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ҚОЖА АХМЕТ ЯСАУИ АТЫНДАҒЫ
ХАЛЫҚАРАЛЫҚ ҚАЗАҚ-ТҮРІК УНИВЕРСИТЕТІ

HOCA AHMET YESEVİ
ULUSLARARASI TÜRK-KAZAK ÜNİVERSİTESİ

1150 жыл
Әл-Фарабидің мерейтойы

175 жыл
Абай Құнанбайұлының мерейтойы

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Журнал Қазақстан Республикасының Баспасөз және бұқаралық ақпарат істері жөніндегі ұлттық агенттігінде 1996 жылғы 8 қазанда тіркеліп, Қазақстан Республикасы Инвестициялар және даму министрлігі Байланыс, ақпараттандыру және ақпарат комитетінің **№232-Ж** куәлігі берілген.
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KURUCU:

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WAYS OF DEVELOPMENT OF ACTIVE AND COGNITIVE ACTIVITY OF PUPILS IN SUBJECTS OF NATURAL SCIENCES

The world is changing, changing in turn the education system, so the education system should form such a quality as professionalism in everything-the ability to quickly change directions and methods of activity. There is a concept of the information society, which is interested in the fact that its citizens were able to independently, actively act, make decisions, flexibly adapt to living conditions. Accordingly, in the teaching of natural Sciences, new approaches to the eternal problems: how and what to teach, new pedagogical technologies, techniques, methods, new views on the relationship between teacher and student.

Keywords: education, subjects of natural science, teaching, activity, work in small groups, individual work, group discussion

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Жаратылыстану пәндерін оқытуда оқушылардың танымдық белсенділігін дамыту тәсілдері

Әлем өзгеруде, өз кезегінде білім беру жүйесі де өзгерістерге ұшырауда, сондықтан білім беру жүйесінде кәсібилік сияқты-іс-әрекеттің тәсілдері мен әдістеріне тез бейімделу қабілеті қалыптасуы тиіс. Ақпараттық қоғамның оның азаматтары өз бетінше әрекет етіп, шешім қабылдап, өмір сүру жағдайларына икемді бейімделе алуы үшін мүдделі болуы керек деген тұжырымдамасы бар екені белгілі. Сәйкесінше, жаратылыстану пәндерін оқытуда өзекті мәселелерді шешуде жаңа тәсілдер: қалай және неге үйрету керек, жаңа педагогикалық технологиялар, тәсілдер, әдістер, мұғалім мен оқушының өзара қарым-қатынасына жаңа көзқарастар қалыптасты.

Кілт сөздер: білім беру, жаратылыстану пәндері, оқыту, белсенділік, кіші топтардағы жұмыс, дербес жұмыс, топтық пікірталас.

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Способы развития познавательной активности обучающихся при изучении естественнонаучных предметов

Мир меняется, меняется в свою очередь и система образования, поэтому в ней должно формироваться такое качество, как профессионализм во всем – умение быстро менять способы и методы деятельности. Существует концепция информационного общества, которое заинтересовано в том, чтобы его граждане могли самостоятельно, активно действовать, принимать решения, гибко адаптироваться к условиям жизни. Соответственно, в преподавании естественнонаучных предметов появляются новые подходы к актуальным проблемам: как и чему учить, новые педагогические технологии, приемы, методы, новые взгляды на взаимоотношения учителя и ученика.

Ключевые слова: образование, естественнонаучные предметы, преподавание, активность, работа в малых группах, индивидуальная работа, групповая дискуссия

Education is of great importance in the formation of the intellectual potential of the nation. Therefore, the Republic of Kazakhstan is focused on the technology of training of advanced information and industrial States. Therefore, the development of national education is a matter of state strategy. In order to correctly formulate the strategy of modernization of education it is necessary, firstly, to carefully analyze the development of Kazakhstan and, secondly, to use the positive experience of other advanced countries [1].

