Course #7
'Science Scent'

Lesson #9
'Generous' and 'Selfish' Metals

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Lesson Plan

Time	Activity
10 min	'Generous' & 'Selfish' Metals
10 min	Identification Game
20 min	Building a Chemical Clock
5 min	Conclusion

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In every class there are different types of students:

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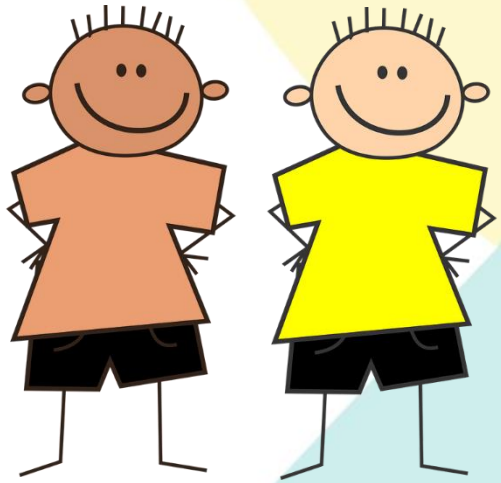
Generous

In every class there are students whom all the other children like. When a child is missing a shekel or two to buy an ice cream, there are always certain students ready to share their money with others. If a child leaves his or her lunch at home, these students will share half of their sandwich with this child. These students are 'generous', although some people mistakenly view these students as 'naive' or 'easy to take advantage of'.



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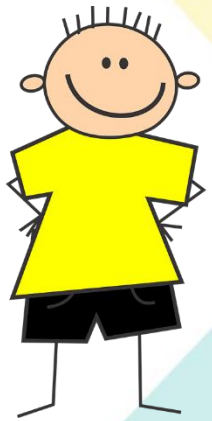
Selfish

On the other hand, every class has ‘selfish’ students. If a child asks this student to borrow a shekel to buy a falafel, the student will act like they don’t remember where their money is, or they will make up excuses like, “My parents don’t let me lend money to friends”. These are ‘selfish’ students who don’t share what they have, but are happy to take from others.



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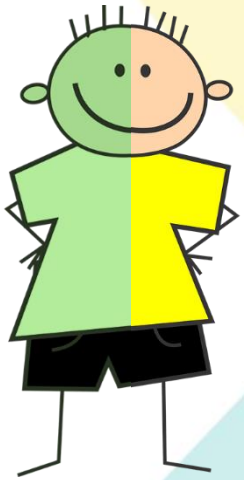
In Between

Then there are students who are neither overly generous or overly selfish. They may always lend money to certain friends, but they may never lend money to other children in the class. In short, there are different types of students in regard to their altruism or stinginess.



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Similarly With Metals

It turns out that a similar phenomenon exist with metals. Instead of sharing money with one another, the metals share electrons with one another. Some metals are **'generous'** while other metals are **'selfish'.**

(Electrons are the smallest particles in nature that carry an electric charge)

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‘Generous’ Metals

Take for example **Magnesium**. This metal is very ‘generous’, ready to give up its electrons to any other metal. **Zinc** is also considered ‘generous’, but not to the same degree as Magnesium. **Iron** is somewhat ‘generous’, but somewhat stingy as well. Iron is only willing to share its electrons with ‘selfish’ metals, but not with other ‘generous’ metals.

Zinc

Iron

Magnesium

Which metals are ‘Selfish’?

Gold, Silver, and **Copper** are like the ‘Three Musketeers’ of selfish metals. They do not easily share their electrons with other metals, although they are more than ‘happy’ to receive electrons from other metals.

Copper

Silver

Gold

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Electrochemical Scale

The scientific community created an Electrochemical Scale to rank metals by their willingness to either give or take electrons when interacting with other metals.

The further to the left a metal is on the scale, the more easily it will give electrons

The further to the right a metal is on the scale, the more easily it will take electrons

‘Generous Metals’					‘Selfish Metals’		
Magnesium	Aluminum	Zinc	Iron	Lead	Copper	Silver	Gold
Easily gives electrons to other metals					Easily takes electrons from other metals		

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Identification Game

Preparation:

Before class, the teacher should write the names of the following metals on scraps of paper, fold them up, and put them in a box.

Magnesium, Aluminum, Zinc, Iron, Gold, Silver, Copper

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Playing the Game

The teacher will pick two students at a time, and ask them to remove two pieces of paper from the box. Next, the students of the class should discuss the metals that were chosen from the box.

Examples of questions the teacher could pose to the students are:

Would you label this metal 'generous'/ 'selfish' ?

Is this metal more 'generous'/'selfish' than the other metal ?

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Who is Taller? Differences in Voltage

The teacher should choose three students with different heights.

Note: For this demonstration, emphasis will be placed on the difference between the heights of the students and not the heights themselves. (As each student is exactly the right size!)

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Step One

Have the tall student stand next to the medium student. The difference in their heights should be noticeable, but not overtly so. The difference in their heights should be recorded in a table on the next slide.

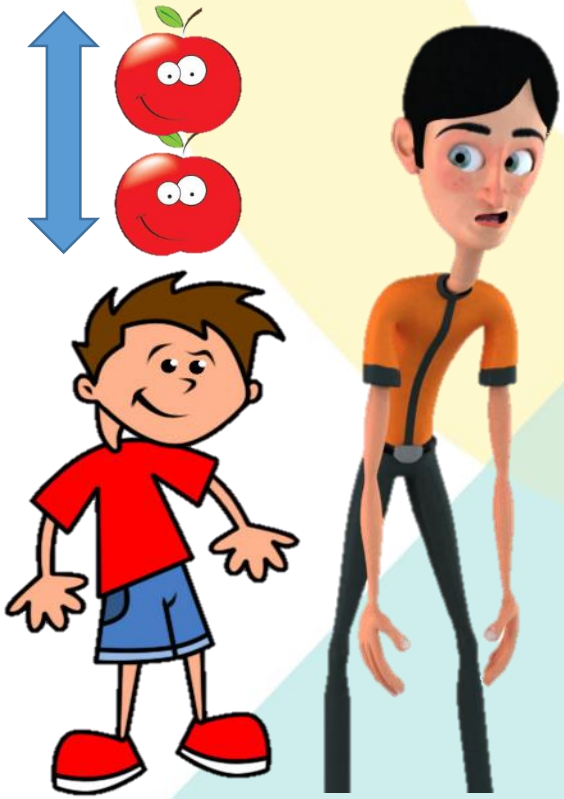

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Table to Record 'Height Differential'

Students	Difference in Height
Tall and Medium	10 cm (2 apples)

Step Two

Stand the medium student next to the short student. Here also, the difference in height should be noticeable, but not overtly so. Record the height differential in the table.

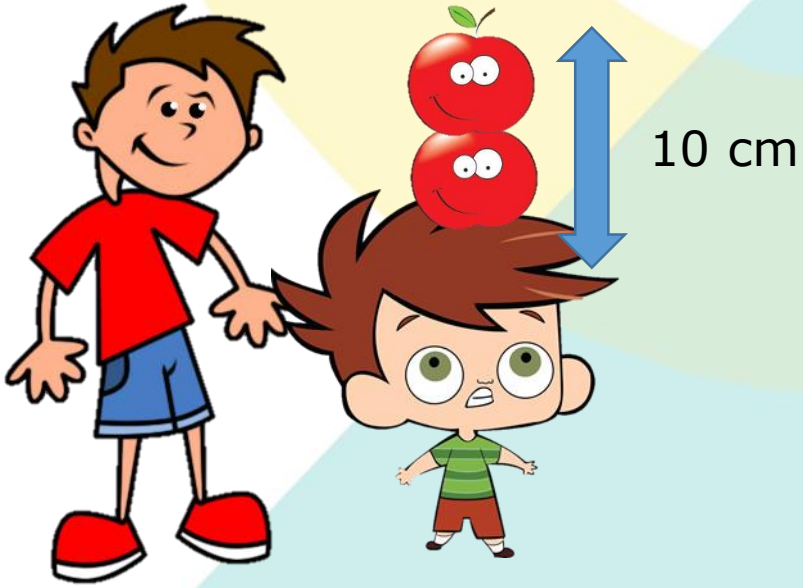
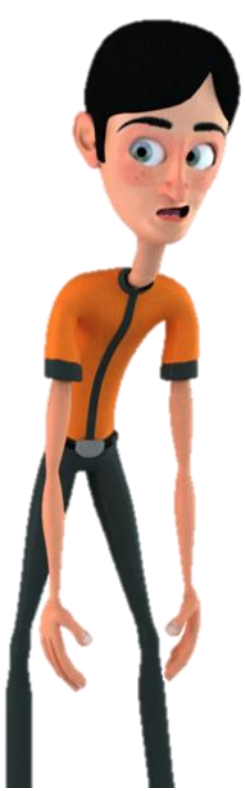


Table to Record 'Height Differential'

Students	Difference in Height
Tall and Medium	10 cm (2 apples)
Medium and Short	10 cm (2 apples)

Step Three

Stand the tallest student next the shortest student. Here the difference in height should stand out. Once again, record the differential in the table.



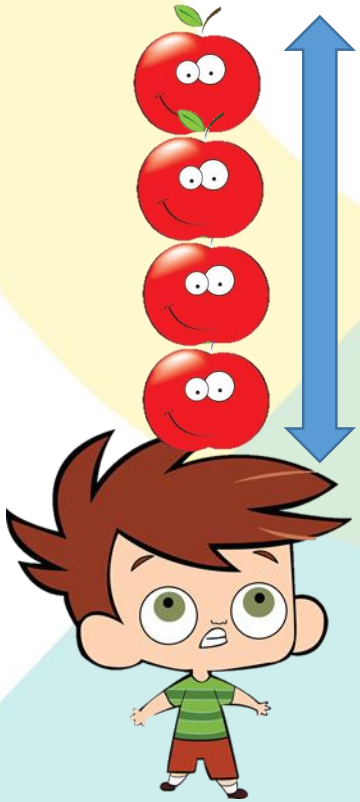


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Table to Record 'Height Differential'

Students	Difference in Height
Tall and Medium	10 cm (2 apples)
Medium and Short	10 cm (2 apples)
Tall and Short	20 cm (4 apples)

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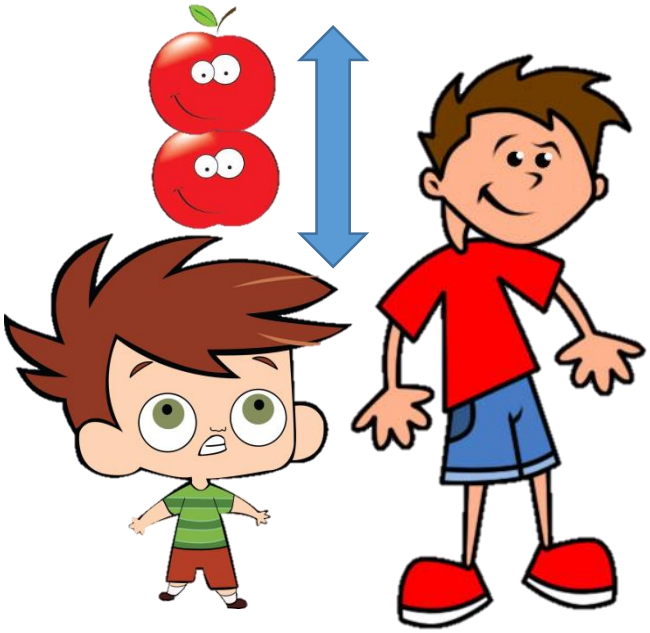
As we mentioned earlier, the ‘height differential’ does not just depend on the height of one child, but the height of one child relative to another child. Two students could both be very tall, but they may have a 0 cm difference in height between them. On the other hand we could take a set of two short students (Yonatan & Yehuda) and measure the difference between them as 10 cm, and then take two completely different students, who are both taller than the first students (Rami & Gadi) and find that they also have a 10 cm height differential between them.

Yonatan & Yehuda
Difference: 10 cm



Rami & Gadi
Difference: 10 cm

Similarly with Metals

Rather than ‘height’, each metal has a property known as its ‘electric potential’. Some metals such as Magnesium and Zinc have high electric potential, while other metals such as Gold and Silver have low electric potential.

However, the electric potential by itself is not meaningful unless it is compared to the electric potential of another metal.

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Let's Give an Example:

Magnesium is 'tall' (has a high electric potential), while copper is 'short' (has a low electric potential). When each metal is found by itself, its electric potential is not meaningful.

However, when we compare the 'height' of each metal, we see a 'height differential' between the metals.

This difference is known as the difference in 'electrical voltage'.

Under certain conditions, the 'tall' metal will transfer part of its 'height' (electrical potential) to the 'short' metal, until the two metals will be the same 'height'. This process where the 'tall' metal transfers 'height' to the 'short' metal creates what is known as **electric current.**

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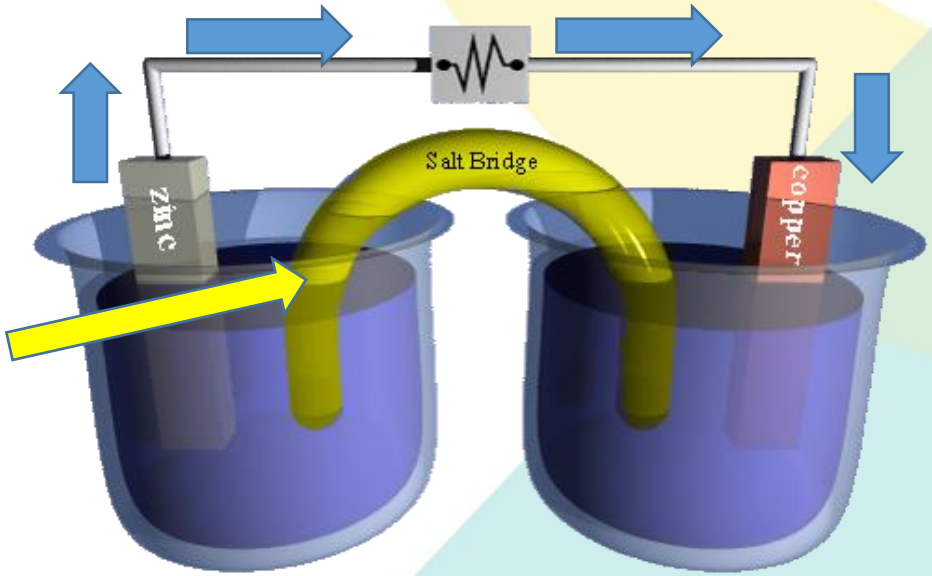
Generating Electric Current

Understanding the difference in 'electric potential' allows us to generate electricity. If we take a 'generous' metal such as Zinc, and a 'selfish' metal such as Copper, it is the difference between these two metal that makes them a great team. The altruistic Zinc is 'happy' to give electrons to the stingy Copper, while the Copper is 'happy' to take electrons from the generous Zinc. The scientific term for this arrangement is known as a **Galvanic Cell** or an Electrochemical Cell.



= Movement of Electrons

<u>This is a salt bridge</u>
Inside this salt bridge is a solution that conducts electricity and closes the electric circuit.

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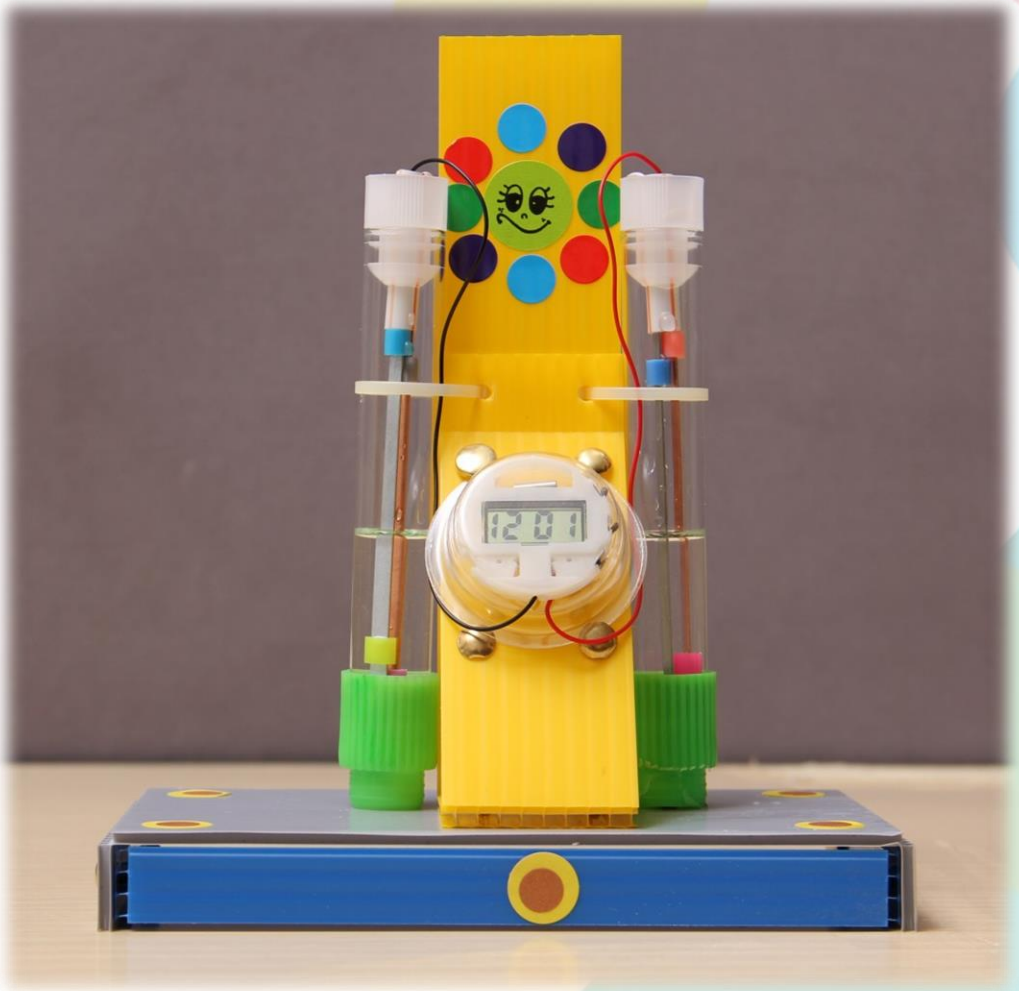
Building an Chemical Clock



