114 年 高雄市科學園遊會 執行計畫

組別:國際雙語科學組

Magic Powder: Light It Up!

魔法粉塵～點亮吧！

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報名類別:國際雙語科學組

類別:物理類

攤位編號:

壹、活動目標 | Purposes of the Activity

- Make conductive dough and find out why salty dough can conduct electricity.

  製作導電黏土，找出「鹽 + 水」為什麼能讓黏土導電。

- Fill a gap with dough and turn an open circuit into a closed circuit.

  用導電黏土補上缺口，讓原本的斷路變成完整通路。

- Try “one road” and “two roads” to compare series and parallel circuits.

  用「一條路、兩條路」理解串聯與並聯的差別。

- Use a light-sensor control circuit and a dough switch to make a little night light.

  結合感光控制電路與導電黏土開關，完成一盞小夜燈。

貳、實驗器材 | Experimental Equipment

- All-purpose flour, salt, water, glycerin, vegetable oil, a mixing bowl, and a spoon.

  中筋麵粉、食鹽、水、甘油、植物油、攪拌容器與工具。

- A low-voltage battery pack (3 × AA batteries), copper tape, LEDs, and 220–330 Ω current-limiting resistors.

  低壓電池盒（裝 3 顆 AA 電池）、導電銅箔膠帶、LED，以及 220–330 Ω 限流電阻。

- Conductive dough and activity boards.

  導電黏土與操作底板。

- A prepared light-sensor control circuit (photoresistor/LDR + control component or module) and an LED.

  已接好的感光控制電路（光敏電阻 / LDR + 控制元件或模組）與 LED。

- Cardboard, a small box, and decorations for the night-light case.

  小夜燈外殼、紙盒與裝飾材料。

- **參、闖關活動｜Game Stations**

第一關：揉麵團！魔法粉塵變身

Station 1: Knead the Dough! Turn Magic Powder into Conductive Dough

Steps:

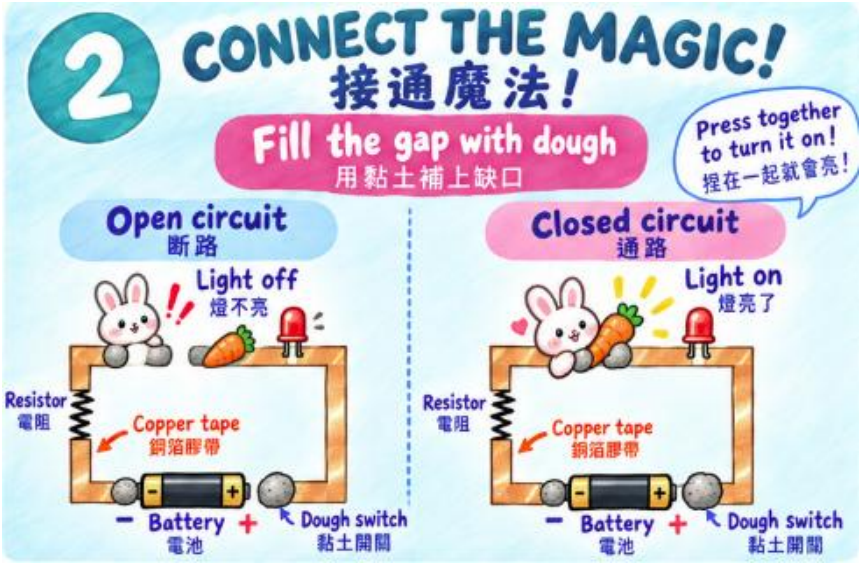
1. Mix the flour, salt, water, glycerin, and vegetable oil.
   1. 把麵粉、鹽、水、甘油和植物油混合。
2. Knead it until it feels soft and easy to shape.
   2. 揉到柔軟、好塑形。
3. Test it: Can this dough help an LED light up?
   3. 測試看看：這團黏土能不能讓 LED 亮起來？
4. Compare unsalted dough and salty dough. Which one helps the LED light more easily?
   4. 比較不加鹽的麵團和含鹽麵團，哪一種比較容易讓 LED 亮起來？

☆ ***Conclusion*: When salt dissolves in water, it forms tiny charged particles called ions. These ions can move through the moist dough, so the dough can conduct electricity.**

鹽溶在水裡後會形成可以移動的帶電粒子（離子）。這些離子能在含水的黏土中移動，所以黏土可以導電。

第二關：接通魔法！

Station 2: Connect the Magic!



Steps:

1. Look at the square copper-tape circuit. There is a small gap, so the circuit is open and the LED is off.

1. 先觀察方形銅箔電路：其中留了一個小缺口，所以電路是斷開的，LED 不亮。

2. Shape the conductive dough into a cute switch, such as a bunny and a carrot or two little fish.

2. 把導電黏土捏成可愛的開關，例如「小兔子 + 紅蘿蔔」或「兩隻小魚」。

3. Keep the two dough shapes apart. The gap stays open: “Open circuit — light off!”

3. 讓兩個黏土造型分開，缺口沒有接上：「Open circuit — 燈不亮！」

4. Touch the two dough shapes together to close the gap: “Closed circuit — light on!”

4. 讓兩個黏土造型碰在一起補上缺口：「Closed circuit — 燈亮了！」

★Conclusion：Gap open, light off. Touch the dough pieces together, and the light turns on!

