and meters, and v for velocity and volts, and confusing the symbol ν for frequency with a v.

Another thing that students can find confusing is the inconsistency between books or professors in using different symbols for the same quantity. An example which kept coming up in my conversations with professors is the symbol used to denote the imaginary number $\sqrt{-1}$. Throughout physics the symbol used is i, but in electrical engineering classes, the symbol used is j. Students coming from one discipline can get confused when they see the other disciplines symbol. As one professor pointed out, once "you know what it is, it's no problem", however thats only because this is a single case. Imagine if you had to remember two different symbols for everything. There should be consistency to avoid confusion, which by-in-large we have, with the SI unit system.

One more source of confusion for beginning students is the Greek alphabet. Physics makes heavy use of Greek letters to help avoid the duplication problem. Most high school students will not have seen any Greek letters by the time they graduate. When they get to college physics they have no grasp as to what these weird looking symbols mean, α, γ, ν, μ, etc. In fact many students think that ν is a script v when they first see it, and they are used to seeing f used for frequency. One professor commented on this saying "I cannot tell you how many times [a student has] called ν, v, or ω, w." Students have to learn what the symbols are at the same time they are learning what they represent. One professor I interviewed proposed a solution, saying that "students in high-school should learn the Greek alphabet". I'm not sure how often Greek letters are used outside of the sciences, but it sounds like a good thing to go over in a high-school level physics class.

Many professors also commented on how unique my project is. Some said that a project like this "has never been done before". From my research I would say that might be true. I never found an article, paper, report, book, or anything that tries to tie together the meanings of various symbols in physics. The information is out there, scattered to the wind, and this is the first attempt (to my knowledge) to tie it together. Many professors also wanted to know how I came up with the idea, which I have my advisor, Professor Carolann Koleci, to thank. In my sophomore year I took PH2301 with her, the intermediate electromagnetism course. She mentioned how she was curious about symbols in class, and (I thought in jest) that it would make a great IQP. I talked to her after that class and we decided that, yes, this could work as an IQP, and here we are.

6 Conclusion

My goal for this project was to find out why some of the names and symbols of physics got named the way they did. I didn't find out about all the symbols I set out looking for, but overall I'm satisfied with what I have given the amount of time I had to do it. Many of the basic units we use today are named after famous physicists who made large contributions to their fields. It is important to remember where the foundation we have came from, and honoring the great physicists of the past with unit names is one way to do that. Some symbols, like c for the speed of like and I for current have origins in languages other than English. A, B, and H in electromagnetism originate from Maxwell putting things in alphabetical order. There is more interest among undergraduates (82%) then high school students (40%) when it comes to the names and symbols of physics, and also more undergraduates (74%) then high school students (60%) have wondered about why the names and symbols are what they are. Things diverge a bit when it comes to professors, with a whole range of interest, which may by due to the interview process, rather than the binary yes/no on the survey.

There are many different reasons why a symbol can be chosen. From the obvious to the obscure, there has to be some rational behind each and every symbol and name in physics. I set out to find what some of that rational is, and succeeded in finding out about a handful of symbols. (If only I had more time!) I also succeeded in finding the general amount of interest here at WPI in regards to my project. However I cannot make any generalizations to the physics community at large, specifically physicists not involved in physics education. I have only scratched the surface when it comes to the number of symbols that don't have a clear reason for being what they are. There is still much research to be done. Perhaps it would be nice for someone in the future to pick up where I left off, and do an IQP of their own on this subject.

As a final remark, here is a table with the symbols I discovered the meanings behind:

Symbol/Name	Reason
c, Speed of Light	From the Latin word *celeritas*
I, Current	French term "intensite' du courant"
A, Magnetic Vector Potential	Alphabetical order from Maxwell
B, Magnetic Field	Alphabetical order from Maxwell
H, Auxiliary Magnetic Field	Alphabetical order from Maxwell
Permittivity	Named by Oliver Heaviside
Permeability	Named by Lord Kelvin

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A Survey and Interview Questions

Professor Interview Questions

1. Have you ever wondered why a symbol was assigned to a particular physical quantity? If so, which?

2. Have you ever disagreed with a symbol? If so which and what would you re-name it?

3. Are their any particular symbols in your field or research you would like to know more about?

4. In general how do you think symbols get assigned?

5. Why do you suppose the speed of light is denoted as c?

6. Why do you suppose the magnetic field is denoted as B?

7. Are there any symbols that you know why it was assigned, and the reason is unintuitive or not obvious?

8. Which symbol do you think is the most confusing (for you or students)? i.e. repeated a lot or non-intuitive.

9. Would you be interested in learning more about why various things in physics have been given the symbols they have?

10. Have you thought about these kinds of things before? Or did this interview spark your interest?

Disclaimer: Data collected will be used for research purposes only. Any personal information provided will be kept confidential.
If you run out of room, please use the back of this paper, noting which question you are continuing.

1. a) Have you ever wondered why any of the quantities in physics have been *named* the way they have? (ex: Ohms for electrical resistance)

b) If yes, what names of physical quantities are you curious about?

1. a) Have you ever wondered why any of the quantities in physics have been given the *symbols* they have? (ex: Ω for Ohms)

b) If yes, which symbols in physics are you curious about?

3. Why do you suppose the symbol given for magnetic field is B?

4. Why do you suppose the speed of light denoted as c?

5. Are there any names or symbols in physics that you think should have been given a different name or symbol? Why?

6. Would you be interested in learning more about why things have been given the names and symbols they have? Feel free to elaborate.

Demographic Information
How would you rate your personal interest in physics?

Very Interested   Interested   Somewhat Interested   Barely interested   No interest

You are currently a...

High school student   Undergraduate student   Graduate student   Professor

May I contact you should there be any questions about your responses or in regards to any questions you may have? If yes, please provide your e-mail.

If you have any further questions, comments, or concerns, please note them in the space below, and/or on the back of this page.