

Computer on - line to study the energy issue among collisions

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Abstract. Physics and its education is experiencing many changes concerning reconstruction of knowledge to improve physical concepts and their teaching and learning. New technologies and organized learning are being widely recommended to support new methods in teaching and learning. New technologies are meant to satisfy the physical need for perfecting methodologies and precision measurements meanwhile organized learning is aiming the implementation of efficient schemata in physics education. Therefore, organized learning with computer technologies is implemented to study mechanical collisions. The Computer – Interface – Sensor is used to verify the energy and momentum conservations in several cases of collisions. Class activities have enabled students to establish a good relationship between experimental quantities and theoretical qualities of collision energy and momentum.

Keywords: education, physics, collision. energy, momentum, conservation

1. Introduction.

Collisions are an important field of science, concerning both classical and modern physics. In classical physics collisions are mainly studied among solid bodies, while in modern physics collisions are concerned with particles [1. Routh, Edward J., 1898].

For this reason, it is quite an enterprise to study collisions either experimentally or theoretically. The classical experiment with two spherical bodies colliding makes a good activity to help students to understand collisions and from simple cases to discuss the complicated ones [2. Maxwell, J.C., 1860].

The first knowledge about collisions is based on the kinetic energy conservation and the conservation of momentum, as first published by Christiaan Huygens in 1669 [3. Tian Yu Cao, 1998]. Thence, it is first

stated that if both kinetic energy and momentum are conserved invariant, the collision is named elastic. Otherwise it should be inelastic.

Examples from different areas of mechanics, such as lifting [4. C. Fratila, T. Axinte, R. C. Cojocaru , C. Berescu, I. C. Scurtu, 2020], harmonic oscillations [5. Masoud Rahmani, Ionut-Cristian Scurtu, Amin Moslemi Petrudi, 2020], collision lab [6. Collision Lab, 2021], or else, demonstrate that computer methods can be very efficient to study and analyze physical phenomenaes. They all deal with kinetics, motion, weight and more.

Kinetic energy and momentum are connected to mass and velocity. To calculate velocities, before or after the collision, precision time measurements are needed. Consequently, a computer, interface and two Photo Gate – sensors purchased from Logger Pro – Vernier Software & Technologies are used to measure time intervals [7. Logger Pro, Vernier Software & Technology].

Since new technologies are being applied to support classical experiments, physics education is also help students to work with innovative practices [8. Iryna Soldatenko, 2020]. Therefore, generative experimentality is implemented to start with experimental data and to produce proper theoretical quantities, figure 1 [9. Koponen T. I. & Mäntylä T., 2010].

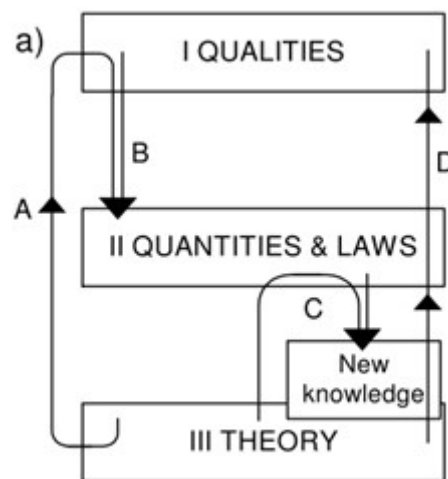


Figure 1

Students, invited to group into teams of five or six, have to observe: 1) motions before collision; 2) the collision; 3) motions after collision. The computer – interface – sensor system measures time intervals that bodies take to go through the Photo Gates.

After this, Newton’s generative experimentality can be implemented to help students with the formation of physical knowledge [10. A. Alizoti, F. Vila, Z. Mulaj, P. Dhoqina, 2013] .

2. Study Theory.

As a spherical body moves constantly forward in a straight horizontal path, its kinetic energy is $E_k = M \frac{v^2}{2}$ and its momentum is $p = Mv$.

After colliding with another spherical body at rest, there are two cases to study: 1) One body moves and the other stops; 2) They both move.

In each of these two cases, two equations are needed to study the specific phenomena: kinetic energy conservation and momentum conservation.

Case Study 1. The rest body moves away and the other stops, figure 2:

$$E_k = E_{k2} \quad \text{and} \quad p = p_2$$

$$M \frac{v^2}{2} = m \frac{w^2}{2} \quad \text{and} \quad Mv = mw$$



Figure 2

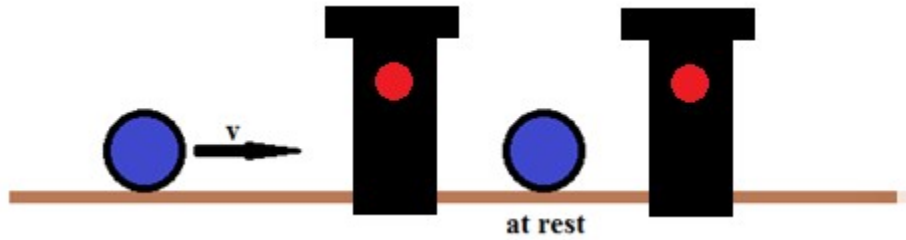
Case Study 2. They both move, figure 3:

$$E_k = E_{k1} + E_{k2} \quad \text{and} \quad p = p_1 + p_2$$

$$M \frac{v^2}{2} = M \frac{u^2}{2} + m \frac{w^2}{2} \quad \text{and} \quad Mv = Mu + mw$$



Figure 3



3. Method.

Two similar spherical bodies of mass M are used to study collisions. Two Photo Gates are used to measure the time intervals that each spherical body takes to go through, then velocities are calculated from the classical formulae [11. A. ALIZOTI, F. VILA, Z. MULAJ, P. DHOQINA, 2020]:

$$v = \frac{D}{\Delta t}$$

D is the diameter measured with a lab meter.

