

# Warm-Up

## Applications of Electromagnetic Induction

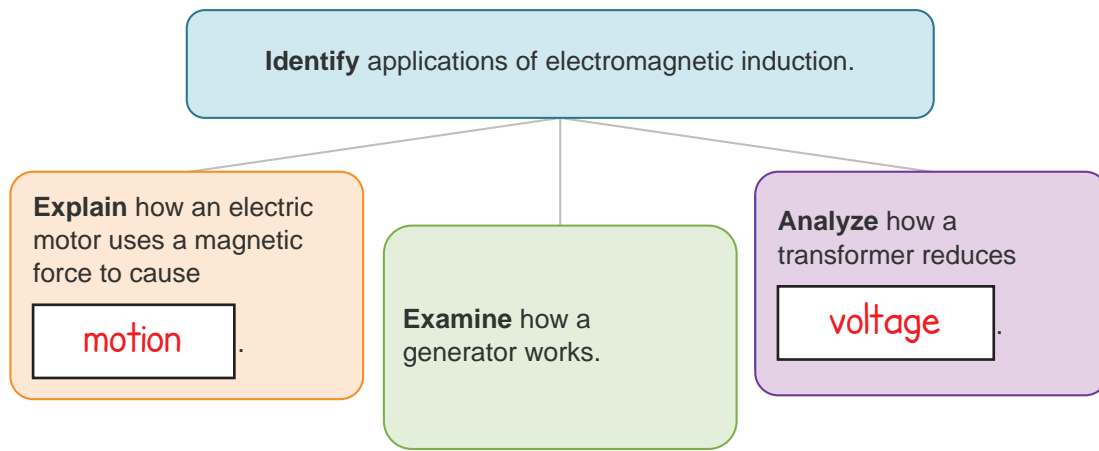


### Lesson Question

What are some applications of electromagnetic induction?



### Lesson Goals



### Words to Know

Fill in this table as you work through the lesson. You may also use the glossary to help you.

armature	the rotating part of an electric <b>motor</b> or generator that consists of many loops of wire wrapped around an iron core
brush	a part in a motor or generator that is the contact point for a commutator or a slip ring and allows <b>current</b> to flow in or out
commutator	a part in a motor attached to the armature that provides a <b>path</b> for current to flow into the armature, allowing the current to change direction
motor	a device that <b>converts</b> electrical energy into kinetic energy to turn an axle



### Words to Know

generator	a device that converts kinetic energy into <b>electrical</b> energy
primary winding	the coil of wire on one side of a transformer through which high-voltage current <b>enters</b> the transformer
secondary winding	the coil of wire on one side of a transformer through which low-voltage current <b>exits</b> the transformer
slip ring	a part in a generator <b>attached</b> to the armature that provides a path for current to flow in and out of the armature
transformer	a device that increases or decreases the voltage of alternating <b>current</b>



### Electromagnetic Induction

- An electromagnet is a **temporary** magnet that has magnetic properties only when current flows through the solenoid.
- An electric current induces a magnetic field.
- A changing magnetic field induces an **electric current**.
  - Change = induction

## Instruction

## Applications of Electromagnetic Induction

Slide

2

**Magnetic Poles**

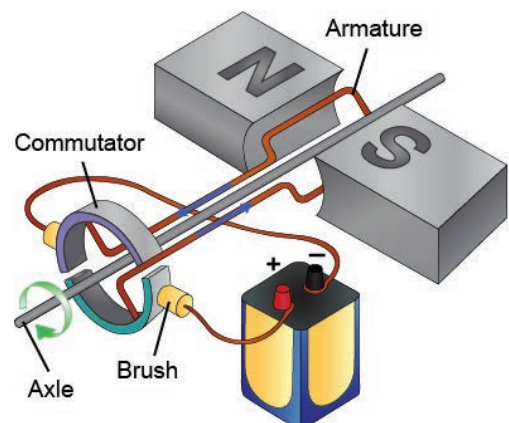
- Opposite poles **attract**.
- **Like** poles repel.

**Parts of a Motor**

- An electric **motor** is a device that converts electrical energy into **kinetic energy** to turn an axle.
  - It uses electric current to produce motion.
- There are two main parts to a simple electric motor:
  - **Permanent magnet**
  - Centrally placed electromagnet

**Inside a Motor**

- An **armature** is a rotating **coil** of wires wrapped around an iron core.
- The **commutator** reverses the flow of **current** through an electric motor.
- Electric current flows from a battery to a **commutator** through an electrical contact called a **brush**.
- An armature is able to continue **spinning** when opposite poles are aligned because the commutators reverse the flow of the current.



Slide

4

### Strength of a Motor

- There are a number of ways to make a motor stronger.
  - **Increase** the number of coils in the solenoid.
  - Increase the **strength** of the permanent magnet.
  - Increase the current sent through the electromagnet.
  - Decrease the **space** between the permanent magnet and the electromagnet.