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Chemical Clock – Materials Needed

Chemical Clock
Description of Materials

1. Polygal Base
2. Polygal Strip for Frame
3. Triangular Polygal Strip
4. 2 test tube stoppers
5. 4 long clear hoses
6. 4 short clear hoses
7. 2 wide stoppers
8. Lemon Clock Set
9. 8 rubber washers
10. 10 small paper fasteners
11. 2 large paper fasteners
12. 2 plastic ties
13. 2 test tubes

Instructor folder

- Stickers
- Dropper
- Salt
- Plastic spoon
- Plastic cup

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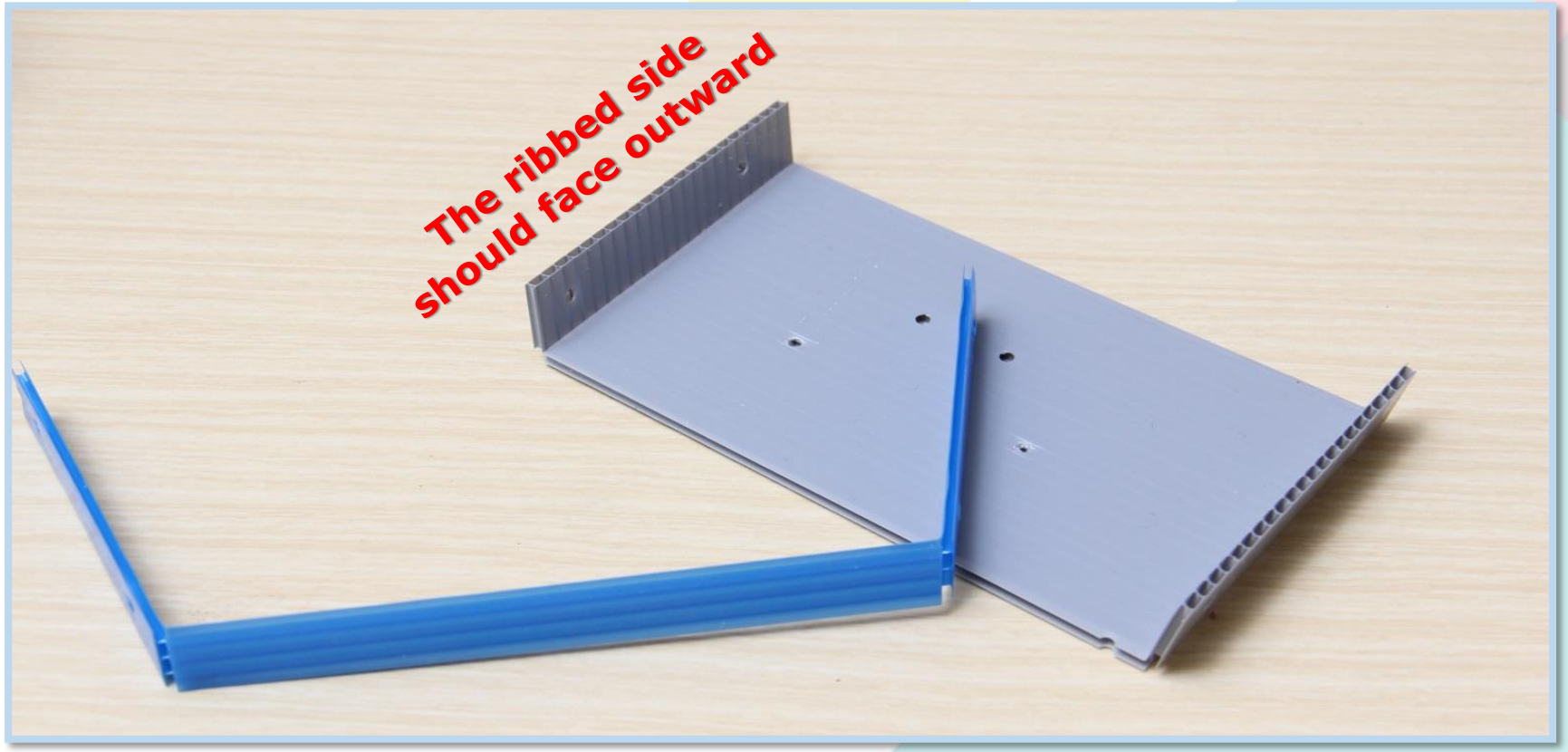
Take the Polygal base (1) and the Polygal strip (2) and fold them along the line markings.



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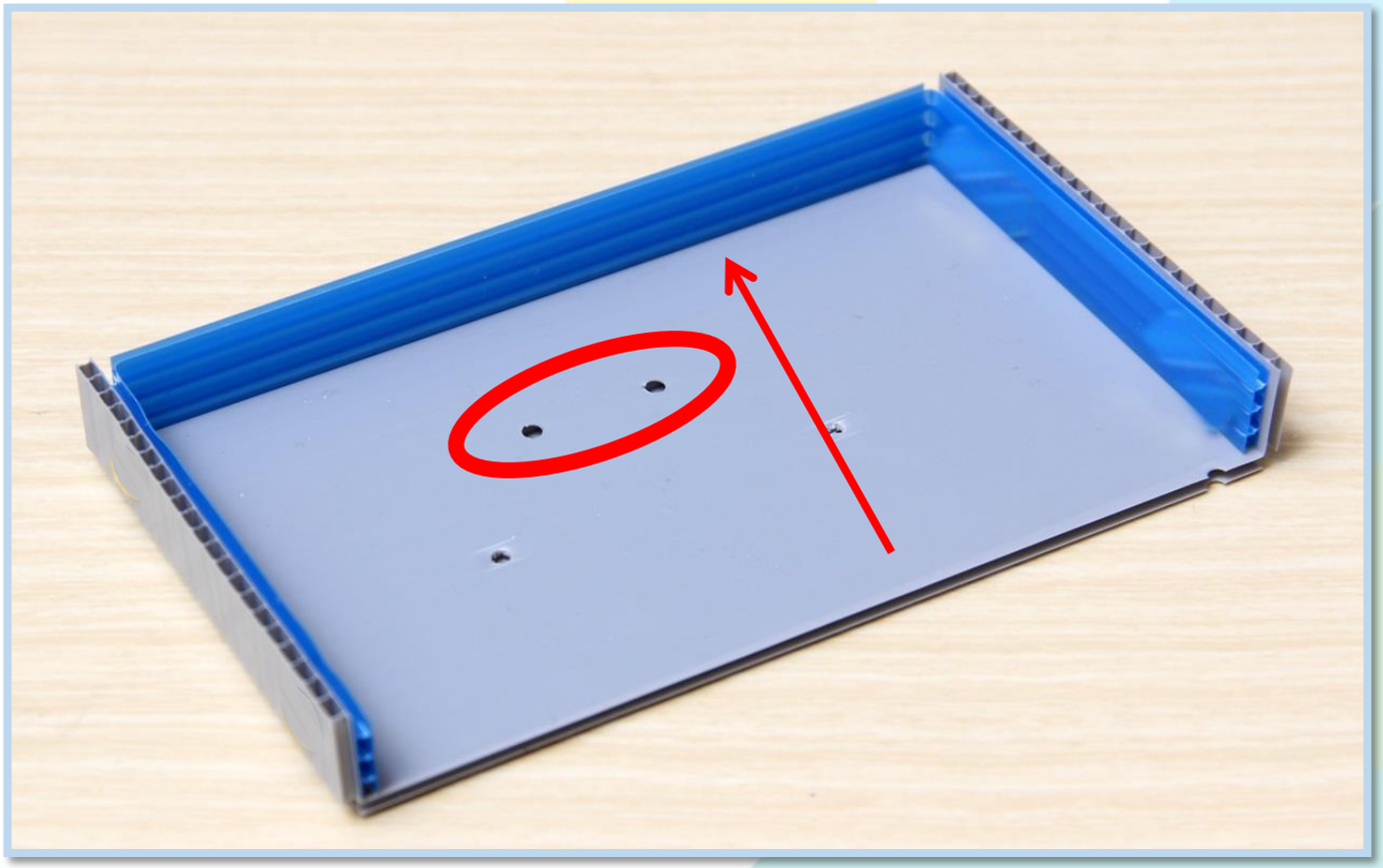
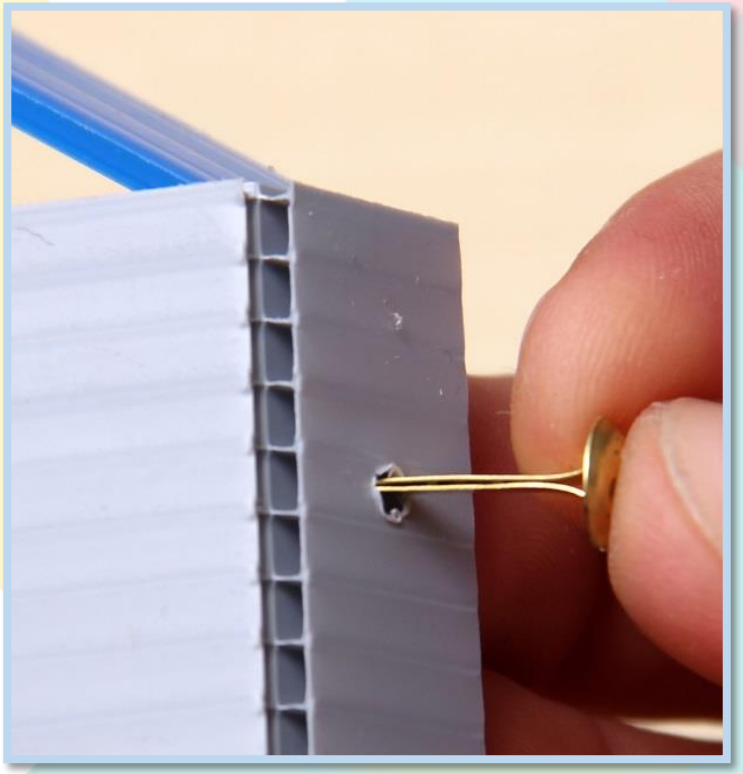
Place the Polygal frame (2) around the Polygal base (1) so that the long wall created is closest to the adjacent holes (circled in red)

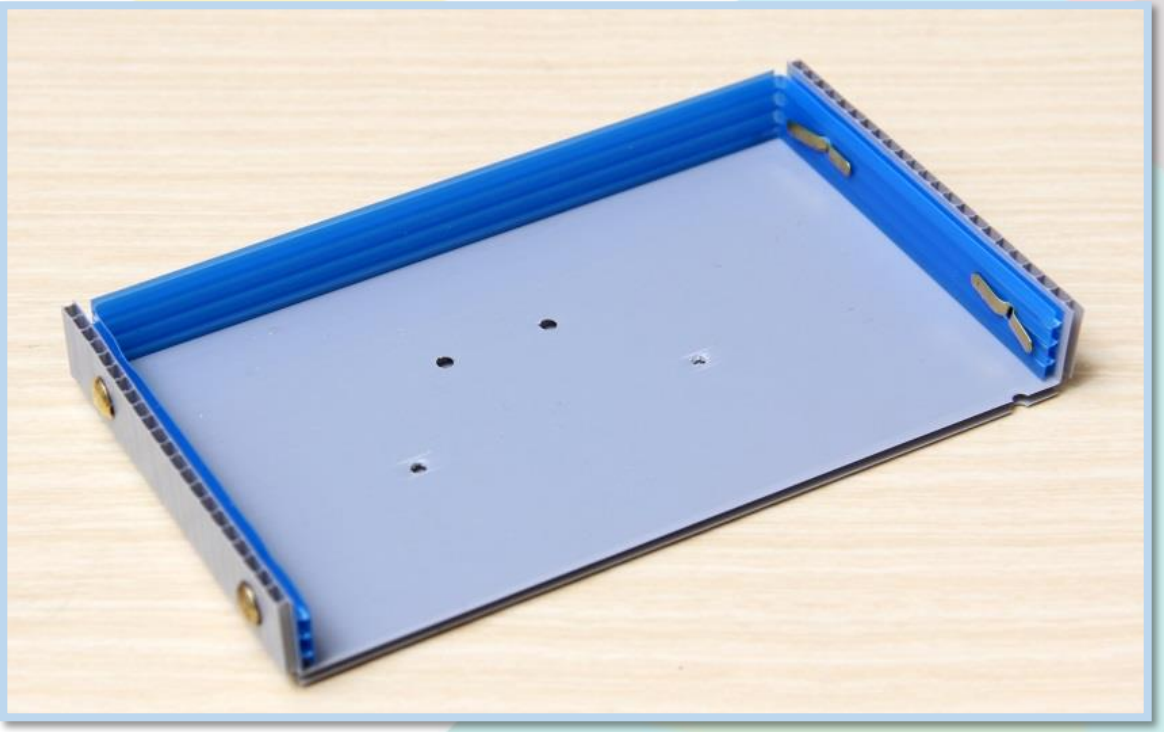


Insert the small paper fasteners (10) through the holes on the short wall of the Polygal so that the flat circle is on the outside of the frame.

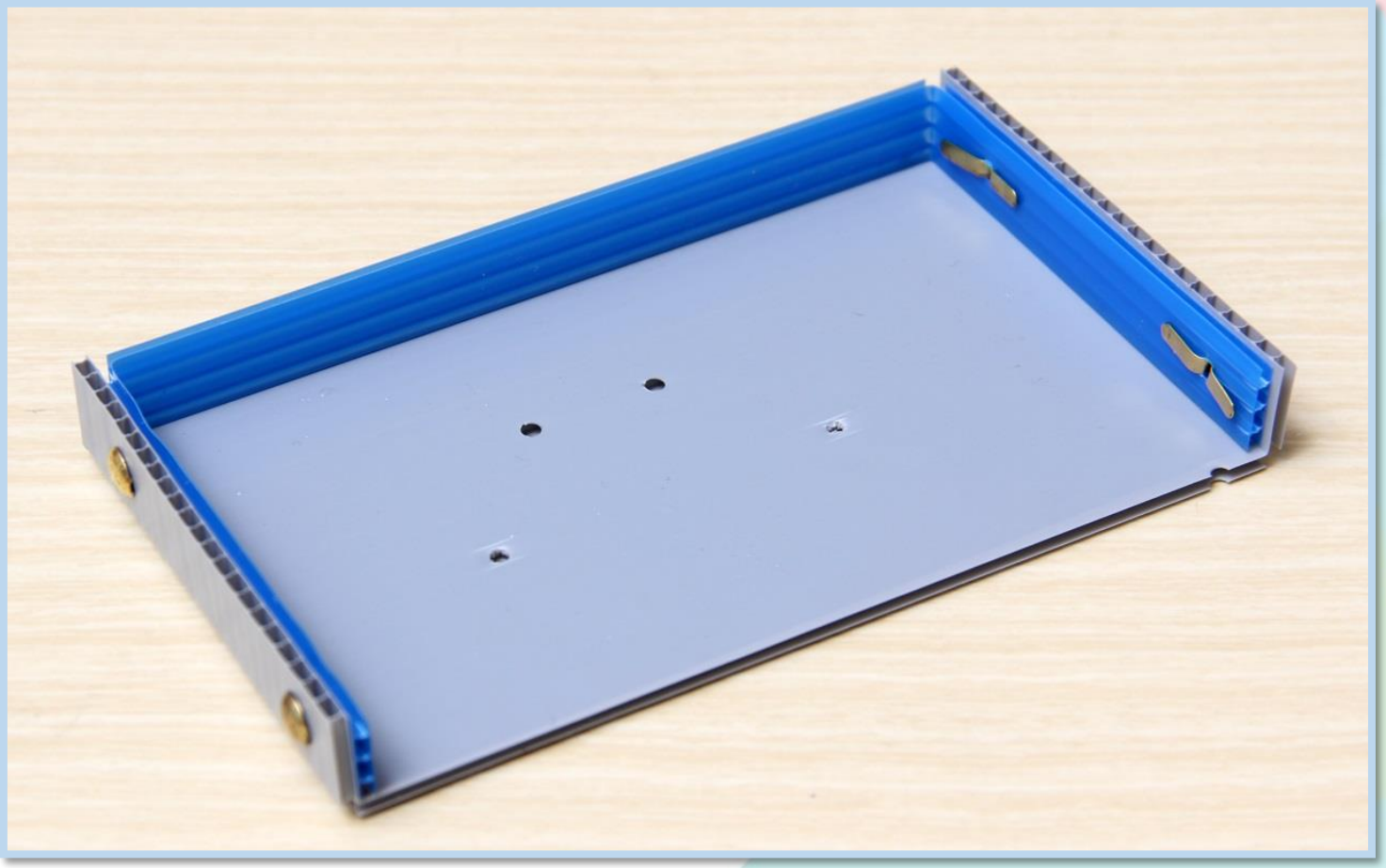


Place another small paper fastener (10) through the adjacent hole on the wall of the Polygal frame and spread the bottom of the fasteners so that they are secure.

Attached two more small paper fasteners (10) on the opposite Polygal wall and once again spread the bottom of the fasteners to secure.



