

Interesting Aspects in Complement the Teaching Process of Physics

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Abstract – The forms and ways of transmitting knowledge in Physics, can vary from one teacher to another. Between a broad range of teaching methods, the teacher is in possession of qualitative scientific content. This is very helpful, in order to build a problematic situation. The situation should contain a structure that stands in unity and equilibrium during the teaching process. This type of structure should provide the students with the possibility of recognition, understanding and the analysis of the laws and the application of scientific knowledge. Since the above mentioned elements, are considered as the basis of each lecture, we are focusing on some of the details that best meet this basis. During this article, we will engage in interesting aspects of the use of the Excel program, (mainly the creation of calculating programs in it), in a one - hour Physics lecture for the students of the Information Technology branch. It is often the case, that students create some artificial barriers in their minds regarding the knowledge acquired from different subjects. Often, their thoughts create a contrast, between what they learn from a subject and the possibility of application of that knowledge to another subject. Regarding the subject of Physics, the aforementioned contrast cannot be more misleading. Physics is spreading its roots every day more, in other scientific fields of knowledge. It is supplying problems for solutions from different fields but at the same time, it's posing problems to be solved. In this article, in particular, a vector analysis of three charges operating on a fourth will be analyzed. In addition, the size (numeric value) will be calculated, along with the direction of the resultant force. By building the corresponding application in Excel, we will derive the results for both calculations. Such aspects, applied occasionally, have transformed the teaching of Physics into an interesting class time for the information technology students.

Keywords – Teaching, Calculating Application, Vector Size, Vector Direction.

I. INTRODUCTION

The education system in Albania has often changed the curricula in recent years. This definitely has consequences on how pupils and students are formed in terms of knowledge in different subjects. It is obvious that in these conditions and the desire of the pupils to study a particular subject sits. This raises the need of teachers to fill the program with the right scientific material but also to find interesting ways to teach the knowledge transfer.

II. METHODOLOGY

Beforehand we introduce the students to the theoretical aspects of Coulomb's Law. We give a short definition of the Coulomb's Law:

'The force of interaction between two stationary point charges is proportional to the magnitude of each of them and inversely proportional to the square of the distance between them'. (fig.1).

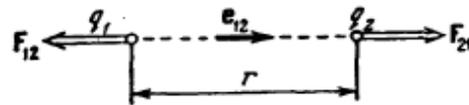


Fig. 1. The forces of interaction between two charges

Mathematically expressed by the formula:

$$\vec{F}_{12} = -k \frac{q_1 q_2}{r^2} \vec{e}_{12} \text{ and } \vec{F}_{21} = k \frac{q_1 q_2}{r^2} \vec{e}_{12}$$

where k it's a positive proportional constant, q_1 and q_2 the values of the interacting charges, the r distance between charges, the \vec{e}_{12} unit vector, orientated from q_1 to q_2 and the \vec{F}_{12} force operating on the q_1 charge (the case described in Fig. 1 corresponds to the charges with the same symbol) (I. V. Savelyev 1989).

The application of Coulomb's law in Excel

Let's analyze the case of three elementary point charges, operating on a fourth one (I. Prifti, A. Prifti 2001). The charges are supposed to be placed on a coordinated circuit like in Fig. 2. A group of cells are scaled to a 1:1 size, where the role of the X - Axis is played by the columns and the role of the Y - Axis is played by the rows. The charges are placed in four of these cells (fig.2).

Each of the charges is identified by a cell of distinct color from each other.

