Electric Motor – Teacher Notes

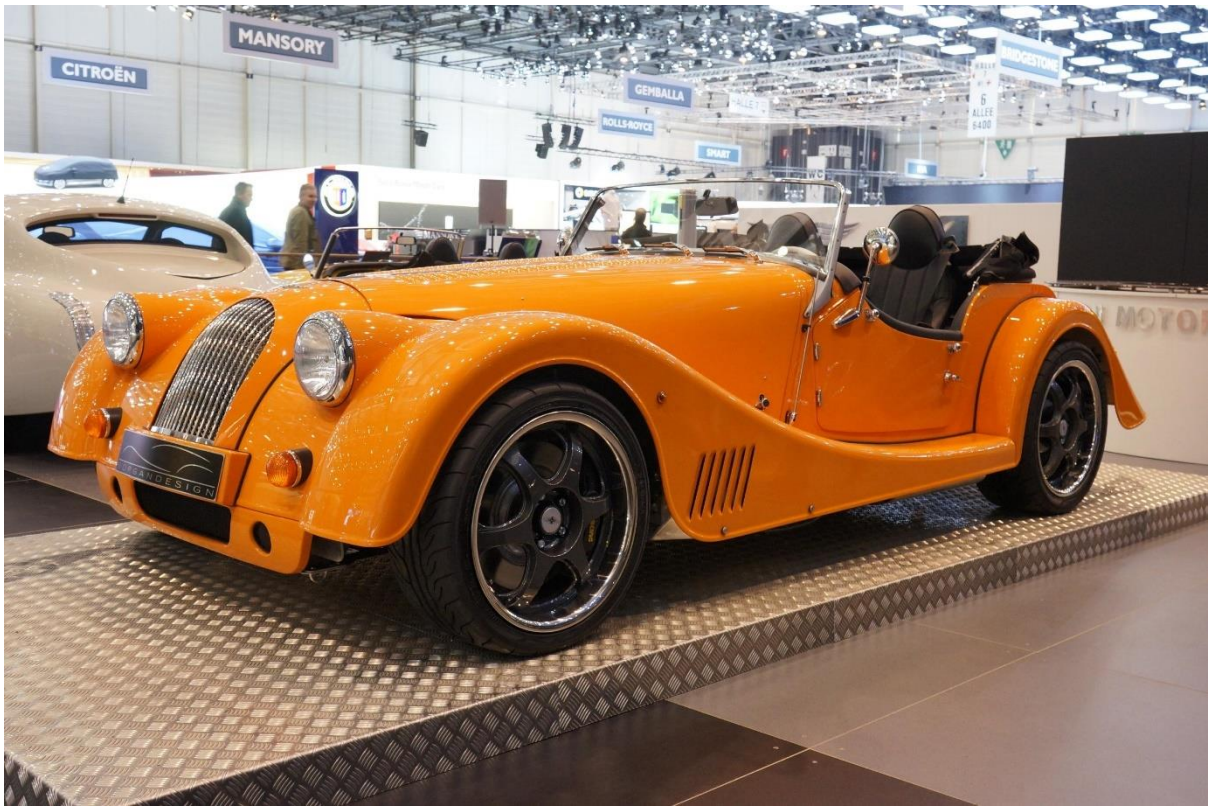

Figure 1 – 2012 Geneva Motor Show – Morgan Plus - Eight

Aim

Today's laboratory is very exciting, students will construct their own electric motor and observe it working and doing work. But what is an electric motor? It is a device which converts electric energy to mechanical energy. In other words, it will use electric energy and use it to accomplish different sorts of work. Electric motors are in almost all the devices we use on a daily basis, from small toys to heavy machinery. Thanks to Michael's Faraday discovery of electromagnetic induction, we now live in a world where machines can do the washing, cooling, transport, cleaning and produce materials.

Plan

Electric motors use what is called the motor effect to produce kinetic energy. If you place a current carrying wire in a magnetic field, the wire will experience a force and hence it will move. Depending on the student's ability, the teacher may explain this phenomenon in varying depth..

Students need to know that the basic building blocks of an electric motor are a coil of wire, a magnet and a source of electric current.

