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# Research on Experimental Education for Measuring Metal Resistivity

**Yiwei Wang[1], Jinguang Zhu[1], Chenwei Li[2], Defeng Zhang[1]**

*[1]Second High School of Hohhot, Hohhot, 010020, Inner Mongolia, China*
*[2]Affiliated High School of Inner Mongolia Normal University, Hohhot, 010020, Inner Mongolia, China*

***Abstract:*** *Education, as an important part of national economic development and the main method for cultivating specialized talents, plays a leading role in promoting the construction of ideological and moral civilization and socialist construction with Chinese characteristics. Based on this, this paper takes the experiment of measuring metal resistivity in high school physics teaching as the main research object, analyzes the method of detecting metal resistivity, further standardizes the detection process of metal resistivity, improves the accuracy of daily detection data, comprehensively enhances students' physics knowledge, and promotes the sustainable development of education.*

***Keywords:*** *High school physics; Measuring metal resistivity; Experimental research*

## 1. Introduction

Resistivity is a special physical quantity that can show various characteristics of resistance in materials. By applying a certain special material, it can be made into a conductor with a cross-sectional area of 1 $m^2$ and a length of 1 m. In numerical terms, it is equivalent to the resistivity of this material, which accurately reflects the resistance of the material to the flow of electric current. We often use experimental tools to measure the resistivity of metals in testing. Currently available detection techniques mainly include measurement systems, testing bases, heating and cooling mechanisms, and racks. Among them, the heating and cooling mechanism passes the cooling box, temperature control box, and heating furnace through the heating furnace vacuum tube and sets it on the top of the rack, supported by the lead screw nut transmission mechanism. After heating and testing the resistivity, it should be cooled in the cooling box as soon as possible to control the test time reasonably, or after heating the sample, the change of resistivity during cooling should be measured to further expand its convenience of application. However, from the current actual application situation, there is no need to manually adjust in the measurement process, and the performance of the experimental teaching is poor. It is urgent to solve this problem by a new type of experimental tool to improve students' learning effects.[1]

## 2. Analysis of a New Type of Experimental Tool for Measuring Metal Resistivity

The main purpose of this paper is to provide a new type of experimental tool for measuring metal resistivity to solve the problems in the existing technology. Firstly, the new experimental tool mainly includes a box, heat insulation strips, fixing plates, and metal bodies. The staff should install the top cover on the top of the box and set an observation window on the front outer wall. The side outer wall of the heat insulation strip should be divided into fixed resistance part, power supply part, and measurement part. The fixing plate should install the metal body on the top outer wall and connect the fixed resistance, metal body, power supply part, and measurement part to each other. At the same time, in the actual implementation plan, the measurement part consists of a voltmeter, a first support plate, an ammeter, etc. The voltmeter and ammeter should be fixed by bolts and set on the top outer wall of the first support plate. The power supply part has a switch, a second support plate, a power supply, etc., which are fixed by bolts on the top outer wall of the second support plate. The fixed resistance part has a sliding rheostat and a third support plate, and the sliding rheostat is fixed on the top outer wall of the third support plate by bolts. The two ends of the voltmeter are connected to the second conductor, and one end of the second conductor is connected to the metal body to form a sound parallel circuit. The two ends of the sliding rheostat are equipped with a third conductor, and the two ends of the third conductor are respectively connected to the switch and ammeter.[2] One end of the power supply is

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inserted into the first conductor, and the power supply is connected to the ammeter, metal body, switch, sliding rheostat, and power supply through the first conductor and third conductor to form a series circuit (as shown in Figure 1). The inner wall of the box is fixed with an electric heater by bolts, and the top outer wall of the top cover is set near the electric heater, with the corresponding temperature measuring device installed.

