

**ELECTRONIC EDUCATIONAL TECHNOLOGIES FOR DEVELOPMENT
ALGORITHMIC THINKING IN PHYSICS AND MATHEMATICS**

¹A. N. Sevchenko Institute of Applied Physical Problems of Belarusian State University,
Minsk, Belarus

A mnemonic method of learning basic physics formulas for high school students and university applicants, designed to prepare them for centralized testing, olympiads and facultative lessons in high school, has been developed.

There are many types of examinations to determine the level of knowledge in mathematics and physics in the world, for example, in the USA Sat or Act. in Germany Abitur, in Japan UECE - University Entrance Center Examination, in France baccalauréat or abbreviated BAC, in Brazil ENEM, in UK A-levels, Kazakhstan – UNT, Ukraine – ZNO, South Korea – Sunyn, Kyrgyzstan – ORT, China – Gaokao, Russia – USE, Belarus – centralized testing or CT. Centralized testing in the Republic of Belarus has been conducted since 2003 and in 2023 it will be taken by the twentieth wave of future students.

The specific feature of these exams is a big number of multilevel tasks to be solved in a limited time. Exam materials differ in the volume and complexity of the tasks and, for example, in mathematics, according to online tutors [1], the highest complexity of mathematics exams for the school course in South Korea, China, and Russia. Different countries have different levels of preparation in physics and mathematics. Data from the international TIMSS study [2] show how school curricula differ in, for example, mathematics Figure 1.



Figure 1 – Diagram indicating in which grades the mathematical concepts of rotation, reflection, and rotation of geometric figures are studied.

In the modern world of innovation, new educational practices using electronic media are being actively improved and new educational methods are being created. Nowadays some of the well-known educational methods are heuristic learning, Fishbone, Singapore educational technology, gamification, exploratory method, learning from Influencers, etc. The listed methods use different ways to carry out the learning process, the main goal of which is to achieve the maximum effect of the learning process, the rapid development of skills and abilities, the formation of a new way of thinking in a specified branch of knowledge.

ABC of Physics is a method developed on the basis of the experience of physics classes at the Belarusian State University (Minsk), Olympiads for schoolchildren and applicants, facultative classes in secondary schools. The idea of the method is to quickly memorize formula constructions, teach how to work with formulas, and form the habits of using the equations for solving problems.

For example, when asked what mass is, the student must reproduce and explain the laws and formulae listed below: Newton's second law, body momentum, the law of universal gravitation, kinetic and potential energy, density, molal quantity, RMS speed of molecules, Clapeyron-Mendeleev equation, heat on heating (cooling), pendulum, relativistic mass, mass–energy equivalence, etc.

$$\vec{F} = m\vec{a}, \quad p = mV, \quad F = G \frac{m_1 m_2}{R^2}, \quad E_K = \frac{mV^2}{2}, \quad E_P = mgh, \quad \rho = \frac{m}{V}, \quad \frac{N}{N_A} = \nu = \frac{m}{M} = \frac{V}{22.4},$$

$$\overline{V^2} = \frac{3kT}{m_0}, \quad pV = \frac{m}{M} RT, \quad Q = cm\Delta T, \quad T = 2\pi\sqrt{\frac{m}{k}}, \quad m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}, \quad E = m_0 c^2 \quad (1)$$

It is known that formulas are a scientific "foreign" language in which one must learn to think. This requires going from understanding, accepting, and recognizing the material to reliable knowledge "without remembering." "Cramming", solving numerous problems and tests, analyzing theory is the traditional way of learning formulas, which can and should be accelerated.

Making up imaginative phrases in Russian and showing accompanying pictures of formulas makes the learning process more effective. For example, the formula for the internal energy of an ideal gas can be coded with the phrase in Russian: У КаТаНы ВеТРа РѐВ U КаТаНа VeTRa RhoV and illustrated with a picture:

$$U = \frac{3}{2} kTN = \frac{3}{2} \nu RT = \frac{3}{2} pV, \quad (2)$$

Developed "ABCs of Physics", "ABCs of Mathematics", "ABCs of Physics International" includes chapters on mechanics, molecular physics, electricity and magnetism, oscillations and waves, atomic and nuclear physics and offers about 300 basic formulas and over 800 advanced ones to memorize. In PowerPoint, materials are developed to teach and test the formulas of both individual physics sections and all formulas for a particular year of school physics (grades 7-11) using code in the built-in VisualBasic language. Presentations have a page for configuring teaching modes, modes of displaying tasks, allow organizing a variety of tests and generating reports. ABC of Physics and Mathematics is successfully used to train students for centralized testing in a free RF-PE school for applicants to the Faculty of RF&KT in physical electronics and radiophysics, organized on the website of the Faculty of Radio Physics and Computer Technologies of BSU.

Reference

1. Online resource: <https://www.youtube.com/watch?v=K6zR30ArdwA&t=2975s> MSU Mathematician, Savvateev and Raigorodsky. Access date 1.04.2023.
2. Online resource: <https://timss2019.org/reports/> TIMSS 2019 International Results in Mathematics and Science. Access date 1.04.2023.
3. Online resource: <https://didact.bsu.by> Interuniversity portal "Methodology, content, practice of creative education". Date of access 1.04.2023.