For this purpose it is important to develop active and cognitive activity of pupils, to form interest to a subject, to ways of search, self-education, assimilation, processing and application of information that would allow pupils to be guided easily in the modern quickly changing world. Modern teaching at school is faced with the problem of reducing the interest of students to study subjects. Such a school subject as the subjects of natural science society has long attributed to the category of the most difficult. We have considered ways of development of active and cognitive activity of pupils in subjects of natural Sciences:

- use differentiated questions, differentiate expected answers;
- plan and prepare questions for students with special learning needs and gifted students;
- prepare assignments at a higher level than for self-study students;
- I try not to overload more capable students with tasks;
- use open-ended questions to engage more capable students in an interactive debate;
- stimulate gifted students to conclusions on the material covered;
- if necessary, we involve students in modeling in the subjects of natural science;
- prepare for highly gifted students questions and tasks of the highest level, and for students with low abilities simple questions of low level;
- we use modeling to build confidence in students with low abilities;
- we use the necessary terminology for the application of metacognition, which should be known by students with a high level of abilities.

For the development of active and cognitive activity of students in the subjects of natural science self-evaluation should be directed not only to encourage, but also to form the goals and evaluation criteria [2]:

- announce grading criteria in advance;
- change the style of action and do not allow excessive pressure on students;
- stimulate students 'self-esteem, use self-esteem sheets, monitor students' self-reading and writing, and master science subjects within the subject;
- bring tasks and exercises in line with the abilities of students, aiming for high expected results;
- support students in seeking specific answers, independent conclusions and initiative;
- prepare experimental tasks based on research aimed at solving the problem;
- plan to receive independent feedback from students, create the conditions for the maximum scale of practical and research tasks and exercises;
- plan the use of the computer, consider helping older students younger students, for example, mentoring, ensure the availability of the computer at the appropriate level.

Group discussion – a method of group discussion that allows you to identify the full range of opinions of group members, possible ways to achieve the goal and find a common group solution to the problem. In the discussion, each participant gets the opportunity to show their position. Group discussion activates the creative abilities of the student, his interest in the subject of discussion. it is an excellent means of cohesion and development of the group, ensures the adoption of the most optimal decisions by the group. For a group discussion [3]:

- Encourage students not only to familiarize themselves with the task, but also to explain it.
- Use the opportunities to familiarize them according to their roles and work report.
- Remind students to write down their notes for feedback.
- Allow students to define different deadlines for feedback.
- Using appropriate vocabulary and terminology, pay attention to the consideration of the mastered topic.
- Solve complex problems.
- Make sure the students think about their teaching.
- Form the concept of complex (important) ideas.
- Give students the opportunity to work in groups with classmates with similar abilities.
- Provide the organization of a group mini-discussion.

Along with such approaches, it is important to use methods in teaching subjects of natural science. Consider specifically several effective of them.

The case study method or «method of specific situations» (case-study method) refers to non-game simulation active learning methods. This method is a method of active problem-situation analysis, based on learning by solving specific problems – situations, solving cases. The purpose of case-study is to analyze the situation arising in a particular state of Affairs, to develop a practical solution through the joint efforts of a group of students. At the end of the process – evaluation of the proposed solutions and choosing the right one.

To create an effective case-technology, you need a good case and a certain method of its use in the classroom.

Requirements for case:

- fitness for purpose;
- be relevant;
- illustrate aspects of life and typical situations;
- develop analytical thinking;
- provoke discussion and find several solutions [4].

Main stages of case creation:

1. The place of the case in the discipline, the discipline section, the formulation of goals and objectives.
2. Program map consisting of the main theses.
3. Collection of information regarding the case card.

4. Writing the text of the case.
5. Conducting a methodological experiment.
6. Case preparation.
7. Implementation of the case, its application during training sessions.
8. Development of guidelines for the case.

Advantages of the method:

– the principles of problem-based learning;

– of navika solve real-world problems, the ability of the group's work;

– logical scheme for solving the problems, the arguments;

– skills of group work and presentations;

– getting the skills to ask questions and make answers.

One way to develop active and cognitive activity of students in the subjects of natural science is innovative pedagogical activity. Today, in a modern school teaching methods of natural science is going through a difficult period associated with a change in the goals of education, the main goal of the school is: the success and health of the younger generation [5–6].

