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EDUCATIONAL SOFTWARE FOR PRESENTATION OF THE IDEAL GAS LAWS

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ABSTRACT:
The informative society needs important changes in educational programs. The informational techniques needs a reconsideration of the learning process, of the programs, manuals structures, a reconsideration of the methods and organization forms of the didactic activities, taking into account the computer assisted instruction and self instruction. This paper presents a software package, which can be used as educational software.

KEYWORDS:
Educational software, ideal gas, graphical interface

1. INTRODUCTION

Today, it is use the computer in many areas, including in education, from the elementary school to the universities, by following some purposes. Between these purposes it can be cite the necessity to prepare the young people for a future where the computer science is a dominant area. This purpose can be realized by using new didactical teaching methods based on educational software that is programs useful in teaching-learning process [1][2]. The CBL type systems (Computer Based Learning) are used in universities from the entire world. For instance, at Dundee University, Scotland, UK [2] a CBL system is integrated part in the courses from the first two years in computers field. These courses present the students the object-oriented programming, data structures and algorithms. Has been made study on a group of 8 students from 35 to evaluate the CBL methods. Further this study, were drawn the following conclusions: Importance of the design (an attractive and clear interface), the role of CBL as support for the course, in order for this to be able to replace totally the classic support and the role of CBL as motivator – the students having the possibility to interact with virtual created environment, this method being preferred in comparison with lecturing of a classic material. By using the computer in didactical activity it is increase the learning productivity: the necessary information is faster and accurate obtained, process and sends, by eliminate unnecessary time delay. It can be showing to the student some information which is inaccessible otherwise: dynamic diagrams, moving images, sounds. The computer can quickly process all the available information, by a relevant manner present.

The educational software has an important characteristic: it is and can be interactive. Thus, the user can interfere with the program by changing on line some parameters for the studies process. The institutions of superior education, and not only these ones, must comprise as soon as possible the possibilities of new online technologies as quality improvement means for education. This increasing interest for online technologies used in education is accompanied by the increasing interest for different strategies for online monitoring of the courses' quality. The students must be able to use different types of educational environments, as for these to combine flexibly different types of interfaces. Not all types of educational soft packages meet these conditions. Many of the soft packages used in mathematic and sciences excel by the quantity of scientific information, but in return they are poorer from other major viewpoints. The soft is too expensive, fragmented, and does not meet the market's requirements.

2. CLASSICAL IDEAL GAS

An ideal gas or perfect gas is a hypothetical gas consisting of identical particles of negligible volume, with no intermolecular forces. Additionally, the constituent atoms or molecules undergo perfectly elastic_collisions with the walls of the container. Ideal gas law calculations are favored at low pressures and high temperatures. Real gases existing in reality do not exhibit these exact properties, although the approximation is often good enough to describe real gases.

The equation of state of a classical ideal gas is given by the ideal gas law.

$$PV = nRT = NkT$$

The internal energy of an ideal gas is given by:

$$U = \hat{c}_V nRT = \hat{c}_V NkT$$

where $\hat{c}_V$ is a constant (e.g. equal to 3/2 for a monatomic gas) and:

- U is internal energy (joule)
- P is the pressure (pascal)
- V is the volume (cubic meter)
- n is the amount of gas (mole)
- R is the ideal gas constant (joule per kelvin per mole)
- T is the absolute temperature (kelvin)
- N is the number of particles k is the Boltzmann constant (joule per kelvin per particle),
- $nR=Nk$ is the amount of gas (joule per kelvin).

The ideal gas law is an extension of experimentally discovered gas laws. Real fluids at low density and high temperature, approximate the behavior of a classical ideal gas. However, at lower temperature or higher density, a real fluid deviates strongly from the behavior of an ideal gas, particularly as it condenses from a gas into a liquid or solid.

A gas that obeys these gas laws exactly is known as an ideal gas (or perfect gas). An ideal gas does not exist; however, some gases follow the laws more closely than others given standard conditions.

The most important gas law is the ideal gas law, which states that:

$$PV = nRT$$

where

- P is the pressure in Pascal
- V is the volume in Cubic meters
- n is the number of moles of gas
- R is the ideal gas constant (8.31 J/mol K)
- T is the temperature in kelvins.

Other gas laws, such as van der Waals equation, seek to correct the ideal gas laws to reflect the behaviour of actual gases. The van der Waals equation alters the ideal gas law to reflect how actual gases function using a series of calculated values called van der Waals constants.

