

The dynamics of the tasks used in physics admission exams

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We have been using tests for students' admission since 1992. Admission by tests in comparison with the recent method has some advantages. First, psychological problems of relationship between the examiner and the student are taken away. Second, all students are in the same condition and there are no subjective factors that can influence to the student's performance. And finally, the number of tests is greater than the number of questions in the recent system; therefore it is possible to check student's knowledge on different nominations. We have made great progress in preparation and implementation of Tests on physics. In this article we observe the dynamic of progress on the form and maintenance of tests on physics from 1992 till 2006.

During the first years (1992-1994) there was no any experience in test preparation. A group of subject specialists were separated 10 days before the exam and worked on the tests. It was natural that tests prepared in such conditions were subjective choice of these specialists by the form and meaning. Mostly, this choice was done without any scientific and methodological aspects. Therefore some technical and scientific mistakes were made in these tests.

In 1994 the State Students Admission Commission (SSAC) established a special seminar on physics. Many specialists from different institutions (higher and secondary) were invited to take part in physics test bank organization. Also the main demands to the test on physics were identified.

Tests on physics should reply the following demands:

- they should be valid (check only the required aspect of the knowledge or skill)
- they should be clearly given
- simple, so only one question in one test
- reliable, so based on present-day reality
- they should be suitable to the syllabus on physics

All tests that satisfy the indicated conditions can be separated on the following nominations:

1. Formulas
2. Units
3. Experiments
4. Definitions
5. Graphical tests
6. Quality tests
7. Calculations

Tests also can be separated by their difficulty: simple, average and difficult. Simple tests can be given on some formulas, rules, units, relations between two different physical quantities. These tests are given to check the basic knowledge of the students [1].

Average tests can be given on matching the formula with the physical quantity, on expressing the physical quantity by the main units, on guessing the graphical relationship between quantities. 2-3 mathematical operations might be used in test solution. To solve such test correctly the student should have ability to investigate physical rules and apply his knowledge in changed conditions.

Difficult tests are to check the thinking ability of the student, how this student uses his knowledge in nonstandard situations. To solve such test the student should apply his knowledge from different sections, also skills from algebra, geometry and trigonometry should be demonstrated [2].

Tests are prepared on the following topics from main sections of physics:

MECHANICS

1. Uniform rectilinear and uniformly accelerated motion.
2. Uniform circular motion.
3. Newton's laws.
4. Gravity. A law of gravitation.
5. Force of elasticity. A frictional force.
6. Statics.
7. An impulse. Energy. Conservation laws.
8. Work. Power.
9. Mechanical oscillations and waves.
10. Aerostatics and aerodynamics.

MOLEKULAR PHYSICS AND THERMODYNAMICS

1. The molecular-kinetic theory. Laws of ideal gas.
2. Thermodynamics.
3. Saturated and nonsaturated steam.
4. Properties of solid bodies and fluids.

ELECTRODYNAMICS

1. Electrical charge. The electric field.
2. An electric capacitance. Energy of an electric field.
3. Laws of a direct current.
4. An electric current in various mediums.
5. A magnetic field. A magnetic induction.
6. A motion of charged particles in a magnetic field.
7. An electromagnetic induction. Energy of a magnetic field.
8. The variable electric current.
9. Electromagnetic oscillations and waves.

OPTICS, RELATIVITY and QUANTUM PHYSICS

1. Geometrical optics.
2. Wave optics.
3. Relativity.
4. Light quanta.
5. Atom and nuclear physics.

A special block of tests was organized for checking the abilities of students to find out the relationships between different sections.

The process of test bank building is still going on. Every year we accept new tests to the bank. These tests being new by the form and meaning are used during the pre-tests and in case of approval are accepted to the bank.

The results of pre-tests are discussed, according to the level of knowledge shown on these pre-tests a special technical task for the main examination is prepared. In this task the number of questions from the specific section is given proportional to the number of periods given to the section learning.

Distribution by sections

N	Section	N of tests	Percentage
1	Mechanics	8	32
2	Molecular physics and thermodynamics	3	12
3	Electrodynamics	9	36
4	Optics, relativity and quantum physics	5	20

In the technical task distribution of tests by nominations and difficulty is also shown. Further tests are chosen according to the required nominations and level of difficulty by computer. In the tables shown below the distribution by nominations is given. As it is easily seen from these tables at mid and late 90-s mostly factual tests were dominant. One of the reasons for that was the big number of tests and not enough time for test solution. For good performance only mechanical knowledge was required. It made many students to cram and reduced the level of teaching physics at secondary schools. Therefore from 2000 the number of tests on physics was reduced to 25 and mostly quality problems on rules, actions, application of rules were given (diagram 1).

