Mechanics: Oscillations

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Abstract. *The application is fully interactive, allowing the student to study in a playful way. The visual support allows a better understanding of the phenomena, transforming hours of explanations in just a few minutes.*

The animations and the possibility to review them allow the student to provide optimum feedback to the teacher.

Therefore, the teacher has a useful instrument, which completes the classical teaching methods. The virtual experiments not only allow a better description of the phenomena, but also allows the modification of the parameters on which the oscilatory motion.

Keywords. Educational process, IT, innovation, interactivity

1. Introduction

"Mechanics: Oscillations" is an educational software designed for students studying this mechanics phenomenon, which draws a parallel with other mechanics, optics and heat phenomena.

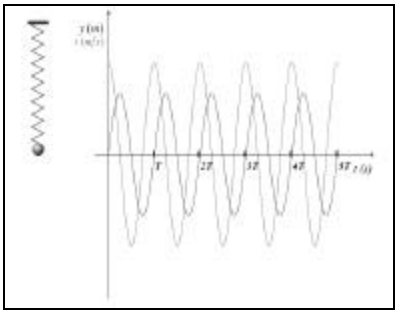

Figure 1. The oscillator and the real-time graphs of the elongation and velocity

The software comprises information on: oscillatory motion, harmonic oscillatory motion - Fig.1.1 (including phasor diagrams Fig.1.8), energy of an ideal harmonic oscillator - Fig.1.6, superposition of parallel oscillations, of the same frequency (including phasor diagrams - Fig.1.9), superposition of parallel oscillations, of different frequencies - Fig. 1.2 - (including phasor diagrams), superposition of perpendicular oscillations (including the representation of Lissajous graphs – Fig. 1.5), 9 examples of oscillatory motions chosen from all the fields of physics (mechanics, optics and heat phenomena – Fig. 1.3).

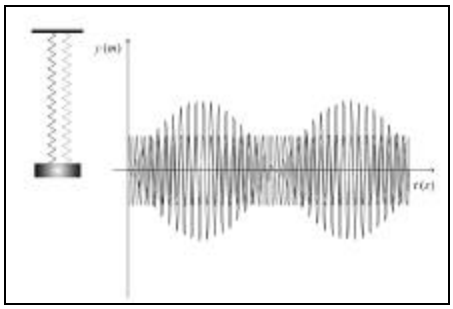

Figure 2. The superposition of two parallel oscillations – the phenomenon of beating

The nine examples of oscillatory motions broaden the horizon of the student, showing a multitude of oscillatory motions in all the fields of physics. They include: the Thomson model of an atom; a tunnel through the centre of the Earth; the elastic, mathematical and physical pendulum; a mercury bubble in the middle of a tube; a plank laid over two rotating cylinders, and others.

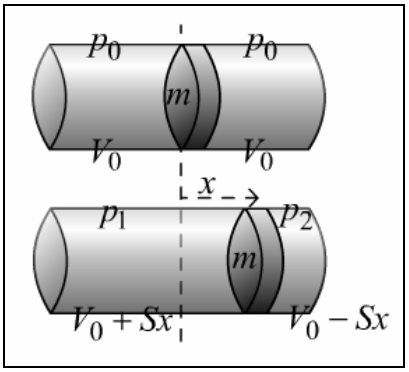

Figure 3. An example of oscillatory movement – a bubble of mercury inside a tube

2. Key advantages

The software is entirely interactive and the study of mechanical oscillations becomes 'a child's play'. The visual support provides a quick understanding of the phenomenon, compressing hours of explanations into several minutes.

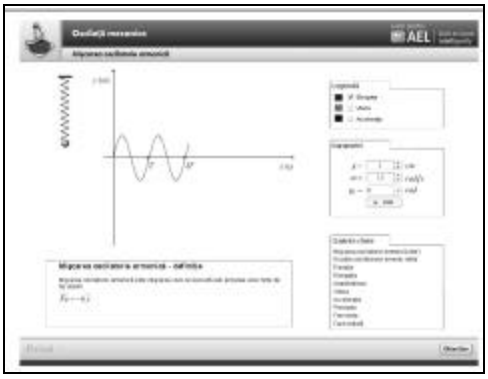

Figure 4. The main interface

Its main advantages are as follows:

The content is well structured into teaching units, giving the teacher the liberty to devise a lesson that is suited to the level of the classroom.

The theory of each teaching unit is structured into keywords, providing a clear and thorough educational support.

