Smithsonian
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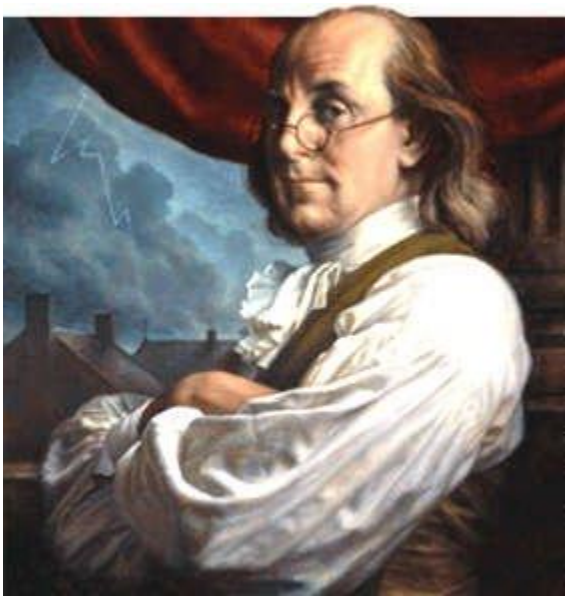
Lemelson Center for the Study of Invention and Innovation

Recreating Ben Franklin's Magical Picture
Teacher's Overview



The Big Idea

Working with a teacher, students will recreate some of the electrical experiments originally performed by Benjamin Franklin between 1746 and 1754. These hands-on experiments highlight Franklin's innovative contributions to science and government. Visitors will experience static electricity and may receive an exciting but harmless electric shock.

Activity Supplies and Materials

- Clear acrylic tubes (27" to 36" in length)
- Paper towels
- Wrapped drinking straws
- Aluminum foil
- Disposable plastic plates
- Tape or glue sticks
- Scissors
- Latex balloons (optional)
- George II template

Outcomes

By participating in this activity, students will:

1) engage in the invention process through hands-on invention experiments
2) use observation, problem solving and critical thinking skills to reach a set goal
3) understand that failure is often part of the invention process
4) use tools to investigate and observe the world around them
5) gain an understanding of how science, engineering, and art can intersect in invention

21st Century Skills

By participating in this activity, students will practice these 21st century skills:

LEARNING AND INNOVATION SKILLS

- Creativity & Innovation
  - Think creatively
  - Work creatively with others (if working with a partner or group)
  - Implement innovations
- Critical Thinking and Problem Solving
  - Use Systems Thinking
  - Solve Problems
- Communication & Collaboration (if working with a partner or group)
  - Communicate clearly
  - Collaborate with Others

LIFE AND CAREER SKILLS

- Initiative & Self-Direction (if working alone)
  - Work Independently
  - Be Self-directed Learners

Suggested Core Subject Links

- Science
- Geography
- History

Recreating Ben Franklin's Magical Picture

Franklin's Method For Generating Static Electricity

Ben Franklin found that the simplest way to generate a static electric charge was by rubbing a piece of buckskin against a hollow glass tube. Rubbing a balloon against your hair will produce the same results. Glass tubes and buckskin were the best materials available to Franklin in 1740s Philadelphia.

To authentically demonstrate how Franklin generated a static charge, substitute a 3' section of PVC for the glass tube and a clean paper towel or cotton cloth for the buckskin.

Hold the plastic tube in one hand and rub a clean paper towel or cotton cloth against the length of the tube. Continue sliding the cloth against the tube until you can feel the static charge or hear it crackling.

While you won't be able to see the static electricity, you can see the effects of the charge by holding the charged tube over a pile of shredded paper. If the charge is sufficient, the paper will begin to "dance" as it is alternately attracted to the static charge and then repelled back down.

The Drinking Straw Version

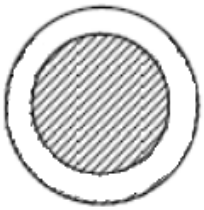
Franklin's method for generating static electricity can also be replicated on a much smaller scale with a wrapped drinking straw and a paper napkin.

Simply unwrap the straw and tear the paper wrapper into small bits (the smaller the better). Collect the paper bits into a small pile. Hold the straw with one hand and rub the straw with the paper napkin for a few seconds. Then hold the charged straw over the pile of paper bits. The paper bits should begin to "dance".

