Problems of the 7th International Physics Olympiad[1] (Warsaw, 1974)

Waldemar Gorzkowski

Institute of Physics, Polish Academy of Sciences, Warsaw, Poland [2]

Abstract

The article contains the competition problems given at the 7th International Physics Olympiad (Warsaw, 1974) and their solutions.

Introduction

The 7th International Physics Olympiad (Warsaw, 1974) was the second one organized in Poland. It took place after a one-year organizational gap, as no country was able to organize the competition in 1973.

The original English version of the problems of the 7th IPhO has not been preserved. We would like to remind that the permanent Secretariat of the IPhOs was established only in 1983; previously the Olympic materials had been collected by individual people in their private archives and, in general, are not complete. English texts of the problems and simplified solutions are available in the book by R. Kunfalvi [1]. Unfortunately, they are somewhat deformed as compared to the originals. Fortunately, we have very precise Polish texts. Also the full solutions in Polish are available. This article is based on the books [2, 3] and article [4].

The competition problems were prepared especially for the 7th IPhO by Andrzej Szymacha (theoretical problems) and Jerzy Langer (experimental problem).

THEORETICAL PROBLEMS

Problem 1

A hydrogen atom in the ground state, moving with velocity v, collides with another hydrogen atom in the ground state at rest. Using the Bohr model find the smallest velocity v_0 of the atom below which the collision must be elastic.

At velocity v_0 the collision may be inelastic and the colliding atoms may emit electromagnetic radiation. Estimate the difference of frequencies of the radiation emitted in the direction of the initial velocity of the hydrogen atom and in the opposite direction as a fraction (expressed in percents) of their arithmetic mean value.

Data:

$E_i = \frac{me^4}{2\hbar^2} = 13.6\ \text{eV} = 2.18 \cdot 18^{-18}\ \text{J}$; (ionization energy of hydrogen atom)

$m_H = 1.67 \cdot 10^{-27}\ \text{kg}$; (mass of hydrogen atom)

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[2] e-mail: gorzk@ifpan.edu.pl

(m - mass of electron; e - electric charge of electron; $\hbar$ - Planck constant; numerical values of these quantities are not necessary.)