2. Now connect the red and black wire of the buzzer to the middle and right spring connectors respectively as shown in Fig. 27.

Fig. 27

3. Now insert two AA size batteries according to the polarity indicated in the battery compartment (see Fig. 5). Press the switch and the buzzer should make a beeping sound. You're done! You can send Morse code message by pressing the switch according to the Morse Code table below.

Morse Code Characters

A ·–	S ···	Period ·–·–·–
B –···	T –	Comma ––··––
C –·–·	U ··–	Slash –··–·
D –··	V ···–	Plus ·–·–·
E ·	W ·––	Equal –···–
F ··–·	X –··–	Open Line –·––·–
G ––·	Y –·––	Open Paren –·––·
H ····	Z ––··	Close Paren –·––·–
I ··	1 ·––––	Dash –····–
J ·–––	2 ··–––	Quote ·–··–·
K –·–	3 ···––	Underscore ··––·–
L ·–··	4 ····–	Single Quote ·––––·
M ––	5 ·····	Colon –––···
N –·	6 –····	Semicolon –·–·–·
O –––	7 ––···	Dollar Sign ···–··–
P ·––·	8 –––··	Warning ·–·–·–
Q ––·–	9 ––––·	Error ·····–
R ·–·	0 –––––	Repetition(ii is) ·· ··

Fig. 28

Fig. 29

Explanation:

In 1836, Samuel Morse demonstrated the ability of a telegraph system to transmit information over wires. The information was sent as a series of electrical signals. Short signals are referred to as dits (represented as dots). Long signals are referred to as dahs (represented as dashes). With the advent of radio communications, an international version of Morse code became widely used.

The most well-known usage of Morse code is for sending the distress signal: SOS. The SOS signal is sent as:

··· ––– ···
S O S

Morse code relies on precise intervals of time between dits and dahs, between letters, and between words. Here's a chart that shows these relationships:

dit	1 unit of time
dah	3 units of time
pause between letters	3 units of time
pause between words	7 units of time

Activity 8 Light Control Alarm

Material: - 1 Base plate (5) - 3 Spring connectors (9) - 1 Buzzer (13) - 1 Light sensor (36)
Extra items you will need: - A Torch

Steps:

1. Repeat step 1-2 of Activity 7, but do not install the switch plate (7) and metal plate (8). Connect the red and black wire of the light sensor (36) to the left and middle spring connectors (9) respectively as shown in Fig. 28.

2. Now insert two AA size batteries according to the polarity indicated in the battery compartment (see Fig. 5). Illuminate the light sensor with a torch. (Fig. 29) The buzzer will be turned on.

Explanation:

The light sensor is an electronic component which changes its resistance with the amount of light illuminated on it. When the light is bright, its resistance decreases and vice versa. Many electrical appliances and lighting make use of this component to function. For example, a street light will turn on automatically in the evening when the street gets dark.

Activity 9 Make a Bell

Material: - 1 Base plate (5) - 1 Switch plate (7) - 1 Metal plate (8) - 2 Spring connectors (9) - 1 Adjusting screw (19) - 1 Adjusting screw spring (20) - 1 Adjusting screw knob (21) - 1 Adjusting screw lug (22) - 1 Screw holder (23) - 1 Nut (24) - 1 Bell (25) - 1 Bell stand (26) - 1 Enamel-insulated wire (27) - 1 Iron rod lock (28) - 1 Hammer (29) - 1 Hammer Stopper (30) - 1 Hammer Stand (31) - 1 Iron rod (32) - 1 Metal bracket (33) - 1 Sand paper (34) - 1 Spool (35)

Steps:

Fig. 30

Fig. 31

1. Insert the small nut (24) to the back of the screw holder (23) first, then insert the adjusting screw (19) through the adjusting screw knob (21), adjusting screw spring (20), adjusting screw lug (22), and lock them into the nut. (Fig.30, 31)