缺口沒接上，燈就不亮；讓兩塊導電黏土碰在一起補上缺口，LED 就會亮。

第三關：串聯與並聯 *Station 3: Series and Parallel Circuits*

Steps:

1. Try SERIES: both LEDs are on one shared road.

先做串聯：兩顆 LED 共用同一條路。

2. Open one spot. If that one road breaks, both LEDs go off.

把其中一處斷開；只要這一條路中斷，兩顆 LED 都會熄滅。

3. Try PARALLEL: each LED gets its own road.

再做並聯：每顆 LED 都有自己的路。

4. Open one branch. The other LED can still shine.

斷開其中一條支路，另一顆 LED 仍然可以亮。

5. Use conductive dough for the left and right side links and copper tape for the rest. Add the current-limiting resistor(s) shown in the diagram to protect the LEDs.

左右連接段使用導電黏土，其餘線路使用銅箔膠帶；依圖加入適當的限流電阻保護 LED。

★Conclusion：Series = one shared road. If it breaks, both lights go off. Parallel = separate roads. One branch can stop while the other still shines.

串聯 = 大家共走同一條路；路一斷，兩顆燈都熄滅。並聯 = 分成不同支路；其中一條斷開，另一條仍可以亮。

第四關：LIGHT UP THE NIGHT！感光小夜燈

Steps:

1. Start with a prepared light-sensor control circuit, LED, battery pack, and copper tape.

準備已接好的感光控制電路、LED、電池盒與銅箔膠帶。

2. Use copper tape for most of the circuit, but leave one small gap near the battery connection.

大部分線路使用銅箔膠帶，但在電池與線路的連接處保留一小段缺口。

3. Put a small piece of conductive dough in that gap to make an ON/OFF dough switch.

在缺口放入一小段導電黏土，做成可以開 / 關的黏土開關。

4. Turn the dough switch ON. Cover the light sensor: does the LED turn on? Shine light on it: does it turn off?

先把黏土開關接通。遮住感光元件：LED 會亮嗎？再照亮它：LED 會熄滅嗎？

5. Decorate it and make your own little night light!

最後加上裝飾，完成自己的小夜燈！

★Conclusion：In our night-light circuit, the light sensor helps the control circuit tell bright from dark. Bright room: light off. Dark room: light on. The dough piece works as the ON/OFF switch.

在這個小夜燈電路中，感光元件讓控制電路分辨明暗：環境亮時燈熄滅，環境暗時燈亮起；導電黏土則負責控制通路的開與關。

Science note: The LDR does not switch the LED by itself. It works with the prepared control circuit to turn the LED on or off.

科學提醒：光敏電阻（LDR）不會單獨直接控制 LED；它需要搭配已接好的控制電路，才能依明暗控制 LED。

肆、安全提醒 | Safety Reminders

- Use only low-voltage battery packs. Never connect this activity to a wall outlet.
  只使用低壓電池盒；本活動不可接家用市電插座。
- Use the current-limiting resistor(s) prepared for the LEDs. Never connect the battery terminals directly with copper tape or conductive dough.
  LED 要搭配準備好的限流電阻；不可用導電黏土直接連接電池正、負極。
- If a battery, wire, or component gets hot, disconnect the power and stop immediately.
  如果電池、導線或元件明顯發熱，立刻斷電並停止操作。
- Conductive dough is an experiment material, not food. Wash your hands after the activity and discard dough that smells bad, changes color, or grows mold.
  導電黏土是實驗材料，不可食用；活動後請洗手，若出現異味、變色或發霉就應丟棄。

伍、闖關判定 | Passing Criteria

- Station 1: Make conductive dough and explain that salt + water helps the dough conduct electricity.
  第一關：完成導電黏土，並能說出「鹽溶於水後」的水溶液能幫助導電。
- Station 2: Use the dough switch to show “open = light off” and “closed = light on.”
  第二關：能操作黏土開關，示範「斷路 = 燈不亮、通路 = 燈亮」。
- Station 3: Tell series and parallel circuits apart and name at least one difference.
  第三關：能分辨串聯與並聯，並說出至少一項差異。

- Station 4: Complete the night light and show how the light sensor and dough switch work together.
  第四關：完成小夜燈，並能示範感光控制與導電黏土開關如何一起運作。

陸、活動核心科學概念 | Key Scientific Ideas

The magic behind Magic Powder: salt + water creates movable ions → the dough can conduct electricity → dough switches help us see open and closed circuits → Learn about series and parallel circuits by comparing “one shared road” and “separate roads.” → a light-sensor control circuit + dough switch makes a night light.

「魔法粉塵」的科學魔法：食鹽溶於水形成可移動的離子 → 黏土具有導電性 → 用黏土開關理解斷路與通路，並避免短路 →比較「共用一條路」與「分成不同支路」的變化後理解串聯與並聯的概念 → 最後結合感光控制電路與黏土開關，完成小夜燈。

柒、參考資料 | References

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