Software Resources for Remedial Physics Teaching in UK University Chemistry Departments

Summary

There is a substantial minority of students who do not have the necessary physics background to tackle parts of most first year physical chemistry courses and for whom some kind of remedial action is required.

Software tools have been developed to address the problem with priority being assigned to topics most frequently occurring in the curricula. After discussion with colleagues, the topic of 'Particles and Waves in Chemistry' was selected. The tools consist of simulations (and high quality diagrams with relevant animations) designed to accompany tutorials or workshops. They are not 'stand-alone' programs and assume that the teacher has covered the basic groundwork. In this way, the material does not impose any learning style and should be treated as a simple resource similar to an illustration or photograph. Substantial numbers of numerical problems (in practice, an infinite number) are included for use as reinforcement learning tools – a technique that has been shown to be extremely effective in tackling specific numerical shortcomings.

Given that the overwhelming majority of the targeted students have chosen to avoid physics, great care has been taken to ensure that the context enclosing the materials is identifiable as chemistry only.

Subject area: Chemistry

Description

Software tools have been developed to help chemistry students with elementary problems in physics. These consist of simulations (and high quality diagrams with relevant animations) designed to accompany tutorials or workshops. They are not 'stand-alone' programs and assume that the teacher has covered the basic groundwork. Substantial numbers of numerical problems are included for use as reinforcement learning materials.

Type of activity

Simulation. Numerical practice.

Content covered

- 1. Electromagnetic waves.
- 2. Wavelength and frequency.
- 3. The electromagnetic spectrum.
- 4. Radiation energy.
- 5. Atomic spectroscopy.
- 6. The hydrogen atom spectrum.
- 7. Interference.
- 8. Diffraction.
- 9. De Broglie wavelength.
- 10. The photoelectric effect.

Application

The tools have been designed to accompany tutorials or workshops together with a large number of numerical problems suitable for self-study. In addition the teacher may,

- a. Specify the precision required.
- b. Determine whether or not to insist on the correct precision being used.
- c. Allow the students to control their own precision.
- d. Determine the type of answer checking employed,
 - 1. Level 1 answer checking responds by quoting the correct answer.
 - 2. Level 2 answer checking responds with the accuracy exact, within 1%, within 5% and above 5%.

Level 3 is more complex and gives a student three attempts at getting the answer right by responding with the accuracy figures used in level 2. Exact answers and those within 1% are regarded as correct, whilst beyond 5% the student must try again. When level 3 checking is operative then the program keeps a record of student progress.

e. Completely replace the text with his/her own version.

Further comments



Figure 1 An animation illustrating the generation of atomic spectra by electronic excitation

New Directions in the Teaching of Physical Sciences

e Photoelectric effect	
Incoming tablation Ejectred effectives 45 eV 025 eV 7215:19 J 4016:30 J 11996:15 Hz 23/E-5 m/l	The incoming radiation consists of a beam of particles, each of which has an energy hr. The photoelectric effect occurs when a quantum of energy hr is given to an individual electron, which may then have sufficient energy to escape the metal surface. The energy required to do this is called the 'work function' Φ of the metal. If hv is greater than Φ , the energy difference appears as kinetic energy of the electrons. $hv = \Phi + y_{3}nv^2$ The electrons may be stopped by applying an electric field E, $eE = y_{3}^{2}mv^2$
Set initial Stop	In an experiment to demonstrate the photoelectric effect, a metal surface made of aluminium (week function 4.00 eV) was irradiated with light of wavelength 191 nm.
Click on 'begin' to observe the effect of gradually increasing the photon energy. Notice that no photoemission occurs until the radiation frequency reaches a 'threshold' value corresponding to the work function of the metal. The more this value is exceeded, the grater the energy and hence the velocity, of the emitted electrons. You may start from a higher initial value to reduce the time before this happens.	Calculate the velocity of the emitted electrons (in m s ⁺). Answer Manual Answer Manual Answer Answer Answer Calculator Menu Question Picture

Figure 2 A simulation of the photoelectric effect illustrating the 'threshold energy'. A typical numeric problem has been requested.

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http://www.physsci.ltsn.ac.uk/devprojs/reports/phys_soft_res.htm Development project: Software Resources for Remedial Physics Teaching in UK University Chemistry Departments

http://www.physsci.ltsn.ac.uk/devprojs/Gcsephys.htm Briefing paper: The Physics Problem

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