The introduction of active and cognitive activity of students in the subjects of natural science in the educational process allows the teacher:

- to work out the depth and strength of knowledge, to consolidate skills in various fields of activity;

- develop technological thinking, the ability to plan their own educational, self-educational activities;

- building an individual learning path for each student;

- develop habits of strict compliance with the requirements of technological discipline in the organization of training sessions.

In the teaching of natural Sciences, students have the opportunity to replenish their knowledge, to delve deeply into the studied problem and suggest ways to solve it, which is important in the formation of worldview [7].

When teaching science classes are conducted with different methods of interactive teaching. Students know and have the opportunity to replenish their knowledge, to delve deeply into new material. We offer several methods of working with students [8–9].

Method «Interview”

The objectives of the method: the development of students through the organization of activity, sense-making, dialogue.

Framework conditions for the implementation of the method

1. The optimal number of participants - up to 30 people.
2. Necessary equipment: notebooks; notebooks; pens, attributes of the draw (drawings or postcards, cut in half, according to the number of pairs of participants).
3. Implementation time of the method (depending on the number of participants) – from 10 to 20-30 minutes.

The algorithm implementing the method:

1. The teacher explains the conditions for the implementation of the method: creating pairs of interlocutors, participants will need to exchange information on the proposed issues for 5 minutes, then each pair will alternately present the received information to everyone.
2. The teacher invites the participants to determine their interlocutor-interviewer (the choice can be made by lot: each participant is offered one of the car-points, which depicts part of the picture, on the other part of his drawing, the participant finds his pair).
3. Interviewees (couples) are placed next to each other.
4. Next, the teacher offers participants to ask questions for an interview (2-3 questions).

5. Within 5 minutes, the interlocutors exchange information among themselves on the proposed issues (information can be recorded in a notebook, Notepad).

It is fundamentally important to give no more than 5 minutes for the exchange of information between the interlocutors – this encourages the participants to dialogue, to demonstrate the ability to listen and hear, not to occupy the entire communicative space. Next, the teacher alternately invites couples to quickly present the information received (each participant tells not about himself, but about his interlocutor). The reflection of the implemented method and the interaction is carried out.

The method of «Cross-group»

The objectives of the method: the development of independent thinking, communication skills, individual consciousness through the organization of interaction, mental activity, sense-making, reflexive activity.

Framework conditions for the implementation of the method

1. The optimal number of participants – up to 30 people.
2. Necessary equipment: sheets of paper size A-3 or watman; markers (1–2 per group).
3. The implementation time of the method is 30–60 minutes.

The algorithm implementing the method

1. Participants are invited to create several creative groups (for example, 6 groups of 4 people).
2. The teacher explains the conditions for the implementation of the method: creative groups need to discuss the proposed problem for 5–10 minutes, find a solution to the problem (create a project, develop a model).
3. Then the participants in the groups are calculated by sequence numbers (for example, the first-fourth).
4. Creative groups of new composition are created (for example, four groups of 6 people: one group combines all the «first» numbers, the other all the «second», etc.).
5. Groups of a new composition is proposed to re-discuss the solution to a given problem, each participant tells the group about the outcome of the first composition. Work on the problem is carried out during 10–15 min.
6. Each of the creative groups of the second (new) composition presents its own version of the solution to the problem.
7. Reflection of the interaction is organized.

Method «1*2*4»

The objectives of the method: the development of students (communication skills, individual consciousness, thinking) through the organization of interaction, the combination of individual work, work in pairs, in creative groups, through the organization of mental activity, sense-making.

Framework conditions for the implementation of the method

1. The optimal number of participants – up to 30 people.
2. Special equipment implementation of the method does not require.
3. The method implementation time is 15–30 minutes.

The algorithm implementing the method

1. The teacher calls the method and explains its essence: the solution of the problem will be carried out first individually by each, then-in pairs, then-in creative groups.
2. The teacher puts forward a problem (question) and offers all participants individually for 3-5 minutes to find a solution to this problem (answer to the question).
3. Five to seven participants present (voice) their options for solving the problem.
4. Pairs of participants are created (at will, by lot).
5. Couples are invited to compare texts for 3–5 minutes to solve the problem of each of the participants and create a common text, expanding and deepening its content.