7

### Function of a Generator

- A **generator** converts kinetic energy into **electrical energy**.
  - A generator uses motion to produce an electric current.
  - Either a magnet or a conducting wire may be moved to produce large quantities of **electricity**.

## Instruction

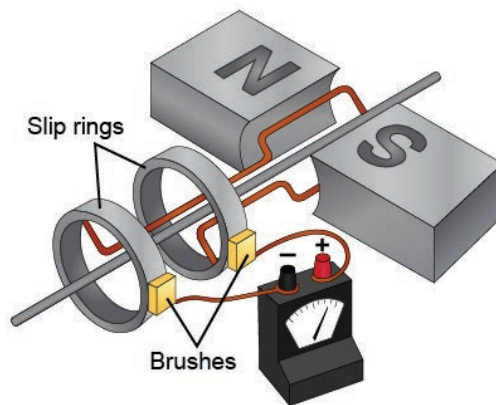
## Applications of Electromagnetic Induction

Slide

7

**Inside a Generator**

- Like a motor, an axle is attached to an **armature** that rotates through a magnetic field.
  - Induces a current in the wire
- Two **slip rings** in contact with brushes provide a **path** for the current to leave the generator.
- The current starts to flow through the armature in one direction; as the armature rotates between the north and south poles of a magnetic field, the current switches **direction**.

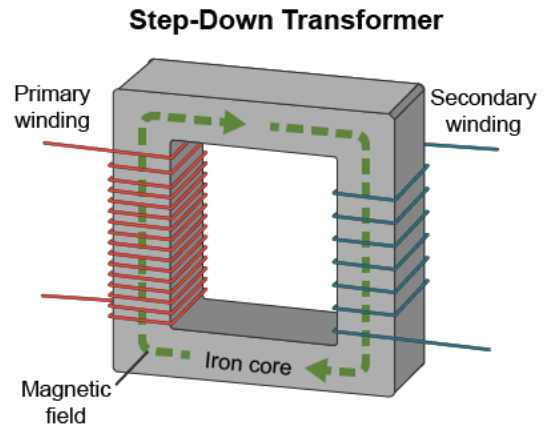


Slide

10

### Transformers

- A **transformer** is a device that **increases** or decreases the voltage of alternating current.
- A transformer consists of:
  - an **iron core**.
  - a **primary winding**.
    - Current enters
    - **High voltage**
  - a **secondary winding**.
    - Current exits
    - Low voltage



### Step-Down Transformer

- The current in the primary winding **induces** a magnetic field across the iron core.
- The magnetic field induces a current in the secondary winding.
- The voltage drop is due only to the fact that the secondary winding has fewer **coils** than the primary winding.

Slide

12

**The Transformer Formula**

- The transformer formula relates the number of coils in the primary and secondary windings to the voltage in each winding.
  - $N_1$  – the number of coils in the primary loop
  - $N_2$  – the number of coils in the secondary loop
  - $V_1$  – the voltage in the primary loop
  - $V_2$  – the voltage in the secondary loop

$$\frac{N_1}{N_2} = \frac{V_1}{V_2}$$

**Calculating Exit Voltage****EXAMPLE**

A primary winding with 15 coils carries a current of 300 V. What is the secondary voltage if the secondary winding has 6 coils?

- Given:

- $N_1 = 15$  coils
- $N_2 = 6$  coils
- $V_1 = 300$  V

- Unknown:  $V_2$

- Formula to use:  $V_2 = \frac{N_2}{N_1} V_1$

$$\begin{aligned} V_2 &= \frac{N_2}{N_1} V_1 \\ V_2 &= \frac{6 \text{ coils}}{15 \text{ coils}} \times 300 \text{ V} \\ &= \boxed{120 \text{ V}} \end{aligned}$$

## Summary

## Applications of Electromagnetic Induction

?

## Lesson Question

What are some applications of electromagnetic induction?

✓

## Answer

(Sample answer) The principle of electromagnetic induction is used in many modern technological devices such as motors, generators, and transformers.

Slide

2

## Review: Key Concepts

- A motor converts electrical energy to kinetic energy and spins an axle.
- The like pole of the electromagnet pushes away from the like pole of the permanent magnet. The motion continues as the commutator continually reverses the flow of the current.
- A generator converts kinetic energy into electrical energy.
  - Steam, water, or wind causes initial motion. Motion causes constantly changing magnetic fields to induce electrical energy.
- A transformer can be used to lower voltage by passing current from a primary winding to a secondary winding.

$$\bullet \frac{N_1}{N_2} = \frac{V_1}{V_2}$$



# Summary

## Applications of Electromagnetic Induction

*Use this space to write any questions or thoughts about this lesson.*

A large empty rectangular box with a thin blue border, intended for student notes or questions.