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Electricity on Paper

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Abstract. The paper proposes a practical cycle of classes on electricity at school. The main goal of these classes is to form students' interest in physics and electronics, as well as acquaint them with the basics of building electrical circuits and their main components.

Keywords. STEM Education, Entertaining Circuitry, Practical Electricity Classes with Schoolchildren.

1. Introduction

Currently, the highest priority is STEM education, which covers the natural sciences, technology, engineering and mathematics [1-2]. The STEM learning space is a combination of new teaching technologies and flexible learning environments, and is designed to arouse children's curiosity and provide them with interesting learning materials. The main difference of the STEM approach is that children use their brains and their hands to successfully study a variety of subjects. Important components are self-preparation and the ability to work in a team.

As part of the implementation of STEM education in elementary school (grades 2-4), a practical cycle of classes in electricity is offered.

2. Practical classes on electricity with students

For classes use notebooks printed in them assembly electrical circuits. There are more than twenty different schemes with a description of the devices in which they can be used, as well as with the description, in a form accessible to children, observable physical phenomena, or phenomena on which the work of the components of the scheme is based. In addition, instructions for work and various clues are placed in notebooks, each work contains test questions and tasks for self-preparation.

In addition to notebooks, before each work, children receive a corresponding set of components used in the circuit, a conductive copper tape, a power source (3 V) and the simplest device for checking the presence of voltage in different parts of the circuit to be assembled. This device consists of a wire, colored needle tips, and an active buzzer that beeps when voltage is present.

On the assembly of one scheme, there are several classes. At the beginning of each lesson, the teacher works with the whole class: talks about a new electrical circuit; discusses issues that arise when assembling circuits; checks the performance of tasks for self-preparation. After this, the class is divided into groups of four people and the practical part of the lesson begins. Children distribute the responsibilities of each of the group members and start work; in the next classes, the duties are redistributed, which allows everyone to express themselves in different types of work.

Assembling the circuit is as follows. Cut off the pieces of copper tape of the required length. One side of the adhesive tape is dielectric sticky, the second is copper conductive. The adhesive side is glued to the paper, the components of the circuit and the power source are fixed on the conductive side, according to the assembly diagram, instructions for work and prompts. Copper tape is also used for fastening. The presence of voltage in different parts of the circuit, during assembly, is monitored by a device with a buzzer.

At the first lessons of this cycle, a galvanic battery GB (3 V) is used as a power source. Subsequently, children are introduced to renewable energy sources - solar batteries, in addition, ionistors (electrolytic capacitors with high capacitance) are proposed to use as accumulators of electrical energy [3].

Children assemble a simple device consisting of solar batteries and connected to them for charging ionistors (10 F). Later in the classroom, ionistors are used, which the children, if necessary, charge and use as a power source.

The proposed schemes in the classroom are arranged in a sequence from simple to complex. Simple schemes are replaced by more complex, in addition, in each work uses a new element in the scheme, with which you can

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create more complex devices. For example, Figures 1 and 2 show electric flashlight circuits, the first one uses the usual red LED HL1, the second uses the RGB LED, which can emit different colors: the three primary colors and their combinations depending on the position of the S1 - S3 switches.

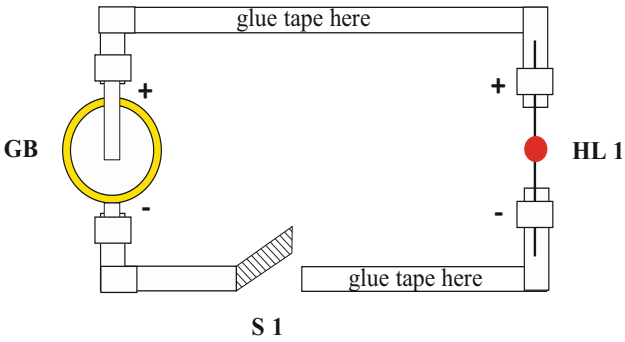

Figure 1. Flashlight

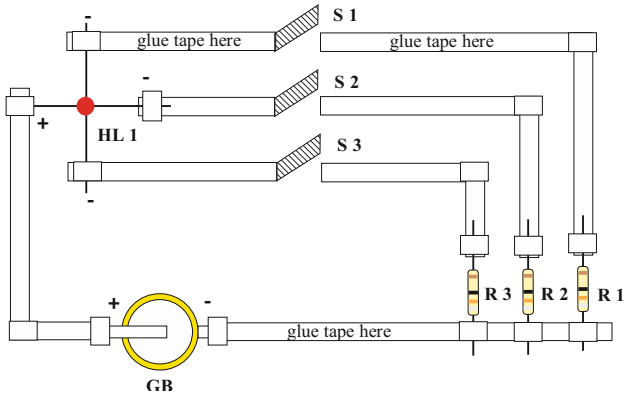

Figure 2. Multicolor flashlight

3. Conclusions

The idea of using copper conductive tape for building electrical circuits is not new, there are similar kits for sale [4]. The originality of this work is as follows:

- it is proposed to use copper conductive tape for assembling electrical circuits in notebooks (electricity on paper) during the practical training cycle in elementary school as part of the implementation of STEM education;
- describes the general algorithm for conducting classes in the classroom, the proposed work of children in groups of four with the distribution of responsibilities and the interaction of group members. This approach is necessary for the development of teamwork skills;
- in the classroom, children use their brains and hands. Developed fine motor skills in children 8 - 10 years old, when working with copper tape; the use of the simplest instrument to check for the presence of electrical voltage develops research abilities;
- renewable energy sources (solar panels and ionistors) are used as power sources in electrical circuits.

The proposed practical cycle of classes in electricity in elementary school is propaedeutic and precedes further activities with children on digital electronics and devices based on them in high school.

4. References

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