Let's have a look at the following examples.

1. What is the force that influences the 2 mKl point charge on the electrostatic field of $4 \cdot 10^6 \frac{\text{V}}{\text{m}}$ strength?
A) 10 N B) 8 N C) 2 N D) 0,8 N E) 5N

(1994)

2. What is the formula for the strength of electrostatic field?

A) $\vec{E} = q^2 \cdot \vec{F}$ B) $\vec{E} = \frac{\vec{F}}{q^2}$ C) $\vec{E} = 2q\vec{F}$ D) $\vec{E} = \frac{\vec{F}}{q}$ E) $\vec{E} = \frac{\vec{F}}{2q^2}$

(1999)

3. What is the name of physical quantity that is numerically equal to the force that influences on the unit charge located in the given point of the electric field?

- A) potential decrement B) electromotive force C) voltage
D) strength of electrostatic field E) electric constant

(2006)

In the given examples 1 and 2 good performance doesn't mean understanding the meaning of the physical quantity. In the first example it is possible to use only mathematical calculations. In the second one it is enough to remember the formula without understanding the meaning of the physical quantity. However in the last example it is necessary to understand the intensiveness of the electric area and using the information about its differences from the other characteristics it is possible to give the correct answer.

The statistical analysis of answers to the second and third test assignment shows, that the coefficient of discrimination at the third assignment is higher (diagram 2) [3].

The changes made in test preparation increased the level of knowledge shown on the exams and also made very good support in learning physics at the universities. Investigations held on the 1 course students of Azerbaijan Oil Academy showed that the results have been increased (diagram 3).

It proves that the advantage given to the quality test was the correct step and it is necessary to improve this activity.

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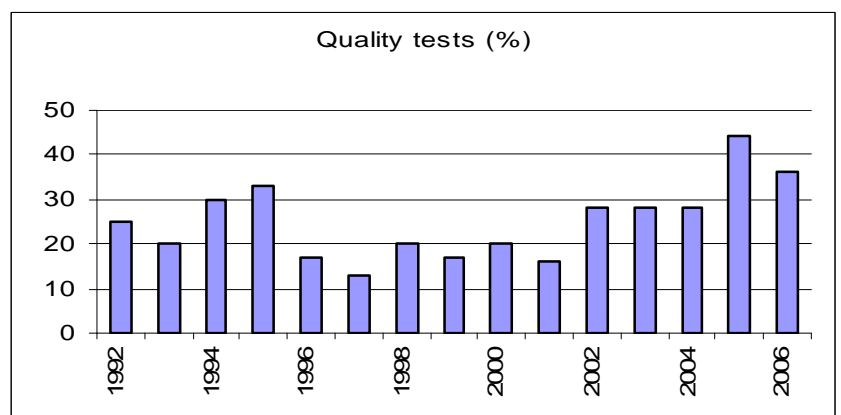
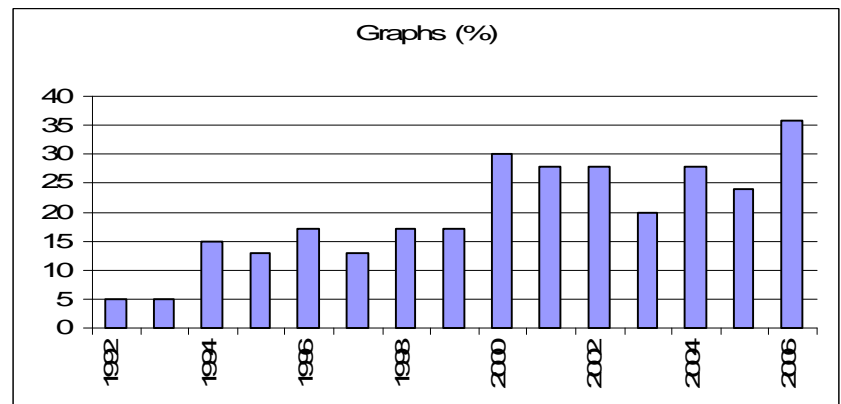
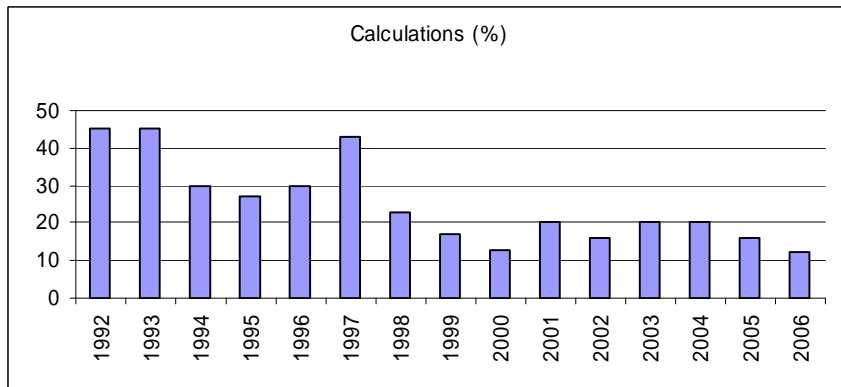
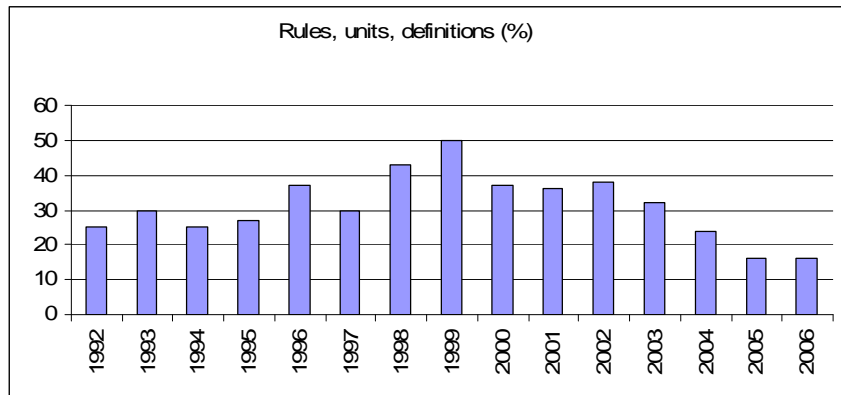


