Certification

Product Name: Electromagnetics laboratory box

Specification and model: ayst-01

Inspector: No.18

The product is allowed to leave the factory after passing the inspection

PHYSICAL ELECTROMAGNETICS EXPERIMENT

GENERAL INSTRUCTIONS

Pay attention:Different packages contain different products, this manual only for product awareness reference!

EDUCATION TECHNOLOGY CO., LTD. SHANDONG EINSTEIN
ADDRESS: NORTH OF WUHUA ROAD, HUADE BUILDING MATERIALS MARKET, SHENGDE STREET, LUOZHUANG DISTRICT, LINYI CITY, SHANDONG PROVINCE
TEL: 0539-8598118
MOBILE PHONE NUMBER: 15550938118 (SAMENUMBER ON WECHAT)

Electromagnetic experimental box is an effective solution for students studying junior high school physics. It is an educational subject involving physics teachers and researchers with senior and secondary titles who have many years of rich teaching experience. It is an effective method to solve the problem of students' independent inquiry learning under the new curriculum standard. It is composed of dedicated inquiry equipment (physical basis) for students and equipped with independent exploratory books (written information carrier), resources website downloads or CD-ROM version of computer software and other resources (multimedia information carrier). Therefore, it is an effective solution based on diverse methods for students to learn physics.

It is suitable for the inquiry-based curriculum teaching mode, which can stimulate students' interest in learning, cultivate and mobilize the potential of students to use their brains. At the same time, it enriches the form of teaching, improves the teaching level and the students' performance. The student's experimental inquiry learning material is a new multi-functional student appliance integrating teaching instruments, intelligent toys and school suppliers, so that students are not restricted by time and space and students' subjective initiative of learning are aroused. It is a golden key to start physics learning and it is a new product recommended by nation's new physics curriculum.

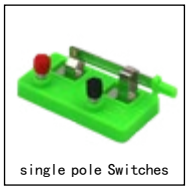
目录

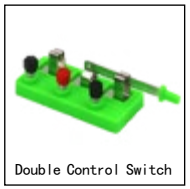
Know the products

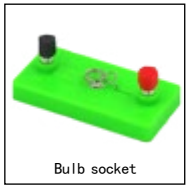

Ammeter

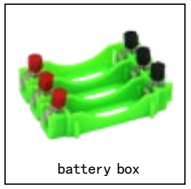

Voltmeter

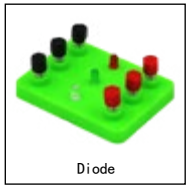

Sensitive ammeter

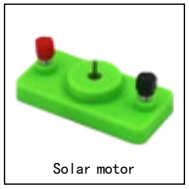

single pole Switches

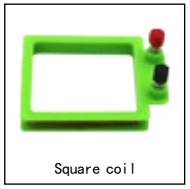

Double Control Switch

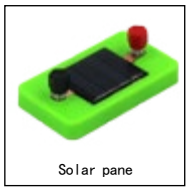

Bulb socket


battery box

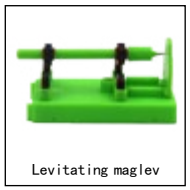

Diode

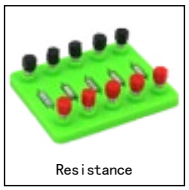

Solar motor

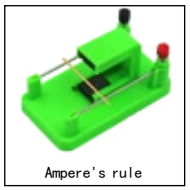

Square coil


Solar pane

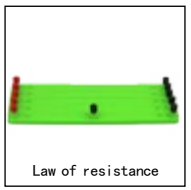

Buzzer


Levitating maglev

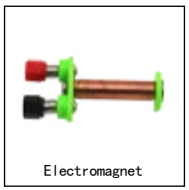

Resistance

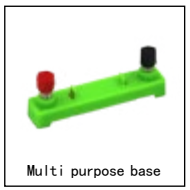

Ampere's rule

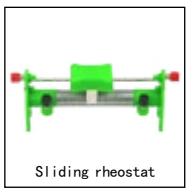

Wind powered car


Law of resistance

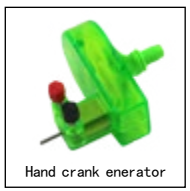

electric bell

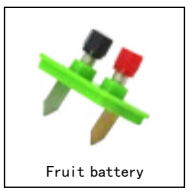

Electromagnet


Multi purpose base


Sliding rheostat

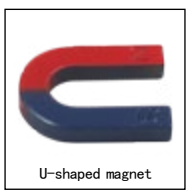

Little magnetic car

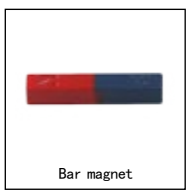

Hand crank enerator

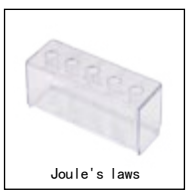

Fruit battery

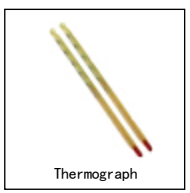

Electroscope


Compass


U-shaped magnet

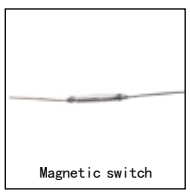

Bar magnet

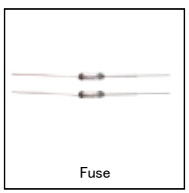

Joule's laws


Thermograph


Wires


Alligator clip wire


Magnetic switch


Fuse


LED

Different packages contain different products, this manual only for product awareness reference!