Create the Magical Picture

Make a copy of the sketch of George II printed at the end of the activity, and cut it out around the border. Cut a slit across the top where the crown sits on his hair.

Take the thin 9 inch disposable plastic plate and glue or tape aluminum foil on the front side of the plate, as shown.

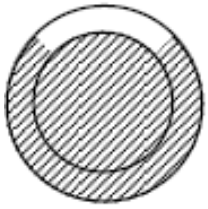


FRONT OF PLATE, FOILED AREAS IN GREY

Glue or tape the picture of George II to the aluminum foil on the front of the plate, as shown below. Do not apply glue to the area around the slit for the crown.

FRONT OF PLATE, WITH FOIL BEHIND PICTURE

Turn the plate over and glue or tape aluminum foil to the back side of the plate, as shown. The top of the plate should not be covered in aluminum foil.

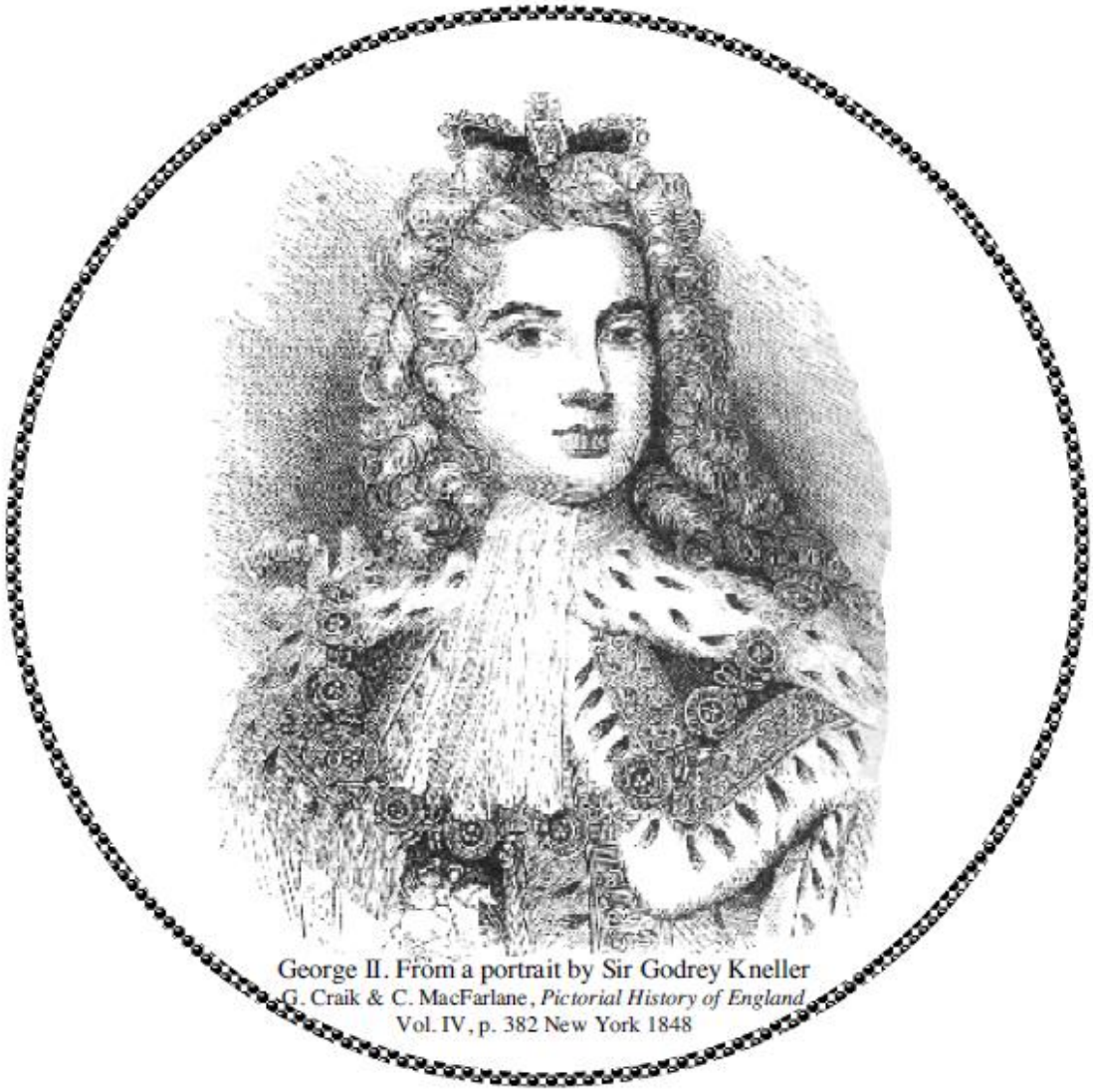


BACK OF PLATE, FOILED AREAS IN GREY

Fold a piece of aluminum foil in half and in half again to get four thicknesses, and cut a crown that will fit in the slit, with a wide top so that it does not slide all the way in.

FOIL CROWN TEMPLATE

Insert the crown into the slit on the front of your Magical Picture, so that it looks like the crown is sitting on George II's head.



George II. From a portrait by Sir Godrey Kneller
G. Craik & C. MacFarlane, *Pictorial History of England*
Vol. IV, p. 382 New York 1848

Charging the Magical Picture

Working in pairs, one person will hold the Magical Picture by the top (unfoiled part) with one hand and touch the crown with the other hand.

The second person will generate a static charge on the plastic tube by rubbing it with a paper towel, as directed above. Then transfer the charge from the tube to the foil on the back of the Magical Picture by sliding the charged tube across the foil. Repeat this process 2-3 times to make sure that the Magical Picture is adequately charged.

Being much smaller than Franklin's version, the shock from this version of the Magical Picture is perfectly safe.

If you hold it by the top rim – no foil, you can safely remove the crown. Hold it by the side or bottom and you get a slight shock.

How Do We Know About Franklin's Electrical Experiments and the Magical Picture?

Fortunately for us, Franklin documented his electrical experiments in his correspondence with members of the Royal Society in London and other experimenters across Europe. Franklin's letters have survived, and provide an excellent primary source. Franklin's description of the Magical Picture is found below.