Boyle's law (sometimes known as the Boyle Mariotte law) is one of the gas laws. Boyle's Law is named after the Irish natural philosopher Robert Boyle (1627-1691) who discovered it in 1662. Edme Mariotte (1620-1684) was a French physicist who discovered the same law independently of Boyle in 1676, so this law is often known as Mariotte's or Mariotte Boyle law.

Boyle's law states that the product of the volume and pressure of a fixed quantity of an ideal gas is constant, given constant temperature. Expressed mathematically, the formula for Boyle's law is:

$$PV = k$$

where:

- *V* is volume of the gas.
- *P* is the pressure of the gas.
- *k* is a constant .

The value of k is computed from measurements of volume and pressure for a fixed quantity of gas. After making a change to the system, typically by forcing a change in the volume of the vessel containing the fixed quantity of gas, the new volume and new pressure are measured. The result of computing the product of the measured new volume and the new pressure should be the original value of the constant k. Without being too rigorous at this point, the equation says that, after forcing the volume V of the fixed quantity of gas to increase, keeping the gas at the initially measured temperature, the pressure P must decrease proportionally. Conversely, reducing the volume of the gas increases the pressure.

Boyle's law is commonly used to predict the result of introducing a change, in volume and pressure only, to the initial state of a fixed quantity of gas. The "before" (subscript 1) and "after" (subscript 2) volumes and pressures of the fixed amount of gas, where the "before" and "after" temperatures are the same (heating or cooling will be required to meet this condition), are related by the equation:

$$P_1V_1 = P_2V_2$$

In practice, this equation is solved for one of the two "after" quantities to determine the effect that a change in the other "after" quantity will have.

Charles's law (sometimes called the Law of Charles and Gay-Lussac) is one of the gas laws. It states that at constant pressure, the volume of a given mass of a gas increases or decreases by the same factor as its temperature (in kelvins) increases or decreases.

The law was first published by Joseph Louis Gay-Lussac in 1802, but he referenced unpublished work by Jacques Charles from around 1787. This reference has led to the law being attributed to Charles. The relationship had been anticipated by the work of Guillaume Amontons in 1702. Charles' Law has been used in many different ways, from hot air balloons to aquariums. Charles' Law is one of the most important laws governing the way a gas behaves. The formula for the law is:

$$\frac{V}{T} = k$$

where:

- *V* is the volume.
- *T* is the temperature (measured in kelvins).
- *k* is a constant.

To maintain the constant, *k*, during heating of a gas at fixed pressure, the volume must increase. Conversely, cooling the gas decreases the volume. The exact value of the constant need not be known to make use of the law in comparison between two volumes of gas at equal pressure:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \quad \text{or} \quad \frac{V_2}{V_1} = \frac{T_2}{T_1} \quad \text{or} \quad V_1T_2 = V_2T_1$$

Gay-Lussac's law was named after the French chemist Joseph Louis Gay-Lussac. There are two laws that are attributed to Gay-Lussac which relate to the properties of gases, and are known by the same name.

Gay-Lussac's law states that the ratio between the combining volumes of gases and the product, if gasous, can be expressed in small whole numbers, which Gay-Lussac discovered in 1809. In 1811, Avogadro used Gay-Lussac's data to form Avogadro's hypothesis which later gave way to modern gas stoichiometry.

The other law, discovered in 1802, states that the pressure of a fixed amount of gas at fixed volume is directly proportional to its temperature in kelvins. It is expressed mathematically as:

$$\frac{P}{T} = k$$

where:

- P is the pressure of the gas.
- T is the temperature of the gas (measured in kelvins).
- k is a constant.

This law holds true because temperature is a measure of the average kinetic energy of a substance; as the kinetic energy of a gas increases, its particles collide with the container walls more rapidly, thereby exerting increased pressure.

For comparing the same substance under two different sets of conditions, the law can be written as:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \qquad \text{or} \qquad P_1 T_2 = P_2 T_1$$

3. APPLICATION PRESENT

The application is implemented in Borland Delphi 6.0, under Microsoft Windows operating system. The graphical use interface was structured in three parts: a theoretical presentation part, a simulation part and a practical application part. From the main application window, it can select by a main menu one of these parts. After an option is selected, a new window is opened. First, a theoretical presentation for the selected lesson was present. The main window is representing in fig. 1.