1. Electrification by static electricityfriction

1. Electrification by friction: as shown in Figure 1-1, after rubbing the rubber rod with fur, put the rubber rod close to the paper scraps, and it is found that the paper scraps are attracted. This phenomenon is called friction electrification.

2. The object after friction can attract the small object, which is the property of the charged object.

The law of the interaction of electric charges: As shown in Figure 1-2, make the rubber rod that has been rubbed with fur to get closer to the rubber rod that has been rubbed with another fur. Observe what will happens? Then do experiment with a glass rod rubbed with silk as shown in Figures 1-3, observe the phenomenon, and summarize the law: the same kind of charges repel each other, and the different kinds of charges attract each other.


1-1 Friction electrification phenomenon


1-2 Same charges repels each other


1-3 Different charges attract each other

2. Understanding electroscope and principle

Structure: An electroscope is an instrument that detects whether an object is charged and roughly estimates the amount of charge. The typical structure is shown in Figure 2-1 on the left. When the object under test touches the conductor on the top of the electroscope, the electric charge carried by itself will be transferred to the box in the glass bell jar.

Because charges of the same kind repel each other, and the boxes will automatically separate and open at a certain angle. According to the angle of the two boxes, the size of the object's charge can be estimated.

Principle: Use the same kind of charge to repel each other


2-1electroscope experiment

3. Simple circuit

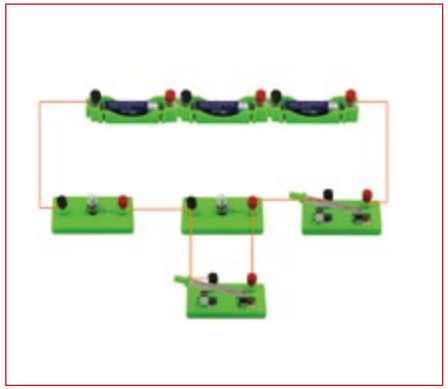
1. Use the battery box, battery, switch, bulb socket wire, etc., as shown in Figure 3-1, to form a basic circuit. When the switch is closed, the small bulb will light up, so the circuit is a path. As shown in Figure 3-2, the switch is open, and there is no point flow through the circuit, so the circuit is called disconnection or open circuit.

2. Short circuit: As shown in Figure 3-3, after the switch is closed, the current does not directly form a path through electrical appliances such as light bulbs. This is called a short circuit. Under normal circumstances, the circuit is not allowed to be connected in this way, and such batteries are quickly burned out. Short circuits in homes and industrial circuits can cause fires. As shown in Figure 3-4, one of the bulbs is short-circuited, also known as a partial short circuit.

3-1 Simple circuit

3-2 Simple circuit

3-3 Short circuit experiment



3-4 Partial short circuit

4. Understanding series parallel circuit and parallel circuit

In real life, we not only connect one bulb (electrical appliance) to the circuit, but also need to connect multiple bulbs (electrical appliance) to the circuit, which requires us to learn series and parallel circuits.

1. Series circuit: as shown in Figure 4-1, connect the bulb in the circuit in turn, such circuit is called series circuit;

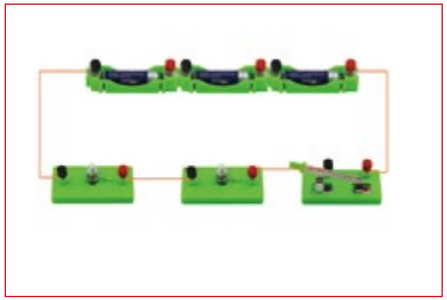


Figure 4-1 Series circuit 1

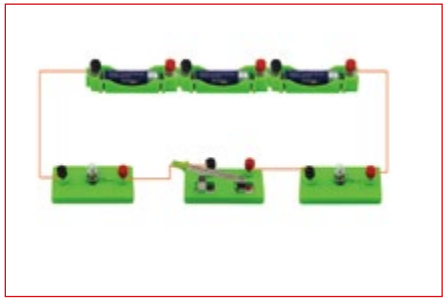


Figure 4-2 Series circuit 2

2. As shown in Figures 4-2 and 4-3, change the position of the circuit switch, observe what has changed in the circuit, and summarize what are the characteristics of the series circuit

Parallel circuit: As shown in Figure 4-4, the electrical appliances are connected in parallel in the circuit. Such a circuit is called a parallel circuit, and the current has multiple branch paths, and the path where each electrical appliance is located is called a branch circuit. The path that all branch circuit will flow through is called the main cruurent circuit , and connect the switches to the branch circuit and the main circuit respectively, and observe the characteristics of the parallel circuit.