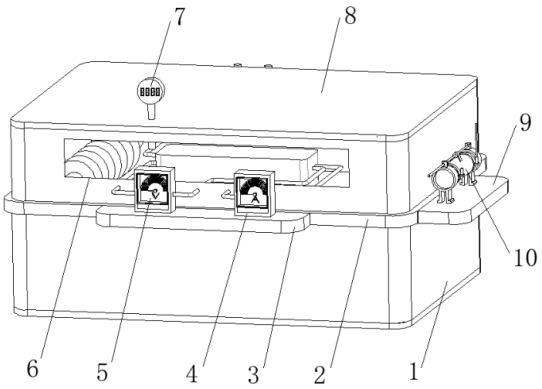


*Figure 1: Experimental Apparatus A for Measuring Metal Resistivity*

The new experimental apparatus for measuring metal resistivity involves first using measuring tools to obtain data such as metal length and diameter, then calculating the specific cross-sectional area and connecting the relevant circuits. The specific voltage and current values are measured using a voltmeter and ammeter. The metal body resistance R is detected using the volt-ampere method. Meanwhile, the resistivity is calculated using the resistivity formula, allowing students to independently perform calculations, which helps obtain accurate metal body resistivity. After multiple attempts, the average value of the metal body resistivity can be calculated. By increasing the temperature of the electric heater and using a temperature measuring device, the changes in metal body resistivity at different temperatures are measured to obtain accurate experimental data.It is important to note that in high school physics experimental teaching, teachers should be aware that students are the main participants in the entire experiment. Therefore, teachers can use a reverse approach to show the experimental results in advance, organize students to freely create experimental procedures and plans to verify the experimental results. In the specific process of conducting biology experiments, teachers can divide the whole class into several small groups and assign corresponding experimental tasks based on the situation of each group. This guides students to deduce the entire experimental process based on the experimental results and record the required materials and detailed plans, which are then submitted to the teacher for review. Regarding each group's submitted experimental plan, the teacher should conduct a comprehensive analysis and study to assess whether students have mastered the experimental plan, laying a solid foundation for students to conduct biology experiments in the later stages. During the entire experimental process, the teacher should play the role of an observer and not blindly interfere with the progress and procedure of the experiment. Only when students need help should appropriate guidance be provided [3].

## 3. Specific Implementation Method

### *3.1. Basic Structure of the Experimental Apparatus*

Due to the drawbacks of the existing experimental apparatus for measuring metal resistivity, which requires computer calculations and lacks manual adjustment during measurement, it severely reduces the performance of experimental teaching [4]. In response to this research, this paper provides a new type of experimental apparatus for measuring metal resistivity. It allows manual calculations to obtain the metal body resistivity and calculates the average value after multiple experiments. By increasing the temperature of the electric heater and using a temperature measuring device, the changes in metal body resistivity at different temperatures can be measured to obtain accurate experimental data. This effectively solves the problems of the existing experimental apparatus for measuring metal resistivity (as shown in Figure 2).

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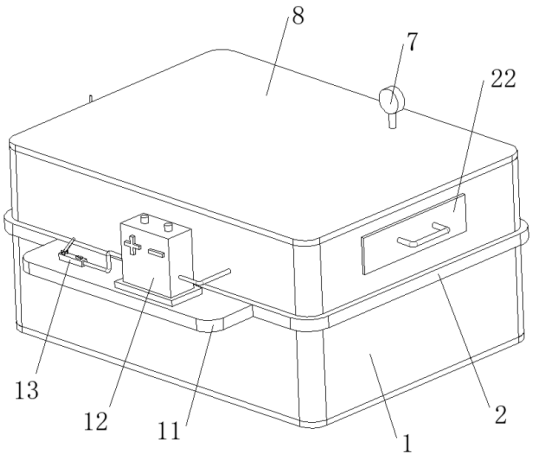


*Figure 2: Experimental Apparatus B for Measuring Metal Resistivity*

The new experimental apparatus mainly includes a box body, insulating strips, fixing plate, and metal body. The working personnel should install a top cover on the top of the box body and set an observation window on the front outer wall. The insulating strips should have fixed resistance section, power supply section, and measurement section on the side outer wall. The metal body is installed on the top outer wall of the fixing plate, and the fixed resistance section, metal body, power supply section, and measurement section are interconnected [5].

(1) The measurement section consists of a voltmeter, ammeter, and supporting plate. The voltmeter and ammeter should be fixed with bolts and set on the top outer wall of the first supporting plate. By setting the ammeter and voltmeter, the actual voltage and current values can be accurately detected, which is beneficial for the working personnel to use the volt-ampere method to measure the actual resistance.

(2) The power supply section consists of a switch, second supporting plate, and power supply. The power supply and switch should be fixed with bolts and installed on the top outer wall of the second supporting plate. By setting the power supply and switch, when the switch is closed, the entire circuit can be automatically connected, fully exerting the effect of power supply, and facilitating the working personnel to measure the actual resistance and calculate the resistivity in the later stage.

(3) The fixed resistance section consists of a sliding rheostat and third supporting plate. The sliding rheostat should be fixed on the top outer wall of the third supporting plate with bolts. By setting the sliding rheostat, it can be used as a fixed resistor to adjust the specific resistance value reasonably.

(4) The two ends of the voltmeter are connected with the second wire, and one end of the second wire is connected to the metal body, forming a complete parallel circuit. By connecting the voltmeter and the metal body in parallel with the second wire, the actual voltage value can be accurately measured.

