Concert Current

Trace energy through a generator, microphone, speaker, and motor.

PHY.5.7 "Analyze and communicate the relationship between magnetic fields and electrical current by induction, generators, and electric motors (e.g., microphones, speakers, generators, and motors) using Ampere's and Faraday's laws."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline where motion changes the magnetic field through a coil, circle where current produces a magnetic field, and write G beside devices that change motion into electricity or M beside devices that change electricity into motion.

How a Bike Powers a Concert

1. At a sidewalk concert, a cyclist pedals a bike that drives a small generator. Inside it, a magnet spins near a stationary wire coil. As the magnet's poles pass the coil, the magnetic field passing through the coil changes. Faraday's law says a changing magnetic field through a circuit induces a voltage. When the coil forms a closed circuit, that voltage drives current to the sound system. Pedaling faster makes the field change more rapidly, which can increase the induced voltage. The cyclist's muscles supply mechanical energy, which the generator converts into electrical energy, with some energy lost as heat.

2. A singer's voice also crosses a boundary between motion and electricity. In a moving-coil microphone, sound waves shake a thin diaphragm attached to a wire coil. The coil moves through a permanent magnet's field, changing the magnetic field through the coil and inducing a varying voltage by Faraday's law. The resulting electrical signal follows the sound's vibrations. That signal is amplified before it reaches a speaker. A microphone does not create energy from nothing: some energy carried by the sound waves becomes electrical energy, while the amplifier uses electrical energy from the generator to strengthen the signal.

3. In the speaker, the amplified alternating current flows through a coil beside a permanent magnet. Ampere's law connects electric current to the magnetic field it produces around the coil. The coil's field interacts with the permanent magnet's field, exerting a force on the coil. As the current reverses, the force changes direction; the attached speaker cone moves back and forth, pushing air to make sound. A fan motor uses a similar interaction to turn a rotor, rather than shake a cone. Unlike the generator, both the speaker and the motor turn electrical energy into motion.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why does the bike generator produce a voltage, and what can happen to that voltage when the cyclist pedals faster?

2. Trace how a sound wave becomes an electrical signal in the moving-coil microphone. Name the law involved.

3. How does alternating current make the speaker cone move back and forth? Use Ampere's law in your answer.

4. A fan motor and the bike generator both involve magnets and coils. How do their energy changes differ?

3 YOUR TURN

Your own words

Design a hand-cranked warning sounder using a rotating magnet, a stationary coil, and a speaker. In 4 to 5 sentences, explain how to connect the parts, predict what happens when the crank turns faster and when it stops, and use Faraday's and Ampere's laws to trace the energy changes.

Concert Current

PART 1 · READ AND MARK

Underline where motion changes the magnetic field through a coil, circle where current produces a magnetic field, and write G beside devices that change motion into electricity or M beside devices that change electricity into motion. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why does the bike generator produce a voltage, and what can happen to that voltage when the cyclist pedals faster?	**The spinning magnet changes the magnetic field through the coil, inducing a voltage by Faraday's law. Faster pedaling can increase the induced voltage.**
2	Trace how a sound wave becomes an electrical signal in the moving-coil microphone. Name the law involved.	**The sound wave shakes the diaphragm and its coil. The moving coil experiences a changing magnetic field through it, inducing a varying voltage by Faraday's law.**
3	How does alternating current make the speaker cone move back and forth? Use Ampere's law in your answer.	**By Ampere's law, current produces a magnetic field around the speaker coil. Its interaction with the permanent magnet exerts a force that changes direction as the current reverses.**
4	A fan motor and the bike generator both involve magnets and coils. How do their energy changes differ?	**The fan motor uses electrical energy to turn its rotor. The bike generator uses mechanical energy from pedaling to produce electrical energy.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would connect the stationary coil to the speaker so current can flow through a closed circuit. Turning the crank spins the magnet past the coil, changing the magnetic field through it and inducing a voltage by Faraday's law. The current produces a magnetic field in the speaker coil by Ampere's law, and its interaction with the speaker magnet moves the cone to make sound. Turning faster can increase the induced voltage, while stopping the crank stops induction and the sound. The crank's mechanical energy becomes electrical energy and then sound.

Accept descriptions of changing magnetic field through a coil for Faraday's law and current producing a field for Ampere's law. In Part 3, the proposed circuit must be closed for current to flow.