2. Insert the hammer (29) to the hammer stand (31) and lock it with the hammer stopper (30). (Fig. 32,33)

Fig. 32

Fig. 33

3. Install the bell (25) on the bell stand (26). (Fig. 34, 35)

Fig. 34

Fig. 35

4. Route one end of the enamel-insulated wire (27) through the small hole on the spool side (35), make a knot and wind it around the spool. Leave about 100mm at each end freely. Route the other end of the wire through the small hole on the spool side when it is fully wound. Make a knot through the hole to prevent loose wire. (Fig. 36, 37)

Fig. 36

Fig. 37

5. Insert the iron rod (32) and the metal bracket (33) to the spool, and fasten the iron rod with the iron rod lock (28). (Fig. 38,39)

Fig. 38

Fig. 39

6. Fold the sand paper (34) to half and sand away the coating of the enamel-insulated wire at both ends, about 30mm long. (Fig. 40)

Fig. 40

7. Install two spring connectors (9) with the switch plate (7) and metal plate (8) on thebase plate (5). Connect the red wire to the spring connector on the left, as shown in Fig. 41.

Fig. 41

8. Insert the screw holder of Step 1 to the base plate, and connect the black wire to the top of the screw lug. (Fig. 42)

Fig. 42

9. Install the bell stand of Step 3 to the base plate. (Fig. 43)

Fig. 43

10. Insert the hammer stand of Step 2 to the base plate. (Fig. 44)

Fig. 44

11. As shown in Fig. 45, insert the spool of Step 6 to the base plate, with the metal rod facing the hammer stand but not touching it. Connect each end of the spool wire to the middle spring connector and the end of the ammer respectively. Now insert two AA size batteries according to the polarity indicated in the battery compartment (see Fig. 5). Press the switch plate to start the bell. Adjust the clearance between the adjusting screw and the metal arm to fine-tune the sensitivity of the bell. They should be just in contact with each other at rest.

Fig. 45

Explanation:

When the switch is pressed, the circuit closed and the current begins to flow through the wire around the spool (the "solenoid"). The metal rod gets magnetized and attracts the metal hammer arm. Due to the movement of the arm, the hammer moves and strikes the bell and the bell rings. The movement of the arm breaks the contact and the current stops flowing.
The electromagnet loses its magnetism and the arm returns back to its original position. This completes the circuit once again and the action is repeated. As a result, the hammer vibrates and the bell continues to ring as long as the switch is pressed.

Activity 10 Make an Electromagnet

In this activity we will make an electromagnet
Material: - 1 Long iron rod (14) - 1 Coil (15) - 1 Base Plate (5)
Extra Material you will need: - Some Paperclips

Steps:

1. Wind the coil (15) to the iron rod (14), leave about 30mm at each end. (Fig. 46)

Fig. 46

Fig. 47

2. Install 2 spring connectors (9) to the base plate (5) and connect the red and black wire to the spring connectors as shown in Fig. 47.

3. Connect each end of the coil to the two spring connectors respectively. (Fig. 48)

Fig. 48

4. Insert two AA size batteries according to the polarity indicated in the battery compartment (see Fig. 5). Now the iron rod is magnetized.

5. Place some paperclips on the table and move the iron rod close to the paperclips and see what happens. (Fig. 49)

Fig. 49

6. Disconnect one end of the coil and move the iron rod close to the paperclips again. Note the result.

Explanation:

An electromagnet is a type of magnet in which the magnetic field is induced by the flow of an electric current through a coil of wire. The magnetic field disappears when the flow of electricity is stopped. The strength of the electromagnet depends on the amount of electric current and the number of turns of the coil. The higher the current and the more number of turns will make the electromagnet more powerful. Electromagnet has two major advantages over permanent magnet. It can be switched on and off, or reversed, or it's strength controlled by changing the electric current. Secondly, it can be made stronger than a permanent magnet of the same size and weight.

Activity 11 Make a Motor

Material: - 1 Base plate (5) - 1 Motor Coil (16) - 1 Metal pin (17) - 2 Long See Saw Leg (18) - 1 Magnet (39) - 2 Spring Connector (9)

Steps:

1. Prepare the wire and the spring connector(9). Fix the wires to the spring connector at about 40mm from the wire's end, with the wires pointing upwards as shown in Fig. 50.

