

## TRAINING AND EVALUATION SOFTWARE FOR RADIOISOTOPES VIA WEB

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**Abstract:** An original client-server interface to use for interactive students work with computer was build. The program serves for detailed understanding of radioactive disintegration, fission, and fusion, as well as corrects writing of nuclear reactions. A PHP program has been done to verify veracity of some equations of nuclear reactions, general questions about radioisotopes, as well as the observation of some reactions that are animated, and this is available through web at the address:

[http://vl.academicdirect.ro/molecular\\_dynamics/radio\\_isotopes](http://vl.academicdirect.ro/molecular_dynamics/radio_isotopes)

**Keywords:** radioisotopes, client-server application, e-learning

### 1. INTRODUCTION

The isotopic marked compounds induce an activity sphere that offers many synthetic and applicative possibilities. The marked compounds have numerous applications, the principal direction of their use at this moment being the syntheses reagents, biosynthetic substrates, the establishment of metabolic schemes, the study of adsorption phenomenon, in vivo and in vitro clinical tracers diagnosis, toxicological and pharmacological studies, as well as establishment of mechanism reactions [1].

From the discovery of radioactivity until now there were discovered more than 1200 radio nucleuses [2, 3]. *The radioactivity* is defined as the property of nucleuses (of some nuclides) to emit spontaneously  $\alpha$ ,  $\beta^\pm$  particles or to suffer an electronic capture and  $\gamma$  disintegration [4].

Heavy charged particles can suffer three types of interactions [5]:

- Collision with atomic electrons (the most important); in these collisions the  $\alpha$  radiation lose its energy in proportion of more than 98% and the effects of collision are excitation (detectors used in study of  $\alpha$  radiations: ZnS), ionization (complete removal of electrons from atoms or molecules, originating positive and negative ions) and dissociation;
- Braking in electric field of nucleus (reemission of  $\gamma$  and X radiations);
- Nuclear reactions, that is taking place with a very low probability, of approximately  $10^{-3}$  %.

## 2. THEORETICAL DEVELOPMENT

In the field of educational applications, some questions require an answer: We want a server-based application or client based application? For a server-based application, we want a server side application or a client side application?

As example, a client side application can have disadvantage of execution on client, and dependence of processing speed by calculation power of client machine. If we prefer this variant, a java script or visual basic script is proper to use.

A server side application requires a web server installed. The area of web servers is also a large set, but few have multiplatform capability. If we want a full-featured web server, Apache is our solution.

Under Apache, we have the possibility to execute programs already compiled in C, Fortran and Java, under Unix machines we can directly execute Perl programs, and, most important, under all operating system platforms we can execute PHP programs if we previously install PHP language and module binaries.

The advantage of PHP programs consist in his portability under most of operating system platforms and internal compilation feature that do not necessity the compilation "by hand" from the user.

PHP programs are puts on a web server into a data folder and executed by them using PHP module (mod\_phpX, X=3,4). The output of the PHP program is in HTML style and can be viewed by any web client (Microsoft Internet Explorer, Mozilla, Opera, Netscape, Konkueror). [6]

For *See reactions* link, we create a simple PHP script, to display the pictures on client web page:

```
<?
echo("<table border=1 width='700'>");
for($i=0;$i<9;$i++){
  echo("<tr>");
  for($j=1;$j<4;$j++){
    echo("<td><BR><nobr><img src='".($i*3+$j)."'.gif' width='100%'></nobr><BR><BR>");
  }
  echo("</td>");
}
echo("</table>");
?>
```

and the pictures are created as animated gif ones.

For the *See animation* link the main part is a HTML one:

```
<bgsound name='sound' id='sound' src='sound.wav' LOOP=0 LOOPDELAY=400>
<img src='movies.jpg' name='film' id='film' HEIGHT=450 WIDTH=480 BORDER=0 DYNSSRC=""
START = mouseover CONTROLS LOOP=2 LOOPDELAY=200
onmouseout=document.all.sound.src='sound.wav';
document.all.sound.loop="5";this.src='pwrschematic.jpg">
</center><BR>
<select name='lista' onchange='document.all.film.dynsrc=this.value;' class='lori'>
<option value=''>Select..
<option value='CameraBule.avi'>Cloud
<option value='ChainReaction1.avi'>Chain Reaction 1
<option value='ChainReaction2.avi'>Chain Reaction 2
<option value='Fission1.avi'>Fission 1
<option value='Fission2.avi'>Fission 2
<option value='Fussion.avi'>Fussion
</select>
```

For the evaluation part (two test), every test has two scripts, one for submission of selected answers, and one for evaluation.