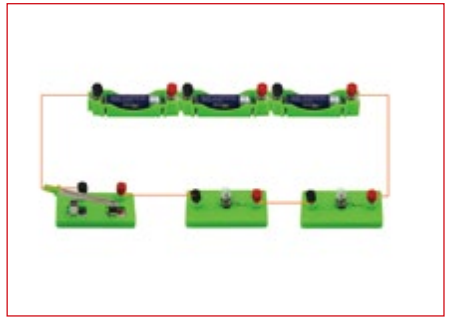


Figure 4-3 Series circuit 3

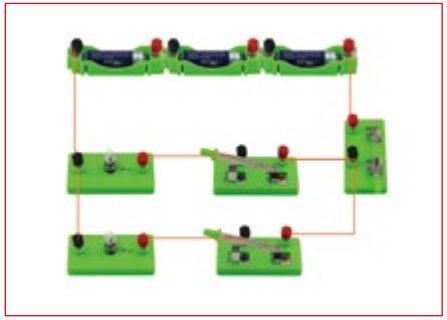


Figure 4-4 Parallel circuit

5. Measuring current with ammeter

1. Recognize ammeter: ammeter is an instrument to measure the amount of the circuit in the circuit path. The ammeter dial is marked with letter A. Three different terminals of ammeter can use two different ranges, and the selection of rangeshould be based on the estimated current;

2. When connecting the ammeter as shown in Figure 5-1, let themeasured current flow into red (positive terminal) and flow out from black (negative terminal)

3. As shown in Figure 5-2, it is absolutely not allowed to connect the ammeter directly to the positive and negative poles of the power supply. This is also a short circuit, which will burn the ammeter.

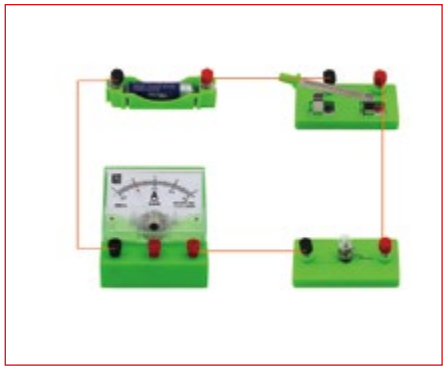


Figure 5-1 Measuring bulb current with ammeter

Figure 5-2 wrong connection

6. What are conductors and insulators

1. Conductors: objects that are easily conductive are called conductors.

2. Insulator: An object that is not easy to conduct electricity is called an insulator.

3. As shown in Figure 6-1, connect common items such as rubber, knife, coin, ruler to the electrical appliance, and observe whether the light bulb in the circuit lights up to judge whether it is a conductor or an insulator that is connected to the circuit.

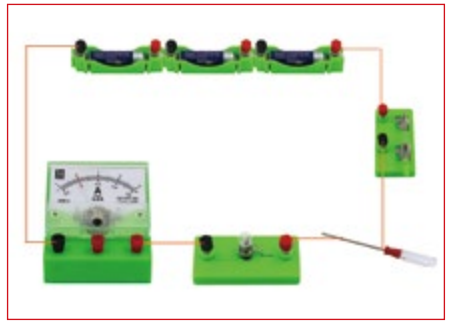


Figure 6-1 conductors and insulators

7. Circuit diagram

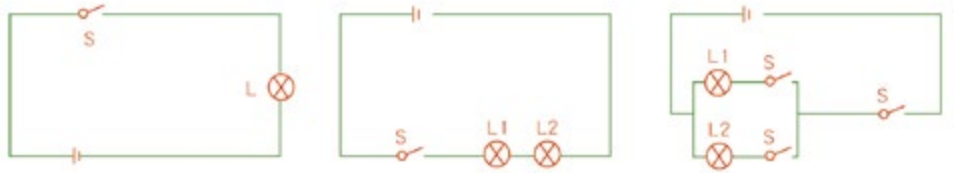
Setting up a building needs drawings. From life to science, there are various kinds of drawings. Drawings are the language of engineers all over the world. Circuit diagrams are also needed to design circuits. Circuit diagrams are diagrams that use agreed symbols to represent circuit connections. They are easier to communicate than real objects and can reflect circuit connections more clearly and intuitively.

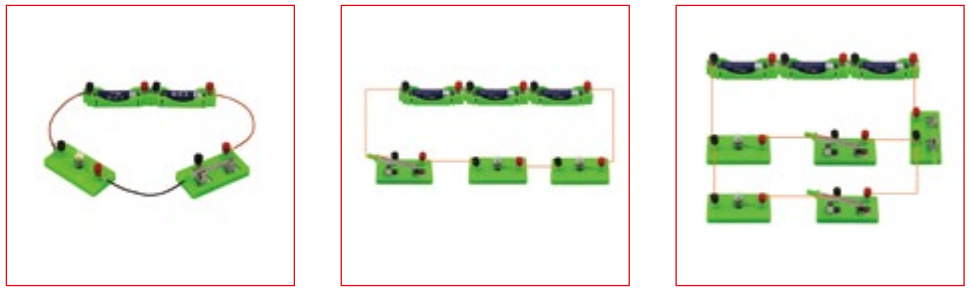
In junior high school, learning to recognize circuit diagrams, design and draw circuit diagrams is a key to learning electricity.

