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LEARNING PHYSICS WITH WOLFRAM ALPHA

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Abstract

We believe we are at the beginning of a new Big Bang. This great explosion places us at the dawn of a new era in learning Physics, and we would like to participate in this fascinating process. Mobile devices are exponentially growing amongst our students, so we are convinced that they must be used to promote active learning.

In this work, we will focus on several apps from Wolfram Research Company: Wolfram Alpha, Wolfram Alpha Viewer, Physics I and Physics II. All of them have many possibilities to achieve an autonomous and active learning. These apps allow users to select different options from a specific menu, enter values of the required parameters and the app calculates by itself the magnitude involved in the process. In addition, these apps also allow us to study the major laws of Physics, to look for the different units of the International System of Units or even to manage the most common physical constants.

We are convinced that there is a necessity of developing more applications for smartphones that will empower a meaningful learning of Physics using apps for the operating systems iOS, Android, Windows Phone and those that arise in the future. This opportunity, which is provided to us by the new technologies, cannot be unexploited. We must strongly engage into this topic to achieve a meaningful learning.

Keywords: Active Learning, University Teaching, Mobile Devices.

1 INTRODUCTION

Smartphones are powerful mobile devices that are occupying a very important role in our lives. If we focus on the learning processes, a smartphone can do practically everything you can do in a desktop computer or notebook or laptop. It also has the great advantage that it is easy to use, access and the immediacy with which you can get the desired information

Firstly, one of the main differences with computers is that you do not need to be permanently connected to a fixed computer; we can use the applications on any site anywhere. Secondly, a smartphone is, above all, a phone, and since you can also connect to the Internet via 3G, 4G or Wi-Fi, it is possible that at any time we can access to lots of information. In a Smartphone, you can use applications that have previously been installed, practically from any place like in a computer, but it has the advantage that being a phone it can connect to the Internet via 3G, 4G or Wi-Fi and thus use resources online or download information. On the other hand, more and more, a great part of the power of the computer does not reside in it; it is on the web, on the remote servers, in a cloud. All of these factors suggest that smartphones could have the potential to be an alternative in the learning process. Recognizing that the potential of the computer is increased strongly by the resources available on the remote servers, that is, in the cloud. These factors position smartphones as a low cost tool that can contribute to the learning of science.

There is a need for good Physics teachers, with teaching experience and with teaching resources to get involved in this process of creating apps for Physics together with a multi-disciplinary team that has computer technicians, graphic designers, teachers, school counsellors and, of course, physics. This work needs to be developed quickly, because the technological evolution is unstoppable, and it can be a tsunami that will end up knocking us down.

2 WOLFRAM ALPHA: THE APPLICATION

In this work we will comment on what we believe are of the best existing applications for mobile devices in the field of physics. The standard application of Wolfram Alpha for Android [1-5] is priced at €2.27, and €2.69 for iOS. In return, we have access to all the same functions that Wolfram Alpha has on the web. As our purpose is to talk about what Wolfram Alpha can offer us with regards to physics, we will start with a brief index of its contents:

- Solve equations of linear and rotational kinematics.
- Calculate the forces of gravity and friction.
- Calculate the motion of rockets, pendulums and collisions.
- Perform calculations with mass, weight, density, energy, work and power.
- Conversions of units.
- Search the laws of Physics and the common physical constants.
- Calculate properties of solids, including tension, pressure, strain, and more.
- Calculate the properties of fluids, including buoyancy, hydrostatics, and more.
- Solve a variety of calculations of Electricity and Magnetism.
- Perform calculations of X-ray optics, including Snell's law, the equation of the construction of lenses, the thin lens equation, and more.
- Calculate the effects that characterize waves, including the properties of diffraction and interference in a thin film.
- Common Thermodynamics calculations, including the law of ideal gases, the first law of Joule, and more.

Next, we will see concrete examples of how to use this computer search engine for Physics. Above all, we will focus on mobile applications specifically available for iOS and Android [6-8] for this purpose, which we will see in detail later, called Physics I and Physics II, without leaving aside the standard version of Wolfram Alpha.

It is necessary to bear in mind that, in reality, the application itself from Wolfram Alpha does not do anything by itself; actually, it shows us the results that are calculated on the servers of Wolfram Research with the relevant algorithms in each case. The application is simply an adapted viewer, i.e. an interface adapted especially to our smartphones, which is limited to the collection of results calculated on their servers and displaying them on screen [9]. As it is evident, the application needs to use an Internet connection to operate and be able to show the results that we are asking for at every moment. You must also consider the case that a mobile application installed on a smartphone gives us many more options when it comes to interact with other applications, which are also installed on that device. We will address briefly the subject further when we talk about Wolfram Alpha Viewer.

3 OBTAINING PHYSICAL CONSTANTS AND LAWS

We can consult the value of any physical constant that we want by typing its name in Wolfram Alpha. It also shows us that value in different units; it gives the corresponding differential equation, if it has it, and any additional information that may be of our interest. On the other hand, if we want to obtain information about a certain physical law, we only have to write its name in Wolfram Alpha to obtain an excellent collection of data about it.

Wolfram Alpha, as a calculation engine, is also capable of putting into practice laws of physics such as the Ohm's law, the Joule law and third law of Kepler, etc. For that, we just have to type the name of the particular law followed by the values that we have for the different variables.

If we want to calculate the mechanical work done by a constant force on an object, we can also do it with Wolfram Alpha. We just have to put the word work, followed by the force and distance data that we agreed upon in each case.