The test.php program it contain a form:

```
<form method='post' action='answer.php'>
...
<input type='radio' name='q1' value='A'><sup>238</sup><sub>92</sub>U
...
<input type='submit'>
</form>
```

The *answer.php* program displays the correct answers and evaluates the answers:

```
<?
$total=0;
?>
<h1>Results</h1>
<BR>
1) Radon has the shortest half-life (3.8 days), and therefore will have the highest activity - by a long shot!
<BR>
<?
if($_POST['q1']=='D') {
    echo("1 pt.<BR>");
    $total++;
} else echo("0 pt.<BR>");
?>
...
<h2>
Total score:
<?
echo(sprintf("%5.2f",1+3*$total/2));
?>
</h2>
```

The *Test 2* link goes to a HTML page, which contain the second evaluation test. The source can be seen with View Source option of the browser.

The *rasp.php* program collect answers from lista.htm and compute the evaluation score:

```
<?
$rez=0;
if($_POST['e1m']=='7) $rez+=1;
...
echo("<h1>Solution: ");
echo(sprintf("%5.2f", (1+$rez/3.22)));
echo("</h1>");
?>
```

### 3. METHOD

The physical model is our model:

- *a Disintegration*  ${}^A_ZX \rightarrow {}^{A-4}_{Z-2}Y + {}^4_2\text{He}$

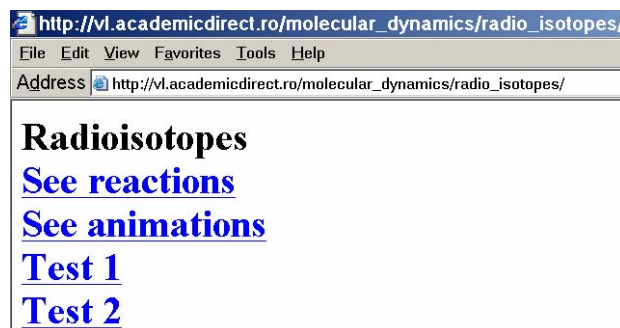
- $\beta$  *Disintegration* (is the result of some reciprocal transformations of nucleons inside nucleuses; two  $\beta$  disintegration are possible):
  - $\beta^-$  - Disintegration:  ${}^A_Z X \rightarrow {}^A_{Z+1} Y + \beta^-$
  - $\beta^+$  - Disintegration:  ${}^A_Z X \rightarrow {}^A_{Z-1} Y + \beta^+$
- *Electronic capture* (the processes of electronic capture consist in absorption of one electron from internal layer (K) in nucleus which contain excess of protons and the transformation of these in neutrons, with emission of one neutrino):
 
$${}^A_Z X + e^- \rightarrow {}^A_{Z-1} Y^* \rightarrow {}^A_{Z-1} Y$$
- *Emission of  $\gamma$  radiation* ( $\gamma$  Radiation is the result of passing of one nucleus, from an excited state to one inferior energetically): the  $\gamma$  emission follows the processes of  $\alpha$  and  $\beta$  disintegration or can appear in nuclear reactions and is as a result, the daughter nucleus is find in an excited state; the  $\gamma$  emission does not modify the mass number or atomic number Z, it being a radiation of denigration
- *Inner conversion (CI)*: A nucleus present in excited state can eliminate the energetic excess through transfer of one electron from internal layers, this being expelled from atom; the resulted electrons are monoenergetically, possessing the energy of nuclear denigration transition minus bond energy
- *Isomeric transition (TI)*: Isomeric transition represents a process of denigration of one nucleus through  $\gamma$  emissive or CI; the difference toward the both previous processes consists only in lifetime of excited state

#### 4. RESULTS AND DISCUSSION

A client server application was build. For implementation of the software, *HTML* language was choused to the easiness to run and use. Only a computer with windows operating system and Microsoft Internet Explorer  $\geq 4.0$  is enough to run all \*.htm\* resulted files.