1. As shown in Figure 7-1, recognize each circuit symbol

2. The wires in the circuit are represented by straight lines,

It is generally horizontal and vertical to make the whole circuit work neatly. This is not only a question of aesthetics, but also the key point is to be clear and standard, convenient for communication, understandable. draw the following circuit diagram.





8. Explore the current law of series circuits

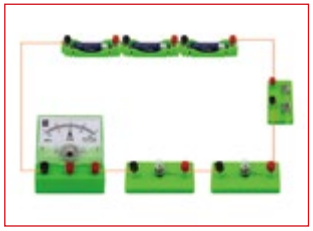
1. Connect the ammeter to A, B and C points in the series circuit as shown in figure 8-1, figure 8-2 and figure 8-3 respectively. Measure and record the current value:

Experimnent No	Current in point A	Current in point B	Current in point C
1			
2			

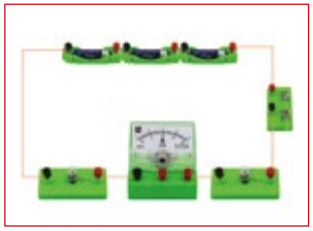
2. Repeat the above experiment with different bulbs, repeat the measurement and record the current.

3. Analyze and summarize the laws of the series circuit current.

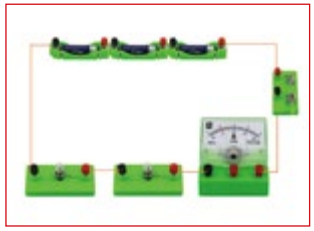
4. Unscrew one of the bulbs, close the switch to observe the circuit operation, and think about the reason.



8-1 Measuring the current in series circuit 1



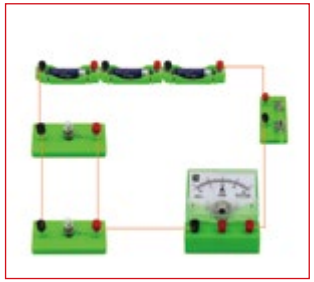
8-2 Measuring the current in series circuit 2



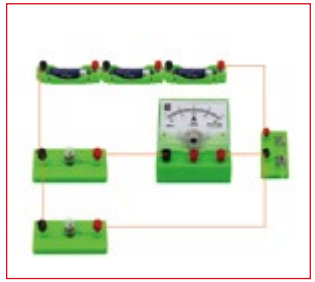
8-3 Measuring the current in series circuit 3

9. Explore the current law of parallel circuits

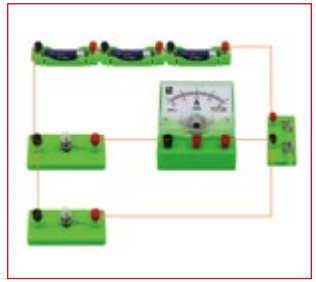
1. Connect the ammeter to A, B and C respectively as shown in Figure 9-1, Figure 9-2 and Figure 9-3, and measure and record the relationship of current.



8-1 Measuring the current in series circuit 1



8-2 Measuring the current in series circuit 2



8-3 Measuring the current in series circuit 3

Analyze and summarize the laws of parallel points, and you can draw the above conclusions.

Experimnent No	Current in point A	Current in point B	Current in point C
1			
2			
3			

10. Measuring voltage with voltmeter

1. The voltmeter is an instrument for measuring the voltage of the circuit. The letter V is marked on the dial of the meter. Like the ammeter, three different binding posts select different combinations to access the circuit, and there are two different ranges

2. As shown in Figure 10-1, connect the voltmeter at both ends of the small bulb of the electrical appliance, so the measured value is the working voltage at both ends of the bulb, as shown in Figure 10-2, if the voltmeter is directly connected to the two ends of the battery is the battery voltage.

3. Similar to the ammeter, the measured voltage cannot exceed the maximum range of the voltmeter, and the positive and negative terminals can not be reversed. Otherwise it will cause damage to the meter.

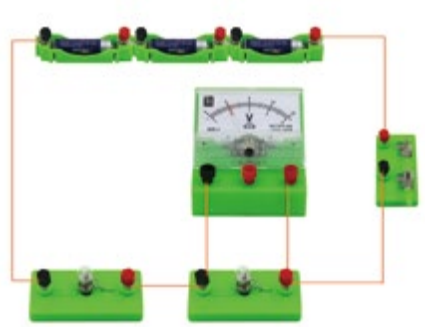


Figure 10-1 Measuring voltage at both ends of appliance

Figure 10-2 measuring battery voltage

11. Explore the voltage law of series circuit with voltmeter

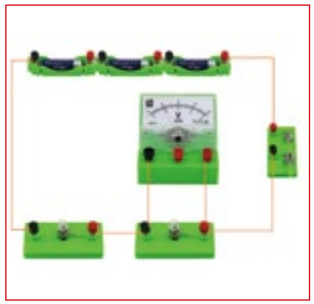


Figure 11-1Measure voltage at both ends of L1

Figure 11-2Measure voltage at both ends of L2

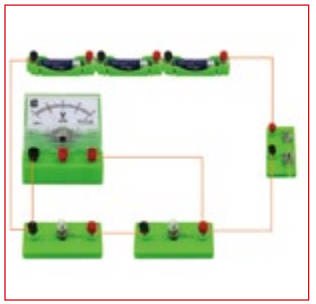


Figure 11-3Measure voltage at both ends ofL1&L2

Connect the voltmeter to the two ends of the bulb L1 as shown as shown in in Figure 11-1. Connect the voltmeter to the two ends of the bulb L2 Figure 11-2 and connect the voltmeter with the circuit as Figure 11-3. Record and analyze the experimental data, what conclusion would you draw?