6. Three to five couples present the results of their work, voice the written texts.
7. Then every two couples unite in creative groups of 4 people.
8. Creative groups are invited to compare versions of texts created in pairs, expand and deepen their content within 7–10 minutes.
9. Each creative group presents its own version of the text to solve the problem.
10. Reflection of the interaction is organized.

The method of «Four corners»

Objectives of the method: Creation of a favorable atmosphere, organization of communication, updating of knowledge, attitude to them, development of positive cognitive motivation, generalization of knowledge, etc.

Framework conditions for the implementation of the method

1. The optimal number of participants – up to 30 people.
2. Necessary equipment: a spacious auditorium with four corners, in which the participants of the game can move freely; 4 sheets of paper of different colors (for example, red, yellow, blue, green), which with the help of adhesive tape are attached one to each corner of the audience so that they can be clearly seen by all participants of the game; a system of questions (7–10) with:

1) Your favorite color: red, yellow, blue, green?
2) Your favorite time of year: summer, autumn, winter, spring?
3) What flower do you prefer: rose, chamomile, Dahlia, carnation?
4) What tree do you prefer: birch, spruce, Linden, oak? etc.

3. The method implementation time is up to 10 minutes.

The algorithm implementing the method

The teacher calls the method, offers to participate in its implementation and hangs in the four corners of the audience on a sheet of colored paper.

The teacher introduces the participants to the rules of implementation of the method: each participant is invited to answer questions, making a choice. Once the choice is made, you need to go to the corner (the color), which corresponds to the choice made. If none of the proposed choices-answers are satisfied, you should go to the center of the audience.

When all participants have made a choice and dispersed to the four corners of the audience or gathered in the center of the audience, they organize communication among themselves: each explains to others in his group (his corner) his choice; the exchange of opinions, arguments about the choice is carried out very quickly (for each choice 1–2 minutes).

Next, it is proposed to make the following choice, again organized communication.

4. After each question and the above four answers, the teacher activates the participants ' choice of any option and their organization of communication.
5. When the participants are offered all the questions and communication on the last of them took place, the teacher organizes a reflection of the interaction held on such an algorithm:

- fix your emotional state during the implementation of the method;
- express your attitude to the content and procedure of the method implementation;
- what thoughts did the method awaken?
- what contributes to the implementation of the method?

There may be a situation when in one or two corners (or in the center of the audience) there is only one participant. In this case, the teacher can listen to their explanation of the choice made or organize communication of participants from different angles.

Functionally, teachers can offer this method to students both in the classroom and in extracurricular activities.

The method of «Colored shapes»

The objectives of the method: the Development of individual consciousness, «I-concept», value orientation of students through the organization of their activity, sense-making, self-identification.

Framework conditions for the implementation of the method

The optimal number of participants – up to 30 people.

1. Necessary equipment: various shapes of colored paper (geometric, flowers, fruits, vegetables, objects, animals, etc.); each figure is presented in 2–3 copies of different colors.

2. The method implementation time is up to 15 minutes.

The algorithm implementing the method

1. The implementation of the method begins with the teacher explaining the rules of its implementation: from a set of figures, the participant chooses one and explains his choice.

2. The teacher lays out all the available colored figures on the table or on the floor in the center of the circle, where the participants are located.

3. Each of the participants chooses one of the figures, which in shape and color corresponds to the individuality of the participant, his current mental, emotional state. Selects one of the figures and the teacher.

4. After 2–3 minutes, the teacher invites each of the participants to explain their choice: what does the color and shape of the chosen figure symbolize for them? Usually the teacher begins by asking his story a certain algorithm for explaining the choice.

5. Then each of the participants in a circle (alternately) explains his choice, showing all the selected figure.

6. As a result, the teacher sums up, emphasizing the individuality of each participant.

«Selection Method»

The objectives of the method: the development of students through the organization mysledeyatelnosti, sense-making, reflective activity.