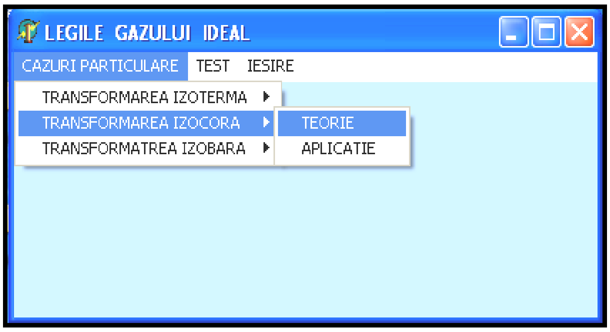

Fig. 1. The main application window

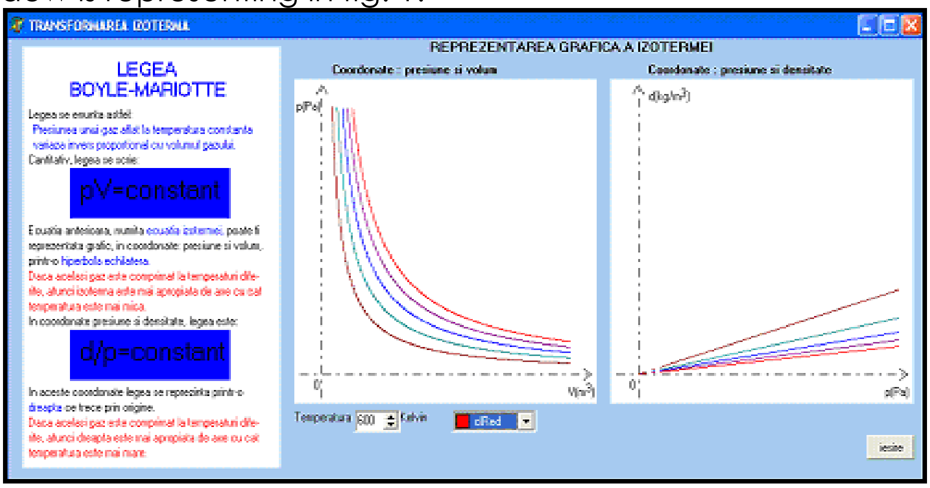

Fig. 2. Boyle's law

The windows wich present the Boyle's law is representing in Fig.2. The graph of Boyle's law is draw by the following procedure:

```
procedure TTizoterma.i2Click(Sender: TObject);
var t,v,p,x,y:integer;
begin
  t:=spinedit1.Value;
  if t>800 then begin t:=800;
              spinedit1.Value:=800;
          end;
  i2.Canvas.Pen.Style:=psSolid;
  i2.Canvas.Pen.Color:=ColorBox1.Selected;
  v:=b-round(b*1/10);
  p:=round(8.3143*2000*t/v);    {presupunem nr. kmoli=2}
  x:=transfx(a,b,v,0,i2.Width);
  y:=transfy(a,b,p,0,i2.Height);
  i2.canvas.moveto(x,y);
  while ((v>=10) and (p<b-round(b*1/10))) do
   begin
    v:=v-5;
    p:=round(8.3143*2000*t/v);
    if (p<=b-round(b*2/100)) then begin
    x:=transfx(a,b,v,0,i2.Width);
    y:=transfy(a,b,p,0,i2.Height);
    i2.canvas.lineto(x,y);
    end;
   end;
```