12. Explore the law of voltage in parallel circuit

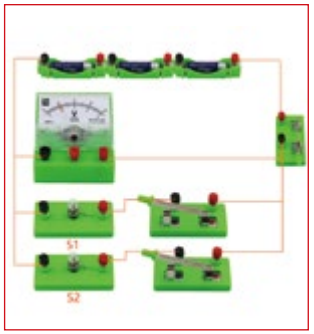


Figure 12-1Measure voltage at both ends of L1

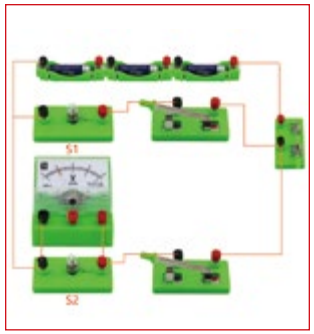


Figure 11-2 Measure voltage at both ends of L2

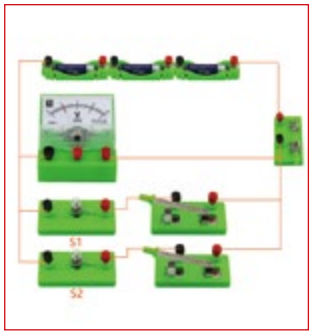


Figure 12-3 Total voltage of parallel circuit

As shown in Figure 12-1, Figure 12-2 and Figure 12-3, three different voltage values were measured respectively, and what conclusions are drawn through analysis?

13. Explore the voltage law of series battery

Figure 13-1 voltage of one dry cell

Figure 13-2 voltage of two dry cells

Figure 13-3 voltage of three dry cells

As shown in Figure 13-1, Figure 13-2, and Figure 13-3, measure the voltages U1, U2, and U3 of the three single cells, and measure the voltage with three cells connected in series.

14. Explore the unidirectional conductivity of light-emitting diodes

Figure 14-1 Unidirectional conductivity of the diode

Connect the diode into the circuit of the two batteries in series as shown in Figure 14-1, and connect it into the ammeter to observe whether the diode is on and the working current of the LED. If the diode is luminous, switch the terminal of the diode into the circuit and observe the light emission of the diode.

It can be found that the diode is not bright when it is connected reversely, which shows that it is unidirectional and the working current of normal lightemitting is very small.

15. Explore the factors that affect the resistance of conductors

Resistance is the conductor's hindering effect on the current, and it is an attribute of the conductor itself.

The resistance of different conductors is different, so what factors are related to the resistance? In the following experiment, as shown in Figure 15-1, we connect different materials, lengths and thicknesses of conductors into the circuit with the same voltage battery, and observe the brightness of the bulb and the value of the ammeter.

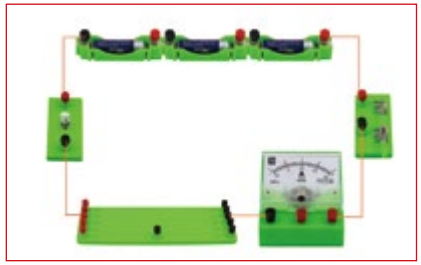


Figure 15-1 Explore the factors that affect the resistance

1. Connect the first copper wire with a diameter of 0.2mm and the third nickel chromium wire with adiameter of 0.2mm respectively. Their lengths are the same. Observe the current indication number and the brightness of the bulb;

2. Connect the second nickel chromium wire with a diameter of 0.3mm and the third nickelchromium wire with a diameter of 0.2mm respectively, and observe the brightness of the bulb and the value of the ammeter.3. Connect the full length of the fifth resistance wire first, and then connect the half length of the fifth wire, observe the bulb brightness and current

representation number. By comparison, what conclusion can you draw?

16. Change the bulb current with a sliding rheostat

The sliding rheostat is a device that changes the circuit current by changing the length of the resistance wire connected to the circuit. Let's experience the function of the sliding rheostat through experiments:

As shown in figure 16-1, the sliding rheostat has four different binding posts. If you connect the circuit in two ways according to figure 16-2, how many ways do you have?

Which of these connections can change the current? Which can't? Is there any rule?