Framework conditions for the implementation of the method

1. The optimal number of participants - up to 30 people.

2. Necessary equipment: three signs with the words «Yes», «no», «maybe»; a small ball (plastic, rubber, tennis, paper); a pre-compiled system of questions on any topic or problem (7–10 questions).

3. The method implementation time is 10–15 minutes.

The algorithm implementing the method

1. The teacher introduces students to the conditions of implementation of the method: a system of questions is proposed, answering which it is necessary to make a choice between three answers: «Yes», «no», «maybe». The participant goes to the appropriate plate; the one to whom the ball will be thrown, catches it and explains his choice.

2. In the audience, in three different places (so that participants can move freely), signs are placed (fixed with tape) with the words «Yes», «no», «maybe».

3. The teacher asks the first question and invites the participants to make a choice of one of the answer options (the participants disperse in the audience, placing themselves under the appropriate plate).

4. The teacher alternately throws the ball to 1–2 participants gathered under each of the plates, and asks to explain his choice of answer. Caught the ball gives reason for his choice.

5. The teacher asks the second and all subsequent questions. Participants choose the answer option and move around the audience under the appropriate sign. After answering each question, the procedure of throwing the ball to the participants with a request to explain their choice is repeated.

6. When all questions are proposed and explanations are received by the participants of the choice of answers, the teacher thanks everyone for participating in the implementation of the method.

The method of «Logical chain»

The objectives of the method: the development of students (in particular, the development of logical thinking) through the organization of intensive communication, reflective activity, sense-making.

Framework conditions for the implementation of the method

1. The optimal number of participants – up to 30 people.
2. Necessary equipment: cards-links (components) of the logical chain; pre-developed content (links and logic of their location) 2–3 logical chains, which will be offered to build a group of participants.
3. The method implementation time is 10–15 minutes.

The algorithm implementing the method

1. 1. The teacher introduces students to the conditions of implementation of the method: everyone is offered a choice of one of the cards on which either a word or a phrase is written. This card and its owner are one of the links of the logical chain that must be built by organizing interaction with other participants. Cards (links) must be built in a certain logic, justifying this logic. On the first card (link) with which the logical chain begins, there should be a generalizing word or phrase that gives the name of the entire logical chain; it is necessary to build 2–3 logical chains.

2. Participants are invited to take a choice of one card. All the cards-links of 2–3 logical chains are mixed and turned so that the participants do not see what is written on them, and are located on the folder that the teacher carries through the audience.

3. After cards are distributed to participants, the teacher suggests them to organize communication among themselves as a result of which it is necessary to construct 2–3 logical chains-one on the left, another on the right in audience; reminds that it is necessary to explain logic of construction of «chain», races of position of its links.

4. Participants interact with each other, building logical chains (determine who in what chain should be and in what sequence, explaining its logic).

5. When logical chains are built, the participants (or those who first built the logical chain) alternately announce the name of the chain, list in logical sequence all the links in the chain, and then explain (this can be done by either one or more participants) the logic of the location of the links in the chain.

6. After the participants present the constructed logical chains, the teacher either agrees with the proposed options, or rearranges the logical chains according to his scenario, explaining the logic of their construction.

7. Reflection of the interaction is organized.

Examples of logical chains

Option 1. The logical chain is «Wardrobe».

Components (links) logical chain (composition and logic location): wardrobe, shelf, hat, tie, hanger, pants, shirt, suit, cloak, coat, mole, wormwood.

Explanation of the construction of the chain: the logical chain is called «Closet»: in the closet there is a shelf on which can lie a hat and tie; on the hanger we first hang pants, then a shirt, jacket, cloak and coat; in the closet sometimes gets a moth, the remedy for moths is wormwood.

Option 2. A logical chain of «Forest».

Components (links) of the logical chain (composition and logic of location): forest, pine, spruce, birch, oak, hazel, hawthorn, juniper, blueberry, Buttercup, chamomile, pear.

Explanation of chain construction: a logical chain is called «a forest». At the heart of its construction is the principle of tiered forests: first there are trees (starting with the highest-pine, oak), then-shrubs (from hazel to blueberries), then herbaceous plants (Buttercup, chamomile) and mushrooms (pear).