Congratulations!
You have completed the base of the clock



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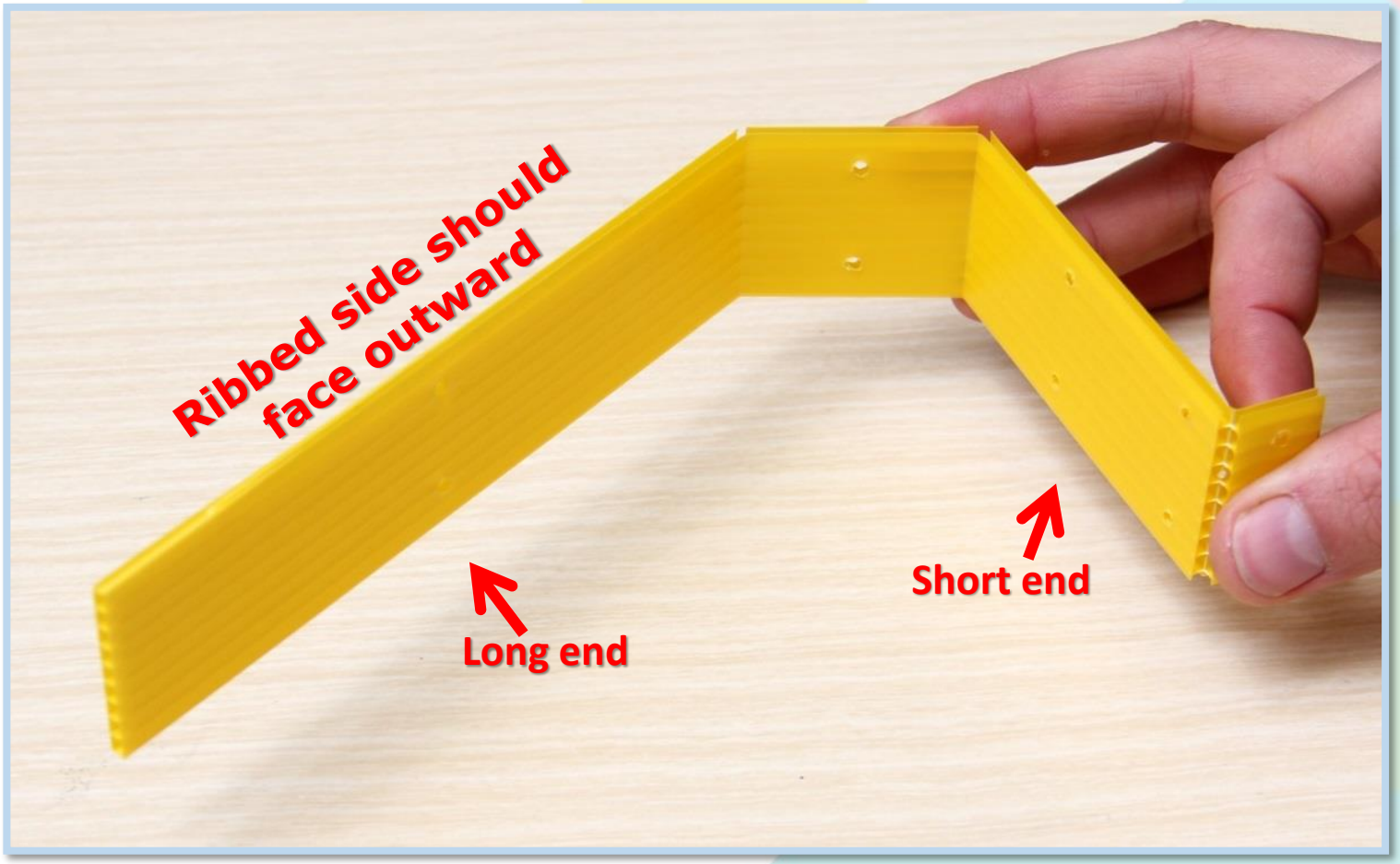
Fold the triangular Polygal strip (3) where indicated and make sure that the strip has a long end and a short end.



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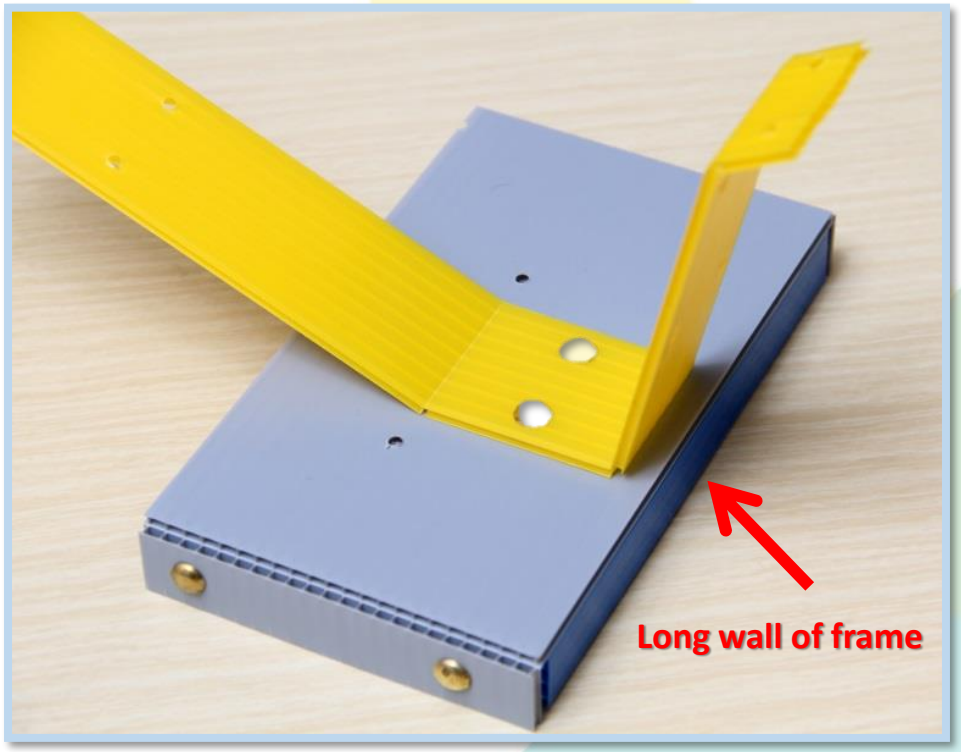
Flip the base, and align the holes of the triangular Polygal strip (3) to the holes on the bottom of the Polygal base, so that the short end of the triangular strip (3) is on the same side as the long wall of the Polygal frame



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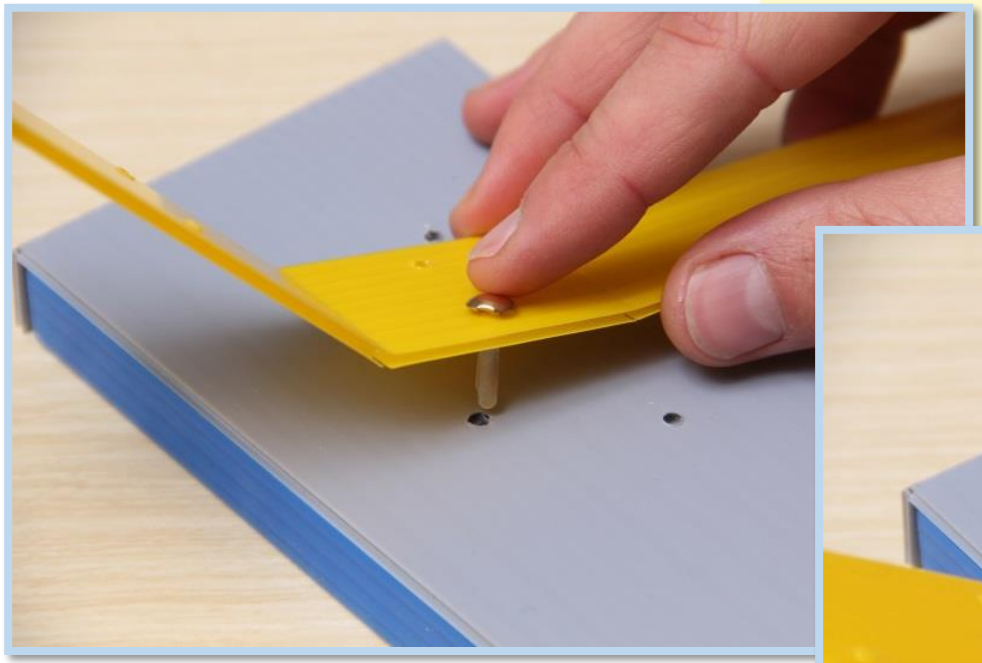
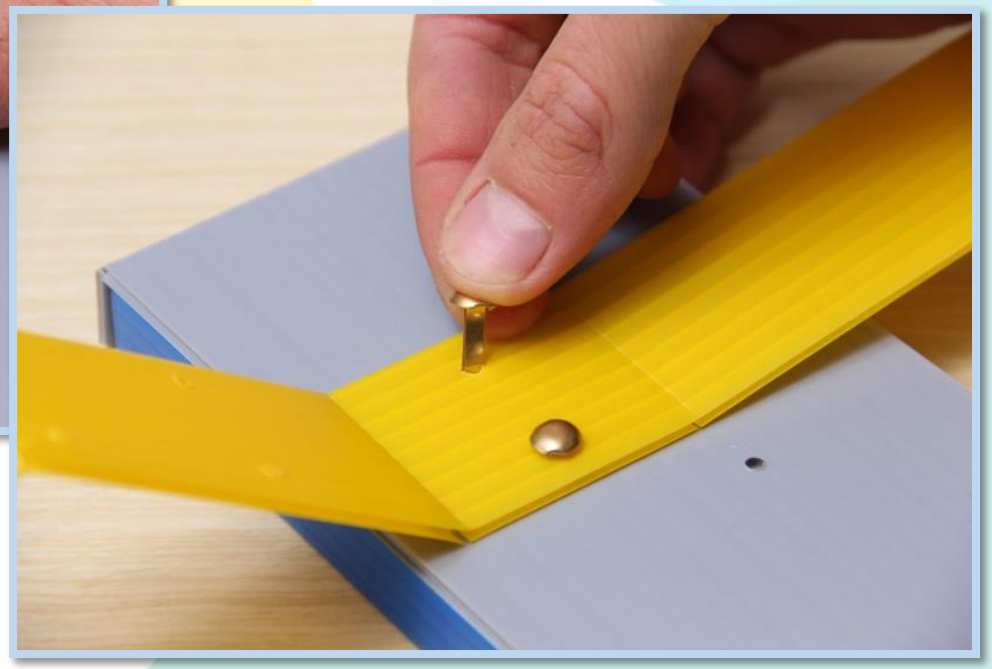
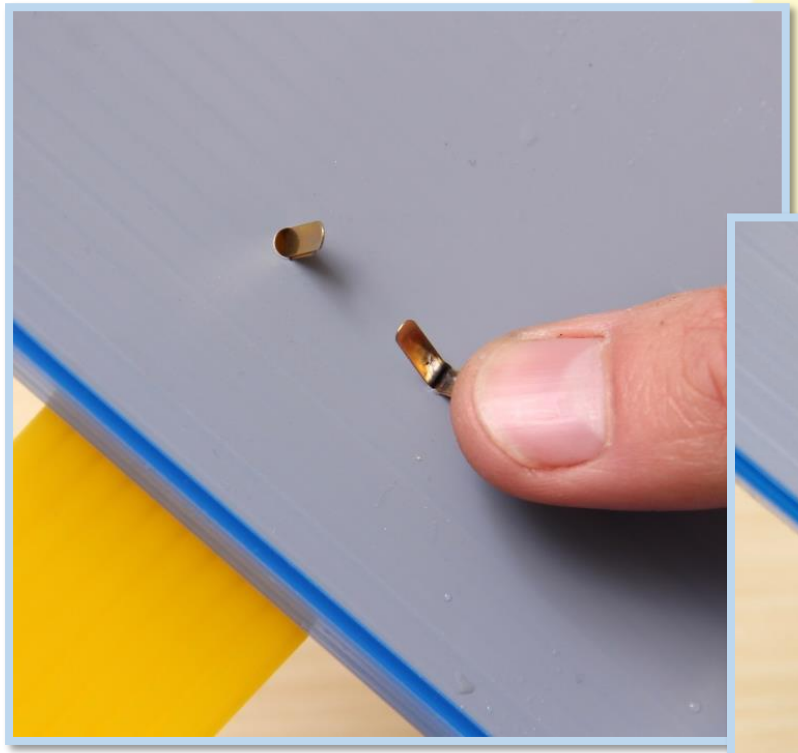
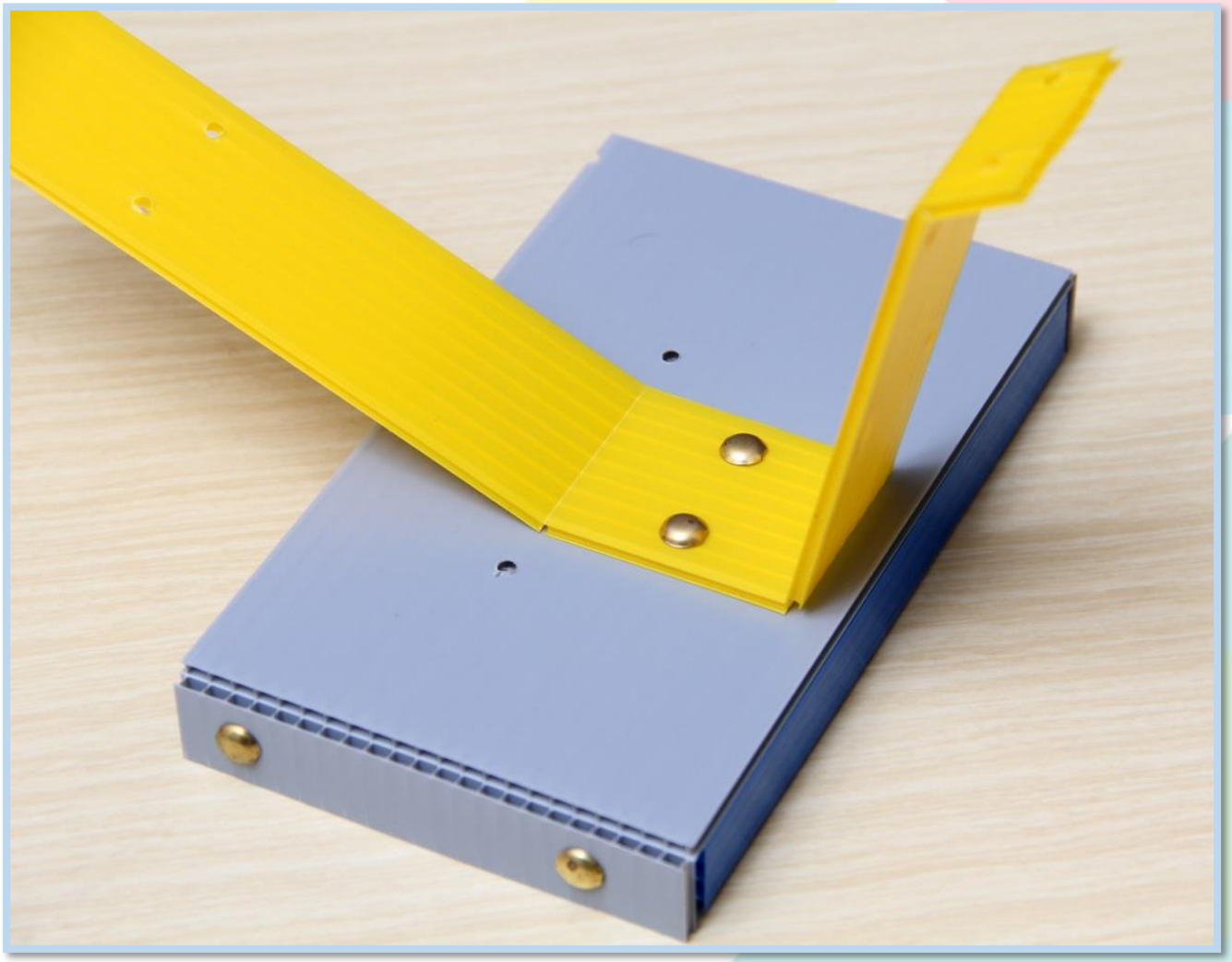
Now fasten the triangular Polygal strip to the bottom of the base with two small paper fasteners (10)





