E-Learning and E-Evaluation

A Case Study

Lorentz JÄNTSCHI, Sorana D. BOLBOACA
Monica M. MARTA, Alexandru LASZLO

Tehnical University
“Iuliu Hatieganu” University of Medicine and Pharmacy
George Baritiu National College
Cluj-Napoca, Romania
Snapshoot of the website

10 items.

Chemistry

Education

Fundamentals

Medicine

Agriculture

Databases

Engineering

Management
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<td>L. Jäntschi</td>
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Aim

• To analyze an e-learning and e-evaluation project, a framework for training, learning and evaluation.
**Gibbs free energy**

Please select substances:

| Na | | HCl | → | Make calculation |

**Details:**

**Your options**

| 2Na + 2HCl | → | 2NaCl + H₂ |

**My 'hidden' data**

| 2Na | | 2HCl | | 2NaCl | | H₂ |

**Please select reaction temperature**

| 238 | |
| 286 | |
| 318.25 | |
| 328.04 | |
| 352.78 | |
| 371 | |

**Equation:**

2Na + 2HCl → 2NaCl + H₂

**Calculations:**

H(Νa, 334.5 K, 1 atm) = 1022.3429 kJ/mol
H(Νa, 334.5 K, 1 atm) = 1022.3429 kJ/mol
H(HCl, 334.5 K, 1 atm) = 969.0713 kJ/mol
H(HCl, 334.5 K, 1 atm) = 969.0713 kJ/mol
H(NaCl, 334.5 K, 1 atm) = 1454.1051 kJ/mol
H(NaCl, 334.5 K, 1 atm) = 1454.1051 kJ/mol
H(H₂, 334.5 K, 1 atm) = 1051.7318 kJ/mol
H(H₂, 334.5 K, 1 atm) = 1051.7318 kJ/mol

ΔG(2Na + 2HCl → 2NaCl + H₂) = 2*H(NaCl) + 1*H₂ - 2*H(Νa) - 2*H(HCl)
ΔG(2Na + 2HCl → 2NaCl + H₂) = 2*H(NaCl) + 1*H₂ - 2*H(Νa) - 2*H(HCl)

26/05/2008
Test

Uranium-238 atoms decay according to a decay series as noted in the chart at the emission of a significant amount of energy - in fact, the energy is the source of power.

1) Suppose you have pure, 1 gram samples of the following elements. Which are radioactive? 
   - $^{238}_{92}$U
   - $^{234}_{90}$Th
   - $^{226}_{86}$Ra
   - $^{222}_{86}$Rn

2) The first decay in the series is the alpha decay of $^{238}_{92}$U.
   $^{238}_{92}$U $\rightarrow$ $^{234}_{90}$Th + 4 $^{0}_{2}$He

   A lot of energy is released in this reaction. Thinking about the masses of the particles:
   - The mass of the uranium atom is greater than the mass of the thorium atom plus 4 alpha particles.
   - The mass of the uranium atom is less than the mass of the thorium atom plus 4 alpha particles.
   - The mass of the uranium atom is the same as the mass of the thorium atom plus 4 alpha particles.
   - All of the particles gained mass over Thanksgiving, as we all did.

3) A sample of pure $^{234}_{90}$Th is sealed in a box, and all of the air is pumped out. The box contains:
   - Hydrogen
   - Helium
   - Thorium
   - Radon

Please select correct elements, atomic numbers and/or atomic masses:

1. $^{234}_{90}$Th $\rightarrow$ $^{230}_{88}$_Ac $\rightarrow$ $^{226}_{84}$Ra $\rightarrow$ $^{222}_{82}$Rn $\rightarrow$ $^{218}_{80}$Po

2. $^{238}_{92}$U $\rightarrow$ $^{234}_{90}$Th $\rightarrow$ $^{230}_{88}$_Ac $\rightarrow$ $^{226}_{84}$Ra $\rightarrow$ $^{222}_{82}$Rn $\rightarrow$ $^{218}_{80}$Po

3. $^{238}_{92}$U $\rightarrow$ $^{234}_{90}$Th $\rightarrow$ $^{230}_{88}$_Ac $\rightarrow$ $^{226}_{84}$Ra $\rightarrow$ $^{222}_{82}$Rn $\rightarrow$ $^{218}_{80}$Po

