FUN ELECTROMAGNETIC PHENOMENA

INVISIBLE FORCES, AMAZING EFFECTS

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1. INTRODUCTION

Our club of young debrouilliards works in the connection of Primary school Tyršova in Nymburk and The House of children and youth in Nymburk, too. The children visit it at the age of 11 to 18. Association of Young Debrouillards of the Czech Republic is a part of The International Federation of Young Debrouilliards (F. I. P. D.). Our project was created to popularize physics among children and youth. We wanted to illustrate tne work of English physicist and chemist Michael Faraday by unconventional experiments. The aim of the project was for children and young people to understand the principle of electromagnetic induction in simple experiments and to think deeply about the functioning of some objects used in everyday life. This year we presented our project at “Week of the Brain” in Prague and at “Mini Maker Faire” in Pilsen and at the Science Fair organized by the Academy of Sciences of the Czech Republic. The project was very positively evaluated by the participants.

2. METHOD AND EXPERIMENTAL DETAILS



- He was an English physicist and chemist.
- He came from a poor family.
- In his youth he was trained as a bookbinder, he read scientific papers in the secret.
- The marvelous and mysterious world of science has opened up to him.
- He became professor of chemistry at the Royal Military Academy Sandhurst.

Discoveries:

- *He defined the laws of electrolysis.*
- *In 1821, he discovered that a magnetic field arises around an electric current conductor.*
- *He discovered the principle of modern air conditioning by pressing and expanding ammonia (NH3).*
- *In 1831 he discovered the phenomenon of electromagnetic induction, magnetic inductionlines and electric field lines.*

Electromagnetic induction
It is a physical phenomenon where a changing magnetic field (eg a moving magnet) induces electric current in a closed electrical circuit.

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$$U = -\frac{\Delta\varphi}{\Delta t} = -\frac{\mathrm{d}\varphi}{\mathrm{d}t}$$

U = Voltage; Φ = Magnetic flux; t = Time

3. RESULT AND DISCUSSION

Based on feedback from the students at our school and from thousands of visitors who have seen our experiments on electromagnetic induction, we can say that for approximately 90 % of all visitors, these experiments were new, very interesting, and initially difficult to understand. The reward for our efforts often came in the form of hearing visitors exclaim „WOW!“ and seeing the excitement in their eyes.

We believe that, thanks to simplification and our experiments, we were able to explain and bring the phenomenon of electromagnetic induction closer to most visitors – the generation of electricity in power plants, the principle of an induction cooktop, and wireless chargers. We also aimed to highlight the risks posed to all electronics during strong solar flares or prominences, when the Sun releases a huge amount of charged particles toward Earth, which we then see in the sky as the aurora borealis.

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EXPERIMENT 1
THE MAGIC TUBE



TOOLS
copper pipe, magnetic bead, nonmagnetic bead

PROCEDURE
- Firstly, to the non-magnetic copper tubes the nonmagnetic ball is thrown, which quickly falls.
- Then toss into a magnetic bead to fade it very slowly.

EXPLANATION
All bodies without exception, fall down to the acceleration g = 9,81 m/s^2 (air resistance are neglected). However, if the magnetic bead is tossed into the copper tube the changing magnetic field of falling ball in the copper pipe will induce eddy currents (Foucault´s Currents) – electromagnetic induction. Because the tube is made of metal that is a good conductor, this voltage creates electric currents that flow round the walls of the tube These eddy currents exert a magnetic field against the change that is caused (fall of a bead) – Lenz´s Law. Faster the moving of the bead is, stronger the slowing power occurs. So dropping of bead is hampered.

EXPERIMENT 2
THE MAGIC TUBES

TOOLS
3 aluminum foils min. length 50 m, larger magnetic ball

PROCEDURE AND EXPLANATION
- Place three aluminum foils close together in the shape ofa triangle, ensuring that there is a gap between them. The gap should be slightly larger than the diameter of the magnetic ball.
- Let the ball fall freely through this gap (it must not touch or rub against the walls of the aluminum foils).