Spread the bottom legs of the fasteners to secure





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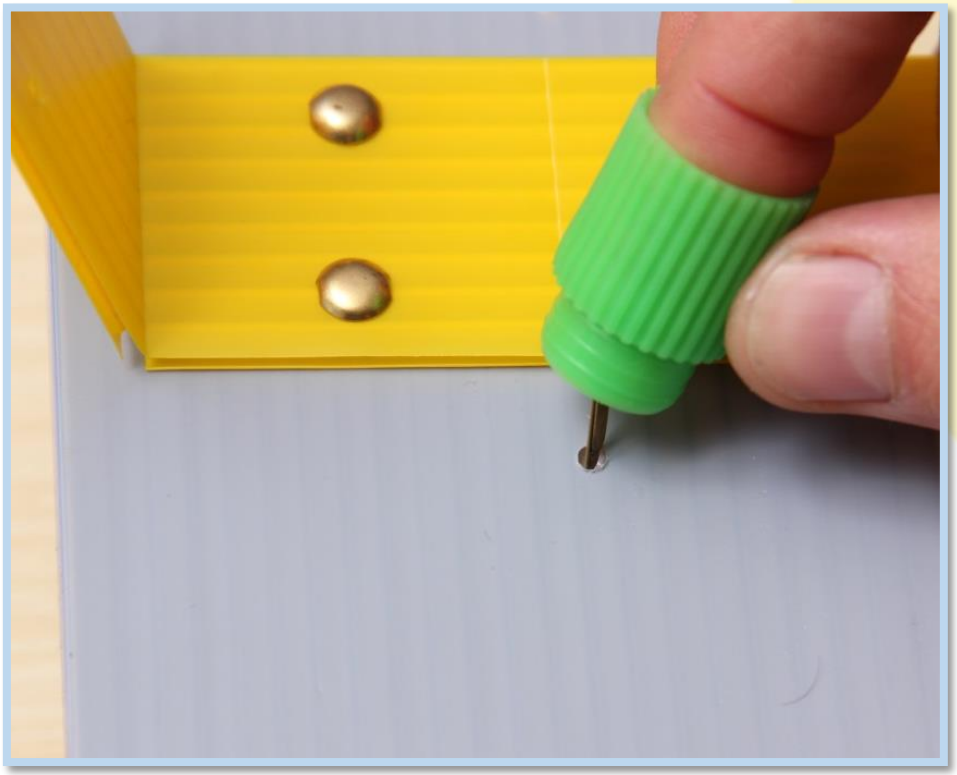
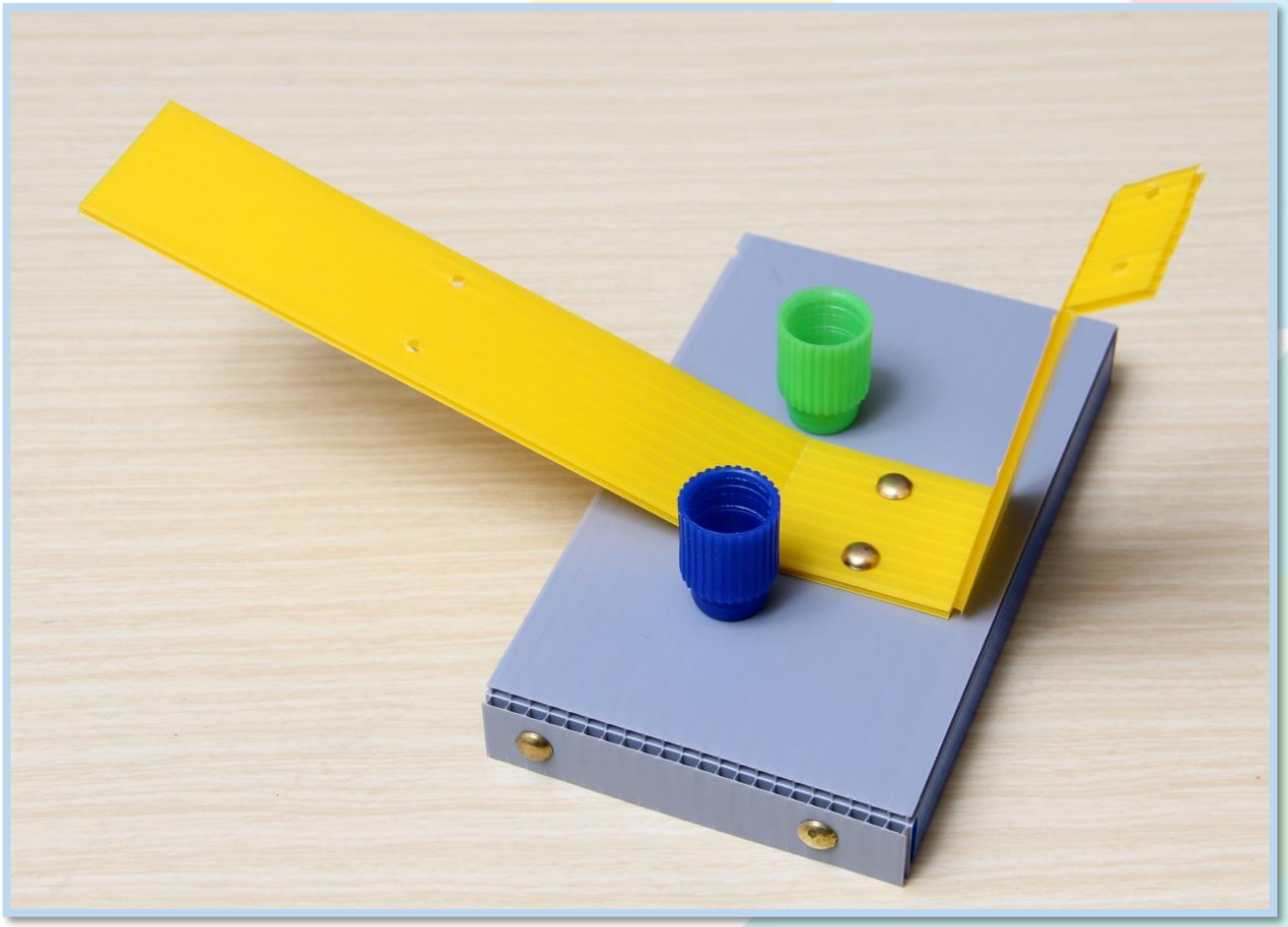
Take one wide stopper (7), and one large paper fasteners (11) and insert the fastener into the stopper so that the flat circle is inside the stopper. Repeat with the second stopper and fastener

Insert the end of the long paper fastener (11) from one of the wide stoppers (7) into the Polygal base on the same side as the triangular strip (3).
Then spread the bottom of each fastener to secure.



This completed section will hold the Chemical Clock that we will build



We will continue building the Chemical Clock in the next lesson

Course #7
'Science Scent'

Lesson #10
Chemical Clock – Part II

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Lesson Plan

Time	Activity
5 min	Review of Previous Lesson
30 min	Finish Building Chemical Clock
5 min	Testing the Chemical Clock
5 min	Conclusion
Extra	Different Types of Clocks

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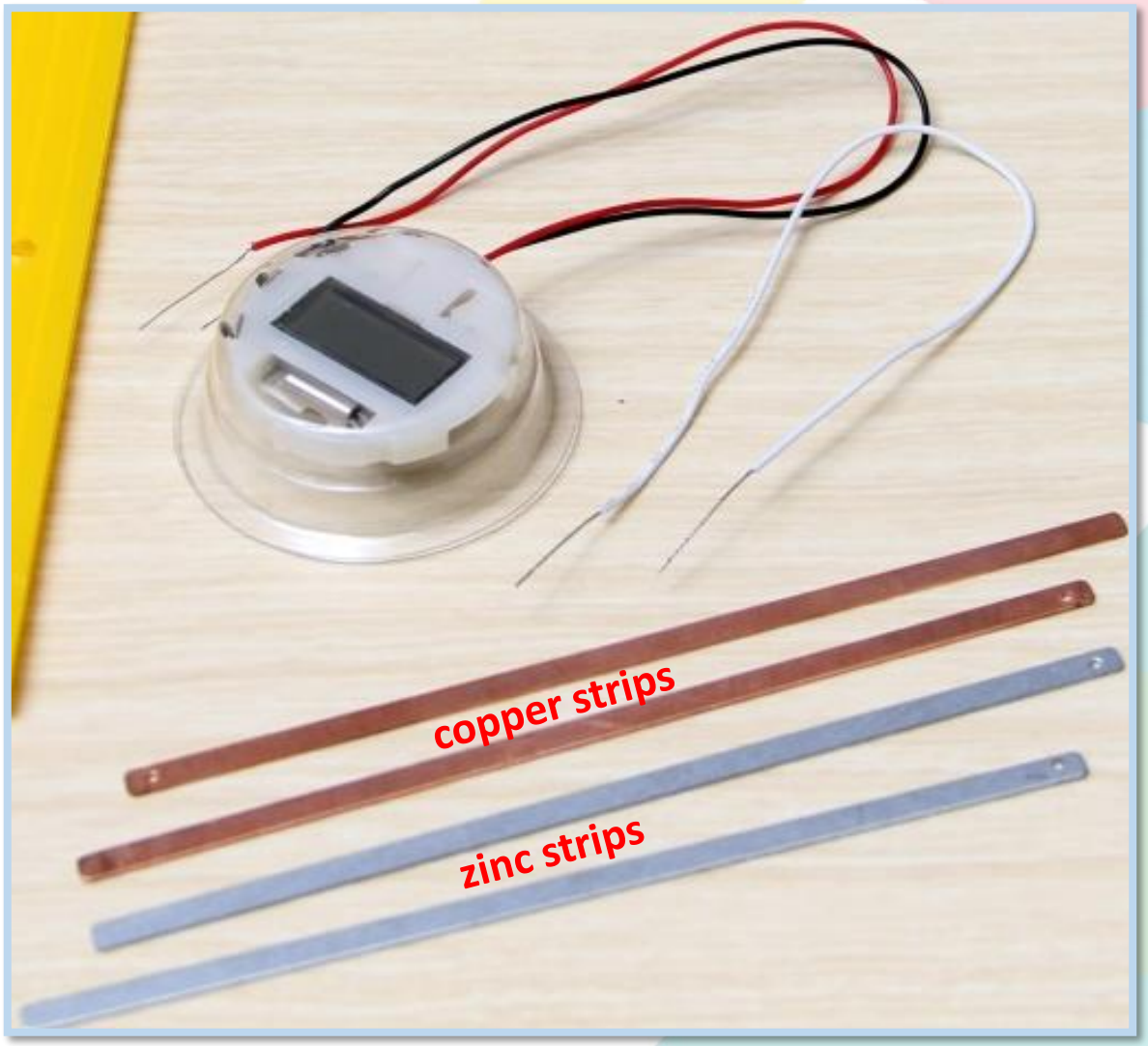
Review of Previous Lesson

Finish
Building the Chemical Clock

Take out the Lemon Clock Set



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Please Note:

As we continue to build the clock, **avoid** stretching the metal wires that are connected to the clock mechanism as these wires are very delicate!

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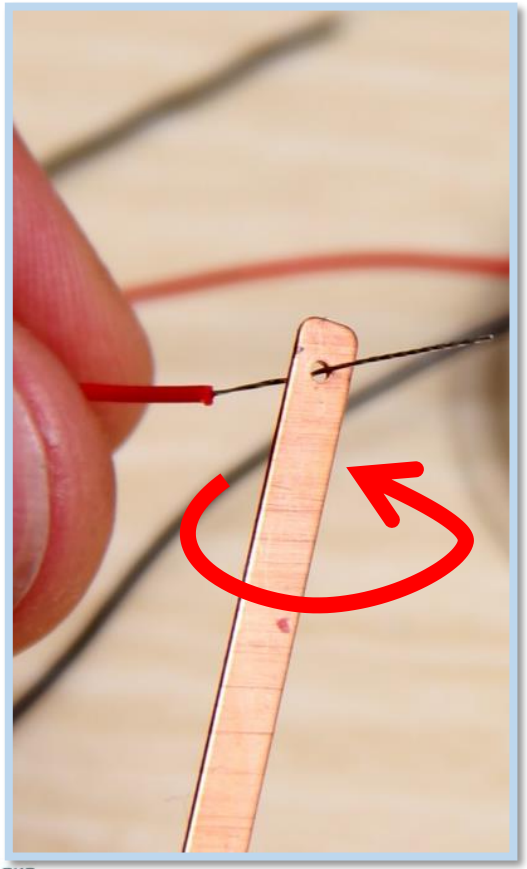
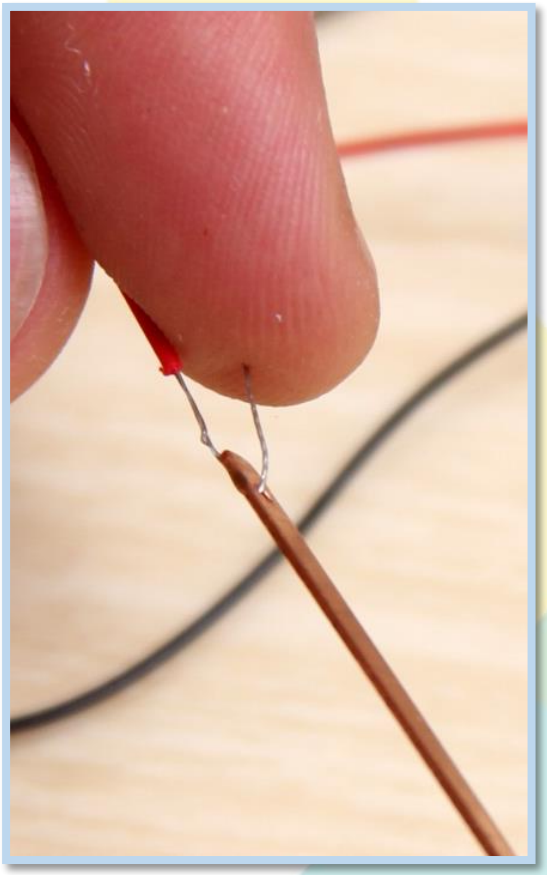
Carefully insert the **red metal wire** at the end of the clock mechanism through the small hole on the copper metal strip and wrap the wire by slowly spinning the copper strip.





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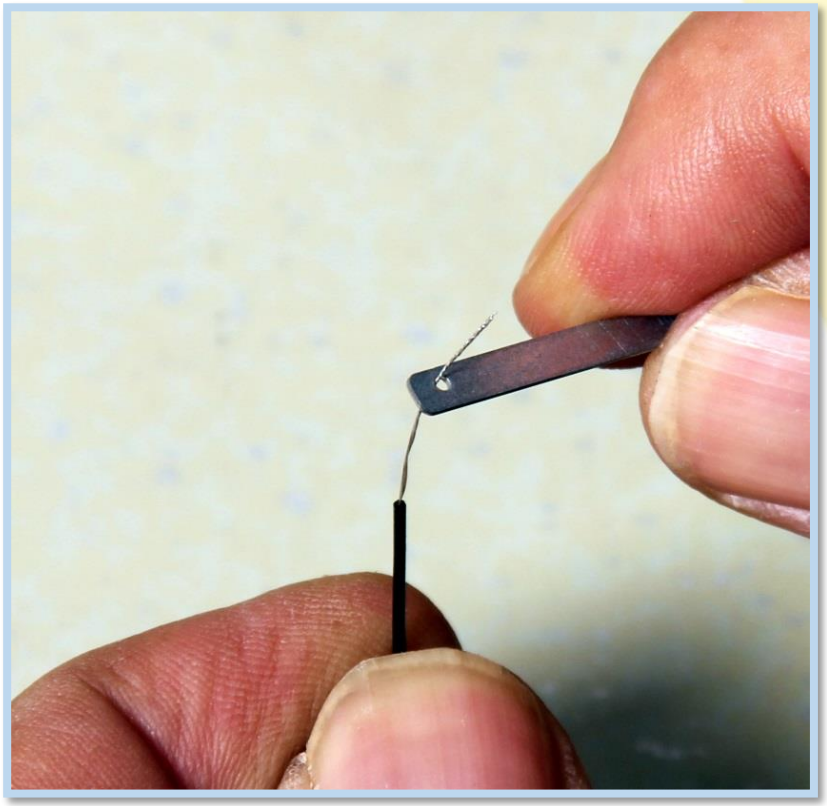
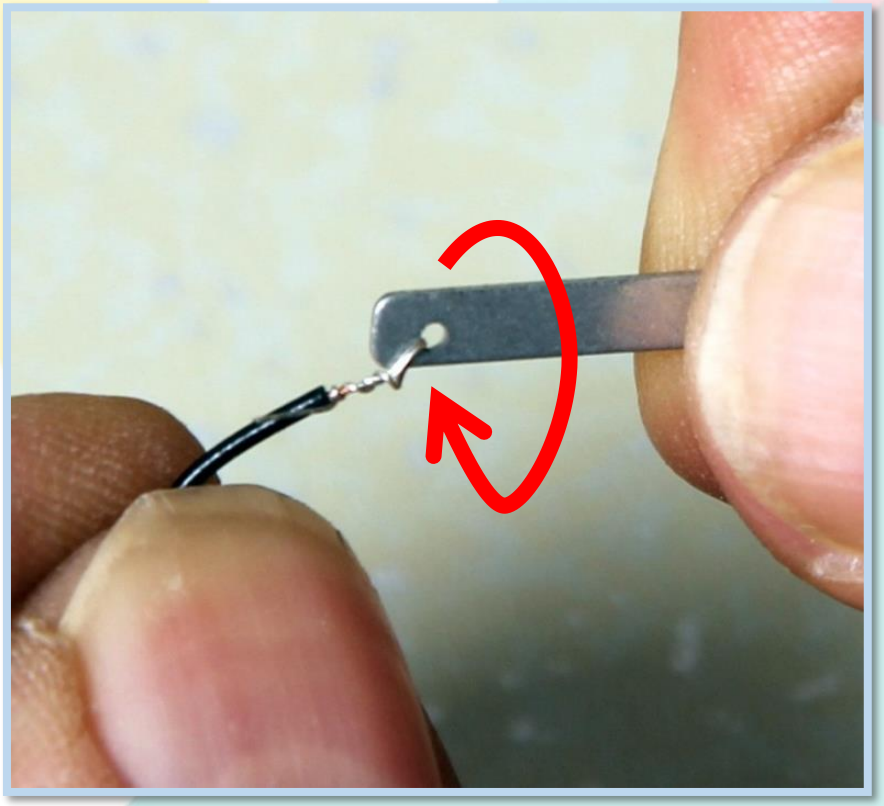
Now carefully insert the **black wire** that is attached to the clock mechanism into the hole on the gray <u>zinc</u> metal strip and wrap the wire by slowly spinning the zinc metal strip.





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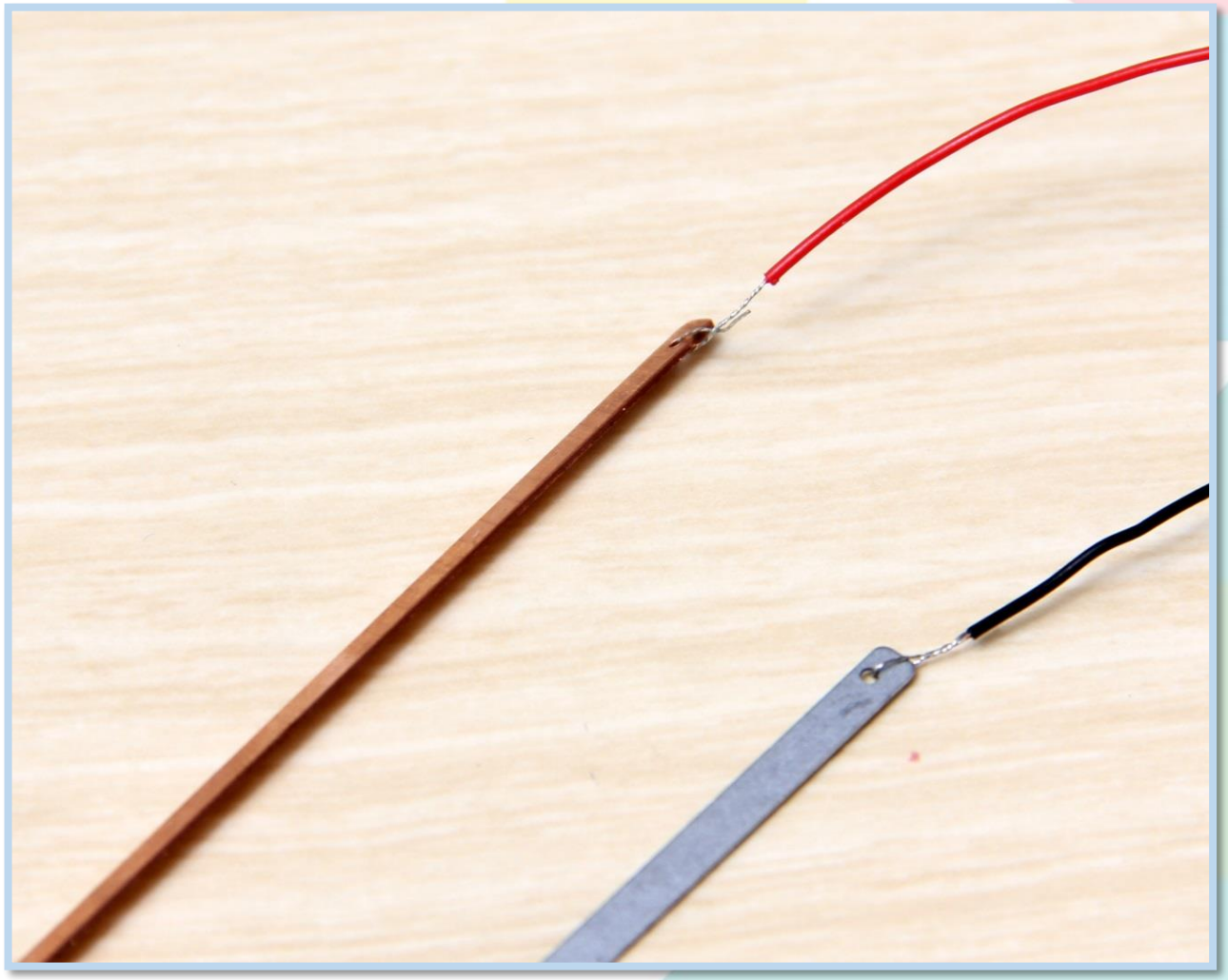
The copper strip should be attached to the red wire.
The zinc strip should be attached to the **black wire**.



