Unit 3. Work and energy

CONTENTS

BIBLIOGRAPHY

Alonso, M. and Finn, E. J., Física (Addison-Wesley Iberoamericana, Wilmington, 1995). Chap. 9.

Young, H. D. and Freedman, R. A., University Physics with Modern Physics (Sears and Zemansky), (Addison-Wesley, Boston, 2011), Chap. 6, 7 and 8.

Beléndez, A., Bernabeu, J. G. and Pastor, C., Temas de Física para Ingeniería: Trabajo y energía (1988). http://hdl.handle.net/10045/11344

Tipler, P. A. and Mosca, G., Física para la Ciencia y la Tecnología, Vol. I (Reverté, Barcelona, 2005). Chap. 6 and 7.

Gettys, W. E., Keller, F. J. and Skove, M. J., Física Clásica y Moderna (McGraw-Hill, Madrid, 1991). Chap. 8 and 9.

González, C. F., Fundamentos de Mecánica (Reverté, Barcelona, 2009). Chap. 5.

In this unit we analyze two of the most important concepts in physics, *work* and *energy*, which will appear in all the units of this course. The importance of the concept of energy arises from the energy conservation law: energy is a quantity that can be converted from one type of energy to another, but can not be created or destroyed.

First we define the work done by a force, both in the case where the force is constant and the motion is linear, and in the general case in which the force is variable and the motion is curvilinear. Different persons or different machines may take different amounts of time to do the same amount of work. The term used to describe this rate of performance of work is *power*. The concept of work allows us to define kinetic energy and the kinetic energy theorem, which states that the work done by the net force on a particle is equal to the change in its kinetic energy. It is important to note that kinetic energy is the energy of an object due to its movement and if the object is moving, it can produce work by modifying its kinetic energy.

Then we study conservative and non-conservative forces and introduce potential energy, which is not associated with the motion of a particle but, as in the example of the force of gravity, with the position of the particle in the gravitational field. Another interesting example of potential energy is elastic potential energy. In the case of conservative forces we introduce the law of conservation of mechanical energy, which is one of the fundamental laws of nature. It is important to note that when a system does work on another, energy is transferred between the two systems. There are many forms of energy and if the energy of a system is conserved, the total energy does not change even if part of it changes its form or nature from one type to another. Generalization of the law of conservation of energy when non-conservative forces act on a system -for which there is no potential energy.

It is important to note that one way to transfer energy (absorbed or transferred) is to exchange work with the surroundings. If this is the only source of energy transferred (energy can be transferred even when there is an exchange of heat between a system and its surroundings due to a temperature difference, as discussed in the unit "Heat and temperature"), the law of conservation of energy is expressed by saying that the work done on the system by external forces is equal to the variation in total energy of the system. This is the work-energy law and it is a powerful tool for studying a wide variety of systems.

The theory of collisions is one of the most important applications of the law of conservation of momentum. We will deal only with collisions between two bodies. The final section of the unit focuses on the study of collisions, both elastic and inelastic. In an elastic collision kinetic energy is conserved. An inelastic collision is one in which kinetic energy is not conserved, for instance, because some energy is lost due to friction.