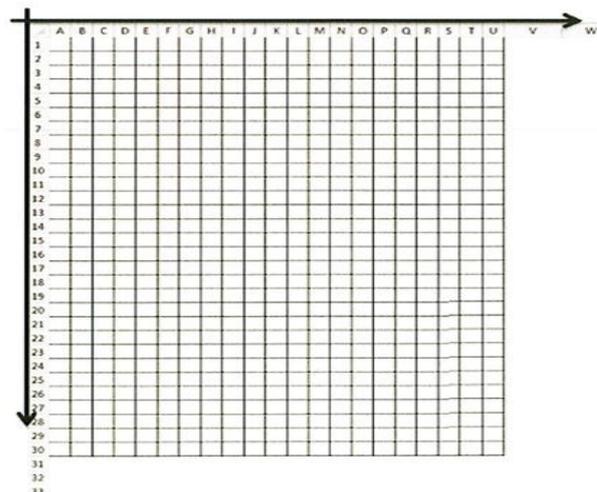


Fig. 2. A group of cells scaled to a 1:1 size

The test charge is signed with red color (fig. 3) and the corresponding cells of the charges are named respectively as q_0 , q_1 , q_2 and q_3 , with the help of the command 'Define Name'. Each of the charges receives its corresponding number, as follows: $q_0 = 12\mu\text{C}$, $q_1 = 12\mu\text{C}$, $q_2 = 12.5\mu\text{C}$ and $q_3 = 12.5\mu\text{C}$. Each of the charges in the respective cells will be displayed as a full number. In the worksheet, we place, collected in a table, every corresponding element (positive constant, charges, distance between charges, components according to the axis for each of the forces applied on the test charge), which will help us calculate the value and the direction of the resultant force. In the table below, we will list all the elements that will help us in the full calculation and definition of the resultant force:

Table 1. The list of the elements for finding resulting force

K
Charges
r
r ²
Force
F _x
F _y
SF _x
SF _y
SF
Angle of resultant force

Where **K** is defined in the 'scientific' format, with approximate value of $9 \cdot 10^9 \text{ Nm}^2/\text{C}^2$, as well as the corresponding charges.

r^2 –

The square value of the distance between the test charge and each of the respective charges.

Force –

It is calculated separately for each of the charges, where **F_x** and **F_y** are its respective components.

SF_x and **SF_y** are the symbols for defining the totals of the corresponding components for each force, which correspond with the two specific components of the full resultant force **SF**, that is applied on the test charge.

The Angle of the Resultant Force –

Is the angle formed between the calculated force and the horizontal direction.

Let's do a brief check on the calculation of these elements in Excel:

r^2 :

Because the charges are adjusted in a coordination circuit, mathematically, the square value of the distance between them will be calculated as follows:

$$r^2 = r_x^2 + r_y^2 = (x_0 - x_1)^2 + (y_0 - y_1)^2$$

In the worksheet's group of cells, designed as a coordinating circuit, the role of the X – Axis is played by the columns, while the role of the Y – Axis is played by the rows. For example, if the charge is positioned in G9, the coordinates will be (7; 9). The functions COLUMN () and ROW (), are used to define accordingly the x and y of each of the charges [3]. This way, the square distance value, between q_0 and q_1 is:

$$f(x) = (\text{ROW}(q_0) - \text{ROW}(q_1))^2 + (\text{COLUMN}(q_0) - \text{COLUMN}(q_1))^2$$

The same way is used to calculate the square distance value between q_0 and q_2 , as well as q_0 and q_3 . It is presented schematically on the figure 3.

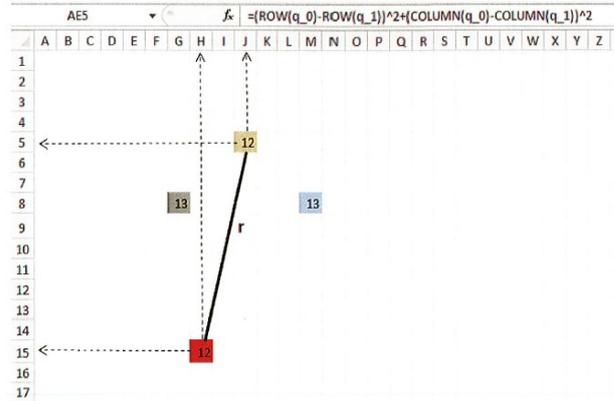


Fig. 3. Schematically illustrated the distance r

r :

Let use the SQRT() function, to calculate the distance between two charges. This way, we calculate the distance between q_0 and q_1 as follows: $f(x) = \text{SQRT}(\text{AE}7)$. In the same way, we calculate the other two cases.

Force:

We calculate the F_1 force (the force of q_1 applied on q_0): $f(x) = \text{AD}2 * \text{AD}4 * \text{AE}4 / \text{AE}7$, where AD2, AD4, AE4, AE7 are the corresponding addresses for the values of K, q_0 , q_1 and r^2 . The same logic is applied in the calculation of F_2 and F_3 .

F_x :

The F_1 component, according to the X – Axis, is calculated as follows: $f(x) = \text{AE}8 * (\text{COLUMN}(q_0) - \text{COLUMN}(q_1)) / \text{AE}6$

The same logic is applied to find the components of F_2 and F_3 , according to the X – Axis.

F_y :

The F_1 component according to the Y – Axis is calculated as follows: $f(x) = \text{AE}8 * (\text{ROW}(q_0) - \text{ROW}(q_1)) / \text{AE}6$

The same logic is applied to find the components of F_2 and F_3 , according to the Y – Axis.