The content of «logical chains» can be definitions, components of the structure of objects and phenomena, leading ideas of the course topic, any field of knowledge.

We offer several methods of working with students. Practical tasks in teaching are also very relevant. Therefore, we consider several works on practice for the formation of worldview and scientific concepts in natural science [10].

Practical work № 1.

Study of the law of conservation of energy.

Comparison of the change in the potential energy of a stretched spring with the change in the kinetic energy of the body.

Equipment: two tripods for front work; dynamometer training; ball; thread; sheets of white and copy paper; measuring ruler; scales training with a tripod; weights.

Task: compare the decrease in the potential energy of the stretched spring with the increase in the kinetic energy of the body associated with the spring.

Theoretical foundations of the work. Because energy is defined via work, the SI unit for energy is the same as the unit of work – the joule (J), named in honor of James Prescott Joule and his experiments on the mechanical equivalent of heat. In slightly more fundamental terms, 1 joule is equal to 1 newton metre and, in terms of SI base units. On the basis of the law of conservation and transformation of energy in the interaction of the elastic forces change the potential energy of the stretched spring must equal the change in kinetic energy associated with her body, taken with opposite sign.:

$$\Delta E\rho = -\Delta Ek$$

For experimental verification of this statement, you can use the installation shown in figure 1. In a foot of a tripod fix the dynamometer. To his hook tie the ball on a thread length of 60–80 cm on another tripod at the same height with a dynamometer strengthen the foot trough. Setting the ball on the edge of the gutter and holding it, move the second tripod from the first to the length of the thread. If you move the ball from the edge of the gutter to x, then as a result of deformation, the spring will acquire a reserve of potential energy

$$\Delta E\rho = \frac{kx^2}{2},$$

where k – is the spring stiffness.

Then the ball is released. Under the action of the elastic force, the ball acquires the velocity V. Neglecting the losses caused by the friction force, it can be assumed that the potential energy of the stretched spring will completely turn into the kinetic energy of the ball:

$$\frac{kx^2}{2} = \frac{mv^2}{2}.$$

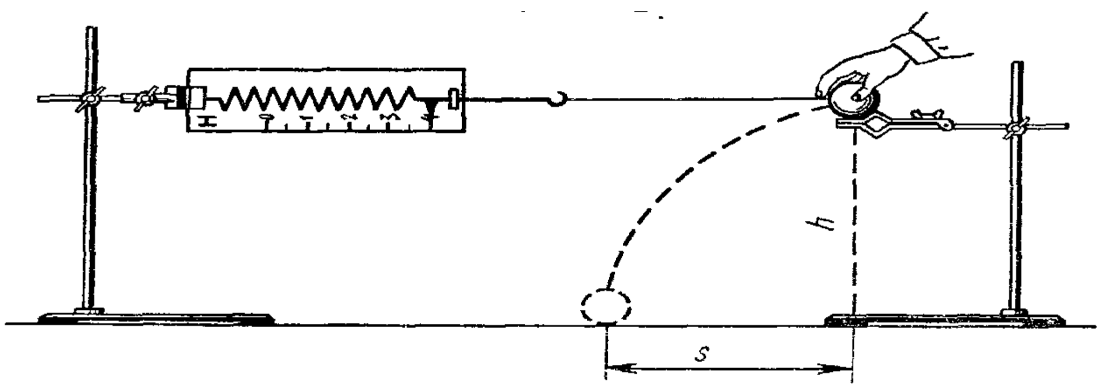

Figure 1 - Demonstration of the law of conservation of energy

The speed of the ball can be determined by measuring the range of its flight s at free fall from height *h.* From the expression $v=\frac{s}{t}$ and $t=\sqrt{\frac{2h}{g}}$ it follows that $\Delta E_k=\frac{mv^2}{2}=\frac{ms^2g}{4h}$.

The purpose of the work is to verify equality: $\frac{kx^2}{2}=\frac{ms^2g}{4h}$.

