1. Introduction

1.1. Contents

The following learning material is an advancement from a former package, which was based on the simulation program xyZET. This program allowed in a three-dimensional representation to animate particles under the influence of various forces (elastic, electric, magnetic, gravitational, contact).

The program xyZET was written in C under UNIX and therefore needed an x-server to run under Windows. To avoid this obstacle for wider distribution and to become platform independent a reduced version of xyZET has been re-written in Java. and is called JavaXYZ (Programmer: Sasa Divjak). JavaXYZ has the form of a workbench and offers the possibility to develop simulations of a broad variety without any knowledge in programming. Only mouse controls and a knowledge about the interface are necessary.

In addition to the prepared simulations and corresponding text a series of computer animated videos have been developed to reduce the gap between a real experiment and the corresponding simulation.

From the traditional curriculum those topics were selected where interactive simulations can play a supportive role for motivation and understanding. For more theoretical topics the students have to refer to the corresponding textbooks.

List of selected topics

Velocity and Acceleration, Force, Falling Objects, Collision, Circulating Objects, Oscillating motion.

1.2. Treatment of Mathematical Aspects for Teaching Physics

The material presented here is based on an alternative approach in comparison to traditional teaching. A main aspect of this new approach is the attempt to avoid relying on mathematical knowledge as a prerequisite for understanding physical concepts. Instead, interactive simulations in combination with animated computer graphics are used to promote the integration of mathematics and physics.

Following this principle, mathematical equations are not derived from theory when introduced but directly presented. By comparing these mathematical expressions with the results presented by the simulation the students shall get acquainted with these results.

1.3. Integration of Simulation and Experiment

When using the materials presented here, it is taken for granted that real experiments are demonstrated and carried out in class whenever feasible. It is a rather trivial fact that a simulation cannot prove anything but needs the proof and support of the real experiment. The teacher has to point out this fact to ensure that students do not stick to any naive and non-reflected opinions about the value and significance of simulations compared to actual experiments.

1.4. Measurements and Units

When measurement are taken while real experiment are performed, it is vitally necessary to note the actual value as well as the used units.

When using a simulation with output in numerical form, the choice of the units is generally free. For the program JavaXYZ for instance, the defined unit for distance corresponds to

something like 1/10 mm, depending on the available solution of the monitor. This unit can represent any distance in real life. The same is true for other numerical values of time, mass, charge etc.

Before using such numerical values presented by a simulation, an agreement has to be found concerning the units to be used. It is advised that the user chooses the common basic units like m, sec, kg, and the derived units like N or m/s, in compliance with the system of units used by the scientific community.

1.5. Media

Videos

The inserted Videos are either pure computer animations or a combination of real experiments and computer animations.

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