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INTERCONNECTED TRAINING IN LABORATORY AND PRACTICAL CLASSES IN SOLID STATE PHYSICS

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ABSTRACT

This article deals with issues related to solid state physics. Methods for solving problems, analysis of the difference between the results of experiments and laboratory problems solved using algebraic calculations. For example, the question" specific heat capacity of solids "and" coefficient of thermal conductivity of solids"is considered.

KEYWORDS: *Methods Of Teaching Physics, Methods Of Solving Problems, Solid Body, Specific Heat Capacity Of Solids, Coefficient Of Thermal Conductivity Of Solids, Temperature, Calorimeter, Solid Plate, Copper Plate, Wood Chip, Collection Of Questions And Problems In Solid Body Physics And Textbook.*

INTRODUCTION

To this day, science and technology have reached enormous heights. It is no secret that we live in a developed period. Therefore, scientists and teachers face great challenges, one of which is the creation of new teaching methods in educational institutions through new modern and pedagogical technologies.

It is known that in the teaching of physics there are theoretical and practical methods. The importance of solving issues from physics within practical techniques is significant. In the process of solving the issue, along with providing knowledge to the students, such important issues as the development of students' abilities, the teaching of students are resolved. **[1]**

The issue are divided into quality, experimental, graphic and creative issues according to the methods of solution. Such a division is also conditional, since both verbal reasoning and graphic and computational work are used in solving experimental issues.

Consequently, the issues will be different in terms of content and complexity. The solutions of these issues are aimed at a specific purpose and have clear methods of solution. Depending on the type of issues, there is literature on the solution aloshida. In this case, we will briefly dwell on these issues.

About the physical experiment in solving experimental problems, it is possible to give students some understanding that the experiment is a method of introducing natural phenomena, on the basis of which the functional connection between measurements and physical dimensions lies in mathematical research. **[2]**

MAIN PART

Experimental problems. One of the ways to connect theory with practice is to solve experimental issues. A characteristic feature of experimental issues, when solving them, either a lab or a demonstration experiment is used. When an experiment is used to solve a problem, such issues are called experimental issues.in the process of solving experimental issues, the activity and independence of students increases. Because they get the necessary information for the solution of the issue from the textbook, from the set of issues not from the ready-made shawl, but from the physical measurements that they perform themselves.

The necessary equipment, materials are given and the information that needs to be found is sufficient to be requested.as we said above, students learn from a number of opinions and arguments, What kind of physical exuberance lies in the experiment, what kind of physical law is expressed. And they come up with the expression ohirgi for the physical dimension, which the sign should be found in the experimental matter. They throw out the last expression and get it by directly measuring the required sizes to solve the issue. **[3]**

In educational practice, in general, a small problem that is solved with the help of an experiment based on logical conclusions, mathematical actions and laws and techniques in physics is usually considered a physical issue. In fact, every puzzle that arises in connection with the study of teaching material in physics, is reflected in the form of a matter in the minds of students. Active thinking in pursuit of a specific goal is an "expression of solution to the issue". In the methodological and educational literature, however, exercises that are chosen for a particular purpose and are aimed at studying physical phenomena, the formation of concepts, the development of physical thinking of students and the ability to apply the knowledge acquired to them are referred to as matter. There are many other purposes for solving issues, such as educating students, taking into account and controlling their knowledge, determining the suitability and the formation of their skills, etc.

Students are introduced to the essence of physical phenomena in various ways: they are given as a story, experiments are demonstrated, laboratory work is performed, extractions are conducted, etc. Here, the activity of students, that is, they arise depending on the depth and consistency of their knowledge — the problematic situation. In a number of cases, in the process of giving such a problematic situation in the form of an issue and its solution, the reader "re-opens" the physical law for himself, but does not get it ready. The matter in this case will be a means of studying the physical phenomenon. For this purpose, quality issues can be used in computational issues, experimental issues and other different issues.