4. $^{238}_{92}$U $\rightarrow$ $^{234}_{90}$Th $\rightarrow$ $^{230}_{88}$_Ac $\rightarrow$ $^{226}_{84}$Ra $\rightarrow$ $^{222}_{82}$Rn $\rightarrow$ $^{218}_{80}$Po

5. $^{238}_{92}$U $\rightarrow$ $^{234}_{90}$Th $\rightarrow$ $^{230}_{88}$_Ac $\rightarrow$ $^{226}_{84}$Ra $\rightarrow$ $^{222}_{82}$Rn $\rightarrow$ $^{218}_{80}$Po

6. $^{238}_{92}$U $\rightarrow$ $^{234}_{90}$Th $\rightarrow$ $^{230}_{88}$_Ac $\rightarrow$ $^{226}_{84}$Ra $\rightarrow$ $^{222}_{82}$Rn $\rightarrow$ $^{218}_{80}$Po

7. $^{238}_{92}$U $\rightarrow$ $^{234}_{90}$Th $\rightarrow$ $^{230}_{88}$_Ac $\rightarrow$ $^{226}_{84}$Ra $\rightarrow$ $^{222}_{82}$Rn $\rightarrow$ $^{218}_{80}$Po

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Milikan's Experiment

In 1911 Robert Milikan set out to try and determine the charge of electron. He did this by balancing charged oil droplets in an electric field, using an equipment similar with the one shown below.

Two forces govern the movement:
- Coulomb force ($qV/d$)
- Newton force ($mg$)

\[ \frac{qV}{d} = \frac{mg}{2} \]

- $q$ = droplet charge,
- $V$ = voltage between plates,
- $d$ = distance between plates,
- $m$ = droplet mass,
- $g$ = let's take as standard gravity

Using the following interface, you can compute one out of five parameters necessary to drops stop moving. Leave blank one of

\[
\begin{align*}
q & \; \text{Coulomb charge} \\
V & \; \text{Voltage between plates} \\
S & \; \text{Surface area} \\
\mu & \; \text{Viscosity} \\
m & \; \text{Droplet mass} \\
g & \; \text{Gravity} \\
m & \; \text{Droplet mass} \\
C & \; \text{Capacitance}
\end{align*}
\]
Dmitri Mendeleev is credited as being the primary creator of the first version of the periodic table of elements. Unlike other contributors to the table, Mendeleev predicted the properties of elements yet to be discovered. After becoming a teacher, he wrote the definitive two-volume textbook on that time, Principles of Chemistry (1868-1870). As he attempted to classify the elements according to their chemical properties, he noticed patterns that led him to postulate his Periodic Table. The program allow constructing and making SQL queries on Periodic System of Elements Information.
Titration is a common laboratory method of quantitative chemical analysis which can be used to determine the concentration of a known reactant. Because volume measurements play a key role in titration, it is also known as volumetric analysis. In 1855, the German chemist, Friedrich Mohr, defined titration as the "weighing without scale" method, because this process allows determination of the concentration of a sample without using complex instrumentation. The endpoint is the point at which there is an abrupt change in pH or some other means of recognizing (indicating) the endpoint at which essentially all of A has reacted. If the endpoint is retraded, thus allowing the amount of A to be found from known amounts of B added up to this point, the ratio of A and B (thus, there are acid-base, complexometric, gravimetric, condensation, and electrometric titrations) is calculated.
## Elementary Reaction Simulator

In 1864, Peter Waage pioneered the development of chemical kinetics by formulating the law of mass action, which states that the speed of a chemical reaction is directly proportional to the product of the concentrations of the reactants. This simulator allows you to explore the kinetics of various elementary reactions.

