Dividing vectors is not defined Corrigendum: Experiments with a varicap

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The editor welcomes letters, by e-mail to ped@iop.org or by post to Dirac House, Temple Back, Bristol BS1 6BE, UK.

Dividing vectors is not defined

Numerous physical quantities are vectors by nature. Although physics and engineering students encounter vectors in their linear algebra class, physics instructors often review vector algebra. Generally, students exposed to vectors in different classes feel that they know vector algebra very well. In the past several years, while teaching various physics classes at two different liberal art universities, I witnessed that a great majority of undergraduate physics and engineering students, who had vector algebra already, did not realize that dividing two vectors is not defined. Most of these students, however, are indeed well prepared to add and subtract vectors as well as to multiply two vectors using dot or cross product. In this letter I wish to point out and share with physics instructors the fact that students often fail to recognize certain mathematical operations that are not defined.

I asked undergraduate students majoring in physics or engineering several questions about vector operations. All of these students studied vectors both in algebra and in physics classes. The students were given the following questions about forces.

If $\vec{F}_1 = 10N\vec{i}$ and $\vec{F}_2 = 20N\vec{j}$ find the ration

$$\frac{\vec{F}_1}{\vec{F}_2}.$$

The most common answers are 1/2 and 0. For example, only one out of 14 students stated 'not possible'.

To ensure that students understood the question, which was expressed mathematically, a similar question has been asked in a different way: what type of physical quantity will be obtained as a result of division of vectors? Again, only one out of 14 students answered the second question correctly. Although most students knew basic operations with vectors, they did not realize that dividing vectors is not defined.

I have noticed in various classes that very few students have a good sense of what is defined and what is not defined in mathematics. It is important for physics students to know when and how to use mathematics because mathematics is the language of physics. It seems that students focus on solving problems and do not find the definitions important. This may be in part due to the fact that instructors generally focus on problem-solving skills and do not test students on definitions. Vectors are not the only example where students fail to recognize that operation or relation is not defined. Have you ever asked your students to compare two complex numbers? This is another example where many students will do what cannot be done.

Instructors may give definitions to students but students are expected to be aware of operations that are not defined. I believe that by learning definitions and theory students will have both the knowledge and confidence to recognize what is allowed or not allowed mathematically. I always challenge my students with definitions in addition to solving problems. The message that I am sending to my students is 'learn the definitions, do not make them up!'

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CORRIGENDUM

Experiments with a varicap

Yaakov Kraftmakher
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Figure 3 of this article should be replaced by the figure that appears below. In the top part of the original figure, a vertical connection between the voltmeter and the rest of the circuit was omitted.

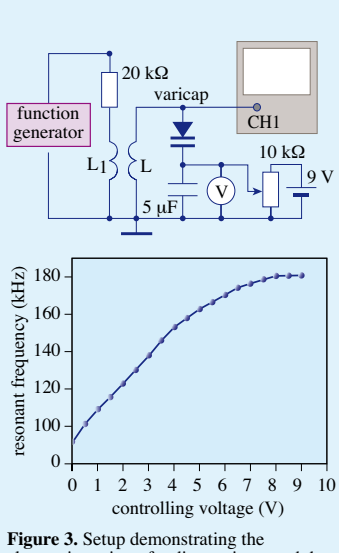

Figure 3. Setup demonstrating the electronic tuning of radio receivers and the resonant frequency versus controlling voltage.