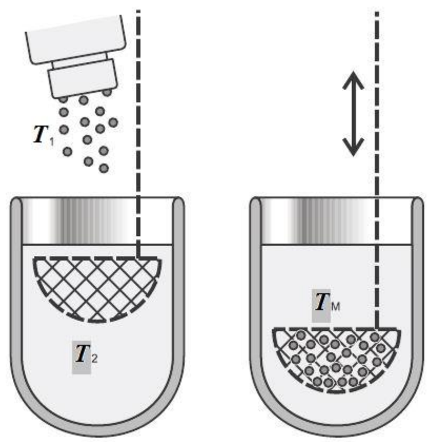
Relying on the knowledge that exists in the students, it is possible to analyze the physical phenomena that have been studied in the process of solving issues, to formulate concepts about physical phenomena and Magnitude.

In solving experimental issues, it is possible to give the students some insight about the physical experiment as a method of introducing the phenomena of the experimental nature, on the basis of which the functional connection between measurements and physical size is made by mathematical research. **[4]**

The methodology for solving the issue depends on many circumstances; its content, the preparation of the students, the purpose set by the teacher. Despite this, there are a number of general rules that students for most issues should take into consideration when resolving an issue with. We see these general issues of the method of solving a physical problem in the following examples. The data of this issue are taken from physical experience and life.

The mass of copper pitra was heated to a temperature of m_1 = 300 g, T_1 = 11,3°C. T_2 = 100°C water with mass m_2 = 200 g was poured on it. Determine the specific heat capacity c_1 of the pitra when the total temperature of the water with pitra reaches T_{um} = 21,5°C and the mass of the calorimeter m_{K} = 112 g due to heat exchange after mixing well c_{suv} = 4,19 $kJ/(K·kg)$. c_{K} = 0,46 $kJ/(K·kg)$.

Case 1. We know that a mass of m_1 is heated to a temperature of pitra, T_1. Water of mass m_2 and temperature T_2 was poured on it. After good mixing, the total heat temperature of pitra and water in exchange for heat exchange is Tum, and the specific heat capacity of copper pitra is calculated by the following sequence, if the mass of the calorimeter is m_{K}.



Solution. It is better to solve the problem in connection with the performance of laboratory work to determine the specific heat capacity of solids. The problem requires the construction and solution of the heat balance equation.

$$\Delta Q_1 = c_1 m_1 (T_1 - T_M) \quad (1.1)$$

(here m_1 is the mass of pitra, c_1 is the specific heat capacity of pitra) equal to the amount of heat absorbed by water ΔQ_2

$$\Delta Q_2 = c_2 m_2 (T_M - T_2) \quad (1.2)$$

here m_2 is the mass of water.

Here, the coefficient of specific heat of water c_2 is assumed to be exact, and the temperature is assumed to be equal to the temperature of steam. The value of the unknown c_1 is calculated from the values of T_{M}, T_2, m_1 and m_2 measured by the following formula:

$$c_1 = c_2 \frac{m_2 (T_M - T_2)}{m_1 (T_2 - T_1)} \quad (1.3)$$

The vessel of the calorimeter also absorbs some of the heat released from the pitra. So the amount of heat absorbed by the calorimeter is

$$Q_K = c_K m_K (T_M - T_2) \quad (1.4)$$

Thus, the water equivalent of the calorimeter vessel is taken into account in the t_{K} calculations. The amount of heat absorbed by formula (1.3) is much more accurate

$$\Delta Q_2 = (c_2 m_2 + c_K m_K) \cdot (T_M - T_2) \quad (1.5)$$

and taking it into account, formula (IV) looks like this:

$$c_1 = \frac{(c_2 m_2 + c_K m_K)(T_M - T_2)}{m_1(T_1 - T_M)} \qquad (1.6)$$

Using this formula, we calculate the specific heat capacity of the calorimeter.

$$c_1 = \frac{(c_2 m_2 + c_K m_K)(T_M - T_2)}{m_1(T_1 - T_M)} =$$

$$= \frac{(4190 \frac{J}{K \cdot kg} \cdot 0,2 kg + 460 \frac{J}{K \cdot kg} \cdot 0,112 kg)(21,5 - 100)K}{0,3 kg(11,3 - 21,5)K} = 0,385 \frac{kJ}{K \cdot kg}.$$

This means that the specific heat capacity of copper pitra is 0.385 kJ/K. This value corresponds to the values in the literature.