Fig. 50

2. Put the metal pin(17) through the motor coil(16), with the long see saw legs(18) on each side. (Fig. 51, 52)

Fig. 51

Fig. 52

3. Carefully place the legs on the base plate. The coil must be placed in between and in contact with the two wires. (Fig. 53, 54)

Fig. 54

Fig. 53

4. Place the magnet (39) on the base plate just under the motor coil. (Fig. 55)

Fig. 55

5. Install the batteries in the base plate according to the polarities as indicated in the battery compartment (see Fig. 5) and flip the coil with your finger. The coil will start to rotate by itself.

Explanation:

Anytime an electric current is passed through a conductor, it produces a magnetic field. So when electric current passes through the coil (called "armature" of the motor), it becomes an electromagnet. Assuming that the magnet is sitting with the North side of it up (it doesn't matter which is up) this is the sequence of events: You give the motor a spin. When the red and black wires reach the stripped part of the coil, current flows, forming an electromagnet. Since magnet pole of the same type repels each other, the North of the electromagnet is repelled by the North of the magnet. This gives the coil a push, and it spins to a position where the wires and the coil break off, and the current ceases to flow. Inertia carries it around until the stripped portion makes contact again. Now the polarity of the electromagnet is reversed because the coil is flipped over, and it is attracted towards the magnet. This gives the coil a pull and it spins to a position where the coil breaks off again. Inertia carries the coil to the other side and the loop repeats. These attract and repel actions enable the coil to rotate continuously.

Activity 12 Solar power cell

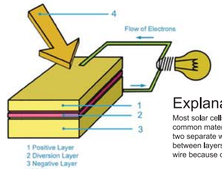
Material: - 1 Base Plate (5) - 1 LED light (6) - 1 Solar panel (37) - 2 Spring connectors (9)

Steps:

1. As shown in Fig. 56, install two spring connectors (9) on the base plate. Connect the red wires of the solar panel (38) and the LED light (6) at one spring connector. Similarly, connect the black wires together at the other spring connector. When placed in a room with good lighting, the solar panel will produce enough electric current to light up the red LED. When the solar panel is getting more light, it produces more current. Try blocking the panel with your hand to see what happens? Does the LED light become dimmer or brighter? You can also experiment with different type of light source, for example, sunlight, fluorescent light or incandescent light bulb.

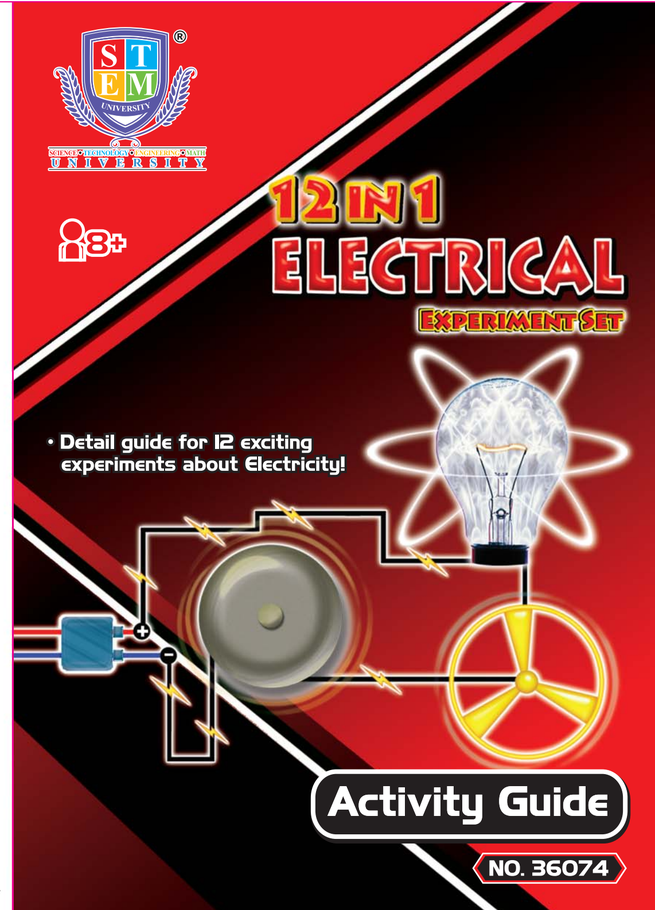
Fig. 56

Solar Cell



Explanation:

Most solar cells in the solar panels are made from a crystalline substance called silicon, one of the Earth's most common materials. Solar cells are typically made by slicing a large crystal of silicon into thin wafers and putting two separate wafers with different electrical properties together, along with wires to enable electrons to travel between layers. When sunlight hits the wafers, electrons naturally travel from one layer to the other through the wire because of the different properties of each layer, resulting in the release of electricity.



12 in 1 Electrical Experiment Set Activity Guide

WARNING!

Only for use by children over 8 years old. To be used solely under the strict supervision of adults that have studied the precautions given in the experimental set. Not Suitable For Children Under 36 Months. Choking Hazard. Hair entanglement may result if the child's head is too close to the motorized unit of this toy. This toy contains functional sharp point – on the component leads. Do notshort-circuit the battery terminals and spring connectors, which may cause overheating. Do not lock the motor or other moving parts, which may cause overheating. The wires are not to be inserted into socket outlets. Use with care and only under supervision of adult.

WARNING! Not suitable for children under 8 years. This product contains a small magnet. Swallowed magnets can stick together across intestines causing serious injuries. Seek immediate medical attention if magnet are swallowed.

⚠ WARNING :

CHOKING HAZARD - Small parts. Not for Children under 3 years.
This product contains a small magnet. Swallowed magnets can stick together across intestines causing serious infections and death. Seek immediate medical attention if magnet are swallowed or inhaled.

IMPORTANT:

Keep these instructions. DO NOT DISCARD.

1. Only adults should install and replace batteries.
2. Alkaline batteries are recommended.
3. If the device has not been used for a long time, remove the batteries.
4. Do not use rechargeable batteries.
5. Do not mix old and new batteries.
6. Do not mix alkaline, standard (carbon zinc) or rechargeable (nickel cadmium) batteries.
7. Exhausted batteries are to be removed from the toy.
8. Non-rechargeable batteries are not to be recharged.
9. The supply terminals are not to be short-circuited.
10. Only batteries of the same or equivalent type as recommended are to be used.
11. Batteries are to be inserted with the correct polarity.
12. Do not dispose of batteries in fire, batteries may explode or leak.
13. Batteries may explode or leak if misused.

Batteries required: 2 x 1.5V AA (Not included)

If at any time in the future you should need to dispose of this product please note that Waste electrical products should not be disposed of with household waste. Please recycle where facilities exist. Check with your Local Authority or retailer for recycling advice.(Waste Electrical and Electronic Equipment Directive)

Components:

1. 1 Motor
2. 1 Fan blade
3. 1 Fan stand
4. 1 Motor holder
5. 1 Base plate
6. 1 LED light
7. 1 Switch plate
8. 1 Metal plate
9. 4 Spring connectors
10. 1 Resistor
11. 1 Plastic plate
12. 1 Cloth
13. 1 Buzzer
14. 1 Long Iron rod
15. 1 Coil
16. 1 Motor coil
17. 1 Metal pin
18. 2 See Saw Leg
19. 1 Adjusting screw
20. 1 Adjusting screw spring
21. 1 Adjusting screw knob
22. 1 Adjusting screw lug
23. 1 Screw holder
24. 1 Nut
25. 1 Bell
26. 1 Bell stand
27. 1 Enamel-insulated wire
28. 1 Iron rod lock
29. 1 Hammer
30. 1 Hammer Stopper
31. 1 Hammer Stand
32. 1 Short iron rod
33. 1 Metal bracket
34. 1 Sand paper
35. 1 Spool
36. 1 Light sensor
37. 1 Solar panel
38. 1 Diode
39. 1 Magnet