Δt is the time interval measured with the computer.

These data are used to calculate kinetic energies and momentums, before and after collision, as displayed in table 1 and table 2.

Table 1: Case Study 1

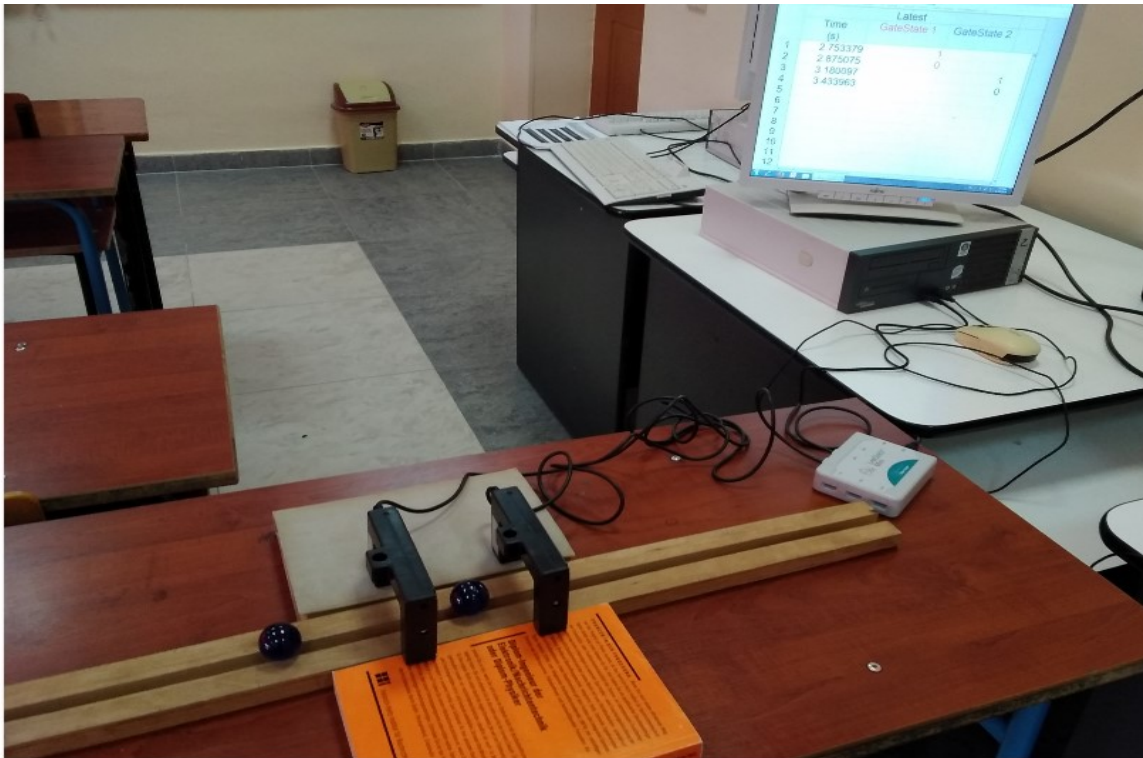
	v (m/s)	u (m/s)	w (m/s)	difference
Velocities				
Kinetic Energy (E_k)				
Momentum (p)				

Table 2: Case Study 2

	v (m/s)	u (m/s)	w (m/s)	difference
Velocities				
Kinetic Energy (E_k)				
Momentum (p)				

Naturally tables like these are drawn for each single experiment. Observations, data and calculations have shown that kinetic energies are not always invariant, and also momentums are not always invariant. Occasionally, there have been some successful verifying attempts, but they needed great care, skills and

accuracy to prevent students from getting confused while working with energy and momentum [12. JOHN W. JEWETT JR, 2008].



4. Conclusions.

Reconstruction of physical knowledge affects either physical concepts or their teaching and learning. Actually, society is living the fourth revolution, concerning industrial developments and applications of technology [13. World Economic Forum, 2021]. Physics and physics education are also influenced by new technologies in science and socio – psychology. Consequently, applications of new technologies demand for implementations of relevant teaching and learning methods.

Students are involved with class activities in groups of five or six. Each group worked as a team, first with qualitative experiments, then with quantitative theories. They collected data about collisions, calculated some physical quantities and compared them among each – other, following generative experimentality. Sometimes they had similar results, other times they didn't and therefore, explanatory coherence has been necessary to justify diversities [14. Ismo T. Koponen & Maija Pehkonen, 2010] and face with foreseen energy problems [15. MARISA MICHELINI, ALBERTO STEFANEL, 2010]. Laboratory activities concerning collisions have shown that explanatory coherence and concept networks should also be used to discuss other cases of collisions in classical or modern physics.

In many cases kinetic energy and momentum are not conserved simultaneously, although theory claims that this is possible. Discussions following after, reminded of the historical debate regarding the issue of which quantity should be most important, energy or momentum, or both. However, today it is being

clearly stated that elastic collision occurs between two bodies when their momentum and kinetic energy are conserved. [16. Serway, Raymond A., 2013]

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