Case 2. We will solve this problem experimentally.

Necessary tools and items

Dyuar vessel, Dyuar vessel sheath, copper pitra, 300 g, training laboratory scales 610 Tare, 610 g, thermometer from -10 °C to +110 °C, NiCr-Ni temperature sensor, digital thermometer, steam generator, 550W/220V, Heater, beaker, 400 ml, V-shaped tripod base, 20 cm, tripod column 47 cm, multi handles Leybold, Universal holder, diameter 0.80 mm, Silicone tubes, inner diam. 7Ч1. 5 mm, 1 m and *a* pair of heat-resistant gloves.

To perform the experiment, we use the device in Figure 2 to determine the specific heat capacity of the copper pitra by taking the experimental results.

Picture 1. ***Determination of specific heat capacity of solids experimental device for. 2-***

- We will install the heater on a tripod.

- Fill the steam generator with water and carefully close the appliance and connect it to the hose connection at the top of the heater (steam inlet) using a silicone tube.

- Connect the silicone tube to the hose connection (steam outlet) on the bottom of the heater and insert the other end of the tube into the beaker. We need to make sure that all the joints are securely fastened with silicone tubing.

- We fill the sample chamber of the heater with copper pita and, if possible, close it tightly with a stopper.

- We connect the steam generator to the mains, and then heat the pits in the heater for 20-25 minutes by passing steam through them.

During this time:

- Determine the mass of an empty Dyuar vessel, then pour about 200 g of water into it.

- Put the Dyuar dish in a holster and put a thermometer or a temperature sensor accordingly.

- We can measure the water temperature T_2.

We open the copper of the Dyuar vessel and set it aside; we put the sample net in the Dyuar container. Place the pits at 100 °C in a sample tray, close the lid and mix the pits thoroughly with water. When the water temperature does not rise, we measure the temperature of the mixture.

In addition, the reason for determining the mass of the pits is given in the problem. In experiments, we measure the mass of a copper pitra with a scale.

We repeat the experiment with copper pits.

Experimental example

Mass of water: m_1 = 200 g

Pitra of temperature: T_2 = 100 °C

Copper pitra va mass: m_1 = 300 g

Accounts:

Water equivalent of a calorimeter: m_K = 112 g

Specific heat capacity of water: c_2 = 4,19 kJ/(K·kg)

c_T = 0,367 kJ/(K·kg),

the result that calculated the problem

c_1 = 0,385 kJ/(K·kg)

was achieved.

Experimental values of specific heat of copper and corresponding results from the literature.

Depending on the type of material, the specific heat capacity of solids has been studied, and their value indicates that water is much smaller than the specific heat capacity.

If the amount of heat passing through the plate in 5 *s* is 106 *J*, the temperature difference between the outside and inside of the plate is 54 *K*, the plate surface is 225 cm^2 and the plate thickness is 10 *mm*, find the coefficient of thermal conductivity of the plate.

Case 1. We know that the amount of heat passing through the plate ΔQ over a period of time Δt is directly proportional to the temperature difference between the outside and inside of the plate ΔT and the surface of the plate *S*, to the thickness of the plate *d* and using the inverse propositional, we write the following formula.

$$\frac{\Delta Q}{\Delta t} = \lambda \cdot \frac{S}{d} \cdot \Delta T. \qquad (2.1)$$

From this formula we can write the following expression for the thermal conductivity of the λ - plate:

$$\lambda = \frac{\Delta Q}{\Delta t} \cdot \frac{d}{S} \cdot \frac{1}{\Delta T}. \qquad (2.2)$$

We use formula (2.2) to solve the problem.