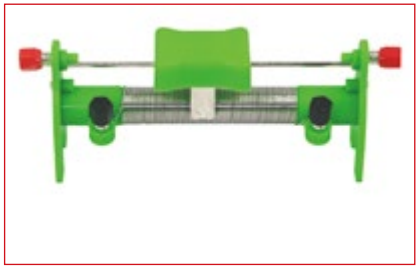


Figure 16-1 Sliding rheostat

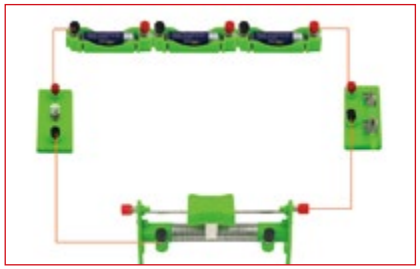


Figure 16-2 Sliding rheostat changes the brightness of the bulb

17. Ohm's Law

Through the preliminary study and experimental operation, you will realize that the current magnitude of the circuit must also be related to the voltage level, and you know that it is related to the resistance in the circuit. So what is the relationship between the three?

1. The resistance remains unchanged, design the following circuit to study the relationship between current and voltage

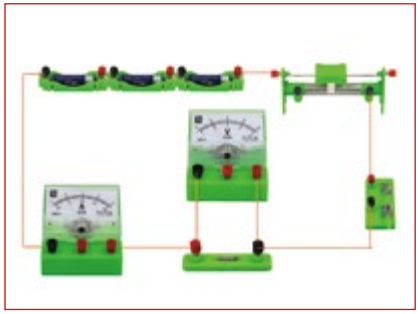


Figure 17-1 explore the relationship between current, voltage

Resistance R=5 Ω

Experiment No	Voltage(V)	Current(A)
1		
2		
3		

Conclusion:

Keep the voltage constant, explore the relationship between current and resistance

R=

Experiment No	Voltage(V)	Current(A)
1		
2		
3		

Conclusion:

In a complete summary, the relationship among the current passing through the conductor and the voltage at both ends of the conductor and the resistance of the conductor itself is the famous Ohm law.

18. Measuring the resistance of a conductor with voltmeter and an ammeter

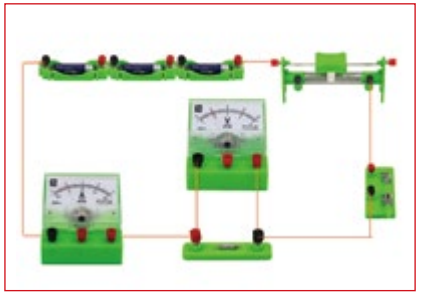


Figure 18-1 measuring conductor resistance

Conductor resistance is a property of the conductor itself. How can the resistance of the conductor be measured? Next, we connect the circuit shown in Figure 18-1 and measure the resistance value:

In order to measure the resistance more accurately and reduce the error, we can change the voltage at both ends of the conductor by sliding the varistor and measure it several times to find the average value

No of times	Voltage	Current	Resistance	Resistance average value
1				
2				
3				

19. Measure the power of the small bulb with a voltmeter and an ammeter

The brightness of a small bulb is related to the working voltage and current of the bulb, that is to say, the brightness is related to the power of the bulb. Next, we measure the power of the bulb through experiments. The bulb has a power under normal working voltage, which is called rated power. The power under actual working voltage is called actual power. Observe the relationship among brightness and actual power and rated power of the bulb through experiments , rated power.

Connect the circuit as shown in Figure 19-1 for experiment:

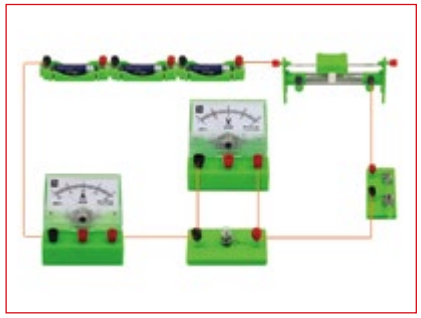


Figure 19-1 measuring the power of small bulb

Observe the rated voltage on the small bulb ()

Value to be measured / Working voltage	Voltage at both ends of bulb(V)	Current through the bulb(A)	Power of the bulb(W)	Luminous situation of bulb	Bulb filament resistance value(Ω)
Below rated voltage					
Equal to rated voltage					
Above rated voltage					

Through the above several measurements, you will find that the power of the bulb is not fixed, the power of different voltages is different, and the brightness of the bulb is also different. When the actual power of the bulb is equal to the rated power, the brightness of the bulb is normal. When the actual power is less than the rated power, the brightness of the bulb is bright. When the actual power is lower than the rated power, the brightness of the bulb is dark. And when the bulb is of different power, the resistance value of the filament is also different. Why?

20. Joule's law experiment

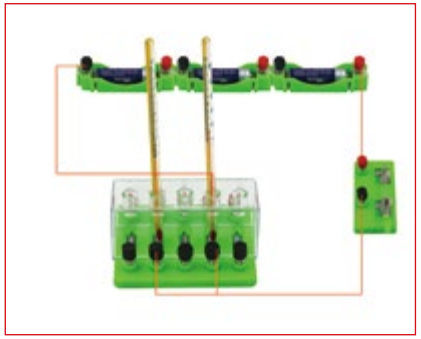


Figure 20-1

The current will produce heat when passing through the conductor. This phenomenon is called the thermal effect of the current. What is the relationship between the heat generated by the current? Next, the experiment is carried out through the circuit as shown in Figure 20-1: scan the QR code to see more videos.