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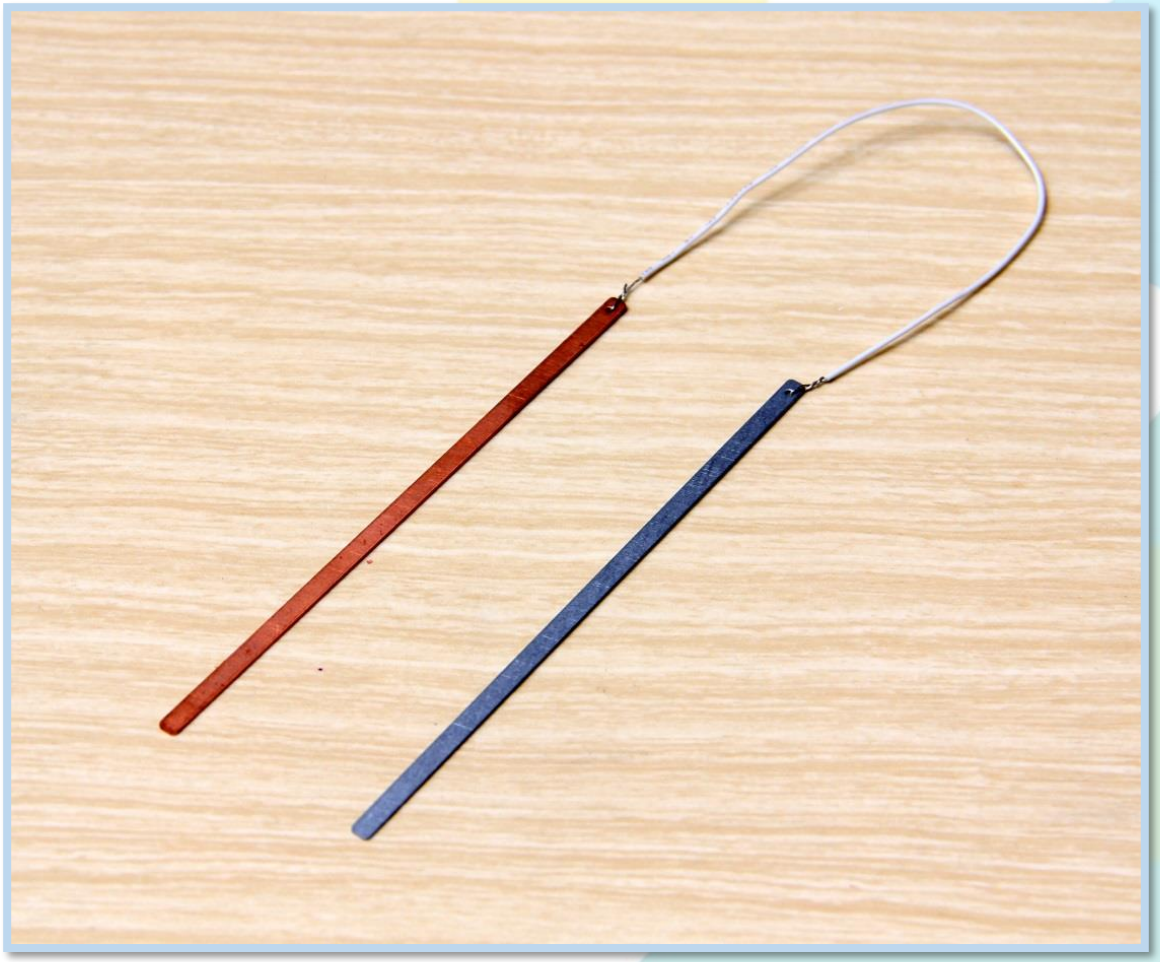
In the same manner, attach the additional copper and zinc strips with the remaining electric wire



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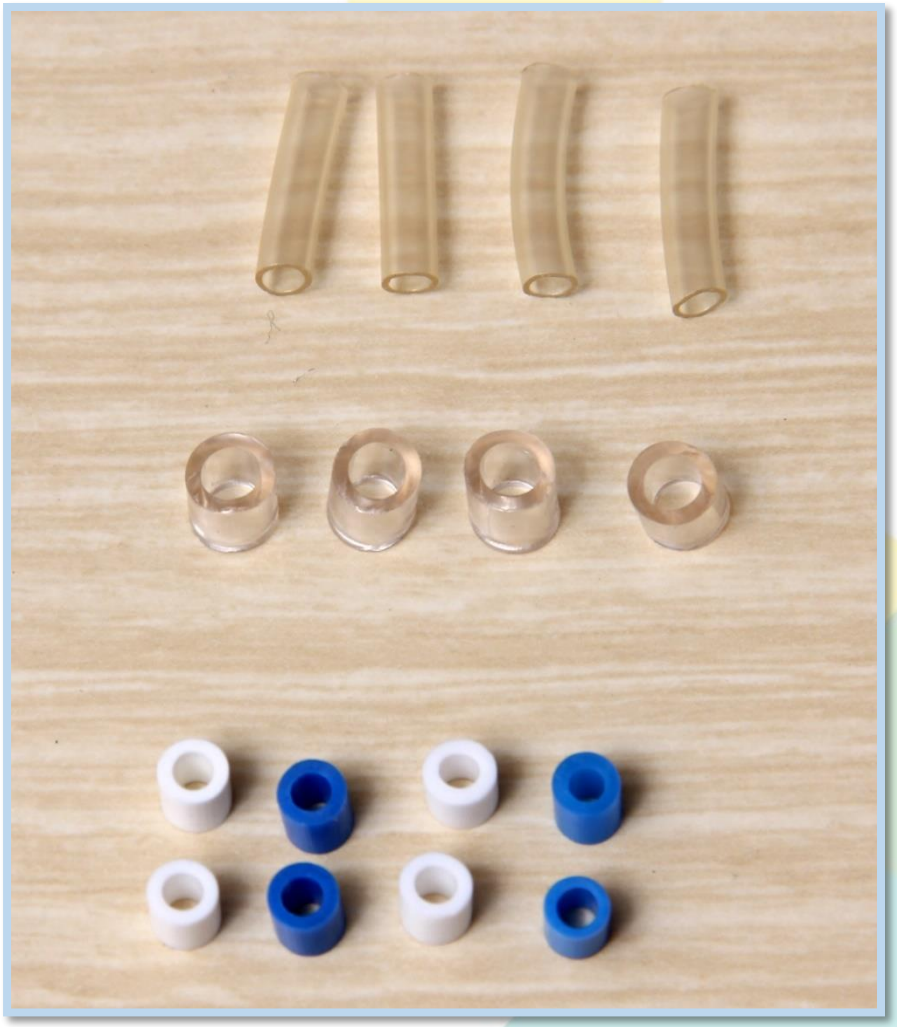
Now we will need the clear plastic hoses and the rubber washers.



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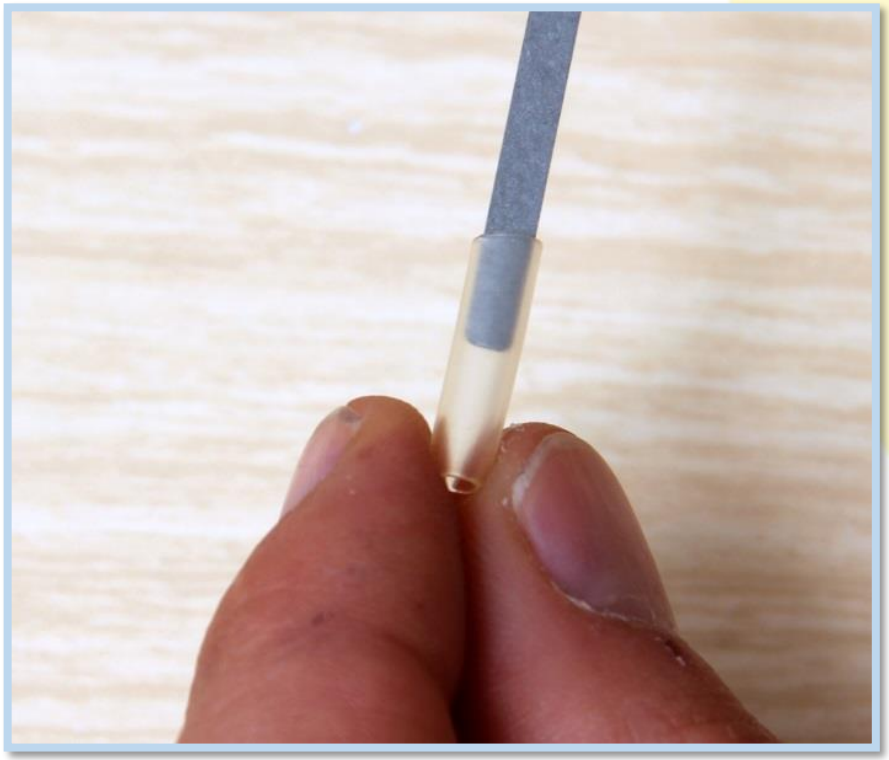
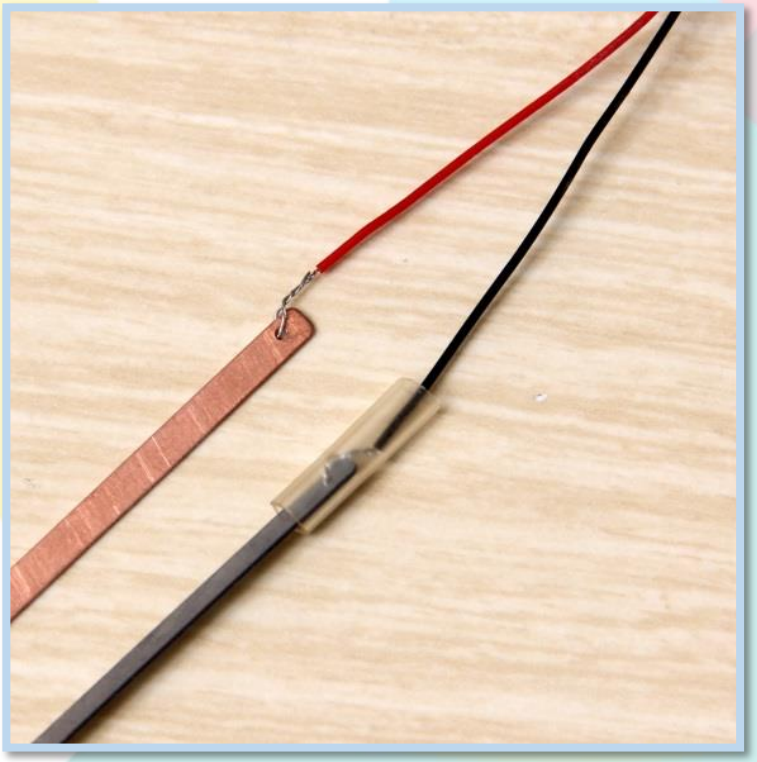
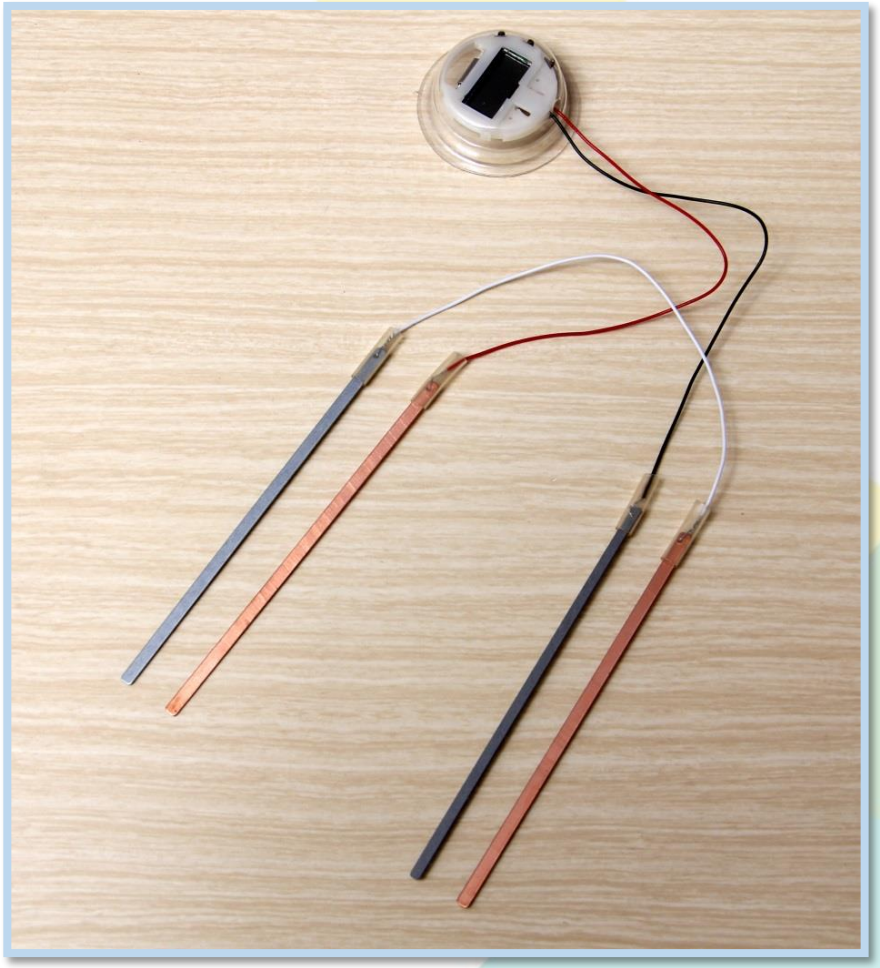
Slide a long clear hose (5) up the zinc metal strip to cover and protect the connection between the **black wire** and the zinc strip

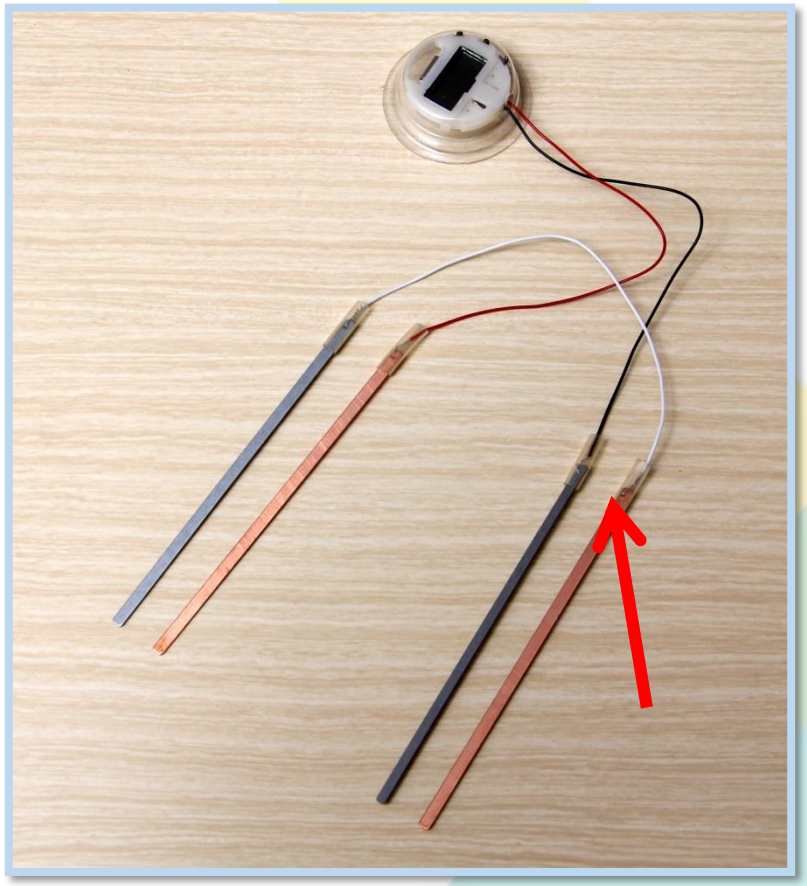




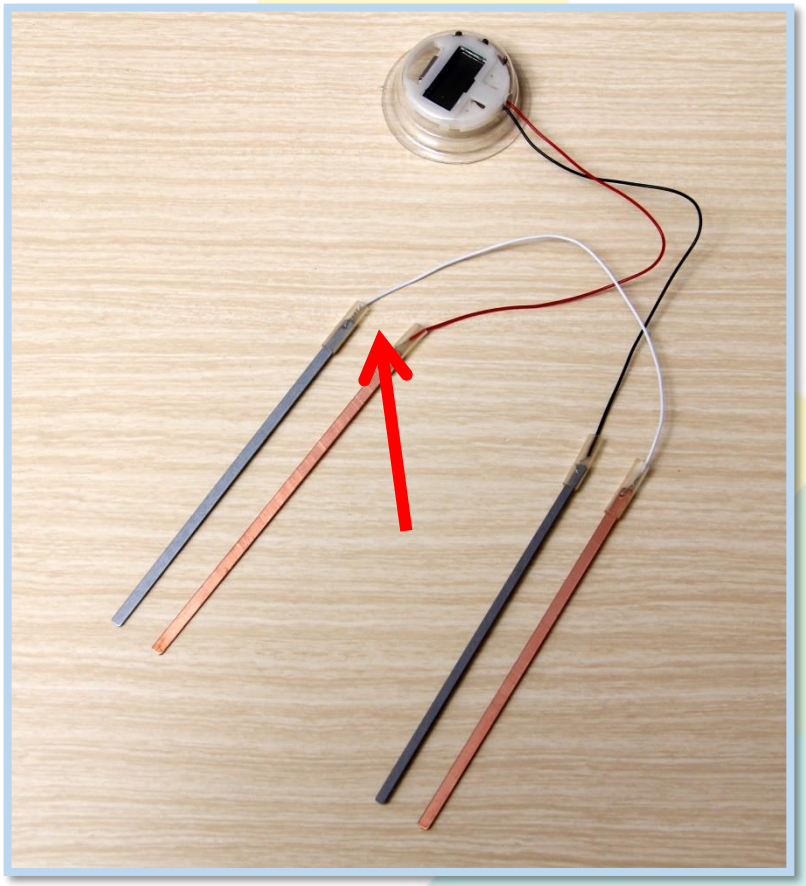
Slide the remaining long clear hoses (5) up the remaining metal strips to cover and protect the wire connections