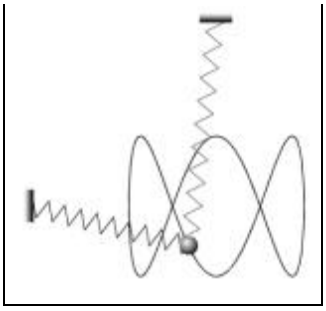

Figure 5. The composition of two perpendicular oscillations – a Lissajous curve

Each teaching unit includes complex simulations and experiments and animated representations (clear illustration of the dependence between physical dimensions, phasor diagrams, the ability to customize the graphs by modifying the parameters – directly or by selecting some properties which characterize the parameters).

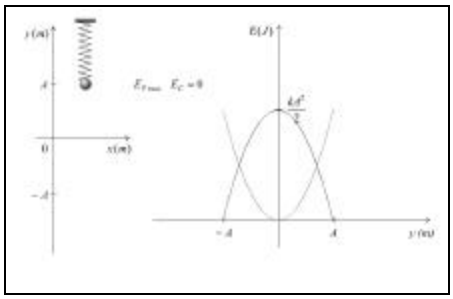

Figure 6. The oscillator and the real-time graph of the kinetic and potential energy

3. Simulations and Experiments

A simulation includes the actual oscillator which accurately moves by the parameters specified by the student. Beside the oscillator there is a real-time graph illustrating the physical dimensions which characterize the motion. The simulation can be paused at any moment, showing the exact state of the system for a better understanding of the relation between physical dimensions.

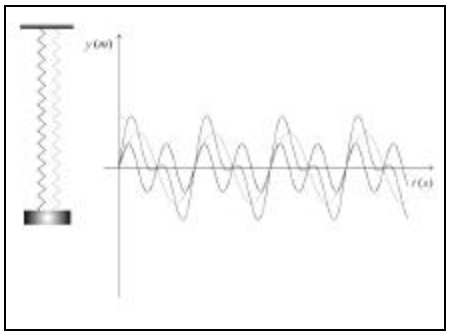

Figure 7. The composition of two parallel oscillations, of different frequencies and the real-time graph of the elongation, the velocity, and the acceleration

The student can easily correlate between physical dimensions, having the liberty to compose his own representation (by choosing which physical dimensions are to be displayed and by modifying the parameters of the oscillatory motion). He can also correlate between the values of the parameters and the resulting oscillatory motion (the influence of the initial phase on the initial state of the system, the difference between the initial phases of the two oscillators, the proportion between the pulsations of the two oscillators, the differentiation between amplitude and elongation).

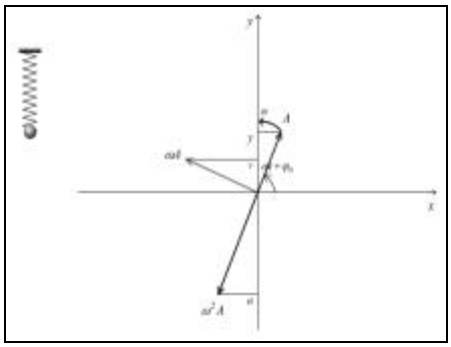

Figure 8. The oscillator and the real-time phasorial graph of the elongation, the velocity, and the acceleration

4. Evaluation

Unlike the classical method of evaluation, this software includes a different test: an example of an oscillatory motion which fully involves the student in finding the equations which characterize the movement. In case the student has difficulties, the solution is gradually revealed in the following steps: 1. multiple choice single answer question; 2. simulation of the oscillation; 3. illustration of the forces which act on the system; 4. complete solution structured on keywords.

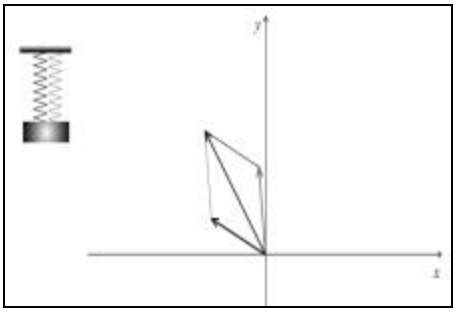

Figure 9. The composition of two parallel oscillations – phasorial representation

5. Accessibility and Compatibility

Another advantage is accessibility: a unified, clear and airy interface, in which the stress is on the simulations. It is divided in windows which logically group the content and the functions of the software. All the buttons, links and explanations are intuitive and easy to understand, and the texts are clear and easy to read.

The software is developed in Macromedia Flash MX 2004, therefore this Flash animation can be run in any browser, with a full compatibility with the software or hardware configuration.

6. References

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