# Vacuum: its meaning and its effects throughout experimental activities

*Marta Rinaudo, Daniela Marocchi and Antonio Amoroso*
*Dipartimento di Fisica Università di Torino, Italy*

The task of the experiment that we intend to present is the effect of the
presence of air and the evaluation of physical phenomena variation decreasing the pressure: the central topic of this work is therefore vacuum, its meaning and its effects.
The choice of the topic was driven by the fact that the concepts involved are often
explained by the theoretical point of view without an experimental evidence; for example, of particular interest is the study on the fall of a grave in the air and in vacuum.
This work has been tested with a group of high school students at the university laboratory and subsequently developed in the classroom by teachers.
In the first part of the laboratory activity we present some qualitative experiences about the balance of forces; before the experiment we ask students to make a prediction of what will happen and to give a physical motivation of the response.
Observing the Magdeburgo hemispheres, the effect of the vacuum on a balloon and on the baroscope behavior inside the vacuum chamber. Students discuss about forces involved and how these forces change decreasing pressure. The baroscope in particular allow to reflect on the effect of the air on buoyant force pointing out that in vacuum only gravity is involved.
In the vacuum chamber is also possible to show that the sound wave needs a medium to propagate using the bell inside the vacuum chamber. This experience underlines the difference between mechanical waves and electromagnetic waves and how the first one require a medium for propagation.
In the second part of the laboratory activity a quantitative measure relative to the phenomenon of the fall of a grave is shown, using a tube and four photocells. This experimental apparatus allows a measure of the acceleration of gravity in vacuum and a measure of the speed of fall at different intervals of pressure. This measure allows students to quantify the buoyant force and the force of viscous friction.
In the third part it is possible to observe the phase transitions of water that occur at different temperatures changing the pressure; in particular it's possible to observe the temperature of the boiling point.
The use of internal energy decreases the temperature of water with its subsequent freezing; this observation allows an interesting discussion with the students on the phenomena involved.
The curve of the boiling temperature as a function of pressure is plotted and it is compared with the theoretical curve for the distilled water: a fundamental educational point of view is the calibration phase in which the student evaluates the right time of reading of temperature and pressure.
Using a solution of water and salt it is possible to compare the boiling point of distilled water and of the solution at the same pressure. The interdisciplinarity of physics and chemistry in this measure is relevant.
This course enables students to understand some fundamental physical concepts, important also in everyday life; it is mainly intended for high school students.