Given the equality $F_y= kx$ we get: $\frac{F_y x}{2}=\frac{ms^2g}{4h}$.

The order of work.

1. Mount the dynamometer on the tripods and keep it at the same height h =40 cm from the table surface. Hook it over the hook of the dynamometer thread, tied the other end to the ball. Put a sheet of white paper and a sheet of copy paper on top of it.

The distance between the tripods should be such that the ball is on the edge of the trough with the thread stretched and no deformation of the dynamometer spring.

2. Move the ball away from the edge of the chute until the dynamometer reading is equal F_y*=2H*. Move the ball away from the edge of the chute until the dynamometer reading is equal s_{av}.

3. Measure the deformation x of the dynamometer spring at the elastic force $F_y=2$N. Calculate the potential energy of the stretched spring.

4. Measure the mass of the ball with weights and calculate the increase in its kinetic energy.

5. The results of measurements and calculations are recorded in the report table.

Reporting table

F_y, N

x, m J

E_ρ, J

ΔE_ρ , J

m, kg

h, m

s, m

E_k, J

ΔE_k, J

6. Estimate the error limits of measuring the potential energy of a stretched spring.

Since $E_\rho=\frac{F_y x}{2}$, then the margin of relative error is: $\varepsilon_{E_\rho}=\varepsilon_{F_y}+\varepsilon_x=\frac{\Delta F_y}{F_y}+\frac{\Delta x}{x}$

The limit of absolute error is: $\Delta E_\rho=E_\rho \varepsilon_{E_\rho}$.

7. Estimate the limits of errors in measuring the kinetic energy of the ball.

Since $E_k = \frac{m s_{cp}^2 g}{4h}$, then the margin of relative error is:

$$\varepsilon_{E_k} = \varepsilon_m + 2\varepsilon_{s_{cp}} + \varepsilon_g + \varepsilon_h.$$

Errors ε_m, ε_g and ε_h compared to the error ε_s can be neglected.

In this case $\varepsilon_{E_k} \approx 2\varepsilon_{s_{cp}} = 2\frac{\Delta s_{cp}}{s_{cp}}$.

The conditions of the experiment for measuring the flight range are such that the deviation of the results of individual measurements from the average is much higher than the boundary of systematic error ($\Delta s_{rand} >> \Delta s_{syst}$), поэтому можно принять, что $\Delta s_{av} \approx \Delta s_{rand}$.

The boundary of the random error of the arithmetic mean with a small number measurements' N is by the formula: $\Delta s_{cp} = \frac{3\Delta s_{кв}}{\sqrt{N}}$, where is calculated by the formula given on the page 16.

Thus, $\varepsilon_{E_k} = 6\frac{\Delta s_{кв} 1}{\sqrt{N} s_{cp}}$.

The boundary of the absolute error of measuring the kinetic energy of the ball is equal to:

$$\Delta E_k = E_k \varepsilon_{E_k}.$$

8. Make a conclusion about the implementation of the law of conservation of energy by checking whether the common points have intervals [$E_\rho \pm \Delta E_\rho$] и [$E_k \pm \Delta E_k$].

Control question:

1. In what cases does the law of conservation of mechanical energy?
2. What can explain the inaccurate equality of changes in the potential energy of the spring and the kinetic energy of the ball?

Practical work №2

Determination of specific heat of water vaporization

Content and method of work. The specific heat of water vaporization is determined by the change in its level in the vessel during boiling.

The process of transferring energy from one body to another without doing work is called heat transfer, or heat transfer. In the process of heat exchange, the body can either receive or give away energy, which is called the amount of heat.

In order to heat a body of mass m_1 from the initial temperature t_1 to the final temperature t_2, it is necessary to expend the amount of heat $Q_1 = cm_1(t_2 - t_1)$, where c is the specific heat of the substance. To convert a liquid mass m2 into steam at a constant temperature, it needs to transfer the amount of heat $Q_2 = Lm_2$, where L is the specific heat of vaporization.

