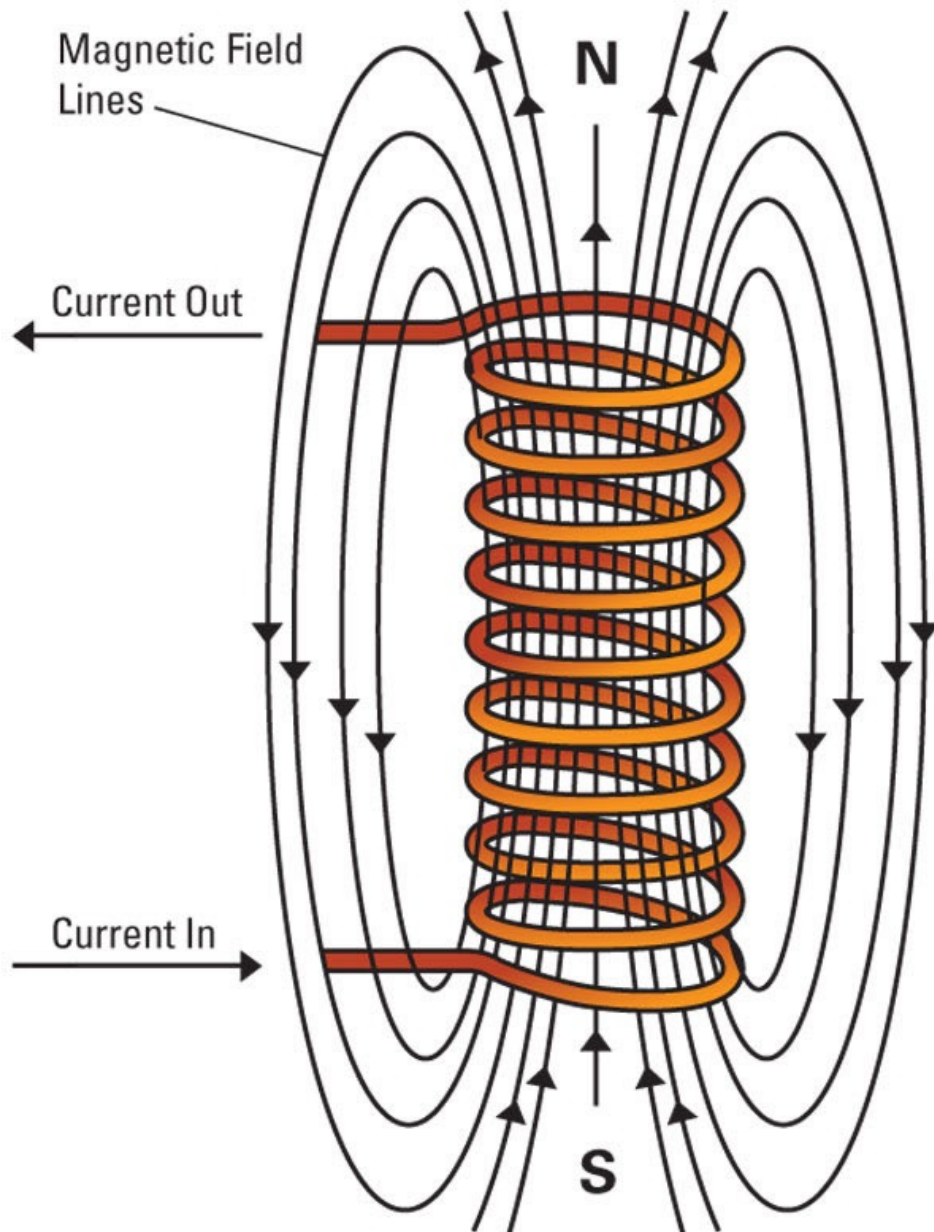


# ENERGY REGENERATION – HOW IT CAN IMPROVE EFFICIENCY

By Bishop Douglass School

## COILS AND MAGNETS



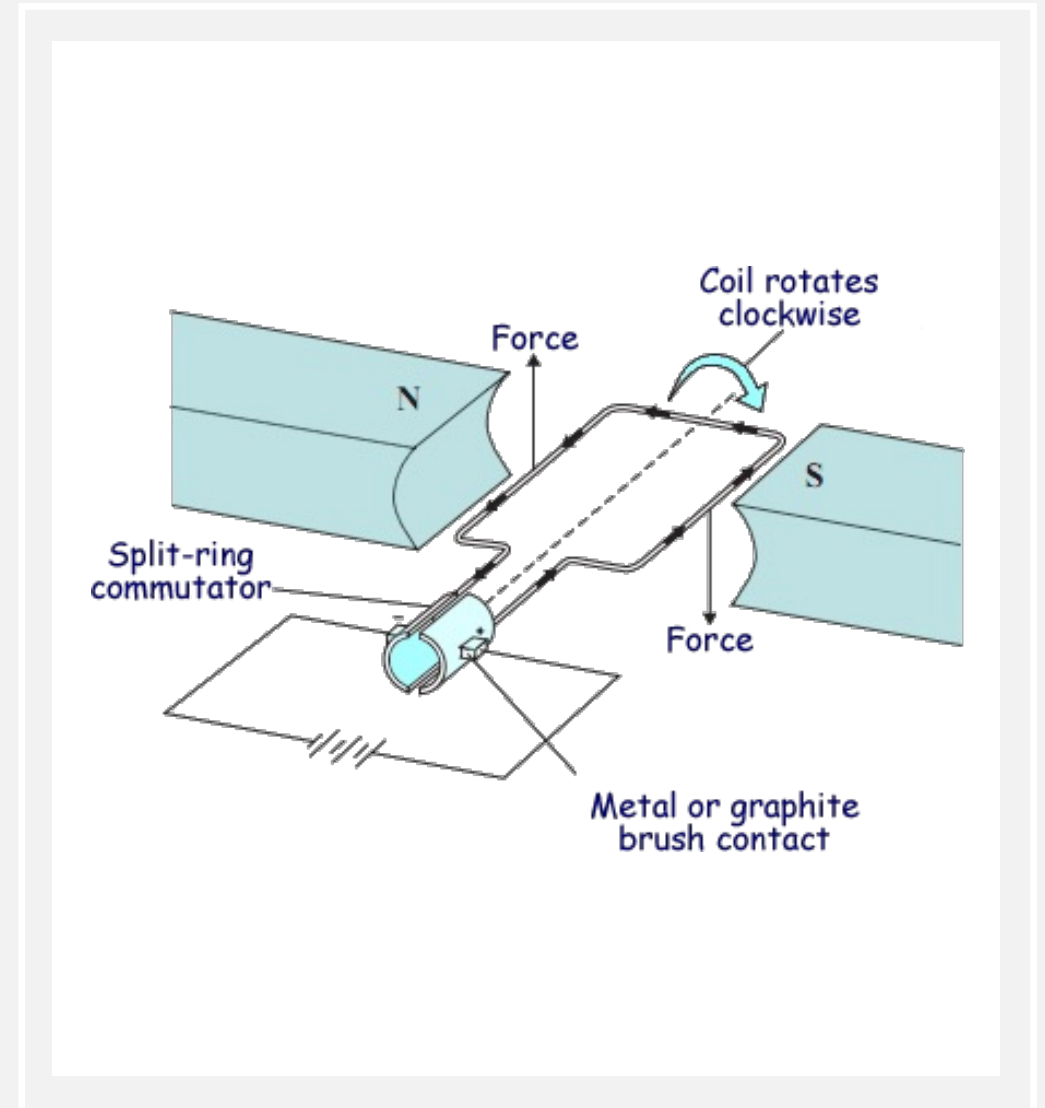
When an electric current is passed through a coil of wire, a magnetic field is formed around the coil in much the same way as a permanent bar magnet.