4 INFORMATION ABOUT ELEMENTARY PARTICLES AND THE UNIVERSE

If we are interested in general information about a physical particle, like its mass, its electric charge, its possible flavours, its structure of quarks, its quantum numbers: spin, isospin, strangeness and hypercharge we can obtain it by only putting the name of the particle which we refer to. If we want to compare the masses of the two particles together, as the proton mass compared to the electron, we only have to write "mass proton/electron" and get 1836.153, besides obtaining the rest mass of the proton and the electron in MeV/c^2 and keV/c^2 , respectively, making use of the well-known Einstein's equation that relates mass and energy with the velocity of light.

We can also obtain information about the cosmological properties of our universe. If we type, "expansion of the universe" we obtain the estimated age of our universe (about 13800 million years), the redshift, the current temperature, the Hubble constant and the timeline of the universe.

With Wolfram Alpha we can also obtain the Earth's magnetic field in New York City, make a dimensional analysis of force, mass and acceleration, make a partial derivative, with respect to the variable x for example, which may be used to calculate the quadratic error average of a physical quantity measured indirectly.

5 WOLFRAM ALPHA VIEWER

If we are users of Apple's mobile operating system, iOS, there is another version of Wolfram Alpha, the so-called Wolfram Alpha Viewer. This variant of the application Wolfram Alpha standard, which we have seen in previous sections, is a free version that has some of the features of the full application. However, we want to point out that it is not the full version; therefore, it does not have all the features. If we want to carry out all kinds of consultations without any restrictions, we will have to buy the full, paid version, which is what we have described before. What is offered to us then by the Wolfram Alpha Viewer? Amongst other things, this application offers us the possibility of testing the application of Wolfram Alpha without having to make any expenditure. Once we are sure that Wolfram Alpha is what we really need, the most advisable thing to do would be to buy the full version in order to be able to use Wolfram Alpha without any restrictions.

Wolfram Alpha Viewer allows you to handle Wolfram Alpha from Siri [10-12], i.e., we can give the orders speaking directly to the smartphone. The Siri application, integrated into the iPhone and iPad, translates our words into an understandable language for the smartphone. The Siri Assistant from Apple is the only way to enter searches with this specific application. With the conjunction of these two applications, you can do the following things:

- Open a detailed view of your results directly from Siri.
- Give a hint on the displayed results to show additional details.
- Change the values by defect that Wolfram Alpha takes in your searches to obtain different results. For example, you may want to consult information about the company Mars instead of on the planet Mars.
- Expand your results using longer calculation times.
- Access your results-related queries. For example, a search on Mount Everest may suggest a query related to other mountains of the Himalayas.
- Browse thousands of examples of different fields, including science, culture, Linguistics, nutrition, health, finance, etc.

6 OTHER APPLICATIONS FROM WOLFRAM RESEARCH: PHYSICS I Y II

Wolfram Research has also developed other specific applications for Physics: we talk about Physics I and Physics II [13-15]. These applications use the same computer search engine that is used by Wolfram Alpha, but unlike this, since we want to be especially centred in the field of physics, we will be guided through the various functions that Physics I and II have available with respect to this scientific field, in particular. These two applications are now free.

Physics I is an app of Wolfram Research specific to the mechanic field. When you open this application, instead of finding the typical interface of a search engine, what appears is kind of a menu with sections of different parts of the mechanic field. Since it is stated in the application itself, we are

before an assistant that enables us to develop the course (course assistant). Unlike the standard application of Wolfram Alpha and its web version, this application of Wolfram Research will always, or almost always, make our calculations by using physical quantities in the International System of Units. Something we consider a true success, since the inconsistency and the use of measures of the Anglo-Saxon system by default in some specific functions of the Wolfram Alpha and Wolfram Alpha Mobile app on the web sometimes become an insurmountable nitpicking to the ones that are accustomed to the International System of Units since more than 50 years ago.

Physics I can be used to calculate the acceleration of a body from its initial speed, the distance and the time elapsed, in a rectilinear motion. The Kepler's laws can be consulted. Specifically, within the section of the application dedicated to Dynamics, choosing the option of Collisions we can calculate the end speeds of two bodies after a completely elastic or totally inelastic collision. We can also calculate gravitational forces, friction forces and work with springs. It allows obtaining trajectories of rockets, pendulums and many more options.

Physics II is an app of Wolfram Research specific to other parts of Physics different from mechanics. The functioning and the structure of the application Physics II are similar to those that we have already commented for Physics I. Using Physics II we can calculate the equivalent resistance of a circuit in which there are two resistors in parallel, one of $7.00\ \Omega$ and another of $15.0\ \Omega$, obtaining a value of $4.77\ \Omega$. If we want to calculate the speed of a proton moving under the action of a magnetic field of $0.500\ \text{T}$ and describing an orbit of $2.00\ \text{m}$ radius, we obtain $95800\ \text{km/s}$. As application of the Snell's law, we can calculate the angle of refraction of a wave when you change from one medium to another of different refractive index. These are just three examples of what you can do with the app Physics II.

7 CONCLUSIONS

The focus of the attention of teachers and researchers is cranking up for the so-called smartphones due to their proliferation. Its calculating potency and, until recently, incredible graphic possibilities make it tremendously attractive to be actors in the teaching-learning process in an active manner. Smartphones allow new forms of learning, so we believe that they are tools strong enough to be considered as a possible alternative or complement to current classes.

We strongly believe in the need to develop more applications for mobile phones that allow enhancing meaningful learning of Physics using apps for the operating systems like iOS, Android, Windows Phone and those that arise in the future.

We have commented on various applications of the Wolfram Research Company: Wolfram Alpha, Wolfram Alpha Viewer, Physics I and Physics II. These apps offer numerous possibilities for a fully active and autonomous learning. They allow us to select different options from a specific menu, enter the values of quantities that are involved and the app calculates us another magnitude in the process.

As a complement to the textbooks that are most widely used, it allows studying the major laws of physics, consult the different Units of the International System and handle the most common physical constants.

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