

Principles of Electric Current-Simple Experiment Kit

⚠ WARNING

- Do not mix old and new batteries.
- Do not mix different kinds of batteries.
- For use with AA general purpose (zinc-carbon) batteries only. DO NOT use other batteries such as alkaline or rechargeable (nickel-cadmium) batteries as they may cause overheating of metal fittings, wires, and/or leakage.
- Install batteries with the +/- terminals in the correct position to prevent overheating of metal fittings, wires, and batteries, and/or leakage.
- Make sure that the circuit is completed as instructed in the manual.
- A short circuit may cause overheating of metal fittings, wires, and batteries, and/or leakage.
- This product contains small magnets. Swallowed magnets can stick together across intestines causing serious harm. Seek immediate medical attention if magnets are swallowed or inhaled.
- Remove batteries when not in use.

⚠ CAUTIONS

To minimize mistakes, make sure to read this instruction manual in its entirety before beginning assembly.

- Follow the instructions given by your teacher and this instruction manual when performing each experiment.
- Be careful not to poke your eyes or fingers with conductive wires or nails. Be careful handling metal fittings to avoid any injury such as cutting your hands or fingers, etc.

After experimenting and when storing the kit, turn off the switch and remove any batteries. Store batteries separate from the kit.

- Use only heavy duty (zinc-chloride) batteries. If other types of batteries are used, the batteries, metal fittings, and wires will overheat and may cause burns or fire.
- Is dangerous if small children use this product on their own or put the parts into their mouth or eyes, etc. At home, please keep this product out of reach of small children.

1 Take inventory of the parts!

You will need: Size D heavy duty (zinc-chloride) battery ×2, Scissors, office tape

Please do not use rechargeable batteries or alkaline batteries.

Let's make sure you have all the necessary parts. Put a checkmark in the box next to each part after you confirm that it was included.

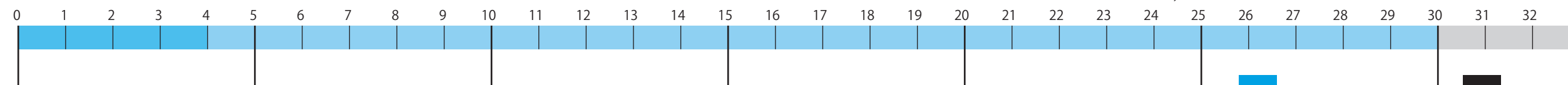
① Battery holder <input type="checkbox"/>	② 200-turn coil <input type="checkbox"/>	③ Bobbin <input type="checkbox"/>	④ Connecting plug <input type="checkbox"/>	⑤ Paper clip <input type="checkbox"/>
⑥ Compass <input type="checkbox"/>	⑦ Nail <input type="checkbox"/>	⑧ Iron core <input type="checkbox"/>	⑨ Sandpaper <input type="checkbox"/>	
⑩ Ferrite magnet <input type="checkbox"/>	⑪ Enamelled wire <input type="checkbox"/>			

2 Experimenting with the electromagnet!

Preparation No.1 Making the 100-turn coil.

- Strip off about 4cm of the enamel from both ends of the enamelled wire.
 - Cut the sandpaper into quarters.
 - File off until the color changes.
 - Leave 4cm out.
 - Attach tape to the back for reinforcement before use.
 - It will not conduct electricity unless the enamel is removed completely.
- Twist one sanded end of the wire around the bobbin tab.
 - Put the wire through the tab hole from inside.
 - Twist the wire around the vertical groove once.
 - Twist the wire around the horizontal groove two or three times.
- Paying attention not to create any gaps, tightly wind the enamelled wire around the bobbin 100 times. Then, twist the wire around the other tab of the bobbin (the tab without a wire around it).
 - Start winding from the edge in order to prevent gaps.
 - Let the battery stand in the circle of enamelled wires so the wires will not be tangled.
 - The bobbin is designed to be wound 50 turns from one edge to another, so one round trip will be 100 turns.
 - Twist the wire around the tab twice to secure at the end of winding.
 - Twist the enamel removed portion around the plug.
 - Put the wire through the hole and fold it back.
 - Twist it around.
 - The start and the end of enamelled wire winding should not crossover.
- Cut the enamelled wire, leaving about 30cm hanging off the bobbin. File off the enamel for approximately 4cm from the end. Attach a connecting plug.
 - Do not throw away any enamelled wire; you will need it later.
 - How to connect the enamelled wire and the plug.

Ruler (cm)



PANTONE 3005C

BLACK

Experiment No.1 Function of the coil in the operation of an electromagnet

Connecting the coil

- 100-turn coil
- Insert all the way

Case No.1 Send current through the empty 100-turn coil.

Result

Switch ON!!

Do not leave the switch ON continuously. Doing so is dangerous as the coil will become too hot. Remove the batteries after the experiment.

Move the nail closer to the energized 100-turn coil and observe what happens. Put the nail head-first halfway into the hole of the bobbin and let go. What happened to the nail when you let go of it?