(5) The two ends of the sliding rheostat are connected with the third wire, and the two ends of the third wire are respectively connected to the switch and ammeter. By using the third wire, the entire circuit can be closed, which is beneficial for the working personnel to measure the actual resistance value.

(6) One end of the power supply is plugged into the first wire, and the first wire and third wire are used to connect the ammeter, metal body, switch, sliding rheostat, and power supply, forming a series circuit. By setting the series circuit, the subsequent experimental operation can be realized [6].

(7) The inner wall of the box body is fixed with bolts for the electric heater, and the top outer wall is set near the electric heater for installing the corresponding temperature measuring device. By setting the electric heater, students can measure the resistance value of the metal body at different temperatures after heating.

(8) A vent is installed on the outer wall of one side of the box body, and the vent is ensured to be at a distance from the electric heater position. Inside the vent, a heat dissipation net is installed, and a pull plate is set on the outer wall of the vent. By setting the heat dissipation net, heat dissipation can be carried out in the box after opening the clamping plate. In addition, a rubber pad is installed on the

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outer surface of the bottom of the box body to increase the overall support effect of the entire device (as shown in Figure 3).

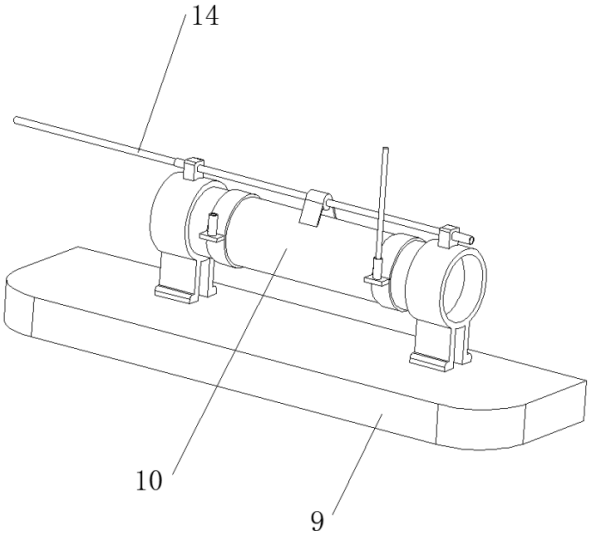


*Figure 3: Composition of the New Experimental Apparatus*

### *3.2. Working Principle*

Currently, in high school biology teaching, teachers should base their approach on the new curriculum standards and consider students as the main participants in the classroom to carry out experimental teaching and ensure students' sustainable development. In this regard, biological questions play a crucial role in high school biology experimental teaching and serve as the premise for conducting experiments. Teachers should implement experimental teaching based on the course content, provide relevant precautions to students in advance, and guide students to expand their thinking by using questions as carriers for biology experiments. However, some teachers focus too much on organizing students to observe their own biological experiments and let students grasp the experimental phenomena through observation. This demonstration-style experimental approach cannot effectively inspire students' enthusiasm for learning, and students sitting in the back row may not be able to see the entire experimental process and thus cannot fully grasp the experimental phenomena. To address this issue, teachers can hand over the entire biology class to students, organize them to conduct biological experiments based on their own knowledge, especially in certain simple biological experiments. Teachers can prepare students in advance to bring alternative biological experiment materials found in daily life to the classroom. For example, in the teaching of measuring metal resistivity, after opening the top cover, students are required to place the metal body on the surface of the fixing plate, connect the power supply, switch, sliding rheostat, metal body, and voltmeter to form a complete circuit. This helps students measure the current and voltage of the metal body, and then use measuring tools to measure the length and diameter of the metal body to calculate the cross-sectional area. By applying the volt-ampere method, students can measure the resistance of the metal body. Additionally, by calculating the resistivity using the resistance formula and considering students' practical hands-on abilities and calculation methods, they can obtain the resistivity of the metal body. After conducting multiple experiments, data can be averaged to obtain more accurate results. Furthermore, by heating the electric heater and using a temperature measuring device to measure the temperature, students can record the changes in resistivity of the metal body at different temperatures and obtain corresponding experimental data [7].

## 4. Conclusion

In conclusion, experimental teaching is a crucial aspect of high school biology education and plays a key role in the overall biology teaching process. Through various biology experiments, students not only improve their practical skills but also identify their own weaknesses during the experimental process, thus comprehensively reinforcing their professional knowledge. However, there are still many challenges in current high school biology experimental teaching, mainly due to insufficient emphasis on experimental classes by teachers. Therefore, this study focused on the experiment of measuring

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metal resistivity and aimed to optimize biology experimental teaching based on students' actual conditions and use the correct teaching methods to achieve the desired teaching results.

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