All About Electric Motors:
Creating Rotating Force from Electricity

IEEE ARIZONA SCIENCE LAB
www.arizonasciencelab.org

Workshop Focus:
Electricity, Magnetism, and Electric Motors: how electricity is used to create strong rotating forces.

Workshop Synopsis:

Students learn the basic principles of electricity, magnetism, electro-magnetism and electric motors and explore their everyday uses. They work in "engineering" teams of two to build a working model of an electric motor using a few simple parts: coil of wire, paper clips, battery, and a magnet.

Age Levels:
10 – 15 years (grades 4 – 8).

Objectives:

- Understand electricity: what it is, how circuits work
- Learn basic principles of magnetism and electro-magnetism
- Learn the basic principles of electric motors
- Build a working model of an electric motor

Anticipated Learner Outcomes:

- Principles of electricity and electric current
- Principles of magnetism and electro-magnetism

- Operation of an electric motors
- Students should also apply theory to everyday uses of electric motors, and expand their knowledge of motor design and operation

Workshop Activities:

Students learn about electricity and electric circuits. Using a breadboard they build series and parallel circuits and understand their operation and tradeoffs. They study static (natural) magnetism and electromagnetism, and how the principles of electromagnetism lead to the design and operation of an electric motor. Students learn how all electric motors work and the elements of basic motors. Students work in teams of two to build a working small DC electric motor from an inexpensive set of parts. They then evaluate the design and operation of its component parts and measure its performance.

Alignment to Curriculum Frameworks:

Note: All Arizona Science Lab workshops are aligned to the National Science Education Standards which were produced by the National Research Council and endorsed by the National Science Teachers Association, and if applicable, also to the International Technology Education Association's Standards for Technological Literacy or the National Council of Teachers of Mathematics' Principals and Standards for School Mathematics. They will also be modified as necessary to be aligned to the Next Generation Science Standards (NGSS) when they are released.

- **National Science Education Standards Grades 5-8 (ages 10 - 15)**

CONTENT STANDARD B: Physical Science
As a result of their activities, all students should develop an understanding of

- Motions and forces
- Transfer of energy

CONTENT STANDARD F: Science in Personal and Social
Perspectives As a result of activities, all students should develop
understanding of

- Risks and benefits
- Science and technology in society

CONTENT STANDARD G: History and Nature of Science
As a result of activities, all students should develop understanding of

- History of science

- **National Science Education Standards Grades 9-12 (ages 14 - 18)**

CONTENT STANDARD B: Physical Science
As a result of their activities, all students should develop understanding of

- Motions and forces
- Interactions of energy and matter

CONTENT STANDARD E: Science and Technology
As a result of activities, all students should develop

- Abilities of technological design
- Understandings about science and technology CONTENT STANDARD G: History and Nature of Science

As a result of activities, all students should develop understanding of

- Historical perspectives

- **Standards for Technological Literacy - All Ages**

Technology and Society

- Standard 7: Students will develop an understanding of the influence of technology on history

Design

- Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving

The Designed World

- Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies

Internet Connections:

- TryEngineering (www.tryengineering.org)
- IEEE Virtual Museum (www.ieee-virtual-museum.org)
- International Technology Education Association Standards for Technological Literacy (www.iteawww.org/TAA/PDFs/ListingofSTLContentStandards.pdf)
- McREL Compendium of Standards and Benchmarks (www.mcrel.org/standards-benchmarks)
    - A compilation of content standards for K-12 curriculum in both searchable and browsable formats
- National Science Education Standards (www.nsta.org/standards)
- Science First (Supplier of Toy Motor Kit) (www.sciencefirst.com)

Recommended Reading:

- The Usborne Book of Batteries & Magnets (ISBN: 074602083X)
- DK Eyewitness Series: Electricity (ISBN: 0751361321)
- Janice Van Cleave's Physics for Every Kid : 101 Easy Experiments in Motion, Heat, Light, Machines, and Sound, by Janice Van Cleave. John Wiley & Sons (ISBN: 0471525057)

Materials and Tools:

All materials and tools required for this workshop are provided by the Arizona Science Lab

Time Needed:

One four hour workshop (inclusive of lunch and restroom breaks).

ASL Staff Responsibilities:

The ASL staff is responsible for the conduct of the workshop:

- Setting up the workshop
- Presenting the lecture and teaching the science
- Performing the demonstrations
- Provisioning the materials and equipment to the student teams
- Supervising the construction project
- Supporting the students during the construction project
- Supervising the project testing
- Answering student questions about the science, the workshop, or any other related topic
- Cleaning up the workshop after the students have left

School Teacher Responsibilities:

- **Managing the students during the class and the lunch and restroom breaks, and imposing discipline as necessary**
  - The ASL staff is NOT responsible for the class management or for student discipline!
  - **The restroom breaks will require at least one male and one female teacher be present from the school**
- Assisting the ASL staff in the teaching of the science
  - This could comprise asking the students questions about what had just been explained, presenting what had just been explained in another fashion, and so on
  - The ASL staff are not necessarily trained teachers and the school teachers know their students very well, so they can provide valuable insights and help to the ASL staff
- Assisting the ASL staff during the project construction and testing