1. Explore the relationship between heat generated by current and resistance.
2. Explore the relationship between the heat generated by the current and the current.
3. Explore the relationship between the heat generated by the current and the conduction time

21. Understanding simple magnetic phenomena

I. Magnetic pole : Use a bar magnet or a horseshoe-shaped small magnet close to the iron powder box. Observe that part of the magnet attracts the most magnetic debris?The place that attracts a lot of iron filings shows that it is strong in magnetism. The strongest magnet is called a magnetic pole. The bar magnets are distributed at both ends. The horseshoe magnet can be regarded as a complete bar magnet.

2. The north and south poles of the magnet: any magnet has two magnetic poles. One magnet that can rotate freely in the geomagnetic field is stationary. The end of the guide is called the south pole of the magnet (S pole), and the north end is called the north pole of the magnet (Npole).

3. Magnetic pole interaction law: Use magnetic levitation in Figure 21-1 and magnetic trolley and bar magnet, ring magnet, etc. in Figure 21-2, Figure 21-3 to make their magnetic poles close to each other, see what will happen? It can be obtained through experiments that magnetic poles of the same name repel each other, and magnets of different names attract.

4. Magnetization: Use the knife inside your stationery box, close to the pin, will it attract? Thenuse a magnet to rub your knife, and then approach the pin, you will find: the original non-magnetic knife is also magnetic, this phenomenon is called magnetization.

5. Magnetic field: The magnet can attract or repel without contact. This is because there is aspecial substance around the magnet called the magnetic field (see Figure 21-4, Figure 21-5); the interaction of the magnet is through the magnetic field. The magnetic field is invisible and intangible, but it does exist.

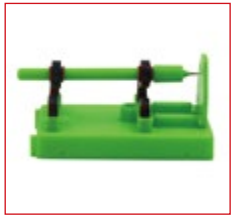


Figure 21-1 Maglev

Figure 21-1 Magnetic car

Figure 21-3 bar magnet

Figure 21-4 U-shaped magnet

Figure 21-5 magnetic field of U-shaped magnet

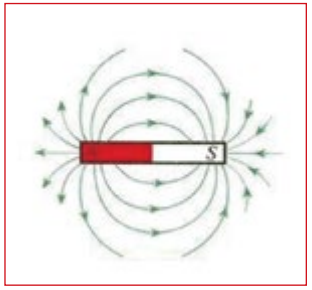


Figure 21-5 magnetic field of bar magnet

22. Oersted's experiment

Human beings have discovered magnetic and electrical phenomena for a long time, but before the 19th century, scientists thought that the two phenomena were isolated and studied separately.

It wasn't until the 1920s that the Danish physicist Auster discovered a major phenomenon.

As shown in Figure 22-1, what do you find when you close the switch?

Oster's experiment shows that there is a magnetic field around the current, which opens the door of electromagnetism for human beings

Figure 22-1

23. Solenoid

1. Solenoid: Oster's experiment caused a sensation in scientists, and then some scientists made the conductor into different shapes and did not study it. Among them, the conductor was wound into a circle, called a solenoid. This is the most representative. What happens to the magnetic field around the solenoid when it is energized?

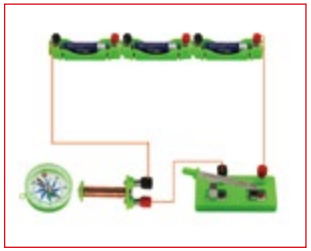


Figure 23-1 Exploring the magnetic field of a solenoid

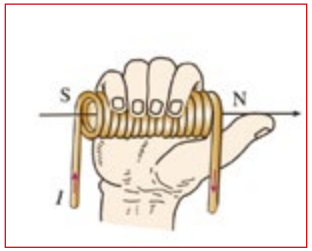


Figure 23-2

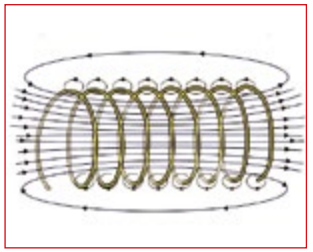


Figure 23-3

As shown in Figure 23-1, use the magnetic needle to explore it!

As shown inFigure 23-2, the magnetic field of the solenoid is similar to the bar magnet;

As shown in Figure 23-3, it is the method to judge the magnetic field direction of thesolenoid

24. Electromagnet

Figure 24-1

There is a magnetic field around the solenoid but it is relatively weak. In order to enhance the magnetic field, an iron core is added inside to make an electromagnet. The electromagnet has many similarities with ordinary magnets.

What does the magnet have to do with magnetic strength? Use the following diagram 24-1 to study and explore:

25. Understanding electric bell

There are many applications of electromagnets, let's take a look at one of them -----bell. Recognize the structure of the electric bell according to Figure 25-1.