SF_x and SF_y :

The components according to the X – Axis and Y – Axis of the resultant of forces applied on q_0 , are calculated: $f(x) = \text{SUM}(\text{AE}9: \text{AG}9)$ for SF_x and $f(x) = \text{SUM}(\text{AE}10: \text{AG}10)$ for SF_y .

SF :

The resultant force, with which the three charges are applied on q_0 , will be calculated: $f(x) = \text{SQRT}(\text{AD}12^2 + \text{AD}13^2)$, so, it results as the square root of the sum of the square roots of the specific components of the force, based upon two components.

The Angle of the Resultant Force:

This is the angle that the resultant force will form with the X – Axis (fig. 4). For easiness in defining the angle, we choose as origin of the axis the q_0 charge.

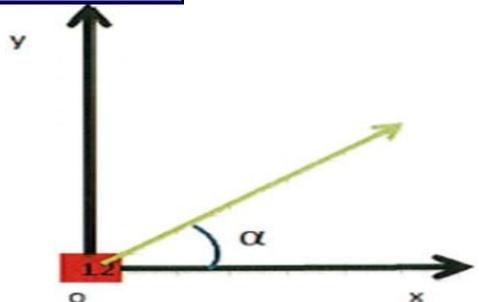


Fig. 4. An illustration of force resultant angle

The function we will refer to, in order to find the angle that SF forms with the X – Axis, is the arctangent with the correspondent Excel function ATAN2(). This function calculates the arctangent of a couple of x; y coordinates and turns it in a radian angle, between $-\pi/2$ and $\pi/2$. The angle is calculated with the formula: $f(x) = \text{ATAN2}(SF_x, SF_y)$. Because the angle calculated in this way is given in radian, to convert it to degrees we follow this logic:

The angle in degrees = The angle in radian *180/π

Then, the form of the function will be:

$$f(x) = \text{ATAN2}(SF_x, SF_y) * 180/\text{PI}()$$

In the case when the component $SF_y < 0$, the angle will result negative. To avoid this, we add the mass of a full angle, 360°. The form of the function calculating the angle, will be:

$$f(x) = \text{ATAN2}(SF_x, SF_y) * 180/\text{PI}() + 360.$$

This way, we reach to a logical condition, which is " $SF_y < 0$ ". Therefore, we use the IF() function, which puts to the test a defined condition and finally gives the result.

At this point of the problem solution process, the function has three split parts: the condition, the action applied if the condition is met and the action applied if the condition is not met. The three parts of the function are: $SF_y < 0$ (the condition), $\text{ATAN2}(SF_x, SF_y) * 180/\text{PI}() + 360$ (the action applied when the condition is met) and $\text{ATAN2}(SF_x, SF_y) * 180/\text{PI}()$ (the action applied if the condition is not met). Summarized, the function calculating the angle is:

$$f(x) = \text{IF}(AD13 < 0, \text{ATAN2}(AD12, AD13) * 180/\text{PI}() + 360, \text{ATAN2}(AD12, AD13) * 180/\text{PI}())$$

Where AD12 - address of SF_x and AD13 - address e SF_y . Below is shown the figure of all the elements calculated above:

AD19	AD	AE	AF	AG
K	9.00E+09			
Charges	q_0	q_1	q_2	q_3
	1.20E-05	1.20E-05	1.25E-05	1.25E-05
r ²		137	41	13
r		11.70	6.40	3.61
r ²		137	41	13
Forca	0.0094599	0.0329268	0.1018462	
Fx	-0.0032331	-0.0205469	0.0576015	
Fy	0.0088903	0.0257115	0.0864052	
SF _x	0.033801415			
SF _y	0.121807065			
SF	0.125639347			
Angle of resultant force	74.39			

Fig. 5. Calculation of the elements for the shown charges configuration

The Direction of the Resultant Force:

In order to find the direction of the resultant force that forms a specific angle, we use the font "Arrows Symbol Font", which is composed of 72 characters in the form of arrows. Meanwhile, the "set arrow" function makes it possible to convert the numbers from 1 to 73, in a specific character of this font. We turn the angle into a number from 1 to 73 (D. Birnbaum, M. Vine 2007), using the formula:

Set arrow = [(angle/5 + 0.5)] + 1, we get the full part of this number. This number will be converted to a specific symbol by the "set arrow" function, which will correspond to a character from the "Arrows Symbol Font". The function of finding the direction and the angle of the resultant force, is: $f(x) = \text{set arrow}(AD19)$.