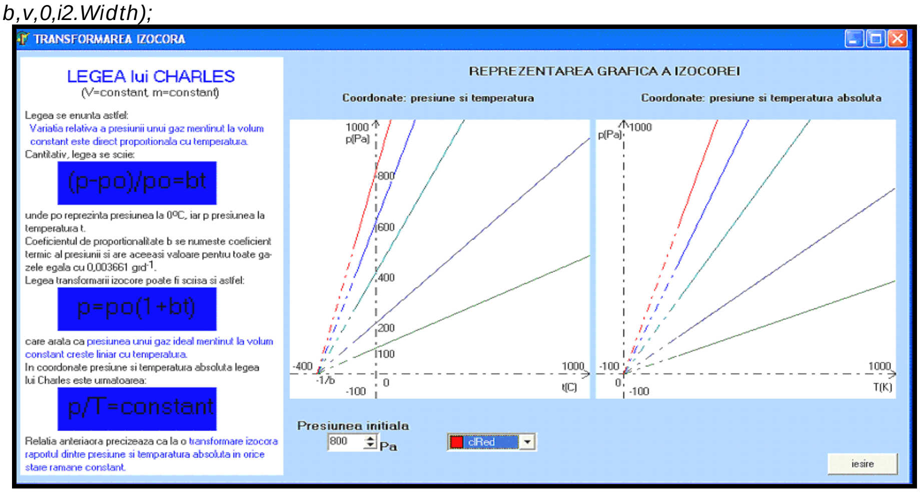

Fig. 3 Charles's law

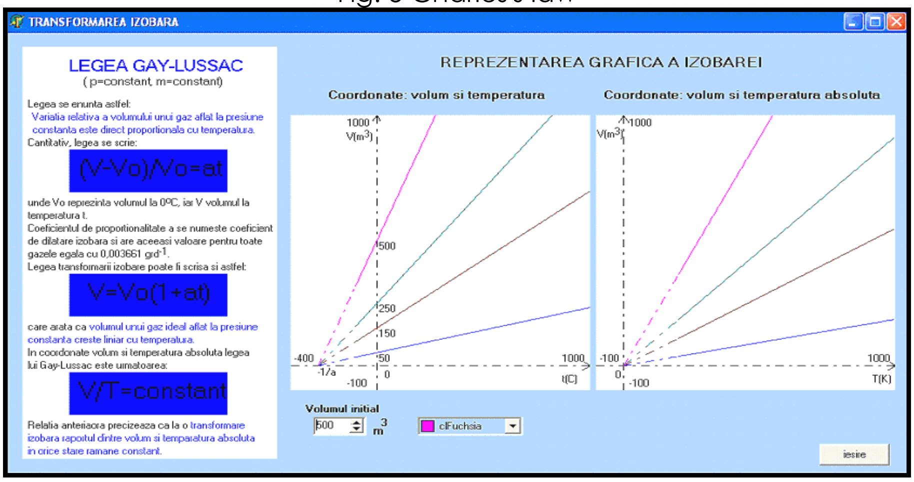

Fig. 4. Gay-Lussac's law

The windows wich present the Charles's law is representing in Fig.3. The graph of Charles's law is draw by the following procedure:

```
procedure TForm2.i2Click(Sender: TObject);
var p0,x,y,xe,ye:integer;
begin
  p0:=spinedit1.Value;
  if p0>800 then begin p0:=800;
              spinedit1.Value:=800;
          end;
  i2.Canvas.Pen.Color:=ColorBox1.Selected;
  i2.Canvas.Pen.Style:=psDashDot;
  x:=-273;y:=0;
  xe:=transfx(a1,b,x,0,i2.Width);
  ye:=transfy(a,b,y,0,i2.Height);
  i2.Canvas.MoveTo(xe,ye);
  x:=-100;y:=round(p0*(1+0.003661*x));
  xe:=transfx(a1,b,x,0,i2.Width);
  ye:=transfy(a,b,y,0,i2.Height);
  i2.Canvas.LineTo(xe,ye);
  i2.Canvas.Pen.Style:=psSolid;
  x:=998;y:=round(p0*(1+0.003661*x));
  xe:=transfx(a1,b,x,0,i2.Width);
  ye:=transfy(a,b,y,0,i2.Height);
  i2.Canvas.LineTo(xe,ye);
  x:=-278;y:=-4;
  xe:=transfx(a1,b,x,0,i2.Width);
  ye:=transfy(a,b,y,0,i2.Height);
  i2.Canvas.TextOut(xe,ye,'-1/b');
  x:=10;y:=p0;
  xe:=transfx(a1,b,x,0,i2.Width);
  ye:=transfy(a,b,y,0,i2.Height);
  i2.Canvas.TextOut(xe,ye,inttostr(p0));
```

end;

The windows wich present the Gay-Lussac's law is representing in Fig.4.

4. CONCLUSIONS

On this application, authors take into consideration the condition that must accomplish a courseware, being made necessary steps [1] [2]. So, in elaboration and utilization of this application must take into consideration next criteria:

- To accomplish some teaching and learning strategy. In this kind of self-instruction and evaluation program it must find basic notions and representation and scanning notions. Animation and graphical modelling must represent the graphical construction way and also scanning of them;
- To exist the possibility to use parameterised variable, in conditions in which users have the possibility to input the variables value;
- To present a method in which the user can be informed about how can use graphical module, i.e. an interaction user-computer exist.

The presented application accomplishes these criteria, and for this we consider that is a good example of how educational software must be realized.

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