20. The magical picture[1] is made thus. Having a large mezzotinto with a frame and glass, suppose of the KING (God preserve him), take out the print and cut a pannel out of it near two inches distant from the frame all round. If the cut is through the picture, it is not the worse. With thin paste or gum-water, fix the border that is cut off on the inside the glass, pressing it smooth and close; then fill up the vacancy by gilding the glass well with leaf-gold or brass. Gild likewise the inner edge of the back of the frame all round, except the top part, and form a communication between that gilding and the gilding behind the glass; then put in the board, and that side is finished. Turn up the glass and gild the fore side exactly over the back gilding, and when it is dry cover it by pasting on the pannel of the picture that hath been cut out, observing to bring the correspondent parts of the border and picture together, by which the picture will appear of a piece, as at first, only part is behind the glass and part before. Hold the picture horizontally by the top, and place a little movable gilt crown on the King's head. If now the picture be moderately electrified, and another person take hold of the frame with one hand, so that his fingers touch its inside gilding, and with the other hand endeavour to take off the crown, he will receive a terrible blow and fail in the attempt. If the picture were highly charged, the consequence might perhaps be as fatal[2] as that of high treason; for when the spark is taken through a quire of paper laid on the picture by means of a wire communication, it makes a fair hole through every sheet, that is, through forty-eight leaves, though a quire of paper is thought good armour against the push of a sword, or even against a pistol bullet, and the crack is exceedingly loud. The operator, who holds the picture by the upper end, where the inside of the frame is not gilt, to prevent its falling, feels nothing of the shock, and may touch the face of the picture without danger, which he pretends is a test of his loyalty. If a ring of persons take the shock among them, the experiment is called *The Conspirators*.

[1] Contrived by Mr. Kinnersley.–F.

[2] We have since found it fatal to small animals, though not to large ones. The biggest we have yet killed is a hen. 1750–F.

Activity developed at the Wright Center for Innovative Science Teaching, Tufts University.

Images courtesy of Robert A. Morse, Ph.D.