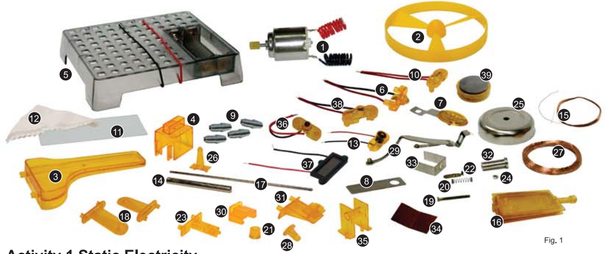


Fig. 1

Activity 1 Static Electricity

Materials: - 1 Plastic plate (11) - 1 Cloth (12)
Extra Material you will need: - 1 Piece of face tissue

Steps:

1. Tear some face tissue into small pieces about 5mm x 5mm And put them on the table.
2. Rub the plastic plate with the cloth about 20 times. Then place it near the tissue you've just made, and see what happen.

Fig. 2

Fig. 3

Explanations:

To understand static electricity, we have to learn a little bit about the nature of matter. Or in other words, what is all the stuff around us made of?

Everything is made of atoms. Atoms are composed of positively charged protons, neutral neutrons, and negatively charged electrons. When the number of electrons in the atom is equal to the number of protons, the atom is said to be neutral or have no charge. If there are more electrons than protons in the atom, the atom has a negative charge. If there are more protons than electrons in the atom, the atom is said to have a positive charge.

Positive and negative charges at rest on an object are called static electricity. Static electricity is an electric charge built up in one place. If you rub only one end of a plastic comb, then only that end becomes charged. The electric charges stay in one place. An object can become charged in several different ways. When electrons are transferred between two objects that are rubbed together, the objects become charged due to friction. Conduction is another way that objects can become charged. It is the direct contact between two objects. An object can also be charged by an already-charged object without there being contact between them. This object is said to be charged by induction.

If two things have different charges, they attract, or pull towards each other. If two things have the same charge, they repel, or push away from each other.

So what happened in the experiment? Rubbing the plastic plate with the cloth moved electrons from the cloth to the plate. The plate had a negative static charge. The neutral tissue paper was attracted to it. When they touched, electrons slowly moved from the plastic plate to the paper. Now both objects had the same negative charge, and the paper was repelled.

Activity 2 Conductors and insulators

In this activity we will find out which material allows electricity through easily and which does not let it pass through.
Materials: - 1 Base plate (5) - 3 Spring connectors (9) - 1 Plastic plate (11) - 1 Cloth (12) - 1 Buzzer (13)
Extra Material you will need: - 1 Paperclip

Steps:

1. Set up the circuit as shown in Fig. 4. Install the spring connectors (9) on the base plate(5) at position 1,2 and 3. Install them with the narrow end down, push the spring as far as it will go. Install the buzzer (13) and connect the wires to the spring connectors. Bend the spring over to create a gap into which the metal wire is inserted.

   Buzzer red wire – Spring connector (1)
   Buzzer black wire – Spring connector (3)
   Battery box red wire – Spring connector (2)
   Battery box black wire – Spring connector (3)

Fig. 4

2. Install 2 AA size 1.5V batteries in the battery compartment according to the polarity as shown in Fig. 5.

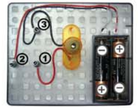


Fig. 5

3. Test the correct working of the circuit by disconnecting the red wire from the spring connector at position (1) and use the exposed metal part of the wire to tap on the spring connector at position (2). The buzzer should emit a beep sound when you do, check the wiring again if no beep sound is heard. Replace the red wire to its original position (1) when done.
4. Put a paper clip (16) between the spring connector at position 1 and 2 so that the metal part is in contact with the springs. Note if the buzzer emits a beep sound. (Fig. 6)

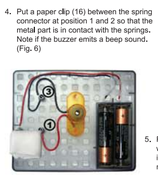


Fig. 6

Fig. 7

5. Remove the paper clip and replace with a piece of cloth (13), as shown in Fig. 7, Note again if the buzzer make any beep sound.
6. Try again with the plastic plate, as shown in Fig. 8 and note the result.