Place the zinc strip with the **black wire** that is connected to the clock, next to the copper strip connected to the electrical wire



Place the copper strip with the red wire that is connected to the clock, next to the zinc strip connected to the electrical wire



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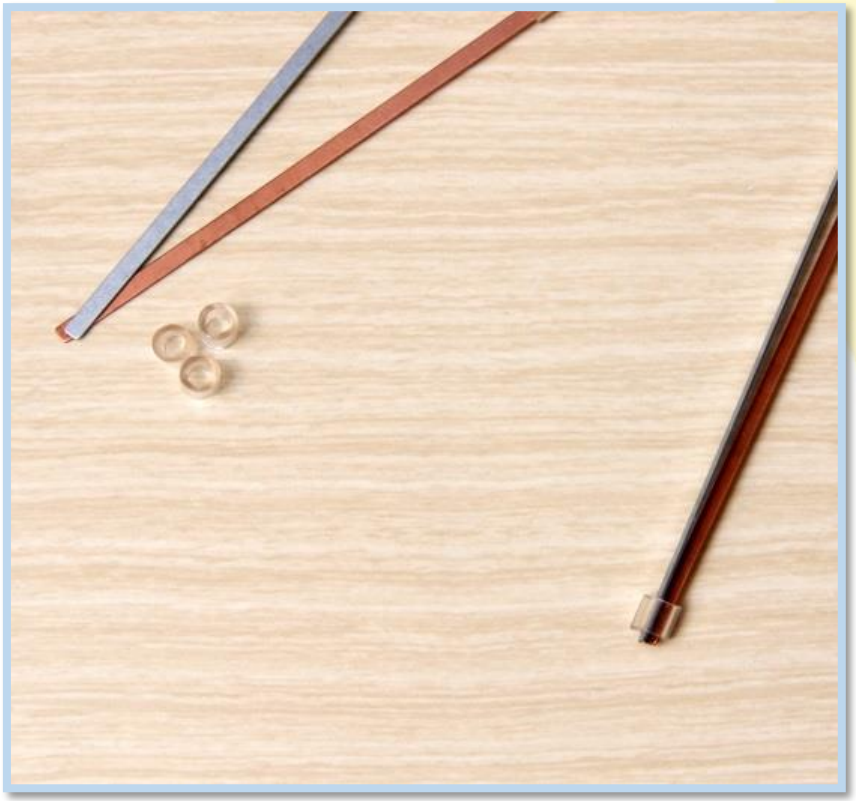
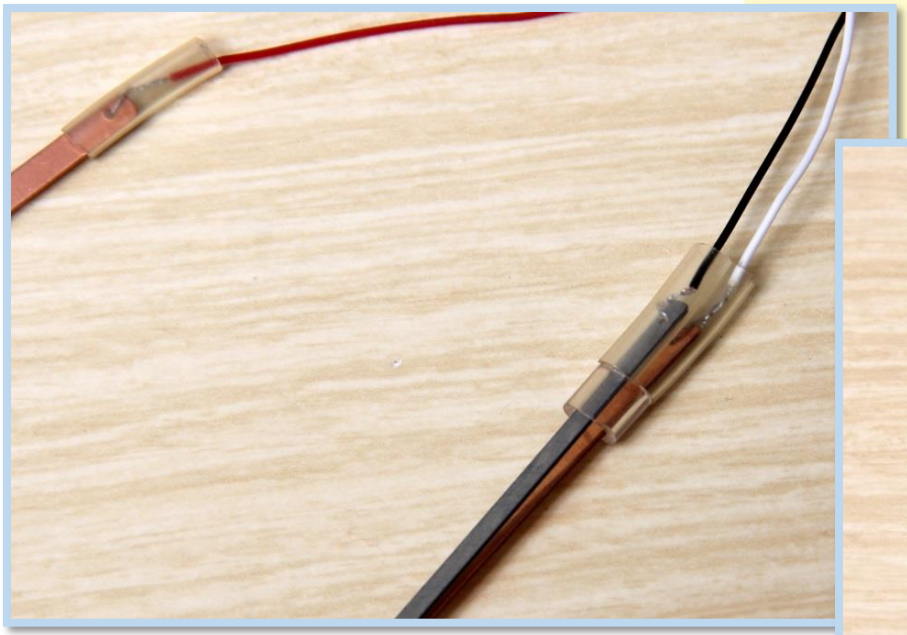
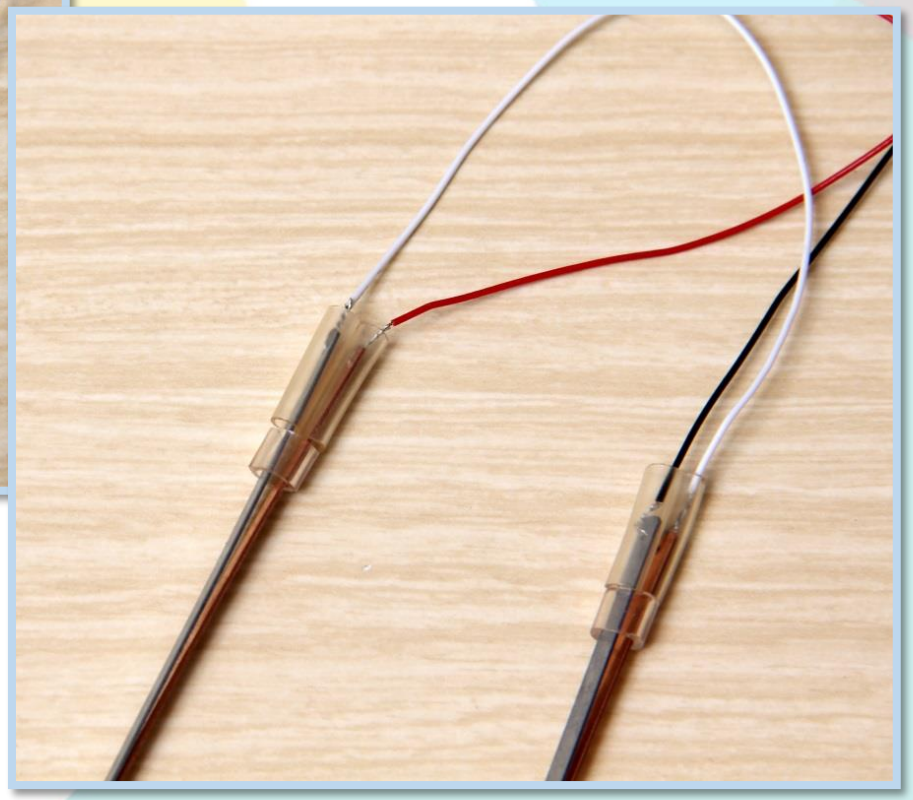
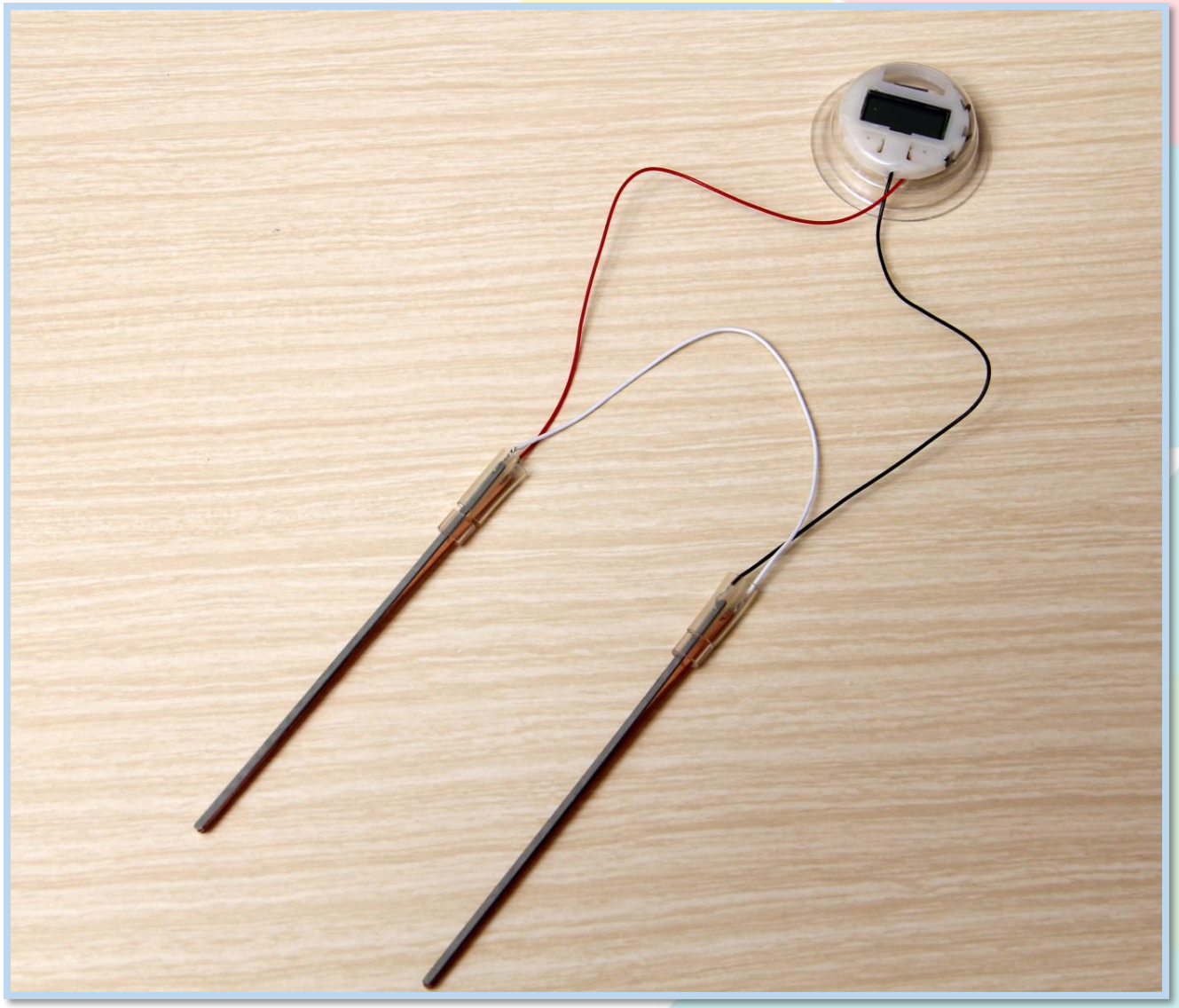
Insert the ends of each pair of copper and zinc strips into a short clear hose (6)



Carefully slide the short clear hose (6) up each pair of copper and zinc strips until the short clear hose reaches the long clear hose (5).







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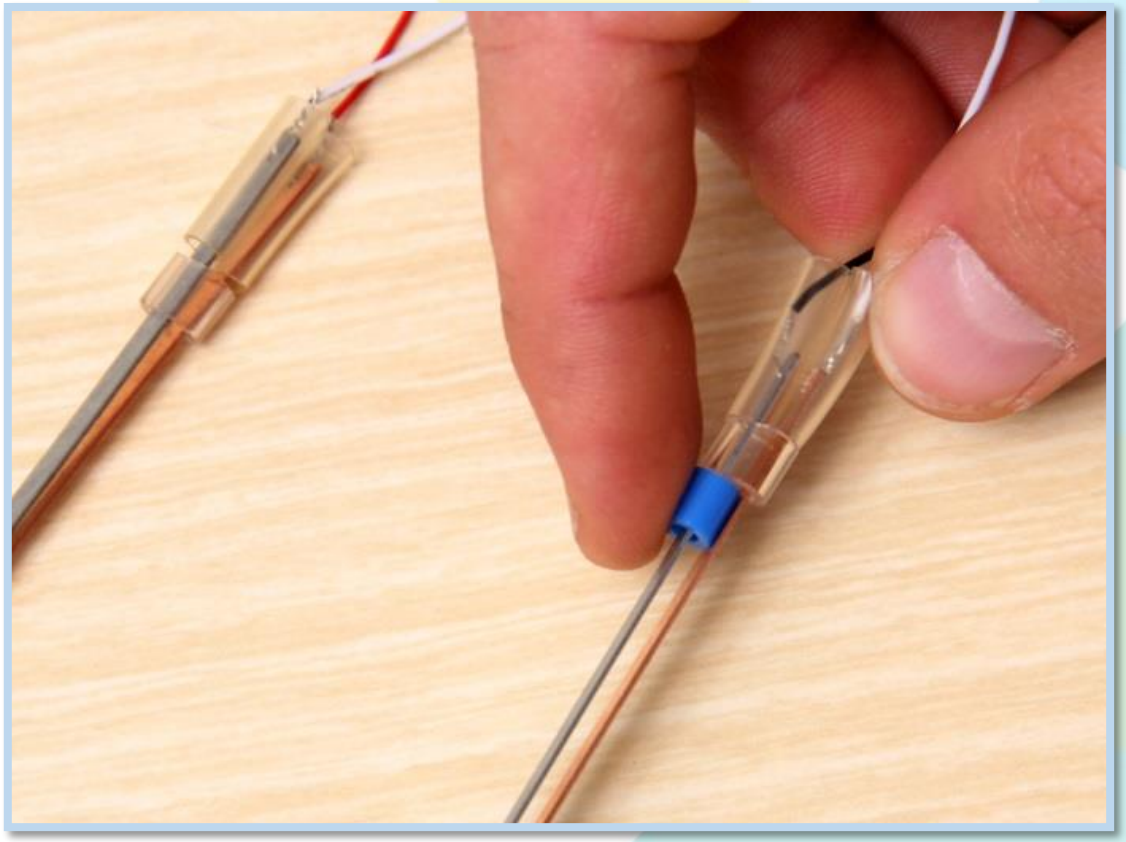
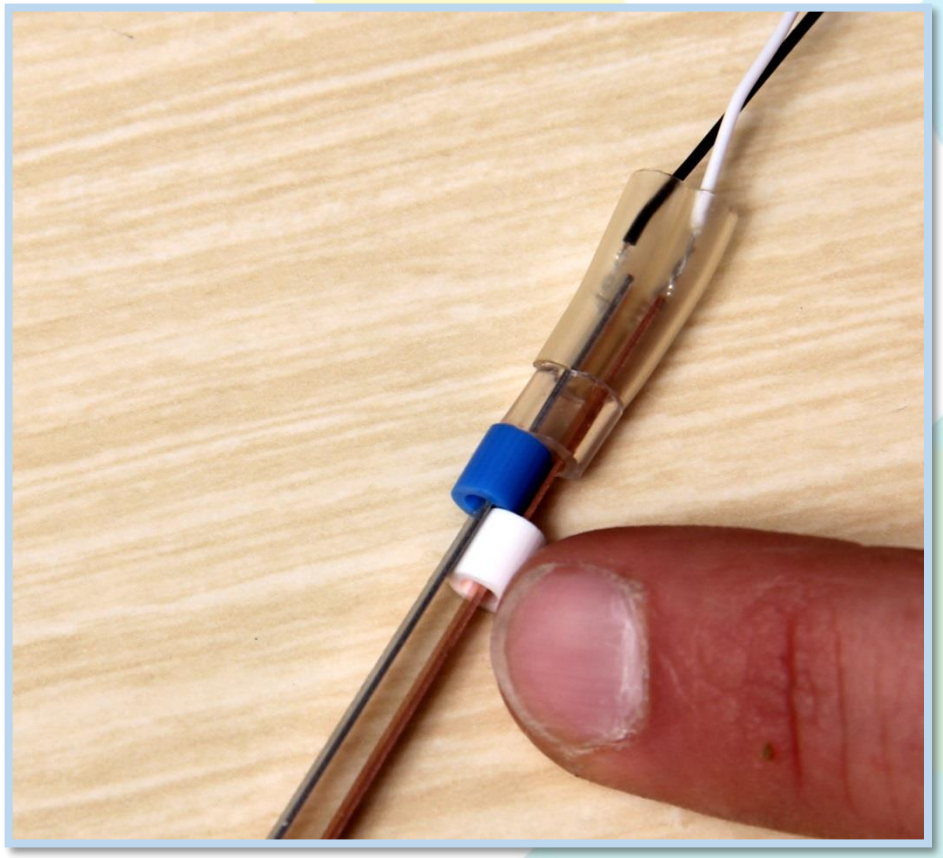
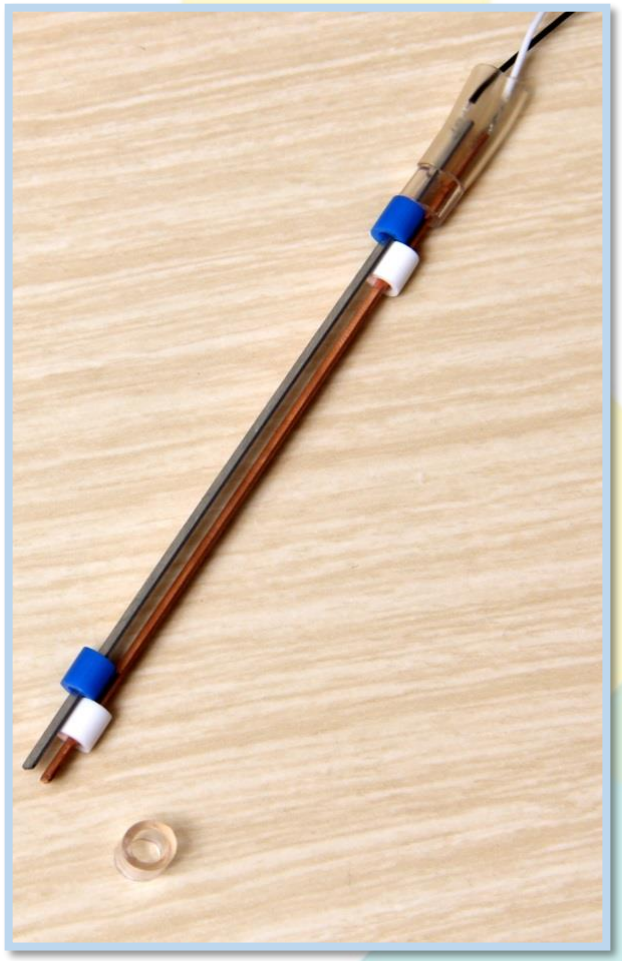
Carefully slide one small rubber washer (9) up one of the zinc strips until it reaches the short clear hose (6)