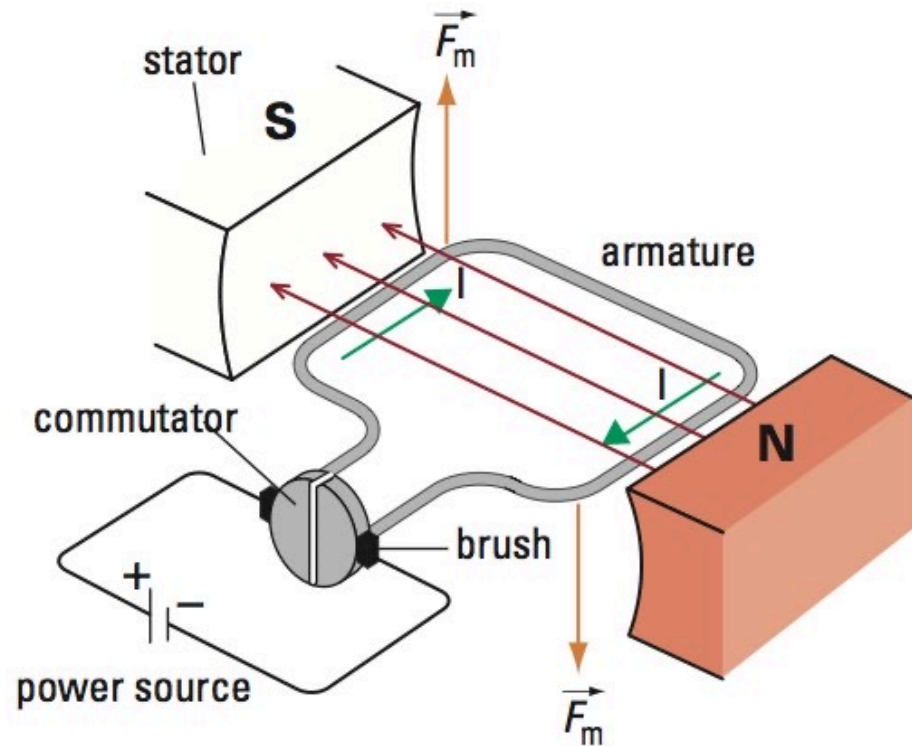
A wire coil is an electrical conductor with one or more turns designed to produce a magnetic field. The more turns of wire on the coil, the stronger the magnetic field will be. The magnetic fields generated by the separate turns of wire will all pass through the centre of the coil producing a strong magnetic field.

## HOW DOES A MOTOR PRODUCE MOVEMENT FROM ELECTRICITY?

A coil of wire can be turned between two opposite magnetic poles to make an electric motor. When an electric current flows through the coil, the coil experiences a force and moves.

Every half turn the currents must be reversed, to use a direct current. An electric field is created using a split ring or commutator, which is joined by a wire coil wrapped in many turns, in order to maximize the magnetic field.





**Figure 12.28** A simple DC motor

## LENZ'S LAW

- A moving magnetic field generates electricity, or EMF, by movement of electrons.
- Electricity, or EMF, generates magnetic field in the opposite direction of the initial magnetic field.
- Proof: in the copper tube experiment, the magnet is stopped by the opposing magnetic field force.

# FARADAY'S LAW

- But how do we calculate the amount of EMF produced?
- Faraday's law:

$$\varepsilon = -N \frac{\Delta\Phi}{\Delta t}$$

N = number of turns in the coil

$\Phi$  = magnetic flux

t = time

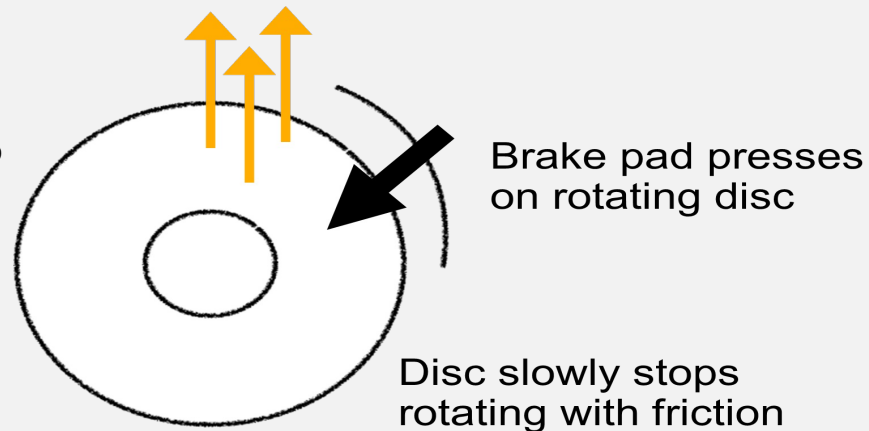
\*Magnetic flux = the strength of magnetic field

- Change in flux can be achieved by moving the magnet
- No change in magnetic flux = no electricity
- THEREFORE, we need to move the magnet constantly to get electricity produced
- This is the principle by which hybrid cars work: EMF is produced from the movement of engine or the wheels.