EXPLANATION
All bodies without exception, fall down to the acceleration g = 9,81 m/s2 (air resistance are neglected). The falling magnetic ball generates a magnetic field around it. This changing magnetic field, as it passes through the aluminum foils, induces an electric current in the foils. This electric current also creates a magnetic field, which interacts with the ball‘s magnetic field and slows its fall (reduces its speed).

EXPERIMENT 3
FLASHING SYRINGE

TOOLS
polished copper wire ca. 40 m, hypodermic syringe 10 ml, neodymium magnet, 2x LED diodes, tape, a piece of cardboard

PROCEDURE
- Polished wire is wrapped around in the middle of the hypodermic syringe (ca. 500–600 threads). We stick or solder anti-parallel way 2 LED diodes to both terminals.
- Into the barrel of syringe insert neodymium magnet and quickly move it in a syringe
- All for strengthening structures and ensuring wrap around a transparent duct
- When passing through the magnet coil wraparound LEDs flash alternately.

EXPLANATION
While passing magnet through the coil there is induced voltage and an electric current will pass through closed power circuit. Since the magnet change the direction in the coil (there and back), also changes its direction of passing and induced current. It is therefore an alternating current. The principle is based on the phenomenon of electromagnetic induction.

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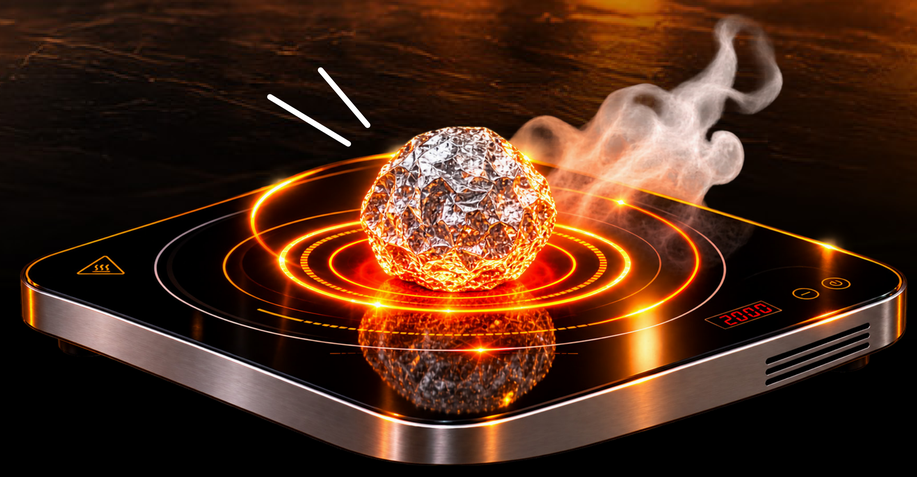
EXPERIMENT NUMBER 4

EXPERIMENTS WITH THE COOKER

TOOLS
induction cooker, exercise book, bulb, conductor, aluminium foil, small pot, water

PROCEDURE
We pour the water into the pot. The pot is put on the cooker. The water is warm, but the cooker is cold.
We put an aluminium foil on the cooker and it is melted (600 °C /1110 °F), but the cooker is still cold.
The bulb with turned conductor is put on the cooker. The bulb will shine without battery.

EXPLANATION
Induction cooker works thanks to electromagnetic induction. It is the same process like in transformer. The warm is not taken by the touch not even flowing.



4. CONCLUSION

Simple experiments on electromagnetic induction successfully helped students and the public to understand the phenomenon of electromagnetic induction, its practical applications, and reminded them of the famous name Michael Faraday. For us, the greatest benefit was the creation of our own blinking light and an electronic circuit on a foil.
The popularization of science should become a key element in the modern and technical world for engaging the public, so that people understand that funding science is certainly not a waste, even when the research occasionally heads in the wrong direction.

5. REFERENCES

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