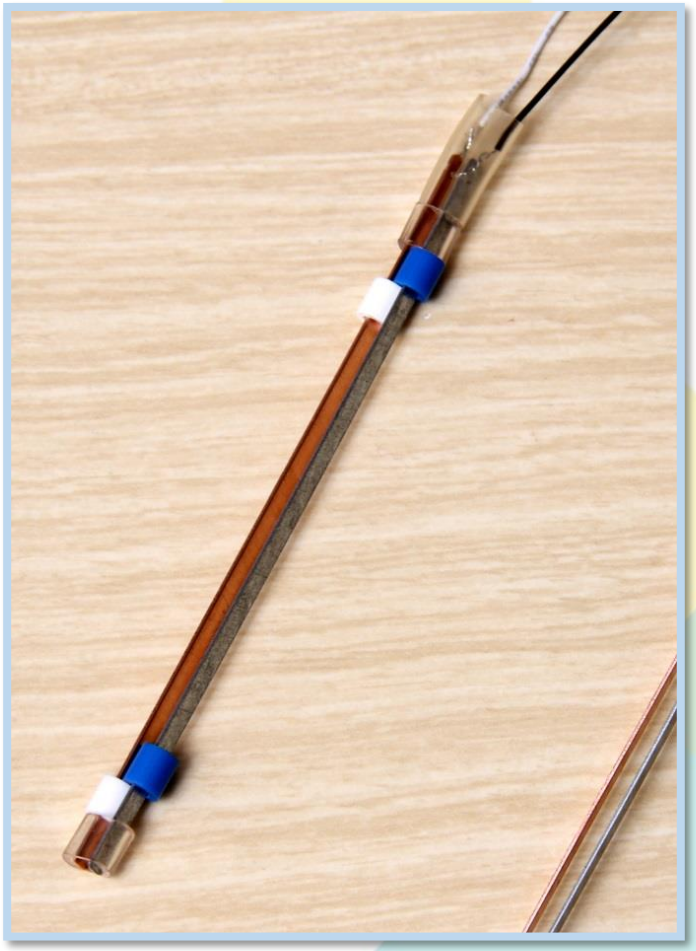
Carefully slide another small rubber washer (9) up one of the copper strips until it reaches the short clear hose (6)



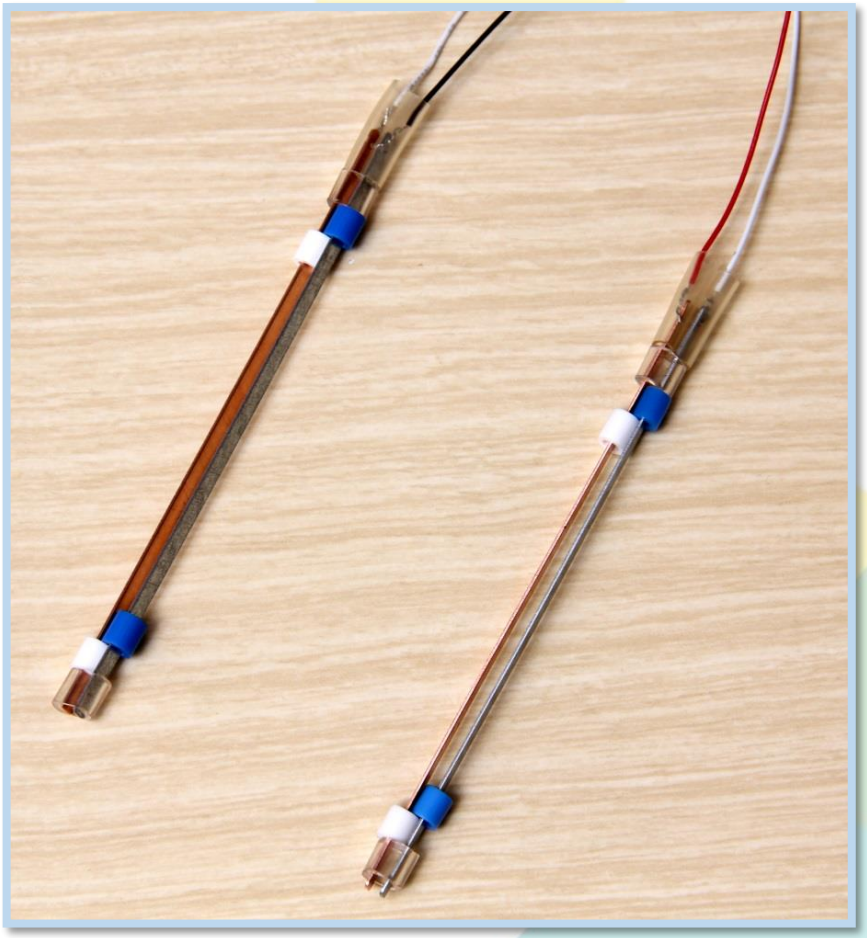
Slide another rubber washer (9) on the end of each strip, leaving the ends exposed.



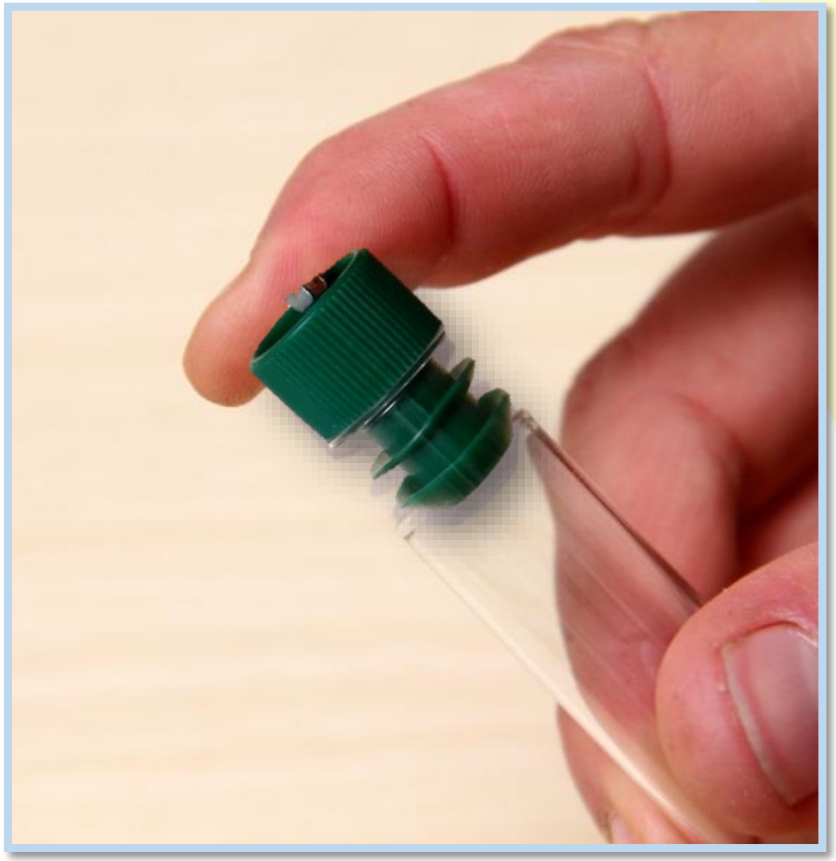
Slip the ends of the copper and zinc strips into the short clear hose (6) so that it rests on the end

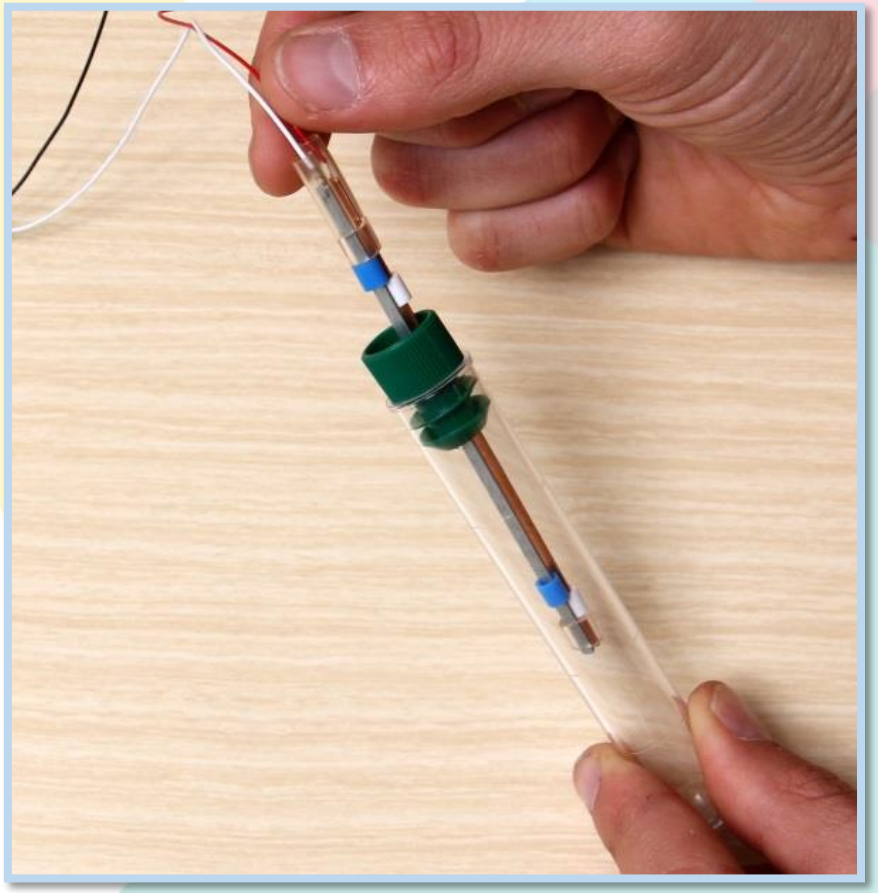


Repeat these steps for the other pair of copper and zinc metal strips



Seal a test tube (13) with a test tube stopper (4) and carefully slide a pair of bound metal strips through the hole in the stopper.





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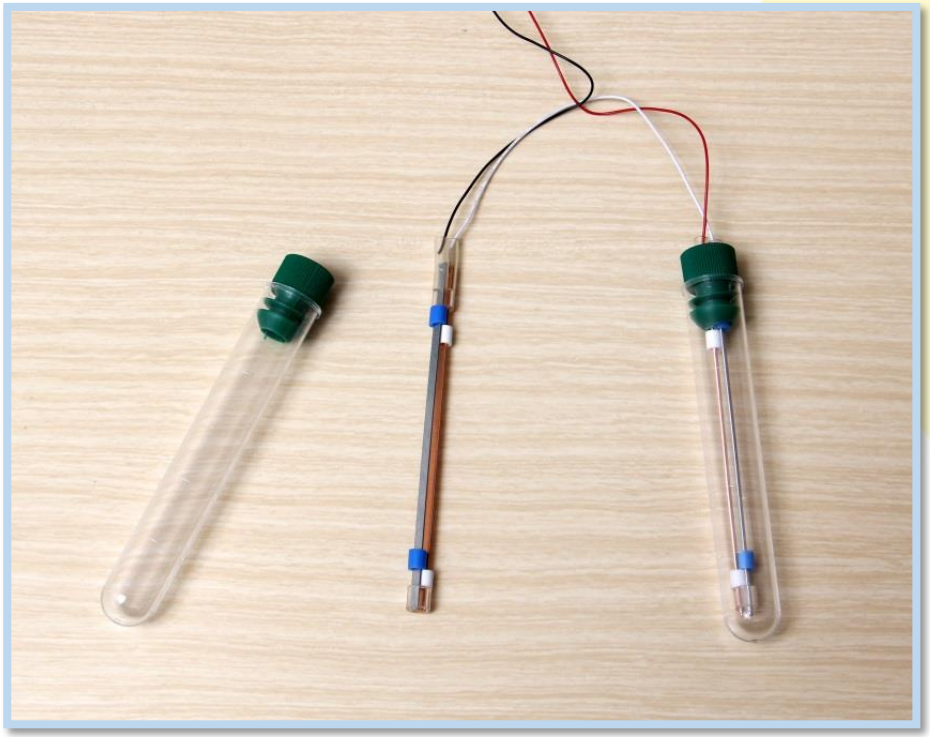
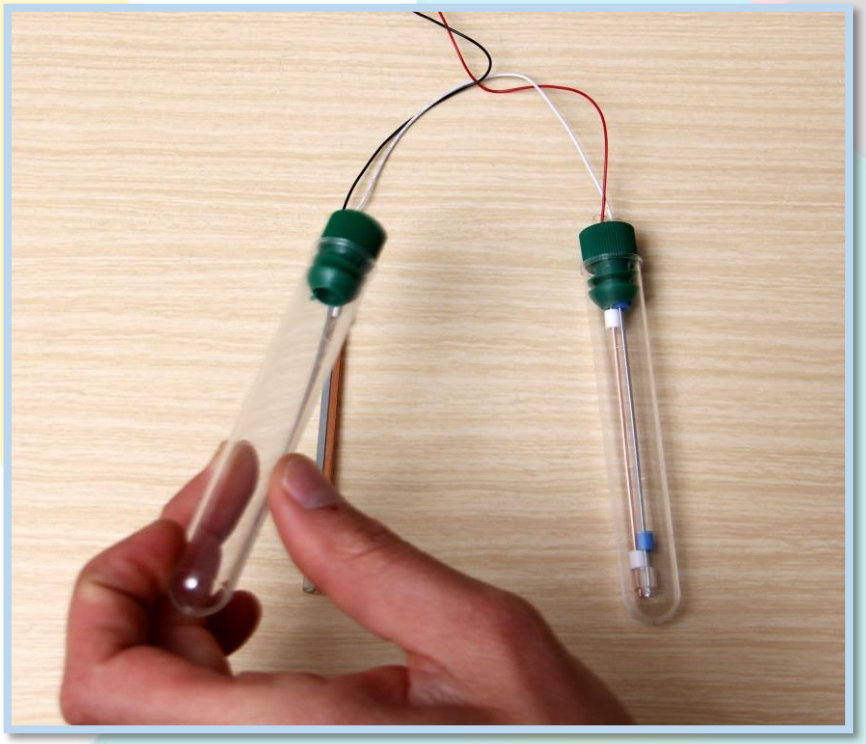
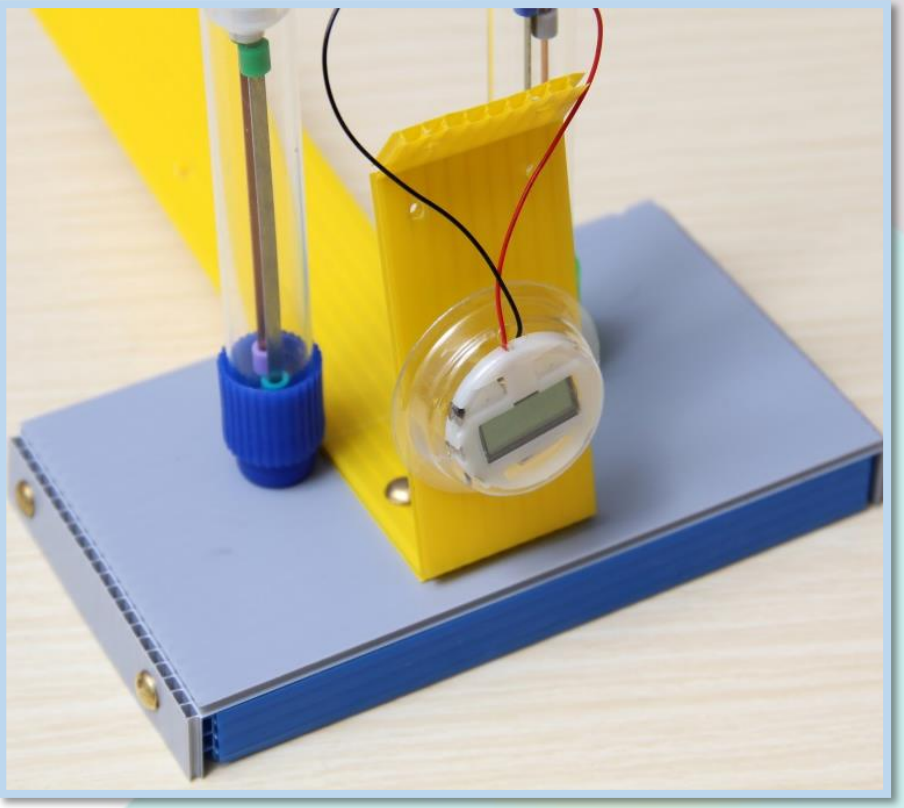
Repeat these steps with the other test tube (13), test tube stopper (4) and bound pair of metal strips.