Given	**SI**	**Formula**	**Solution**
Δt = 5 s ΔQ = 106 J ΔT = 54 K S = 225·cm^2 d = 10 mm	 $225 \cdot 10^{-4}$ m^2 $1 \cdot 10^{-2}$ m	$\frac{\Delta Q}{\Delta t} = \lambda \cdot \frac{S}{d} \cdot \Delta T.$ $\lambda = \frac{\Delta Q}{\Delta t} \cdot \frac{d}{S} \cdot \frac{1}{\Delta T}.$	$\lambda = \frac{\Delta Q}{\Delta t} \cdot \frac{d}{S} \cdot \frac{1}{\Delta T} =$ $= \frac{106\,J}{5s} \cdot \frac{1 \cdot 10^{-2} m}{225 \cdot 10^{-4} m^2} \cdot \frac{1}{54K} =$ $= 0{,}17 = \frac{W}{m \cdot K}.$
λ – ?			

Javob: $\lambda = 0{,}17 = \frac{W}{m \cdot K}$

Answer: $\lambda = 0{,}17 = \frac{W}{m \cdot K}$

In the heat equilibrium, that is, in a steady state where the temperature at each point is constant for a long time, the transmitted energy P corresponds exactly to the heat flux.

Case 2. When we solve this problem experimentally, it turns out to be smaller than its real value. In this case, we take into account that the transmitted energy *P* corresponds exactly to the heat flux.

Figure 2. ***A device for determining the thermal conductivity of a sample of a building material using the single plate method***

The device we will need to solve the problem experimentally:

In this experiment, the temperature of the lower part of the building material inside the chamber and the temperature of the outer part of the chamber (in this case ice) are measured. When the electric hob is connected, the system does not suddenly achieve heat balance. In the case of temperature equilibrium, record the temperature change after a sufficiently long time (approximately 1 hour) to maintain the temperature difference. The change in internal temperature over time is proportional to the temperature and plus some constant:

$$\frac{\Delta T}{\Delta t} = \alpha \cdot T + b$$

This equation of this equation as a time function *T*(t) has the following form:

$$T(t) = T_{IM} - T_{Farq} \cdot e^{\frac{t}{\tau}},$$

where T_{HE} is the internal temperature in the state of heat equilibrium, $T_{Diff} = T_{HE} - T_{Diff}$ is the temperature difference, τ - is the time constant.

In thermal equilibrium, the temperature of the heated part of the building material sample can be expressed by the following function:

f(x) = A - B·exp (-x/C),

and it reflects the measured temperature values in the experiment.

The parameter A obtained for the match corresponds exactly to the given temperature. The ice outside the chamber keeps the temperature of the wood shavings low and, most importantly constant. However, there may be small fluctuations in the temperature value, so the value of the outside temperature is averaged and used to calculate the temperature difference from this mean.

$\Delta T = T_{HT} - T_{cold}$.

and can be found in terms of thermal conductivity.