### Reaction Simulator Interface

<table>
<thead>
<tr>
<th>Reaction Type</th>
<th>Reaction</th>
<th>Initial Order</th>
<th>First Rate Constant</th>
<th>Second Rate Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallel</td>
<td>$X_A + X_B \rightarrow X_Y$</td>
<td>1st order</td>
<td>0.02 M</td>
<td>0.01 M</td>
</tr>
<tr>
<td>Series</td>
<td>$X_A \rightarrow Y_A$</td>
<td>2nd order</td>
<td>0.01 M</td>
<td>0.02 M</td>
</tr>
<tr>
<td>Opposed</td>
<td>$X_A \rightarrow X_B$</td>
<td>3rd order</td>
<td>0.03 M</td>
<td>0.02 M</td>
</tr>
</tbody>
</table>

### Kinetic Equations

- For parallel order: $$\frac{d[X_A]}{dt} = k_1 X_A X_B - k_2 X_Y$$
- For series order: $$\frac{d[Y_A]}{dt} = k_1 X_A - k_2 Y_A$$
- For opposed order: $$\frac{d[X_A]}{dt} = k_1 X_A - k_2 X_B$$
- For consecutive order: $$\frac{d[X_A]}{dt} = k_1 X_A - k_2 X_B$$

### Graph

The graph illustrates the concentration changes over time for different reaction orders and kinetic conditions. It shows how the concentrations of reactants and products change as time progresses, allowing for a visual understanding of the reaction kinetics.
e-Evaluation (1/4)

• Security
  – Running: HTTP_X_FORWARDED_FOR, HTTP_VIA, REMOTE_ADDR, SERVER_ADDR
  – Actions (limited on resources depending on moment): global variables per discipline T/F: time_for_view, time_for_update, time_for_test
  – Authentication: both professor’s and student passwords (encrypted MD5)
e-Evaluation (2/4)

• Flexibility
  – To allow defining the number of questions that a test will contain.
  – To allow defining the Questions & Answers table name, and the name of the discipline.
  – To allow defining the end of the evaluation - date and time.
  – To allow questions with five possible answers, with one to four correct answers.
e-Evaluation (3/4)

• Features
  – The students are involved in the task of creating and adding questions to the database, a task that is voluntary;
  – The student’s work is rewarded through supplementary points added to the final mark.
  – The bonus points for this task are given according to the quality of work. This is an imposed rule, related with the calculation bonus method: the number of correct answers for all inserted questions must have a uniform distribution. The highest bonus can give a plus of 1/5 to the final mark.
e-Evaluation (4/4)

Options

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# Results (1/3)

<table>
<thead>
<tr>
<th>Discipline</th>
<th>Instrum</th>
<th>Kinetic</th>
<th>Mater</th>
<th>Polluta</th>
<th>Toxicol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answers Total</td>
<td>654 (%)</td>
<td>232 (%)</td>
<td>863 (%)</td>
<td>439 (%)</td>
<td>767 (%)</td>
</tr>
<tr>
<td>As is in dB (from 0 to 5 possibilities)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>331 (50)</td>
<td>146 (63)</td>
<td>297 (35)</td>
<td>154 (35)</td>
<td>419 (55)</td>
</tr>
<tr>
<td>2</td>
<td>155 (24)</td>
<td>45 (19)</td>
<td>201 (23)</td>
<td>101 (23)</td>
<td>147 (19)</td>
</tr>
<tr>
<td>3</td>
<td>105 (16)</td>
<td>22 (10)</td>
<td>181 (21)</td>
<td>100 (23)</td>
<td>116 (15)</td>
</tr>
<tr>
<td>4</td>
<td>63 (10)</td>
<td>19 (8)</td>
<td>184 (21)</td>
<td>84 (19)</td>
<td>85 (11)</td>
</tr>
<tr>
<td>students who inserted quest. (2005-2007)</td>
<td>23 (32)</td>
<td>11 (46)</td>
<td>30 (30)</td>
<td>19 (49)</td>
<td>28 (44)</td>
</tr>
</tbody>
</table>
## Results (2/3)

<table>
<thead>
<tr>
<th>Year</th>
<th>2005-2006</th>
<th>2006-2007</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discipline</td>
<td>Tests</td>
<td>Studs</td>
<td>%</td>
</tr>
<tr>
<td>Instrumental</td>
<td>86</td>
<td>42</td>
<td>205</td>
</tr>
<tr>
<td>Kinetic</td>
<td>n.a.</td>
<td>n.a.</td>
<td>-</td>
</tr>
<tr>
<td>Materials</td>
<td>236</td>
<td>99</td>
<td>238</td>
</tr>
<tr>
<td>Pollutants</td>
<td>n.a.</td>
<td>n.a.</td>
<td>-</td>
</tr>
<tr>
<td>Toxicology</td>
<td>80</td>
<td>37</td>
<td>216</td>
</tr>
<tr>
<td>Total</td>
<td>402</td>
<td>178</td>
<td>226</td>
</tr>
</tbody>
</table>