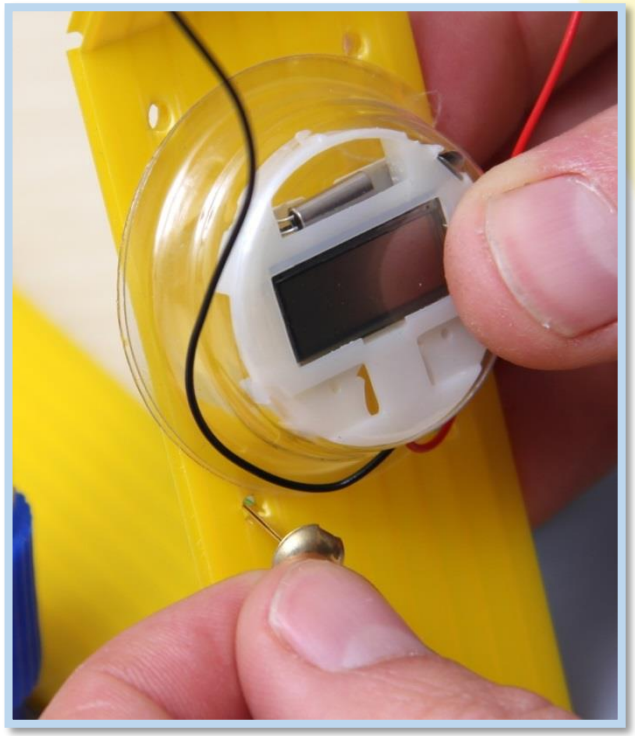


Secure the test tubes by placing them into the wide stoppers (7) that are attached to the base of the assembly kit.



Make sure the clock display is facing outward and the **wires come out from the <u>bottom</u> of the clock mechanism**.

Then, **<u>carefully</u>** affix the clock mechanism to the short end of the triangular Polygal strip, by inserting the short paper fasteners (10) into the designated holes around the clock mechanism.



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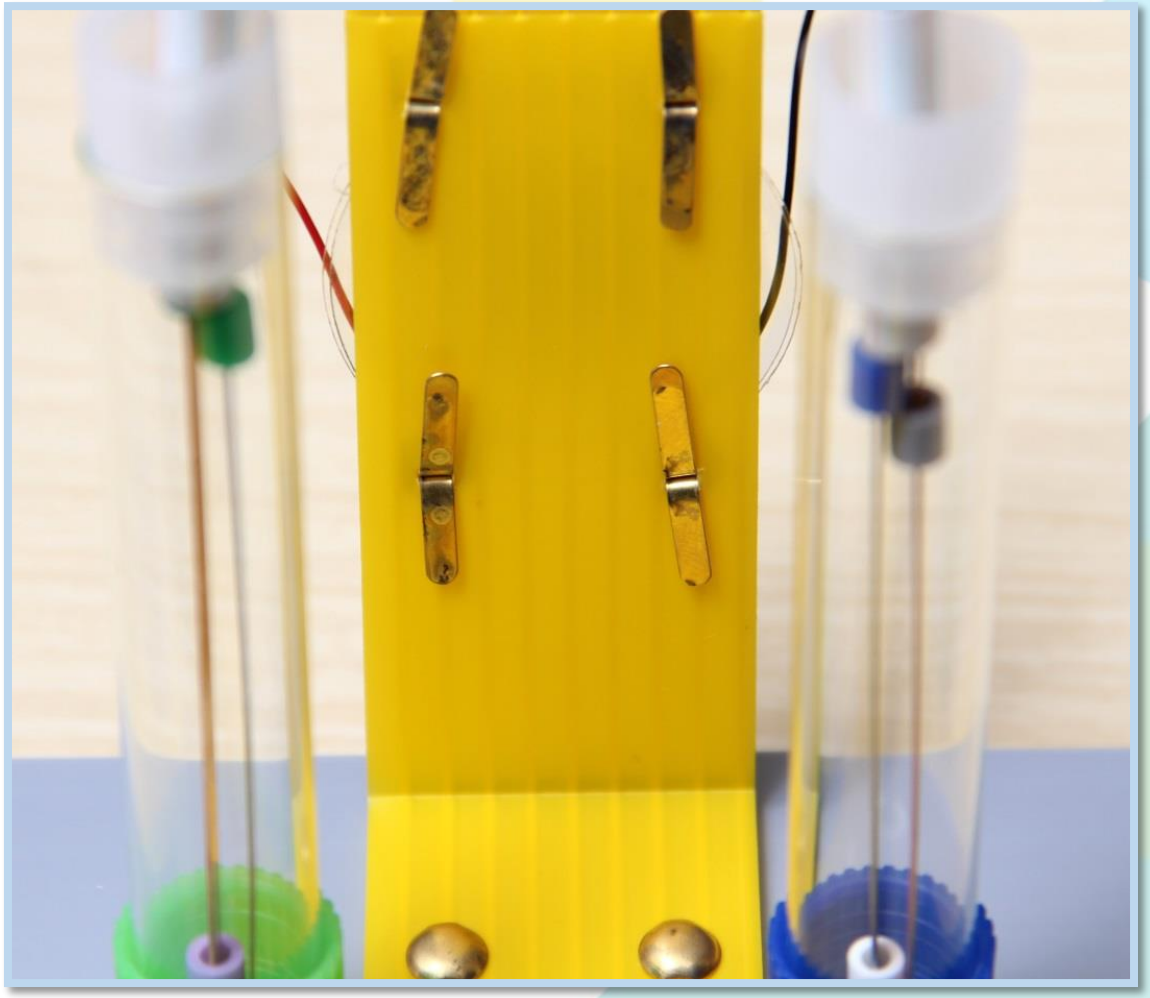
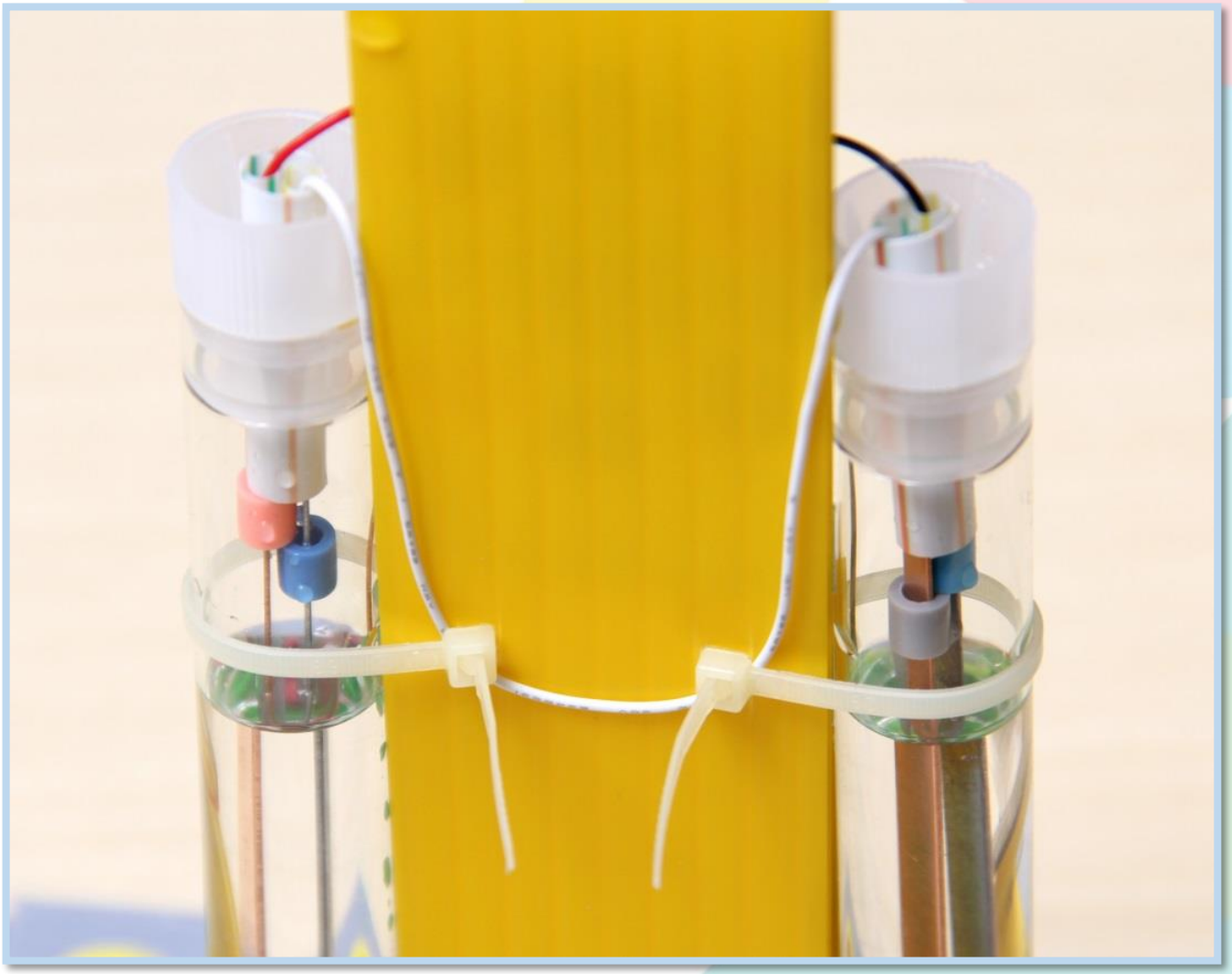
Spread the bottom of the small paper fasteners (10) on the other side of the triangular Polygal strip (3) to secure.



Insert a plastic tie (12) through the small holes on the triangular Polygal strip (3) so that it encircles the test tube (13) and wires, while at the same time joins together the short and long ends of the triangular Polygal strip. Then close the plastic tie carefully to secure.



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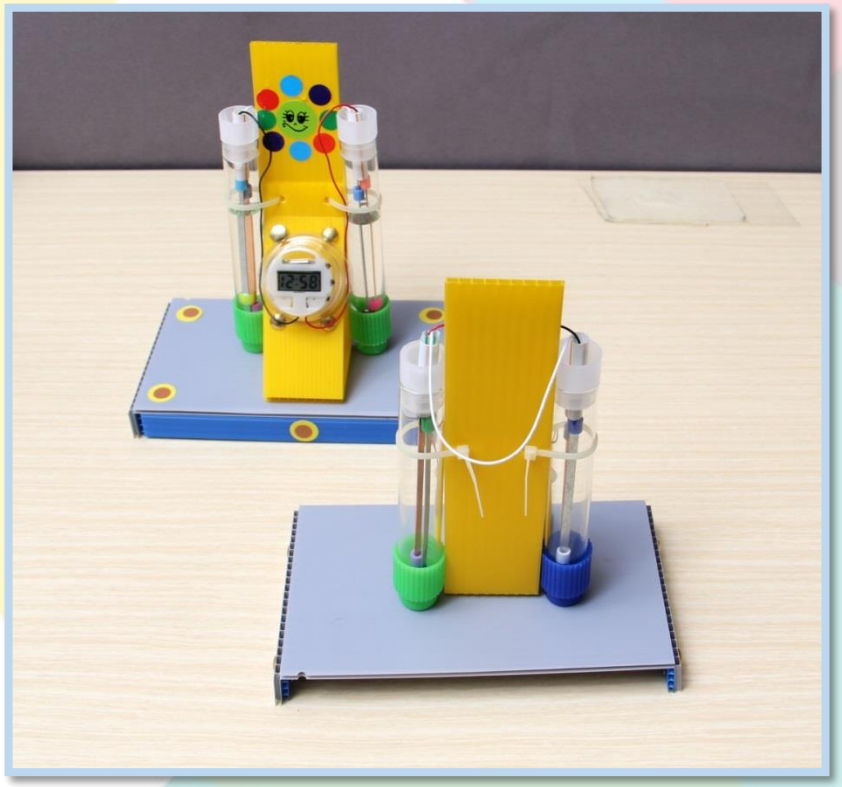
Our chemical clock is finished!



Turning On the Chemical Clock

Mix ½ teaspoon of salt with ½ cup of water (about 100 mL)

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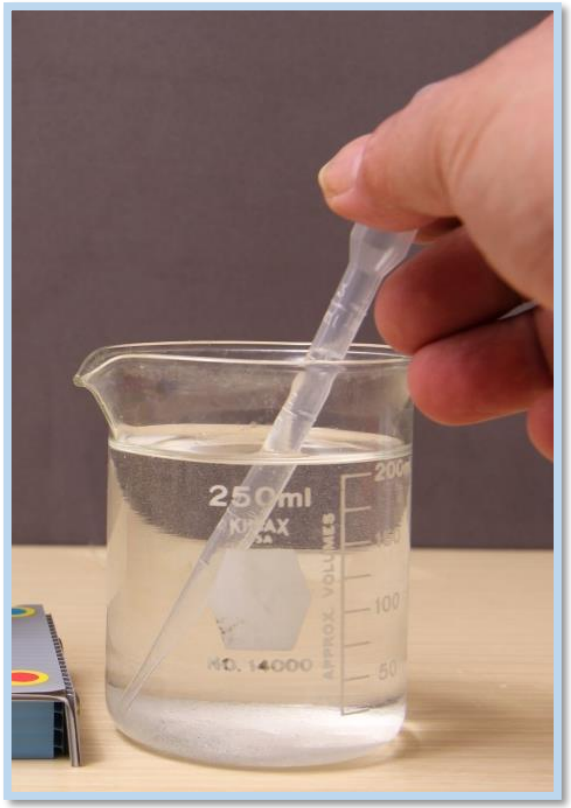
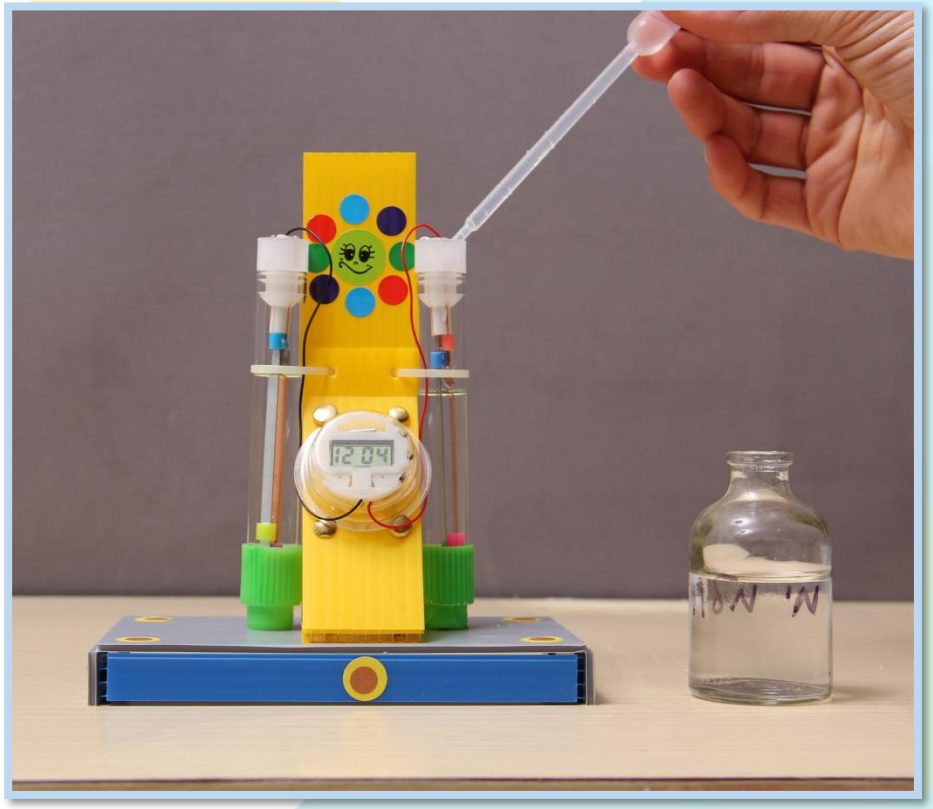
Use the dropper to fill each test tube (13) with the saltwater solution





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Fill each test tube (13) with saltwater solution to within 1 cm from the test tube stopper (4)

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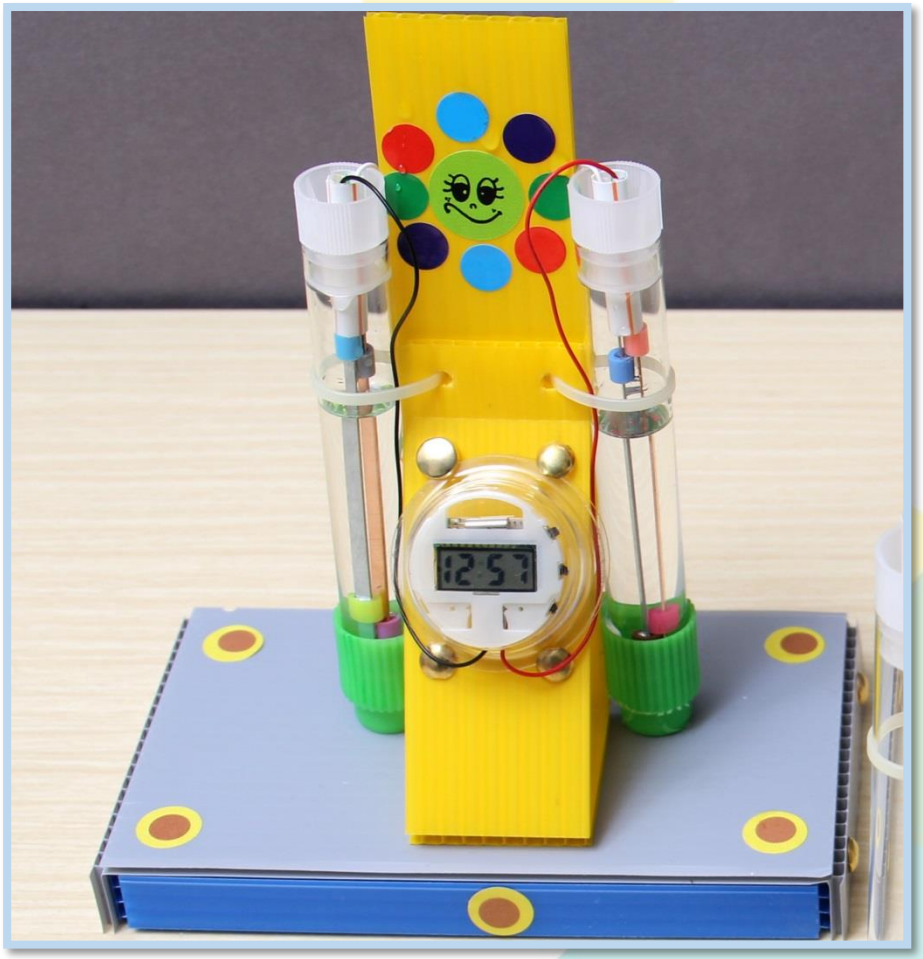
The clock is working!



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