Experimental device

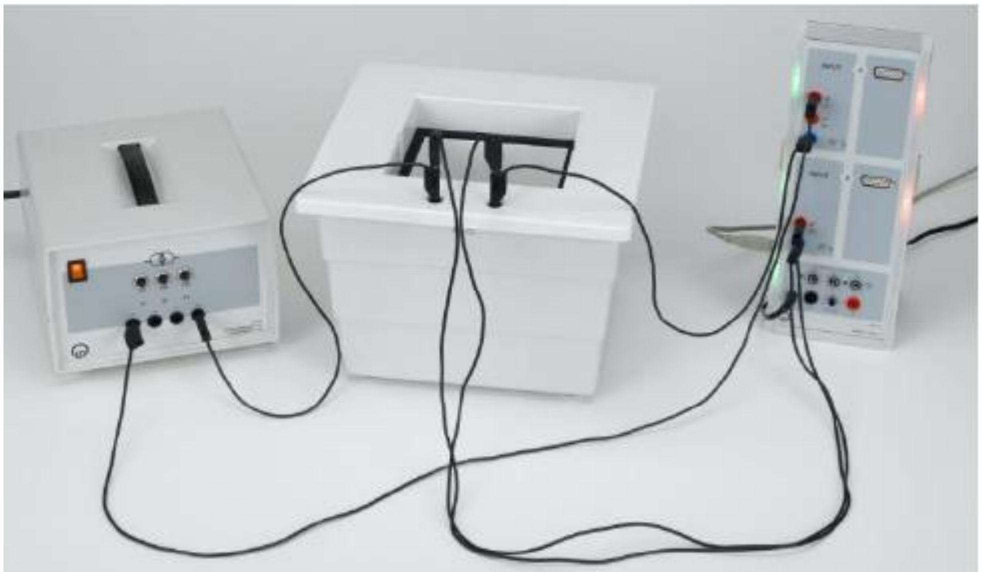


Figure 4. ***Determining the power of electrichob***

Necessary tools and items

Calorimetric camera, Building Materials for Calorimetric camera, Transformer 2 12 V; 120 W, Sensor-CASSY 2, CASSY Lab 2, NiCr-Ni Adapter S, Type K, NiCr-Ni - temperature sensor, 1.5 mm, Type K, Connecting wires 19 A, 50 cm, black, pair, Connecting wires 32 A, 100 cm, black, ice, thin plastic film and PCs Windows XP / Vista / 7/8.

Figure 4 shows the experimental device. It is usually necessary to determine the power P of the hob before starting the experiment. To do this, connect the calorimetric chamber for a short time without a plate of building material.

- Place the hob in the calorimeter chamber. But don't connect the transformer yet!
- Connect the transformer and the calorimeter chamber to the CASSY sensor (Sensor-CASSY) to measure the voltage and current as shown in Figure 4.
- b) Measure the temperature

Figure 1 shows the experimental device.

- ✓ The hob is placed in a calorimetric chamber.
- ✓ Wood chips are prepared for placement in a calorimetric chamber.

✓ Aluminum contact discs are installed inside the circular grooves for mounting on the wood chipboard, using heat-conducting paste. When installing, make sure that the mark made on the contact disc matches the line in the slot.

✓ Use only heat-conducting paste when installing contact discs.

✓ Carefully, without bending, fasten the two aluminum plates together by placing a thin aluminum plate (0.3 mm thick) on the black side of the building material sample with the heat-conducting paste on the outside.

✓ Do the same for the other side of the building material sample.

✓ Carefully slide the tip of the temperature sensor through the hole in the rubber stopper (diameter 1.5 mm) without bending. Don't install it on a calorimeter camera yet!

✓ Install the finished building material sample in an open chamber and place the temperature sensors on the base and on the sample. If you need to lift a sample of building material, use a hook.

✓ Using the adapter NiCr-Ni S, connect the temperature sensor to the SASSU as shown in Figure 3.

✓ Connect the transformer to the hob. Don't start the transformer yet!

✓ Cover the calorimeter chamber with a thin, waterproof plastic film (such as a plastic wrap). Place the bag of ice cubes on top of the aluminum plate. Make sure that water does not enter the camera or come in contact with the cables.

Notes: The box should not be too small. The ice should be in as close contact with the aluminum plate as possible. The smaller the ice cubes, the better the ice will contact the building material. A heavy object that can be placed in a box without damaging it is also useful.

Procedure for conducting the experiment

a) Power measurement

• Upload laboratory settings to CASSY (CASSY Lab 2).

• Connect the calorimetric chamber to the transformer according to the selected pattern.

• Start the transformer, monitor and record the voltage UB1 and current IA1 on the screen.

• Record the power P.

• Switch off the transformer.

