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METHODOLOGY FOR USING VIRTUAL LABORATORIES IN THE GENERAL SECONDARY EDUCATION PROCESS (BASED ON THE 9TH GRADE PHYSICS TEXTBOOK)

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ABOUT ARTICLE

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Abstract: The Presidential Decree No. PF-134 of the Republic of Uzbekistan on the approval of the National Program for the Development of School Education for 2022-2026 outlines several key tasks aimed at enhancing educational resources. Among these, it emphasizes the creation of textbooks, workbooks, and educational manuals for upper-grade students by September 1, 2024. Additionally, it mandates the implementation of specialized electronic systems (such as S-testing, Onlinedu, digital textbooks, etc.) for assessment and teaching, as well as the development of 10 mobile electronic resources and 100 multimedia products for new generation textbooks [1].

INTRODUCTION

The Presidential Decree No. PF-134 of the Republic of Uzbekistan on the approval of the National Program for the Development of School Education for 2022-2026 outlines several key tasks aimed at enhancing educational resources. Among these, it emphasizes the creation of textbooks, workbooks, and educational manuals for upper-grade students by September 1, 2024. Additionally, it mandates the implementation of specialized electronic systems (such as S-testing, Onlinedu, digital textbooks, etc.) for assessment and teaching, as well as the development of 10 mobile electronic resources and 100 multimedia products for new generation textbooks [1].

One of the crucial aspects of this decree is the digitization of the education system, which includes enriching interactive virtual learning platforms (like SmartLand, Edumarket, etc.) with content aimed at developing students' knowledge and skills through educational games. Furthermore, it assigns the

task of preparing scientific-popular short animated video clips (Edukids) for students in general secondary education institutions.

Currently, laboratory equipment for nearly all general secondary schools in our Republic is being supplied by "Elxolding" Limited Liability Company. However, challenges have arisen in conducting laboratory exercises with these tools. Over time and with repeated use, this equipment often becomes unusable, creating difficulties for teachers in conducting laboratory sessions and subsequently hindering the development of students' experimental competencies.

In light of this, during an era where information is increasingly digitized, cloud technologies can be utilized to foster students' experimental competencies. To this end, laboratory activities outlined in the 9th-grade physics textbook can be organized in two distinct ways within general secondary education institutions.

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Firstly, laboratory activities can be conducted with the participation of the teacher during the lesson; secondly, these activities can be assigned to students as tasks without the teacher's direct involvement. By implementing both scenarios, we can effectively develop students' experimental competencies.

METHODOLOGY

What is a "virtual laboratory"? According to V.V. Truxin, a virtual laboratory is a collection of software and hardware that enables the execution of experiments without direct interaction with actual setups or in their absence [3,4]. In the first case, we deal with laboratory configurations that are accessible remotely, which include software and hardware tools for managing real laboratories, as well as communication tools for digitizing the collected data. In the second case, all processes are modeled using computer simulations [3].

Akhmedov posits that before allowing students to conduct laboratory work, they should first complete theoretical topic-related tests. After the teacher assesses the student’s preparedness through this testing process, permission is granted to proceed with the laboratory work. This approach not only ensures that students do not take laboratory tasks lightly and treat the necessary equipment with utmost care but also enhances their sense of responsibility towards laboratory work. Such measures,

once acknowledged by the teacher regarding the theoretical preparedness level, contribute to improving the overall quality indicators of education [2].

RESULTS

Laboratory activities assist school students in analyzing theoretical knowledge and gaining a comprehensive understanding of physical laws. Laboratory work is an integral component of studying physics and other natural sciences. Furthermore, the use of virtual laboratories, animations, and simulators in lessons proves to be highly promising. Therefore, integrating virtual laboratory activities into the physics curriculum for ninth-grade students in general secondary education institutions will enhance the effectiveness of teaching.