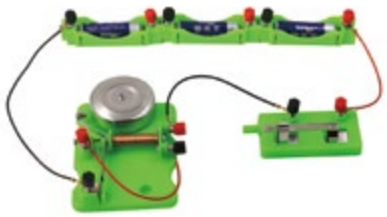


Figure 25-1 Bell Connection

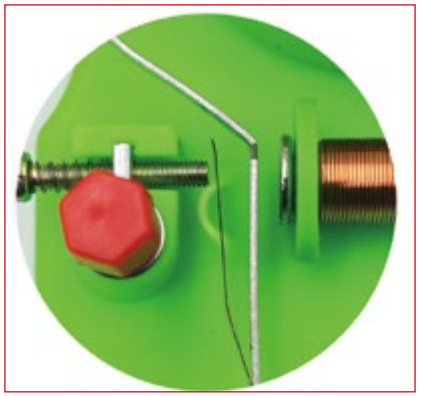


Figure 25-2

26. Ampere's force experiment (The effect of magnetic field on electrified conductor)

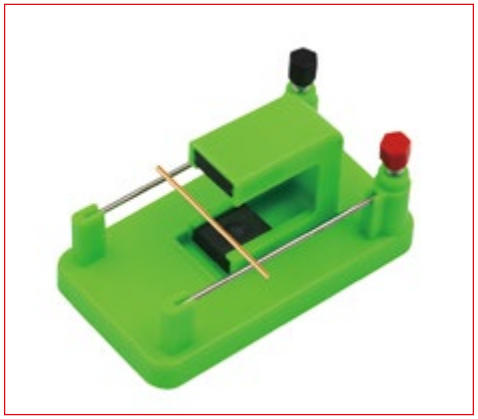


Figure 26-1 Force of magnetic field on electrical conductor

1. Understanding device
2. As shown in Figure 26-1, when the switch is closed, observe that the copper conductor in the magnetic field reacts, change the direction of current passing, and observe;
3. Put the magnet on the U-shaped frame, adjust it up and down, and observe the reaction of copper conductorwhen it is electrified. From the above experiments, what factors are related to the force direction of the electrified conductor in the magnetic field?

27. Understanding current motor

The last experiment shows that the electrified conductor will be affected by the force in the magnetic field. Using this principle, the people invented the electric motor.

1. Understand the motor structure (as shown in figure 27-1).
2. Connect the motor to the circuit and supply power with different voltages, Observe the rotation speed.
3. Exchange the magnet position on the motor and observe the direction of rotation of the motor.
4. Change the direction of the circuit through the motor and observe the direction of rotation of the motor.

Through the above experimental exploration, what will you find? What factors are related to the direction of motor rotation?

Figure 27-1

28. Experiment of electromagnetic induction

Figure 28-1

Oster's experiment shows that electric energy generates magnetism, and vice versa? Using this reverse thinking, physicist Faraday discovered the phenomenon of electromagnetic induction. Let's experience it through experiments.

1. As shown in figure 28-1, let the square coil reciprocate in the magnetic field, and observe the direction of the induced current;
2. Change the direction of magnetic field with the movement direction of the square coil remain unchanged and observe the current direction;What is electromagnetic induction? What factors are related to the circuits it produces?

29. Experiment of generators

Electromagnetic induction phenomenon indicates that: magnetic energy generates electricity!Using this principle, people made generators. How can a generator generate electricity? What are the characteristics of the electricity it emits? Let's explore it briefly!

Figure 29-1

Figure 29-1

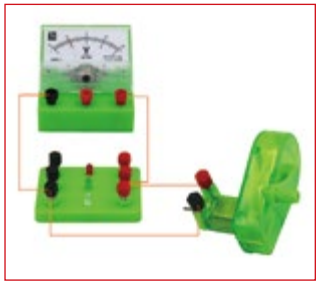


Figure 29-2

1. As shown in Figure 29-1, shake at different speeds and in different directions, and observe the amplitude and direction of the swing of the voltmeter pointer and the brightness change of the small bulb.

2. As shown in Figure 29-2, shake at different speeds and in different directions, and observe the amplitude and direction of the voltmeter pointer swing and the brightness change of the diode.

What conclusion can we draw through the above experiments?

30. Experiment of fuse

If the circuit is short circuited, we know that the current will be very large. According to the thermal effect of the current and Joule's law, we will know that the larger the current is, the more heat will be generated, and the circuit and battery in our experiment will burn out. If the home circuit and industrial circuit are used, the fire will be caused. How to avoid this problem? Observe the following experiments, such as 30-1 circuit experiment.

Close the switch showing in the figure, and the small bulb lights up. Connect the remaining end of the wire to the right end of the small bulb. Observe the fuse and the small bulb at the same time. What's the phenomenon? Then take away the remaining part of the wire. Will the small bulb light up again? Why?

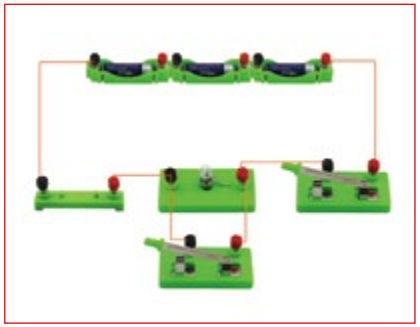


Figure 30-1