Note: During the measurement, the transformer must be connected for as short a time as possible. After that, wait until the hot plate cools to room temperature.

Technical safety

a) Do not allow the calorimeter chamber, wall materials or building material samples to heat above 60 ° C.

b) Measure the temperature

• Upload laboratory settings to CASSY (CASSY Lab 2).

Note: If necessary, check the temperature sensors before installing them on the measuring chamber. To do this, place them in an object with the same temperature, for example, in stagnant water or in a CASSY Lab 2 to determine if they show the same temperature.

• Monitor changes in both temperature sensors.

• Wait until the lowest temperature does not change.

Note: Depending on the ice temperature, this may be appropriate if the temperature is much lower than 0 °C. This temperature should be kept as constant as possible during the measurement, it is recommended that the temperature be between -2 °C and + 4 °C.

• Start the transformer. Don't start measuring yet.

• Observe changes in both temperatures and wait until higher temperatures begin to rise.

• Start with.

• As the internal temperature begins to rise, the external temperature under the ice remains constant. If the outside temperature exceeds 0.5 ° C, improve contact with ice. If necessary, repeat such corrections during the measurement.

• If the internal temperature reaches 60 ° C, turn off the transformer and repeat the experiment at a lower voltage or power.

• If the internal temperature is too slow or does not change (or changes by about 0.15 ° C per minute), the measurement may be stopped.

• Unplug the transformer.

Note: When disassembling, first remove the temperature sensors and then remove a sample of the building material using the hook handle.

Experimental example

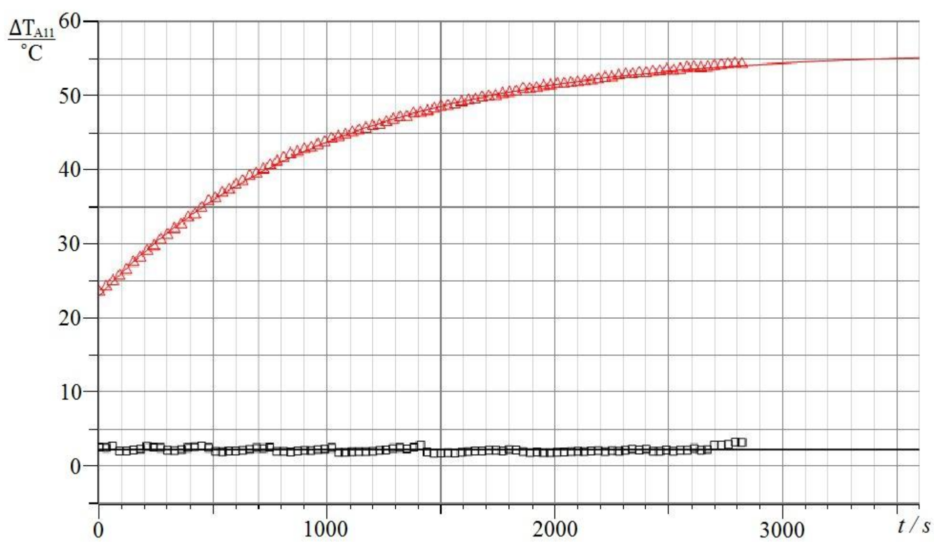


Figure 5. ***shows the temperature change over a long period of time for a wood chips sample.***

The temperature was determined by adjusting T_{A11} from the T_{IM} internal temperature (sample base temperature) curve. A continuous line is a function derived from an exact alignment. The mean value of the low outside temperature (the icy top of the sample) gives T_{A12} temperature.

It serves to calculate the temperature difference.

$\Delta T = T_{IM} - T_{sovuq}$

The final results of the experiments. The value of λ_T is obtained from the product manufacturer.

$\lambda_T = 0{,}07 \div 0{,}17\ W/(m \cdot K)$.