Let the water be heated by an electric boiler and all the work of the electric current goes: 1) to heat the water from the initial temperature t_1 to the boiling point t_2; 2) to the subsequent transformation of some mass m of water into steam. Then, according to the law of conservation of energy, for these two processes can be written:

$$P\tau_1 = cm_1(t_2 - t_1); \quad (1)$$

$$P\tau_2 = Lm, \quad (2)$$

P – the capacity of the boiler, c = 4190 J /(kg • K) – specific heat of water, m_1 – the initial mass of water, t_1 – initial water temperature, t_2 = 100°C – final temperature of water, τ_1 – time of heating water to a temperature of t_2, L – the latent heat of vaporization of water, m – mass of evaporated water, τ_2 – the time during which water flows m turned into steam.

If the water is in a cylindrical vessel, its mass can be determined by the formula:

$m_1 = \rho V_1 = \rho S h_1$, (3)

where ρ = 1000 kg/m^3 – density of water, h_1 – initial water level (figure 2a), S – the area of the bottom of the vessel. Similarly, you can determine the mass of water that will remain after evaporation:

$m_2 = \rho V_2 = \rho S h_2$, (4)

where h_2 – remaining water level (figure 2b). Solving a system of equations (1)–

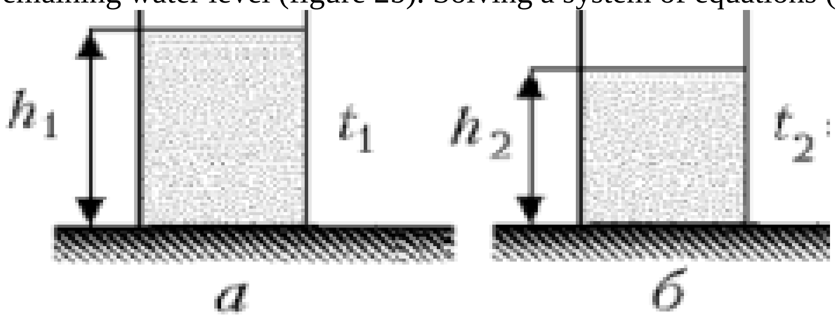

Figure 2 – Demonstration to determine the specific heat of evaporation of water

(4) and given that $\Delta m = m_1 - m_2$, we obtain a formula for calculating the specific heat of water vaporization:

$$L = \frac{ch_1\,(t_2 - t_1)}{h_1 - h_2} \cdot \frac{\tau_2}{\tau_1} \quad (5)$$

Equipment: cylindrical vessel (inner calorimeter Cup); water vessel; electric boiler; thermometer; clock with second hand; ruler with millimeter divisions; foam sheet, tape.

Progress of work

1. Prepare a table in the notebook to record the results of measurements and calculations.

c, J/kgK	h_1, m	t_1, ^{0}C	τ_1,c	h_2, m	t_2, ^{0}C	τ_2,c	L, J/kg

2. Pour water into a cylindrical vessel and measure its temperature t1 and initial level h1.
3. Cautiously, observing safety, lower the boiler into the water, turn it on and measure the time τ1, during which the water is heated to a temperature t2 = 100 °C and begins to boil.
4. Allow the water to boil for some time T2, then turn off the boiler.
5. Measure the h2 level of the remaining water in the vessel.
6. The specific heat of water vaporization is calculated by the formula (5).
7. Compare the result with the table value and calculate the measurement error.

Additional task. Using the proposed equipment, calculate the mass of evaporated water and the amount of heat that went to its evaporation.

Control question

1. Specific heat of mercury 120 J/(kgK), the specific heat of its vaporization 0.29 MJ / kg. What does it mean physically?
2. What energy losses were allowed during the work and how they could be avoided?

Active and cognitive activity of students in the subjects of natural science is skillfully combined (superimposed) with the above methods and technologies, which inevitably enrich the content of education, make the lesson more visual, meaningful and interesting for the current generation. Conducting a lesson in natural Sciences with new technologies is significantly different from the classic. Using a computer in the classroom makes learning mobile, strictly differentiated. Computer lessons on the subjects of natural science complements the learning process. Increases the activity of students, develops their abilities. Stimulates students to gain knowledge, improves the quality of education.

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