**The Simple DC Motor Lab**

**Instructor Guide**

Prior to administering this lab the instructor should purchase the following materials and acquire the necessary tools.

**List of Materials and Equipment**

1. Enamel Magnet Wire 18 Gauge 50 ft. 1/4 lb. from Electronics Express, Part #:2701MG18 at a cost of $4.75 per roll.
2. Duracell CopperTop D Alkaline Batteries, 8 count from WalMart, Part #008261072 at a cost of $11.97. One per eight students.
3. Singer Quilting and Craft Safety Pins, Size 3, 20 count from WalMart, all metal construction. Part #82951 for $2.37 per pack. Two pins per design team.
4. Audiopipe ET11 Electrical Tape, Nippon 10 Pack3/4-in. X 60-ft. rolls from WalMar, $15.18 per 10 pack. Use 5 feet per student.
5. The Hillman Group 7/8-in x 1-7/8-in Ceramic Block Magnet at Lowes for $2.59 per pack of two. Each design team needs one pack of two. Item # 185097 Model # 542003.

**Tools**

Each team will require one medium slotted screwdriver and one pair of diagonal wire cutters.

**Activity Preparation for Instructor**

Instructor should count out the appropriate supplies per expected design team.

For each team

1. Two D- cell batteries
2. 10 feet of magnet wire. The students can cut the wire. Just make sure there is enough wire on the roll.
3. Two magnets
4. Two safety pins
5. Items that can be shared between neighboring teams.
6. A roll of electrical tape.
7. Diagonal wire cutters.
8. Slotted screwdriver.

Instructor should organize the supplies on a table along with a list of materials and the written lab titled “The Simple DC Motor Lab”.

**Activity Steps**

1. As the class begins, read the “Industry/Real-world Scenario” located on page 3 of this guide.
2. Review a few basic concepts about the relationship between magnetic flux and electrical current. This can be a PowerPoint but keep it short and basic. The more in-depth concepts can be discussed as the design teams explore the operation of their new motors. One more thing. Keep the PowerPoint to one statement and one picture per slide. Any more than that has been known to cause “*Death by Power Point*.”
3. Read the “Safety Precautions” on page 3 of this guide.
4. Organize the class into groups of two and refer to them as “design teams”.
5. Pass out the list of materials to each design team.
6. Invite the design teams to the supply table with their list of materials to gather the components they will need to construct their motors.
7. Allow the teams plenty of time to build their motors and get them working. The instructor might help struggling teams.
8. Remember; this part of the lab is a lesson in following written instructions. Don’t tell them how to do it. Direct them to the part of the lab they need to be following.
9. After they have finished the construction phase, and when all the motors are working, begin challenging the teams as outlined under Proposed Teaching Strategies in the Discussion section of this document.
10. To end this learning session, have awards prepared ahead of time to give out to the teams. Print out some simple certificates that you can pass out. Just make sure that every team gets some kind of certificate. Certificates can be for anything from fastest motor to best barely running motor. The certificates should be ready to print but the instructor should customize the titles for each of the teams. Find something each team was good at and honor them with a certificate. Or, you could just say “Clean up, get out, see you tomorrow”.

Before handing out the lab read the following scenario to the class.

**Industry/Real-world Scenario**

After graduating from Surry Community College with an Associate’s of Science Degree in Electronics Engineering Technology, you land an interview with Elon Musk, the CEO of SpaceX. Because of your dedication, hard work, and NC-NET-trained expert instructors, Mr. Musk is very impressed with your technical knowledge and skills. As a matter of fact, he’s so impressed, he hires you on the spot as the chief electronics technician on the first SpaceX flight to Mars.

Quite a few years sprint by as you tirelessly train for that fantastic flight to the mysterious red planet. Launch day finally arrives. It is a picture-perfect liftoff as those colossal space-rocket engines repel you and your comrades quickly from your beloved planet Earth into the vast darkness of the great unknown toward your final terminus so far away.

Flight hours turn to days which become long mind-numbing months of tedious practiced routine. You continue to perform preventive maintenance on the electrical systems of your interstellar household in space without complication.

Then, during a routine maintenance check on the ships oxygen system, you notice an anomaly in one of the CO2 scrubber motors. You realize the motor is about to fail; not good. If the scrubber motor nosedives, CO2 will ultimately overcome the crew and the mission will be lost.

You learn that due to an administration error, a spare motor was not added to inventory. You must repair the failing device or construct a replacement with materials on hand.

And since they don’t call you Angus MacGyver for nothing, you set out to save the crew of the USS REACT from certain demise.

**Safety Precautions**

1. Be careful when using sharp-edged tools. Always point screwdrivers away from your body.
2. When using diagonal wire cutters, be careful not to pinch your fingers.
3. Never leave tools on the floor.
4. When working with magnets, never touch your face or rub your eyes.
5. Wash your hands well with soap and water after the lab.

**Proposed Teaching Strategies**

It is suggested the instructor approach the lab in the following manner.

Pair non-technical students with technical students to for design teams.

1. Foster an atmosphere of playful competition between design teams. Challenge design teams to build the first working motor, the most original motor, the fastest motor, the slowest motor, the most reliable motor, the quietest motor, the smallest motor, the biggest motor, the self-starting motor, and the just plain coolest motor.
2. After the design teams have finished their motors, challenge them with questions about how to modify their motors. For instance; can we use the magnetic field to control the speed of the motor? Can we devise a way to turn the motor on and off? What determines the direction of the motor’s rotation and can we modify the motor to change its direction? Can we modify our motor circuit to change direction on the fly?

**Expected Results**

The students will gain valuable experience working as a team in a competitive environment. They will be instructed in the nature of and practice of the basic laws of electromagnetism. They will gain hands-on training in the concepts of design through structured laboratory procedures and exploration. And most of all; they will have fun.

**Extension Options**

The instructor could assign a short reflective essay.