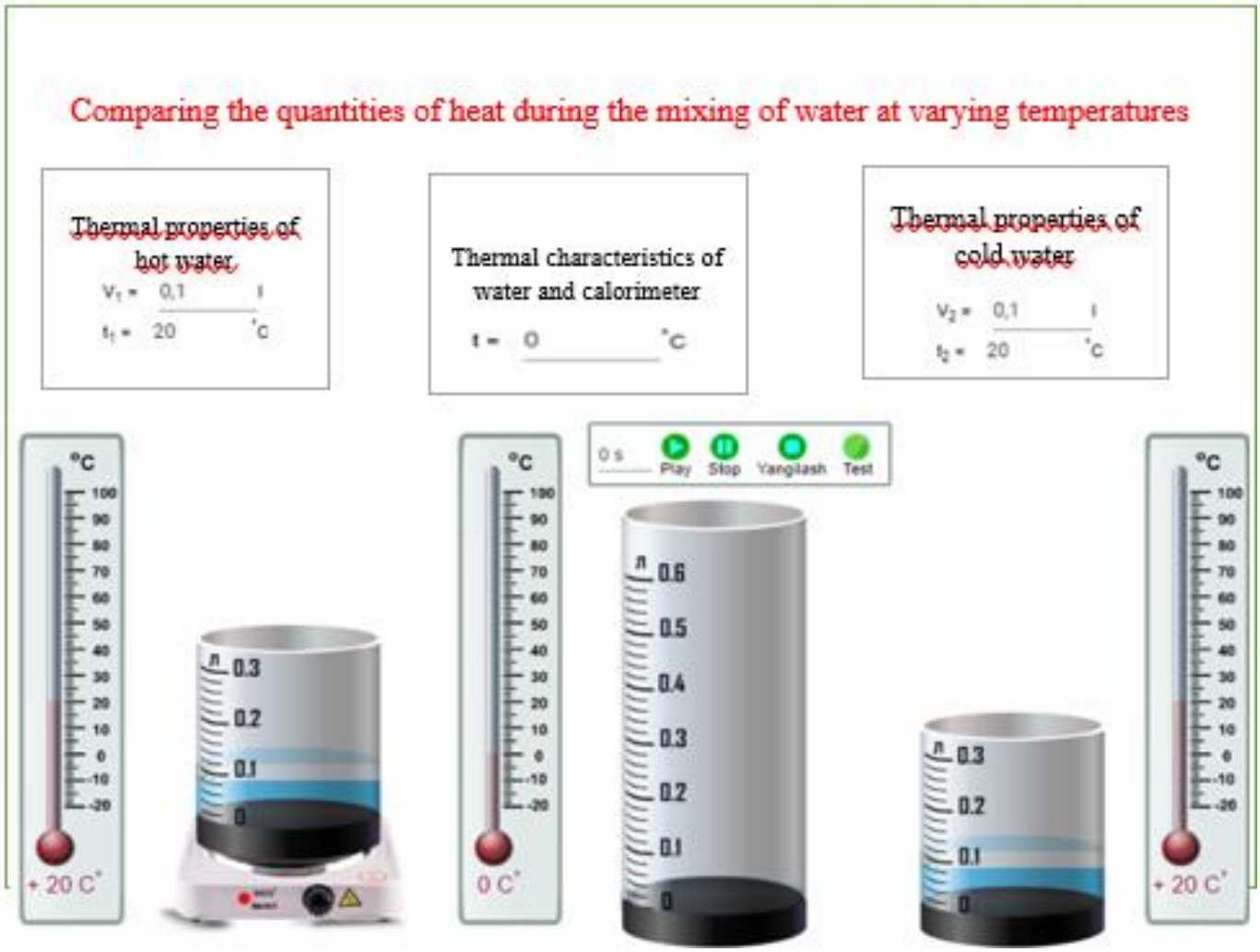
In elucidating the methodology for utilizing virtual laboratories, we will outline the procedure for conducting the laboratory work on the topic “Comparing Heat Quantities in Mixing Water at Different Temperatures,” as presented in the ninth-grade physics textbook.

Laboratory Work: Comparing Heat Quantities in Mixing Water at Different Temperatures (http://nuclearphys-edu.uz/html5/33/index.html)

Objective of the Work: To verify the heat balance equation by comparing the heat quantities exchanged between hot and cold water and interpreting the results.

Required Equipment and Materials: Calorimeter, two water containers, three thermometers, electric heater, power supply.

Picture 1



1. Place the container with hot water on the electric stove and calculate its mass using the appropriate formula.

2. Record the initial temperature of the hot water in the container.

3. Activate the electric stove and wait for the water to heat up to the desired temperature.

4. To obtain the temperature of the hot water, you can stop the heating by turning off the electric stove.

5. Pour the heated water into the calorimeter.

6. Using a measuring cylinder, prepare a specified volume of cold water and calculate its mass using the appropriate formula.

7. Record the initial temperature of the cold water in the measuring cylinder.

8. Pour the cold water into the calorimeter containing the hot water and measure the equilibrium temperature of the mixture.

9. You can obtain the desired temperature of the mixture by pressing the "Stop" button.

10. Calculate the amount of heat transferred from the hot water to the mixture using the appropriate formula, considering the specific heat capacity of water.

11. Calculate the amount of heat absorbed by the cold water in the mixture using the appropriate formula.

12. Vary the masses of both hot and cold water, and repeat steps 1 and 10 three times in accordance with this procedure.

13. Record all measurements and calculations in Table 1 below.

Laboratory results

Table 1

№	c, $J/kg \cdot K$	m_1, kg	t_1, °C	t, °C	Q_1, J	m_2, kg	t_2, °C	Q_2, J
1	4200	0,1	50	35	6300	0,1	20	6300
2		0,2	45	35	8400	0,2	25	8400
3		0,3	50	35	18900	0.3	20	18900

14. To restart the experiment, click the “Refresh” button.

15. To assess your understanding, click the “Test” button and evaluate your performance regarding the laboratory work.

16. Draw a conclusion based on your findings.

Control Questions

1. Compare the values of heat quantities obtained from measurements and calculations. Why is it necessary to fulfill this condition?

Comparing the values of heat quantities derived from measurements and calculations is essential for verifying the accuracy and reliability of experimental results. If this condition is not met, it may lead to erroneous conclusions.

2. Why can we use the temperature difference measured on the Celsius scale instead of the absolute temperature difference in the heat quantity formula?

The temperature difference measured on the Celsius scale can be used instead of the absolute temperature difference because the difference remains consistent regardless of the scale. This simplification facilitates calculations while still yielding valid results.

3. What is meant by the heat balance equation?

The heat balance equation refers to a mathematical expression that accounts for all heat entering and leaving a system, adhering to the law of conservation of energy.

4. How does heat transfer from hot water to cold water?

Heat transfers from hot water to cold water through conduction, convection, or radiation. These processes ensure that thermal energy flows from areas of higher temperature to areas of lower temperature.

CONCLUSION

In conclusion, utilizing virtual laboratories can enhance students' comprehension levels by approximately 10%, while also reducing the time required to complete laboratory tasks by 10-30%. After obtaining results, identifying errors, and drafting reports, students can cross-check their findings with those of their instructor. If mistakes are identified, they can re-evaluate their results or review their methods to correct any discrepancies. This practice fosters independent analysis, self-improvement, and the ability to draw valid conclusions from errors.

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