Fig. 8

7. Find some common objects from around and repeat the test.

Explanations:

Some things need electricity to work. You need a complete circuit to make the buzzer emit beeping sound. In step 3, you complete the circuit by connecting the red and black wire of the buzzer to the positive and negative terminal of the battery. A circuit loop is formed (Battery "+" > Buzzer > Battery "-") and the buzzer can get electric current from the battery. When the circuit is connected as in Fig. 5, a gap exists between spring connector 1 and 2 and electricity can only flow through the circuit if something "conducts" the electric current through the gap. If the gap is connected by something that blocks the flow of electricity, the buzzer will not make any noise.

A material which conducts electricity is called a conductor, it allows electricity to pass through easily. Some materials do not allow electricity to pass through easily. They are called insulators. From the experiment above, you can see that the paper clip is a conductor but the cloth and the plastic plate are insulators.

Activity 3 Make a fan

Materials: - 1 Motor (1) - 1 Fan blade (2) - 1 Fan stand (3) - 1 Motor holder (4) - 1 Base plate (5)
- 1 Switch plate (7) - 1 Metal plate (8) - 3 Spring connectors (9)

Steps:

1. Install three spring connectors with the Switch plate (7) and Metal plate (8) on the Base plate (5) as shown in Fig. 9. Connect the red battery wire to the spring connector on the left and black battery wire to the right as shown.

Fig. 9

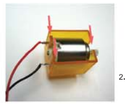


Fig. 10

2. Insert the Motor into the Motor Holder (4) as shown in Fig. 10

Fig. 11

3. Install Motor with the holder to the Stand as shown in Fig. 11.
4. Insert the Fan blade (2) to the shaft of the motor and install the whole assembly onto the base plate, as shown in figure 12. Then, connect the motor's red wire to the spring connector in the middle and its black wire to the spring on the right.

Fig. 12

Fig. 13

5. Refer to figure 13, make sure the switch plate is not in contact with the metal plate below. Now insert two AA size batteries according to the polarity indicated in the battery compartment. The electric fan is now ready. Press the switch to turn on the fan and feel the breeze!

Explanations:

The main component of a fan is the electric motor. Pressing the switch completes the circuit and electricity flows through the coil inside the motor. The motor begins to spin under the interaction of the electric current and magnetic field inside. The fan blade attached to the motor shaft converts this spinning motion into airflow which we can feel.

Activity 4 Resistor

In this activity, you will learn about resistor in a circuit.
Material: - 1 Motor (1) - 1 Fan blade (2) - 1 Fan stand (3) - 1 Motor holder (4) - 1 Base plate (5)
- 1 Switch plate (7) - 1 Metal plate (8) - 4 Spring connectors (9) - 1 Resistor (10)

Steps:

1. Install four spring connectors (9) with the Switch plate (7) and Metal plate (8) on the Base plate (5), Connect the red battery wire to the spring connector at position 1 on the left and black battery wire to position 3 as shown (Fig. 14).

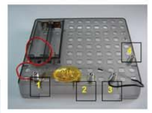


Fig. 14

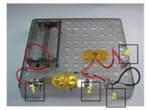


Fig. 15

2. Connect the resistor to the spring connector at position 3 and 4.
3. Insert the Motor (1) into the Motor Holder (4) as shown in Fig. 16

Fig. 16

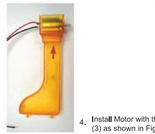


Fig. 17

4. Install Motor with the holder to the Fan stand (3) as shown in Fig. 17.

5. Insert the Fan blade (2) to the shaft of the motor and install the whole assembly onto the base plate, as shown in figure 18. Make sure the fan blade can rotate freely. Connect the motor's red wire to the spring connector at position 2 and its black wire to position 4.

