

Verbs Practice **Core Topic 9.3: Motors and Generators**

(Questions taken from syllabus)

**2. The relative motion between a conductor and a magnetic field is used to generate an electrical voltage:**

- Outline Michael Faraday's discovery of the generation of an electric current by a moving magnet

*Outline:* sketch in general terms; indicate the main features of (typically 2 marks)

General terms

Faraday discovered electromagnetic induction, which is the generation of an emf and/or electric current through the use of a magnetic field. Scientists had been searching for many years for ways to produce an electric current using a magnetic field.

Main features

Faraday showed that moving a magnet near a coil could generate an electric current in the coil, as shown by the diagram. When the magnet is turned around, the galvanometer needle deflects in the opposite direction. He discovered that the magnitude of the current depends on the rate of movement of the magnet; the faster it is moving in and out of the coil, the larger the current.

Diagram

- Account for Lenz's Law in terms of conservation of energy and relate it to the production of back emf in motors

*Account for:* state reasons for, report on (typically 2 marks)

Define situation

Lenz's Law is where an induced emf always gives rise to a current that creates a magnetic field that opposes the original change in flux through the circuit.

State reasons

By the Principle of Conservation of Energy, energy cannot be created nor destroyed, but it can be transformed from one form to another. To create the electrical energy in the coil, work must be done. The moving magnet possesses kinetic energy, some of which is transformed into electrical energy in the coil. Thus, to determine the direction of the induced emf, the induced current must produce a magnetic field that opposes the change in magnetic flux density. For example, if the North pole of a magnet is moving towards a coil, the current must flow in such a way that a 'North' pole is produced at that end.

Electric motors use an input voltage to produce an electric current in a coil to make the coil rotate in the external magnetic field. However, as the rotor rotates, the coils of wire are cutting lines of flux. This produces what is known as back emf between the ends of the wires. By Lenz's Law, the induced voltage is opposite in direction and opposes the input voltage. If this was not the case, the current would increase and the motor coil would go faster and faster, as energy will have been created from nothing.

**3. Generators are used to provide large-scale power production:**

- Compare the structure and function of a generator to an electric motor

*Compare:* Show how things are similar or different (typically 2-4 marks)

Table format:

	Generators	Electric motors
<b>Similarities</b>	<ul style="list-style-type: none"> <li>▪ Both AC motors and generators use slip rings, and both DC motors and generators use split-ring commutators, to connect the devices to the rest of the circuit</li> </ul>	
	<ul style="list-style-type: none"> <li>▪ Both have coils of wire placed in a magnetic field</li> </ul>	
	<ul style="list-style-type: none"> <li>▪ Both have rotors and stators – either the armature of the magnet rotates, while the other part remains stationary</li> </ul>	
	<ul style="list-style-type: none"> <li>▪ Both use brushes to connect the device to the circuit</li> </ul>	
	<ul style="list-style-type: none"> <li>▪ Lenz's Law applies to both motors and generators: in motors, the back emf opposes the supply emf as a result of Lenz's Law, and in generators, the production of an induced magnetic field reduces the kinetic energy of the rotor/moving magnet</li> </ul>	
<b>Differences</b>	<ul style="list-style-type: none"> <li>▪ Generators convert kinetic energy to electrical energy</li> </ul>	<ul style="list-style-type: none"> <li>▪ Motors convert electrical energy to kinetic energy</li> </ul>
	<ul style="list-style-type: none"> <li>▪ The source of energy of a generator is therefore mechanical; this movement is usually rotational, produced by a turbine</li> </ul>	<ul style="list-style-type: none"> <li>▪ The source of a energy of a motor is therefore a supply of emf that gives energy to the charge carriers, such as a battery or a generator</li> </ul>
	<ul style="list-style-type: none"> <li>▪ Generators rely on electromagnetic induction, where the emf is induced in the coil by cutting lines of magnetic flux</li> </ul>	<ul style="list-style-type: none"> <li>▪ Motors rely on the opposite: the force that moving charged particles experience when placed in an external magnetic field</li> </ul>