In addition, a set of *PHP* programs for evaluation of students was implemented. *PHP* (post-processed hypertext) language is a very easy to use and is server-dedicated software. The *PHP* page request is send to web server and the server using *mod\_php* module process the page, compile the program, execute the instructions, and send to the client-processed data in *HTML* format:

- The entry interface of the program is captured in figure 1:



[http://vl.academicdirect.ro/molecular\\_dynamics/radio\\_isotopes](http://vl.academicdirect.ro/molecular_dynamics/radio_isotopes) (index.php file)

Fig. 1. The entry point interface into web program

- *See reactions* link leads to a page, which contain a set of nuclear reactions tabulated into a table with three columns. The page is under constructions and it contains until

now a number of 25 reactions. Every reaction is animated one and is saved into *GIF* format. In figure 2 is presented an example of this type captured in few moments of evolution:

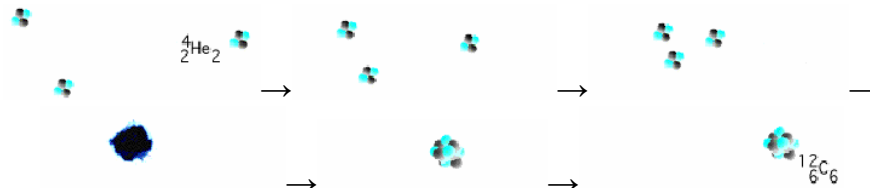


Fig. 2. Fusion of three molecules of  ${}^4_2\text{He}$

- *See animations* link leads into a page with a picture with a nuclear plant, most frequent artificial source of nuclear reactions. When user move the mouse pointer over the image, the image source is modified and page shows a technological scheme of a nuclear reactor. The page, at URL:

[http://vl.academicdirect.ro/molecular\\_dynamics/radio\\_isotopes/filme](http://vl.academicdirect.ro/molecular_dynamics/radio_isotopes/filme)

it contain a select control which allow to choose a audio-video file saved as \*.avi. Selection of one *avi* file makes that the source of picture to be replaced with selected animation. The animation starts then user moves the mouse pointer into movie area and it plays at two times. The repetition is possible by moving again the mouse pointer into movie area.

- *Test1* link goes to a test with 6 questions and every with 4 answers. User choose the correct answer for every question and submit data to the server. The PHP program verifies answers, computes the resulted score, and displays it onto the client browser (fig. 3):

http://vl.academicdirect.ro/molecular\_dynamics/radio\_isotopes/test.php

File Edit View Favorites Tools Help

Address http://vl.academicdirect.ro/molecular\_dynamics/radio\_isotopes/test.php

## Test

Uranium-238 atoms decay according to a decay series as noted in the chart at the end of the uranium ore, it will also contain all of the other elements in the series. Each decay in the series releases a significant amount of energy - in fact, this energy is the source of much of the heat in the earth.

1) Suppose you have pure, 1 gram samples of the following elements. Which sample would rate on a Geiger counter placed near the sample?

${}^{238}_{92}\text{U}$

${}^{234}_{92}\text{U}$

${}^{226}_{88}\text{Ra}$

${}^{222}_{86}\text{Rn}$

2) The first decay in the series is the alpha decay of 238-U:

$${}^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + {}^4_2\text{He}$$

Fig. 3. Test for knowledge checking

- *Test2* link goes to a set of 10 nuclear reactions equations. The mission of the user is to choose the correct atomic number (*Z*) and mass number (*A*), element (*X*) or particle from a list with more than one value (see figure 4):

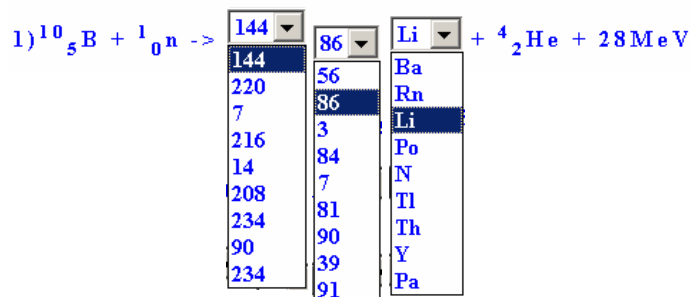


Fig. 4. Nuclear reaction equation

## 5. CONCLUSIONS

The use of PHP language allows us to create the client-server interaction in order to evaluate the test results. This is better than a JavaScript implementation, unprotected on source code view, and the client may check the source in order to answer on the questions.

The web facility of the training program allow execution of the test from anywhere (even if the student is not in the laboratory) and anytime (the program can be executed repeated, until the student acquire the knowledge about nuclear reactions).

The movies feature of the training program allows seeing of the phenomena in motion.

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