It is recommended that the teacher constructs the motor as a demo for the students, especially for younger classes. The teacher can also play a video clip to show students the construction of a motor https://www.youtube.com/watch?v=lDsARJlUp-I

Discuss with students the safety issues associated with this experiment, which includes the following:

- Motors usually include small parts, therefore make sure the working area is always clean and well lit to avoid misplacing or losing the small parts.
- Students should wear safety goggles because motors spin very fast.
- They have to be cautious not to poke themselves with sharp tools.
- Never leave the motor unattended in the working mode.
- They have to be careful not to touch any part of the motor while hot as it could cause burns.
- If students are going to use soldering, they must follow the manufacturer's safety instructions.

Conduct

The experiment is a mix of structured inquiry(students will sharpen the question and discuss their plan with the teacher) and open inquiry. Students will conduct the experiment, record the results, analyse the data by studying trends, use reasoning skills to formulate conclusions and justify their findings and conclusions.

Students will bend the paperclips to act like a coil holder and will attach one end of the clips to either side of the battery (by battery we mean an AA cell). Students may design what they think will be the best way to attach the clips and attach the battery to the table. They will make the coil by winding the wire around a circular object such as a pen or a battery and will clean both ends of the wire from any insulating material. They will then think how to fix the magnet below the coil.

Students will write down their observations.

Extension

This experiment has the capacity to be extended to study the effect of different factors on the performance of the motor.

1. ***Flipping the magnet to the other side.***
2. ***Using two batteries connected in series (positive end of one battery to negative end of the second battery).***
   Here, students can measure the potential difference across the two batteries by connecting a voltmeter in parallel and the intensity of current through the coil by connecting an ammeter in series. It would be useful if they measure the potential difference and intensity of current for the single battery. Students can add up to 3 or 4 batteries in series and take measurements.
3. ***Increasing the number of turns on the coil.***
   Make sure they keep a record of the number of turns in each case.
4. ***Using magnets of different strength.***
   Keep a record of each strength used.

Students will make their observations and compare their results in each case. Their aim will be to deduce a relationship between each variable and the performance of the motor.

Students may measure the performance of the motor by timing a fixed number of revolutions using a stop watch or by counting the number of revolutions in a fixed amount of time.

Analyse

In this section students will write their observations in a format that makes it easy to compare the effect of changing variables. An effective way is to write observations in a table format as follows:

Variable changed	Observation
Flipping the magnet to the other side	
Increasing the number of batteries	
Increasing the number of turns of the coil	
Increasing the strength of the magnet used	

For more detailed results:

Number of cells	Voltage (V)	Current (mA)	Number of revolutions in 1 minute
1			
2			
3			
4			

Number of turns	Number of revolutions in 1 minute

Magnetic field strength (Tesla)	Number of revolutions in 1 minute

Problem solving and discussion

Students should be able to explain their observations. They are also required to determine a relationship between each variable and the performance of the motor.

1. ***Flipping the magnet to the other side.***
   Students will find that flipping the magnet to the other side will cause the rotation of the coil to reverse direction. This means that if the coil is rotating clockwise in one direction, it will rotate anticlockwise if flipped to the other direction. From this observation, students can claim that the direction of rotation depends on the direction of the magnetic field.
   For more advanced classes they can explain how magnetic field lines have a direction starting at the north pole towards the south pole. They can use the right-hand rule to predict the direction of force and how the coil will rotate and can compare their prediction to what happened.

2. ***Using two batteries connected in series (positive end of one battery to negative end of the second battery).***
   In this section, students will find that as the voltage and current increases, the coil will turn faster. This means that the performance of the motor directly depends on the voltage and current used.

3. ***Increasing the number of turns on the coil.***
   Here, students should find that there is a direct relationship between the number of turns on the coil and the performance of the motor. The number of revolutions should increase as the number of turns are increased.

4. ***Using magnets of different strength.***
   A direct relationship follows here, as the magnetic field strength increases the number of revolutions increases.

   If the results disagree with what is expected, then the sources of error could be not placing the magnet at the same height or same position or the battery is going flat.

Conclusion

Students can now state whether their hypothesis was supported or not. They may suggest future work that they would like to perform either to confirm their results or to study the effect of other variables.