**Preview of Period 17: Induction Motors and Transformers**

17.1 **Induced Current and Magnetism**

How can we use induced current and induced magnetism to operate motors?

How does a generator differ from motor?

17.2 **Transformers**

How does a transformer use induced current and magnetism to trade voltage for current?

17.3 **Superconductivity and Induced Magnetism**

How can we use a superconductor to make a magnet “float”? 
Act 17.1 Induced Current

Moving charge (current) flowing through a wire near a magnet causes the magnet to move.

♦ The current induces a changing magnetic field around the wire.

♦ The changing magnetic field alternately attracts and repels another magnet.

♦ The interaction between these magnetic fields causes the motor’s rotor to spin.

The opposite is also true. A moving magnet induces moving charge (current) in a wire.

♦ The moving magnet creates a changing magnetic field.

♦ The changing magnetic field induces a changing current in a nearby wire.

♦ The induced current in the wire induces a magnetic field around the wire.
Induced Current and Magnetism

A changing magnetic field induces a current in a wire.

The induced current in the wire induces a magnetic field around the wire.

The induced magnetic field around the wire interacts with the original changing magnetic field.
Act 17.2 Induced Magnetism

- A moving magnet induces moving charge (current) in a wire.

- The induced current in the wire induces a magnetic field around the wire.

- This induced magnetic field experiences a force from the first magnetic field, attracting or repelling the magnet.
Induction motors require no permanent magnets.
Instead, induction motors use a rotor made of a conducting, nonmagnetic material, such as aluminum.
The rotor is surrounded by a circular metal shell, which contains an electromagnet.
The electromagnet induces a magnetic field that moves around the shell.
The rotating magnetic field in the shell induces a current in the rotor.
The induced current in the rotor induces a magnetic field around the rotor.
The rotor's magnetic field interacts with the shell's magnetic field and the rotor spins.
Calculations with Transformers

Transformers trade voltage for current or current for voltage, while keep the power nearly the same.

\[
\frac{N_p}{N_s} = \frac{V_p}{V_s}
\]

- \(N_p\) = Number of turns in the primary coil
- \(N_s\) = Number of turns in the secondary coil
- \(V_p\) = Voltage in the primary coil (in volts)
- \(V_s\) = Voltage in the secondary coil (in volts)

(Ex. 17.1)

A transformer reduces 240 volts to 120 volts. If the secondary coil has 150 turns of wire, how many turns does the primary coil have?

Solve the equation for \(N_p\) by multiplying both sides of the equation by \(N_s\) and canceling.

\[
N_p = \frac{V_p \cdot N_s}{V_s} = \frac{240 \text{ volts} \times 150 \text{ turns}}{120 \text{ volts}} = 300 \text{ turns}
\]
Act. 17.3: Transformers

We assume the amount of power into the transformer equals the amount of power out.

**Step-Down Transformer Coil**
- Decreased voltage
- Increased current

![Diagram of Step-Down Transformer Coil]

- Primary: $N_p = 5$
- Secondary: $N_s = 3$

**Step-Up Transformer Coil**
- Increased voltage
- Decreased current

![Diagram of Step-Up Transformer Coil]

- Primary: $N_p = 3$
- Secondary: $N_s = 5$
Act. 17.4: Superconductivity and Induced Magnetism

♦ When superconducting material is cooled to a very low temperature, it has zero resistance.

♦ Material with zero resistance allows current to flow continually through it.

♦ A small change in a magnetic field can induce a current in a superconductor.

Hold the small magnet above the superconducting disc. What happens when you release the magnet?

(Please do not lose the small magnet!)
Period 17 Summary

17.1: A changing magnetic field induces a current in a nearby wire.
A current carrying wire induces a magnetic field around the wire.
Magnetic forces between these fields are the basis of induction motors.

17.2: Transformers induce currents and magnetic fields to raise or lower voltage.
The voltage across each coil is proportional to the number of turns of wire wrapped around that coil.
A step-up transformer increases the voltage and decreases the current.
A step-down transformer decreases voltage and increases current.

17.3: Superconducting materials have zero resistance and can transmit electricity with no energy wasted as joule heating.
Period 17 Review Questions

R.1 Explain how an induction motor works.

R.2 How does an induction motor differ from a DC motor?

R.3 Could a transformer be used to change the amount of energy supplied to an electric device? Why or why not? What does a transformer change?

R.4 In what way is a transformer similar to a simple machine, such as a lever?

R.5 What are the advantages of superconducting materials? What are the problems associated with their use?