Fig. 18

6. Refer to figure 19, make sure the switch plate is not in contact with the metal plate below. Now insert two AA size batteries according to the polarity as indicated on the battery compartment. The electric fan is now ready. Press the switch plate to turn on the fan and note the speed of the fan.

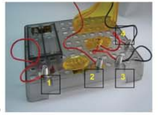


Fig. 19

7. Stop the fan by releasing the switch. Disconnect the motor's black wire at position 4. Reconnect it to the spring connector at position 3. Now press the switch again and compare the fan's speed to that in last step. Does it spin faster or slower?

Explanations:

In step 6 the circuit has a resistor connect in series with the fan, the current must flow through the resistor before reaching the fan motor. In step 7 the resistor is bypassed and the current flows through the fan without passing through the resistor. You can see that the fan spins faster without the resistor because a resistor "resists" the flow of electric current. The higher value of resistance (measured in ohms) the lower the current will be.

Activity 5 Diode

In this activity, you will learn about the diode in a circuit.
Material: - 1 Motor (1) - 1 Fan blade (2) - 1 Fan stand (3) - 1 Motor holder (4) - 1 Base plate (5)
- 1 Switch plate (7) - 1 Metal plate (8) - 4 Spring connectors (9) - 1 Diode (38)

Steps:

1. Follow the step 1-5 from activity 4, and connect the diode (38) instead of resistor. Please notice the colour of the wire of the diode, The red wire of the diode is connected to the spring connector at position 3 and the black wire to the spring connector at position 4.

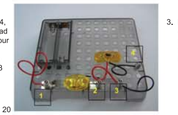


Fig. 20

2. Now insert two AA size batteries according to the polarity indicated in the battery compartment (see Fig. 5). Press the switch and see if the fan is working.

Fig. 21

3. Exchange the position of the diode wire, i.e. The red wire of the diode is connected to the spring connector at position 4 and the black wire to the spring connector at position 3, Press the switch again and see if the fan is working now.

Fig. 22

Explanation:

In this circuit, an electronic component called "Diode" is connected in series with the fan, the electric current must flow through the diode before reaching the fan motor, The diode has the property of allowing the current to flow only in one direction, which makes it act like a valve, In step 2 the fan will spin when the switch is pressed because the current can flow through the diode from its positive side (called anode) to its negative side (called cathode), However, when the diode is connected in the opposite direction, current cannot flow through and the fan will not spin.

Activity 6 Make a Light

We will make a light circuit in this activity.
Material: - 1 Base plate (5) - 1 LED light (6) - 1 Switch plate (7) - 1 Metal plate (8) - 4 Spring connectors (9) - 1 Resistor (10)

Steps:

1. Follow step 1-2 in Activity 4.

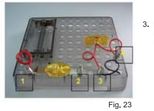


Fig. 23

Fig. 24

2. Connect the red wire of the LED light to the spring connector 2 and the black wire to the spring connector 4 as shown in Fig. 24, Now insert two AA size batteries according to the polarity indicated in the battery compartment (see Fig. 5), Press the switch to turn on the LED light.
3. Now exchange the wire position of the LED light and press the switch again. Does it turn on?

Fig. 25

Explanation:

LED (Light Emitting Diode) is an electronic device which emits light when electric current passes through it. It has the same property as the diode that it allows current to pass through in one direction only. It uses much less electricity than an ordinary light bulb. The colour of the LED will depend on the type of material (called semi-conductor) used to make it.

Activity 7 Make a Morse code machine

Material: - 1 Base plate (5) - 1 Switch plate (7)
- 1 Metal plate (8) - 3 Spring connectors (9)
- 1 Buzzer (13)

Steps:

1. Install three spring connectors with the Switch plate (7) and Metal plate (8) on the Base plate (5) as shown in Fig. 26. Connect the red battery wire to the spring connector on the left and black battery wire to the right as shown.

Fig. 26