Move the nail closer and let it go.

Enamelled wire

Connecting plug

Battery holder

Circuit schematic

Switch

Battery

Coil

Case No.2 Try experimenting with different cores inside the energized 100-turn coil.

How to put the iron core in.

Result

Switch ON!!

Insert the plastic or iron core inside the bobbin. Turn on the switch and move a nail close to the coil.

Enamelled wire

Connecting plug

Battery holder

Iron core

Circuit schematic

Switch

Battery

Electromagnet

Experiment No.2 Flow of electric current and the polarity of the electromagnet

Case No.1 Place the iron core in the bobbin. While moving a compass closer to the energized coil, determine whether the electromagnet has N and S poles like a permanent magnet does.

Case No.2 Assemble the compass.

Result

Draw the needle and indicate N and S on the compass. In the parentheses, write down the direction the compass needle was pointing.

Enamelled wire

Connecting plug

Iron core

Battery holder

Compass

Switch

Battery cell

Electromagnet

Be careful and pay attention to the needle tip!

Put the wire through the hole and fold it back.

Twist it around.

Try changing direction of the battery.

Experiment No.3 Effect of voltage on the strength of the electromagnet

Preparation No. 2 Let's prepare the plug wire

① This wire is to be used when connecting with the ammeter.

⚠ **Cautions**
Please do not connect the battery alone to the ammeter.

- Remove the connecting plug which had been attached to the 100-turn coil. Keep the iron core inside.
⚠ Do not lose the connecting plug since it will be used again later.
- Cut a 30cm section from the remaining enamelled wire. File off 4cm of the enamel each end of the wire. Attach a connecting plug to one end of the wire.
⚠ Do not throw away remaining enamelled wire as it will be used later.

File off until the color changes.

Completed.

How to attach the plug to the enamelled wire

① Insert the ferrite magnet into the hole of the plug.
② Twist it around.

⚠ It will not conduct electricity unless the enamel is removed completely.

How to attach the nails

Case No. 1 Connect one battery, examine the level of electric current flowing through the electromagnet and the number of nails which stick to the electromagnet.

Case No. 2 Connect two batteries in series, examine the level of electric current flowing through the electromagnet and the number of nails which stick to the electromagnet. Compare the results to those you got from Case No. 1.

Level of electric current No. of nails

Level of electric current No. of nails

Switch ON

Switch ON

Ammeter

Ammeter

Experiment No.4 Effect of coil turn quantity on the strength of the electromagnet

Preparation No. 2 Preparation of the 200-turn coil

① Unwind both ends of the enamelled wire from the 300-turn coil. Leave the wire for approximately 4cm from the hole in plug on both ends and cut as shown in the figure. File off 4cm of the enamel from both ends of the wire.

② Twist one end of the stripped enamelled wire around the bobbin tab.

Now it is completed.

⚠ It will not conduct electricity unless the enamel is removed completely.

Twist the enamel stripped portion and connect.

Electromagnet with 200-turn coil and iron core

Electromagnet with 100-turn coil and iron core

No. of turns No. of nails

100

200

Switch ON

3 Let's prepare the motor!

Production No. 1 Making the coil

- Cut a 30cm section from the remaining enamelled wire. Then, as shown in the figure, wind the enamelled wire six times around the tubular portion located on the underside of the battery holder.
- Create a shaft by winding wire around the coil at two positions to secure it, as shown below. Cut off any excess enamelled wire. File off the enamel from the shaft wire as shown. ⚠ Make sure to remove the enamel from the shaft wire all the way to the end, as shown.

Remove top half enamel

Remove all enamel

Place the coil on the illustration above and align the center position of the shaft.

Production No. 2 Bend the paperclip and make the coil receiver

① Make another one in the same manner, preparing a total of two receivers.

① Front View

② Side View

③ Side View

Rotate the bent portion so it faces you

Approx. 60°

Bend outward

Approx. 160°

Place a paper clip on the illustration below and match the bending angle.

2cm

Bend

Production No. 3 Assembly of the motor

- Use tape to attach a ferrite magnet to the middle of a battery. Insert the battery into the holder, positioning it as shown below.
- Insert a bent paper clip deep into the battery holder metal fitting and secure it by inserting a connecting plug. Put paper clips on both sides of the battery in the same manner.
- Place the coil on the paper clip hooks.
- Set the coil in motion!

Arrange the coil so it will be level.

Make adjustments so the coil will be parallel to the magnet.

Set the coil in motion!

Troubleshooting

- Are the batteries become weak?
→ Replace the batteries with new ones.
- Are the enamel completely removed from the ends of the coil shaft?
→ Remove enamel completely.
- Is the coil parallel to the magnet?
→ Adjust the coil position.
- Is the coil level?
→ Adjust the bending angle to match the angle in the illustration.
- Is the coil too far from the magnet?
→ Adjust the coil position by being it as close as possible to the magnet. Rotate the coil.