Diagram 1

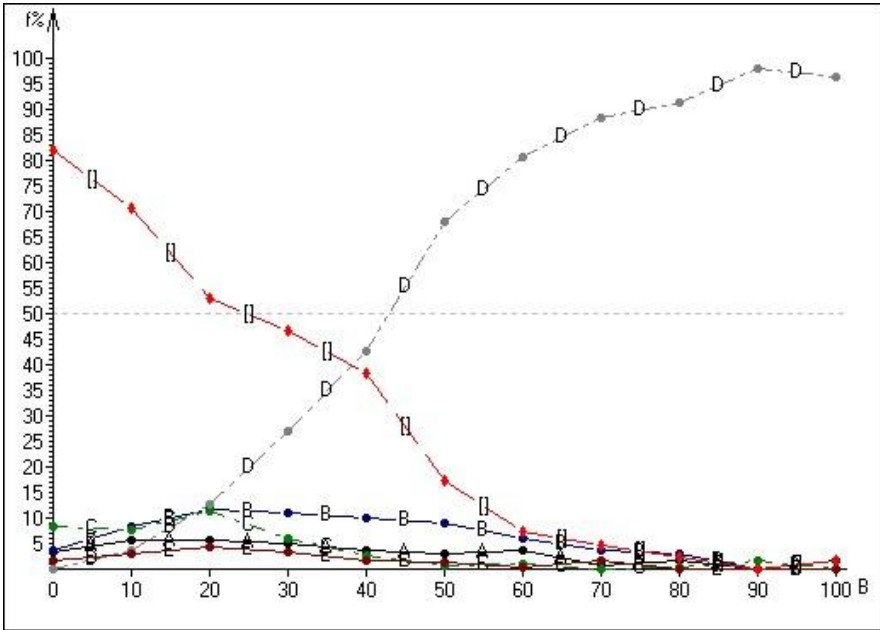
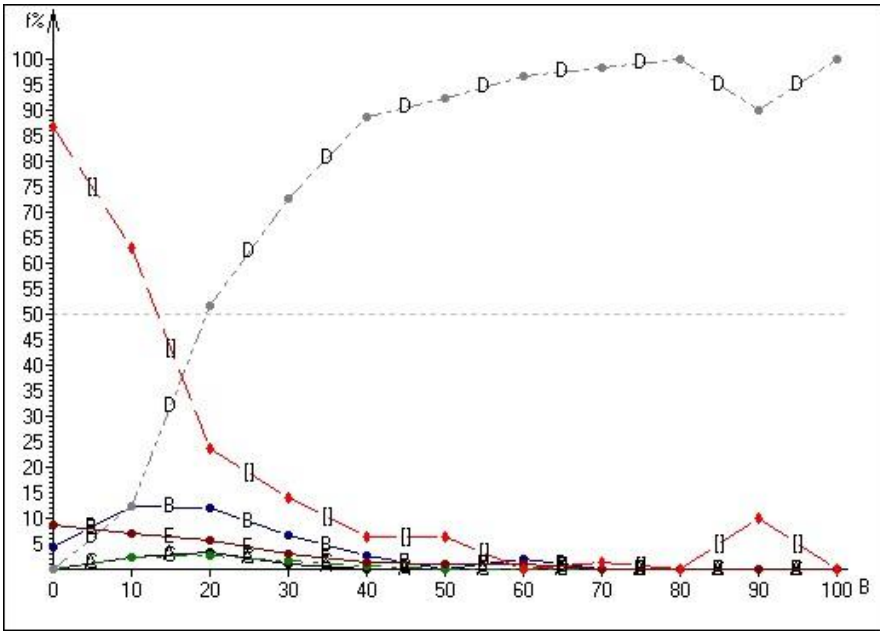


