

To begin, I believe it is necessary to discuss the role of science in society. Science is simply a way of trying to understand the universe. Art, poetry and philosophy are also ways of discussing our existence, and they share a common aspect with science.

Art uses the language of form, figure, color and texture. Poetry uses simile, alliteration and innuendo. Philosophy uses interrogative and logic and so too does science have a language: The language of mathematics.

The advantage of mathematics over other approaches is the lack of ambiguity. While any two people probably differ in opinion as to the definition of 'right' and 'wrong' it is rare to find two people who do not agree on the meaning of the number nine. Additionally, the language of mathematics allows us to make predictions about the future state of numbers. Once a proven mathematical relationship between numbers is established the accuracy of the prediction is limited only by the accuracy of the information used.

Artists, doctors, poets, plumbers and bakers all speak their own language when it comes to their profession. The language of mathematics has its own idiom, specific definitions, assumptions and implications.

The application of mathematics to the observed universe is physics. A 'physicist' is a person who examines information about our observable existence and discusses the results in the language of mathematics to avoid ambiguity and to make results as widely applicable as possible.

It is important to remember that these are only models of our reality and can be modified or discarded in the face of new information. Indeed, this is one of the hallmarks of science: There are no ideas that cannot be questioned and revised as new information is obtained.

Learning to read the universe is a very difficult task, there is no doubt! Learning to read a Dr. Seuss book was once also a very difficult task, and the processes involved in learning to read the universe and learning to read a book are very similar. How is it that you are able to read this paragraph?

Do you have to memorize every possible combination of words that you might ever encounter in your life? Of course not! You have spent a long time learning and understanding the fundamental components of the written language. When you come across a sentence, the rules of language and your vocabulary allow you to understand the content of the message. Before you expect to master the language of physics, just think about the effort required in order to be able to read the English language.

First, you learned to recognize the shapes of the letters and the sounds with which they are associated. You practiced saying the sounds over and over, over and over. You spent many hours drilling the shapes and sounds into your brain until you were able to recognize them on sight.

Then you practiced tracing the letters, following patterns that someone else laid out for you until your mind and fingers learned to work together to make the shapes that were needed. This also took a long time and you had to work very hard at making it part of your knowledge.

Then those shapes were arranged into words. The first types of words we typically learn are nouns and the definitions or meanings of particular objects are encoded in the types and arrangement of letters used. We come to understand that although 'cat' and 'act' contain the same letters, they mean completely different things.

We also learn that there are a staggeringly huge number of definitions. Although a 'pen' and a 'pencil' are similar in many important ways,

they are also different in many important ways. Understanding the subtle differences in similar concepts is essential to mastering a language.

Consider what happens when a young child learns the word ‘dog’. Typically, anything with fur and four legs becomes a ‘dog’. Cat, horse, sheep, camel – it makes no difference, everything is ‘dog’. It takes time to understand that the word ‘dog’ is only applied to four legged, furry mammals of the species *Canis lupus familiaris*. You will find a similar situation when learning physics, and it will take time to sort out the subtle differences.

Finally, the words are arranged into sequences called sentences that are used to convey information. Sentences can be simple or they can be convoluted, but all can be interpreted if you can read and understand the information that is coded within.

You have been following much the same path in your math education. First, you learn about numbers: Zero, one, two, etc... Next, you learn about the various ways in which numbers can be arranged and you learn how to recognize certain arrangements as having particular meanings: Sum, product, difference all have to do with how the same symbols are arranged and that is why we are all comfortable saying 3-1 is not the same as 1-3 even though the symbols used are exactly the same in each case.

So we learn that the arrangement of the symbols carries information. The equation is to physics as the sentence is to language. It is a way of arranging the symbols that will convey information, provided you understand the terms used. Again, there are many terms used to describe an equation; lines, planes, parabolic, hyperbolic, differential, etc. While they are all exactly the same in some ways – they express relationships between numbers – they are also very different, and we develop a variety of techniques to solve them.

Now you are ready to begin reading and writing a description of the way the universe works. Physics uses the language of mathematics, and it is important that you are comfortable with all of the steps that have come before. If you find that you are lacking in some of the background information, it is imperative that you correct the situation immediately. There is little enough time to cover the new material that will be presented, we cannot afford to spend time on material that you should have already learned.

When the course is over, I might like to think I caused you to pass and you might like to think I caused you to fail, but we both know that your success is in your hands. Will you rise to the occasion and invest the time that it will take for you to understand the material? It is your decision alone to make.