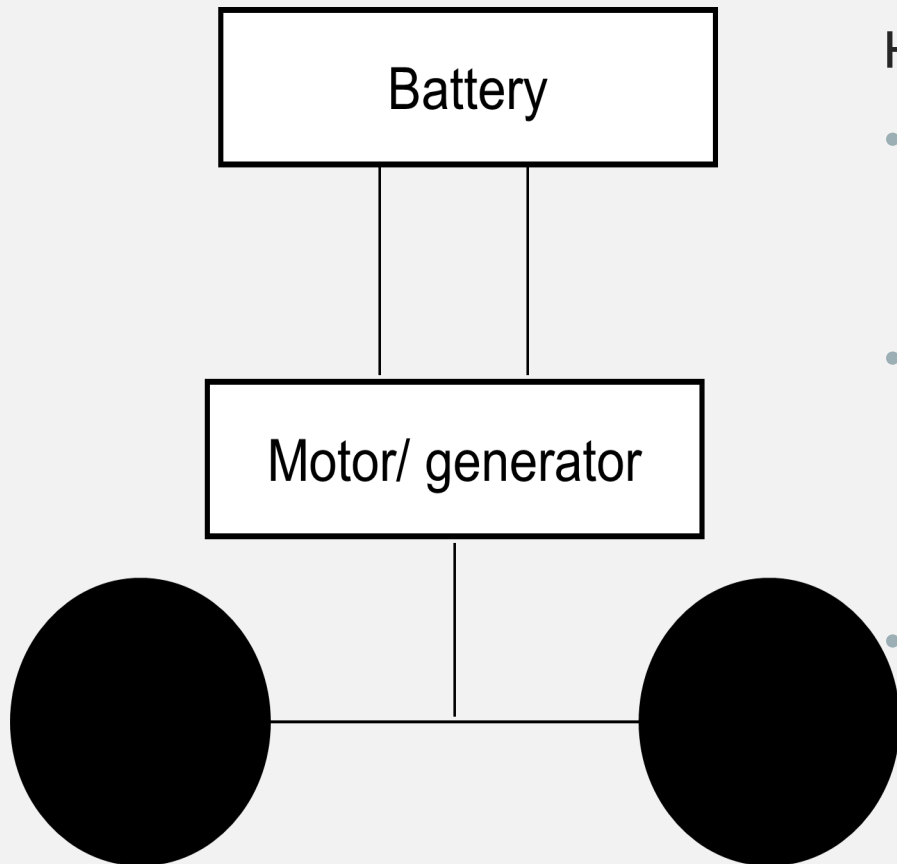
## WHAT DOES THIS MEAN

- These laws cause a serious issue with our experiment as they mean that we cannot effectively brake
- Due to the brake pads using friction, kinetic energy is converted into heat energy which results in wasted energy
- As we try to make our system as effective as possible there is one simply, innovative solution

Friction releases heat that gets released into atmosphere with no use



## HOW WE FIX THIS



How the regenerative braking system works :

- During acceleration, the current from the battery spins the motor and converts the stored electric energy from the battery into kinetic energy to rotate the wheels.
- When the brakes are applied, the motor starts working as a generator and uses the kinetic energy from the wheels and converts it into electric energy that can be stored in the battery. The kinetic energy is lost from the wheels and the car decelerates.
- The stored energy in the battery can be used to power the electric motor and accelerate the car again. So, energy waste is to a minimum because it is not being lost as heat.

# HOW DO HYBRID CARS WORK

As a hybrid car uses the electric motor to drive, the petrol engine powers a generator that produces electricity and charges the battery. The petrol engine doesn't propel the car forward, it provides the motor with energy.

Magnetism and electricity are linked and cause each other by movement. This established the connection between Newton's Laws and electromagnetic phenomena. The founding of this link enabled us to invent innovative technologies such as hybrid cars, fast computers and space rockets!