The lower the thermal conductivity, the higher the internal temperature. It should be noted that to achieve such a temperature, wood chips require much higher strength than other materials (Polystyrene, Fermacell (gypsum) and Roxasell (insulation material)).

When we solve this problem experimentally, it turns out to be smaller than its real value. In this case, we take into account that the transmitted energy P corresponds exactly to the heat flux.

The calculated thermal conductivity is always higher than the actual thermal conductivity. This can be explained by heat loss. In the calculations, the electric power P is taken to be exactly equal to the heat flux.

To calculate the thermal conductivity λ

$P = \lambda \cdot \frac{S}{d} \cdot \Delta T$ ga egamiz.

However, during the measurement, only the heat flux $\frac{\Delta Q}{\Delta t}$ passes through the sample, and therefore for real thermal conductivity

$$\frac{\Delta Q}{\Delta t} = \dot{Q} = \lambda_{real} \cdot \frac{S}{d} \cdot \Delta T.$$

will have

From this we obtain the following

$$\lambda = \lambda_{real} \cdot \frac{P}{\dot{Q}}$$

The heat flux $\dot{Q}$ passing through the plate is less than the electric current P, so the $\frac{P}{\dot{Q}}$ ratio is greater than 1. Therefore, the measured thermal conductivity is greater than the actual thermal conductivity.

Therefore, given that the transmitted electrical energy P does not correspond to the exact heat flux, the measured thermal conductivity λ is greater than the real thermal conductivity λ_{real}.

The use of such issues in the classroom and in extracurricular activities contributes greatly not only to the formation of students' knowledge of physics but also their skills and competencies.

RESULTS AND DISCUSSION

It is known that there are theoretical and practical methods of teaching physics. Among the practical methods, the importance of solving problems in physics is significant. The problem-solving process provides an analysis of ways to address important issues such as student development as well as student development, as well as educating students.

The main purpose of the interconnected laboratory and practical training in solid state physics, first of all, the theoretical calculation of students and pupils in solving problems in solid state physics, and the results of laboratory work were analyzed. . Students will gain the skills, abilities, and experience not only to solve problems, but also to solve them in the laboratory and apply them in real life. It also expands students' knowledge, thinking skills, and outlook. He then uses the knowledge, skills and abilities he has acquired in his future endeavors. **[5]**

Solving problems related to solid state physics was considered. When analyzing the difference between the methods of problem solving, experimental problems solved by abgebraic calculations and the results obtained in the laboratory, the problems of "Specific heat capacity of solids" and "Coefficient of thermal conductivity of solids" were solved theoretically and experimentally. The difference in calculations was studied. **[6]**

CONCLUSION

In the process of solving problems related to the physics of solids, students' logical thinking expands, their creative abilities develop. They have a broader understanding of the nature of physical phenomena, a deeper understanding of the application of the laws of physics in practice. They will become familiar with the function, structure, and working principles of many physical measuring instruments, and will have the skills and abilities to work with them. The issues also teach students hard work, courage, and broaden their horizons.

According to an analysi of many methodological literatures, a problem that can be solved by logical reasoning, mathematical operations, and the laws of physics and by methods is usually called a physical problem. To solve a physical problem is to solve a problem.

Problems in solid state physics are classified on various grounds. For example, depending on the level of complexity of the problem, simpler problems, more difficult problems, less familiar situations than described in the context of the problem, the textbook and the topics covered in the lesson, are problems that students can use to gain new knowledge. **[7]**

Depending on the nature of the problem, it can be about the mechanical, electrical, magnetic, or optical properties of solids, and so on. We know that such a division is conditional, because we often use data from several branches of physics in the context of a single problem. Experimental and laboratory methods were also used to solve the problems.

The methods described in this article were developed by the authors of the Tashkent State Pedagogical University named after Nizami "Methods of teaching physics and astronomy" for 1st and 2nd year students in "General Physics" and 4th year students in "Methods of solving problems in physics." and in the academic lyceum of the university in the process of teaching "Physics" and achieved positive results.

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