Diagram 2

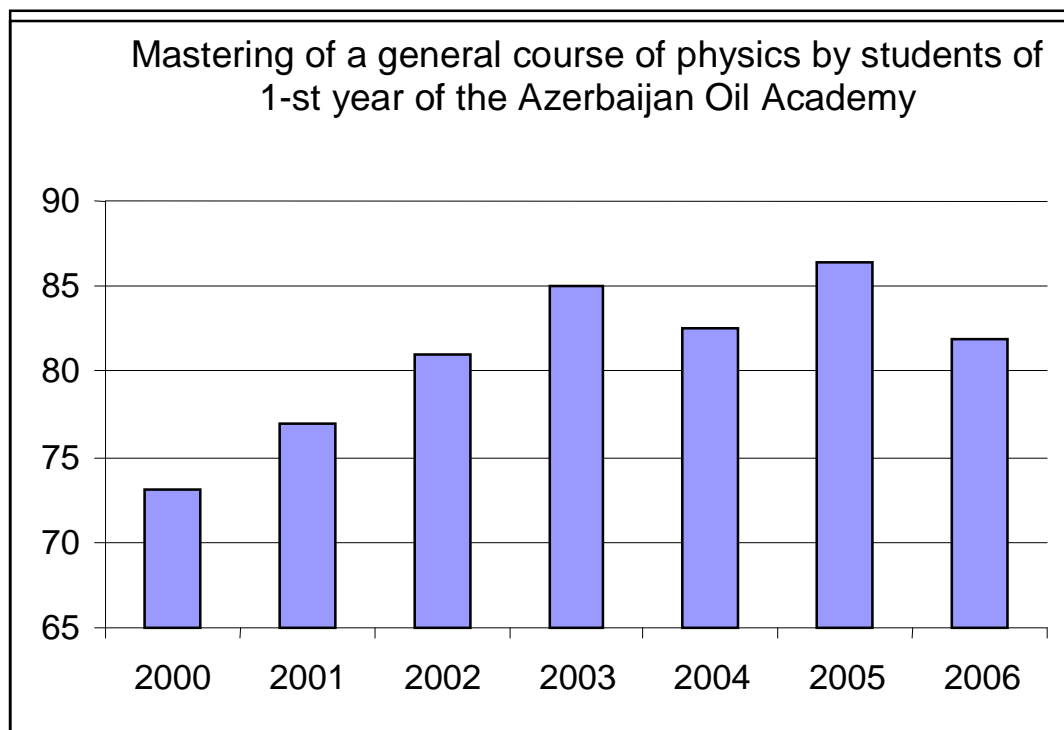


Diagram 3

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There has been studied the development dynamics of the form and content of physics tests (from the test database) which were designed to check skills and knowledge of high school graduates. There has been given detailed information about the test database's main forming phases and there have also been analyzed the requirements for the tests, their difficulty degree and nominations. The test database covering all the fields of physics meets the necessary requirements and enables to check skills and knowledge of school graduates. There has been investigated the distribution of the tasks offered during 1992-2000 according to their nominations. Statistical analysis of the examination results has been conducted and there has been studied the discrimination quotients of the tasks that were used. It was found out more suitable to use quality type problems to assess the knowledge of the school graduates rather than other types of problems. So starting with 2000 the preference has been given to quality type problems. The analysis of the results of semester exams in Oil Academy which is one of the best educational institutions of Azerbaijan showed that students demonstrated better results in physics in recent years.