III. RESULTS AND DISCUSSIONS

The results taken for different charge configurations, is provided in the figure 6.

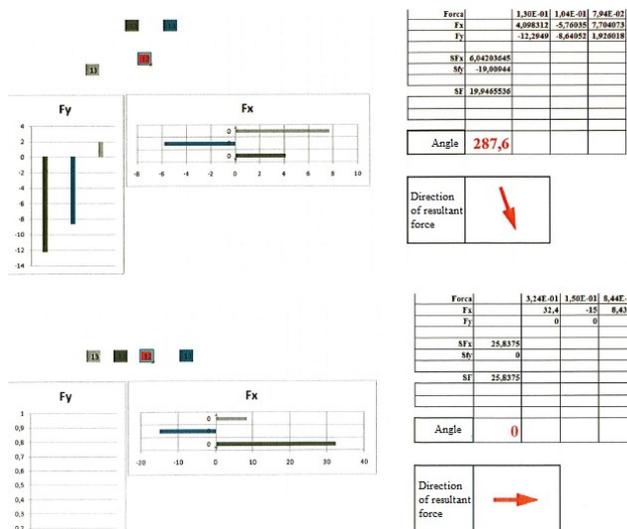


Fig. 6. Results for different configurations of charges

There, all the calculations explained in the methodology are done automatically and in a short time, the needed result is given. It is noticed that the resultant force, is the vectorial sum of the forces applied on the test charge from the other charges. Also, it's pretty clear that, when all the charges are positioned in a straight line (according to the ox axis), the angle formed by ox axis and the resultant force is 0. Thus, as a vector, it is positioned with the direction based on the ox axis.

During this problem, there was a broad choice for participation among students, with their raised interest wakened, especially after discussing this aspect of the problem. The majority of the students tried to solve the problem on a scientific point of view and later on had the chance to derive a multitude of results, using Excel. Certainly, this does not take the majority of class time, regarding the subject of Physics in our school. But, interesting studies of this type raise the interest of the students for the subject of Physics, which regard it as just another additional subject, not as the fundamentals of

scientific knowledge, which can develop long term skills in the learning process.

Physics is a very good example of learning a complex subject and this helps students, to acquire an adaptable expertise with a wide professional range (E. Redish, E. Sayre 2009). The benefits of Physics include a practical approach to problem solving, clear justification ability, and clearly communication of complex idea (E. Redish 2003).

Teaching methods keeping central focus on the student, are more and more popular on college levels (M. Cavanagh 2011, L. D. Fink 2003). These methods should be an indivisible part of teaching.

IV. CONCLUSIONS

- Linking bridges of the knowledge acquired from the students. Thus, they prove with examples that, there are no insurmountable “walls” between sciences, showing their interconnected work for the solution of different problems.

- The interest shown for understanding the essence of a physics problem increased.

- The use of technology urged the full active engagement of the students during classwork.

- The students could predict by themselves, the results of singular cases of charges configuration. This shows a deepening of the understanding of a problem.

- With the high use of technology in every life aspect, results as a necessity the proper use of it during the teaching process.

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AUTHOR'S PROFILES



Lorena Kelo. Was born in 1987 in Korca, Albania. She finished her bachelor studies in Physics in 2008 and her master degree in 2010 at Faculty of Natural Science in Tirana University, Albania. She started to work as assistant professor in Korca University since 2011. The main area of her PhD studies is the methodology in

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Sotirag Marko. Was born in 1961 in Korca, Albania. He has finished his studies for Physics in 1984, in Faculty of Natural Science, Tirana, Albania. In 1985 he started to work as a physics teacher. After 25 years experience in teaching in 2010 he started to work as lecturer at University of Korca. His experience is an inspiration for the new generation. As a good connoisseur of methodology in education, over the years he has given his contribution with many articles published in journals and newsletters in different countries. Mr. Marko is working to implement a project for training new teachers in the field of teaching methodology.



Esmeralda Guliqani. Was born in Korca, Albania in 1991. She finished the first level of study, Bachelor's Degree in Mathematics-Physics, in Korca, Albania in 2012 then she finished her Master's degree in University of Tirana, Faculty of Natural Science, Departamet of Physics with the theme “Photonic crystals: a unique partnership between light and matter” From 2014 she works as an assistant professor in Korca University. Ms. Guliqani is working also for having an unic curricula in albanian education.