Percentual tests by student (95% confidence): 193±17 %
Results (3/3)

- Table 3a: Parameters of evaluations: Instrumental Analysis
- Table 3b: Parameters of evaluations: Toxicology
- Table 3c: Parameters of evaluations: Kinetics
- Table 3d: Parameters of evaluations: Pollutant
- Table 3e: Parameters of evaluations: Materials

<table>
<thead>
<tr>
<th>Param</th>
<th>Correct answ</th>
<th>Time /corr.answ(s)</th>
<th>Bonus (from 10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>n$_{valid}$</td>
<td>50</td>
<td>35</td>
<td>50</td>
</tr>
<tr>
<td>$\mu$</td>
<td>15.94</td>
<td>11.8</td>
<td>40.7</td>
</tr>
<tr>
<td>SD</td>
<td>6.62</td>
<td>5.7</td>
<td>40.0</td>
</tr>
<tr>
<td>Me</td>
<td>16</td>
<td>13</td>
<td>32.7</td>
</tr>
<tr>
<td>Min</td>
<td>2</td>
<td>3</td>
<td>7.6</td>
</tr>
<tr>
<td>Max</td>
<td>29</td>
<td>24</td>
<td>273.5</td>
</tr>
</tbody>
</table>

Year = of evaluation; n$_{valid}$ = sample size; $\mu$ = arithmetic mean; SD = standard deviation; Me = median; TABLE 3B
Analysis (1/3)

• Mean of correct answers obtained by students that took the Instrumental Analysis test in the academic year 2005-2006 was significantly lower (up to eight correct answers, p < 1 ‰) compared with the students that took the test in the academic year 2006-2007.

• The difference was inverse for the students that took the Toxicology test (up to four correct answers, p < 1%)
Analysis (2/3)

• Average time per correct answer was significantly higher ($p = 0.002 \%$) for the students that took the Instrumental Analysis test in the academic year 2005-2006 (almost 83s, Tab.3A) compared with those that took the test in the academic year 2006-2007.

• The students who performed the examination in the academic year 2006-2007 obtained better performances due to the previously interaction with the evaluation system. They performed previously two similar examinations, being familiarized with the system and its components.
Analysis (3/3)

- The students that took the Materials Chemistry test obtained the lowest value for time per correct answer (avg=21.86s) and highest value for correct answers (~22/30).

- Pearson correlation coefficient on time vs. number of correct answers obtained by these students give a value of -0.72 (p < 0.05: time significantly related with number of correct answers; r² ≈ 52: number of correct answers relates with time per correct answer with about 52%).
Discussion (1/2)

- Many online-training and evaluation systems are available today for different domains of interest.
- The impact (of the proposed system) on teaching and learning can be evaluated in statistics terms.
- The examination using multiple choice questions is seen by the students as an easily exam comparing with other forms of examination (both passing rates and student’s opinions).
- The students that used previously the system learn that it is necessary to have knowledge on the subject tested in order to pass the exam (number of fails at first contact)
- Those of students which used the system for the third time had better results compared with other students.
Discussion (2/2)

- Time is one of the factors included into the evaluation for two reasons. First, any decision is limited in time, especially in engineering domain. Second, the time was used for discouraging the cheating (communication between students on the time of evaluation, the use of the forbidden materials as courses and books).

- The e-evaluation environment was constructed as a training and evaluation instrument. The active involvement of the students in the creation of multiple-choice banks introduces a new method of learning. This activity motivates students to ask questions and to find answers, thus involving them into an active learning process and an active interaction with the teacher, which are useful for their development.
Remarks

• The time needed to evaluate each test is considerably low (from 5 to 10 min. for a good student => an advantage when testing large classes);
• The evaluation is as objective as it could be;
• The idea of cheating by looking for the correct answer (the marking depends on the number of correct answers as well as by the time needed to give the correct answer) or by asking a colleague are discouraged.
• Basic computer skills are necessary in order to use the system.
References