Microphones

4.7.3.3 · Magnetism and electromagnetism · revision notes

A moving-coil microphone uses the generator effect to turn the pressure variations of a sound wave into a varying electric current. You need to explain step by step how it works, and how it compares with a loudspeaker. GCSE Physics only, Higher tier only.

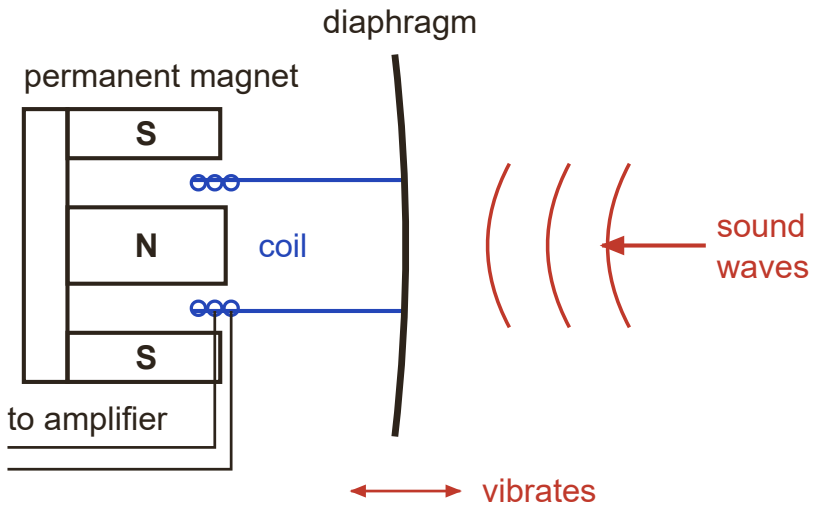
Key facts

- Microphone: sound → vibrating diaphragm and coil → induced pd → alternating current
- Parts: diaphragm, coil, permanent magnet
- Frequency of the current = frequency of the sound
- Microphone = generator effect; loudspeaker = motor effect
- Uses the generator effect
- Converts pressure variations in sound into variations in current
- Louder sound → bigger induced current

Notes

Structure

- A moving-coil microphone has a light **diaphragm** attached to a **coil** of wire.
- The coil sits in the magnetic field of a **permanent magnet** and can move freely.
- The ends of the coil are connected to a circuit, e.g. an amplifier.



Sound → diaphragm and coil vibrate → pd induced (generator effect).

How it works

- A sound wave is a series of **pressure variations** in the air (compressions and rarefactions).
- These make the diaphragm **vibrate**, and the coil vibrates with it.
- The coil moves back and forth relative to the magnetic field, so a **pd is induced** across it: the **generator effect**.
- Each time the coil changes direction, the induced pd changes direction, so there is an **alternating current** in the circuit.
- So the microphone converts the pressure variations in sound waves into variations in current in an electrical circuit.

Matching the sound, and comparing with a loudspeaker

- The current has the **same frequency** as the sound wave.
- A louder sound (bigger amplitude) makes the coil move further and faster, so the induced pd and current are **bigger**.
- A microphone is like a loudspeaker working backwards. Loudspeaker: current → movement (motor effect). Microphone: movement → current (generator effect). Grade 8+ only

How to answer each type of question

Explain how a moving-coil microphone works 4 to 6 marks Grade 7

1. Sound (pressure variations) makes the diaphragm vibrate.
2. The coil attached to it moves back and forth in the magnet's field.
3. So a pd is induced across the coil (generator effect).
4. The pd changes direction as the coil changes direction, so the current alternates, at the same frequency as the sound.

Example. Explain how a moving-coil microphone produces an electrical signal when someone speaks into it. [4 marks]

Model answer. The pressure variations of the sound wave make the diaphragm vibrate (1). The coil attached to the diaphragm moves back and forth in the magnetic field of the magnet (1). So a potential difference is induced across the coil (the generator effect) (1). The pd changes direction each time the coil changes direction, so an alternating current is produced in the circuit, with the same frequency as the sound (1).

Describe how the signal changes with the sound

2 to 4 marks | Grade 7

1. Pitch → frequency of vibration → frequency of the current.
2. Loudness → amplitude of vibration → size of the induced pd and current.
3. Give a reason for each change.

Example. A singer sings a quiet, low note and then a loud, high note into a microphone. Describe how the current from the microphone changes. Give reasons. [4 marks]

Model answer. The current has a higher frequency (1) because the diaphragm and coil vibrate at the same frequency as the sound, which is now higher (1). The current is bigger (1) because the louder sound makes the coil move further and faster in the magnetic field, which induces a bigger pd (1).

Compare a microphone with a loudspeaker

3 to 4 marks | Grade 8

1. Give a similarity: both have a coil in the field of a permanent magnet, attached to a diaphragm or cone.
2. Give the difference in effect: microphone = generator effect, loudspeaker = motor effect.
3. Give the difference in job: sound → electrical signal, or electrical signal → sound.

Example. A moving-coil microphone and a moving-coil loudspeaker have a similar structure. Compare how they work. [4 marks]

Model answer. Both have a coil in the magnetic field of a permanent magnet, attached to a diaphragm or cone (1). In a microphone, sound makes the coil move, which induces a pd and a current: the generator effect (1). In a loudspeaker, the current in the coil causes a force that makes the coil move: the motor effect (1). So a microphone converts sound into an electrical signal, whereas a loudspeaker converts an electrical signal into sound (1).

Don’t lose marks

- Saying the magnet vibrates: the diaphragm and coil move, and the magnet stays fixed.
- Saying a microphone uses the motor effect: it uses the generator effect.
- Missing out the word 'induced'.
- Forgetting to explain why the current alternates: the coil moves back and forth.
- Writing only that the diaphragm or coil 'moves' or 'moves up and down': say it vibrates (moves back and forth).

More tips

Memory tricks

- Microphone: Movement Makes current (generator effect).
- Chain: sound → diaphragm → coil moves in the field → induced pd → alternating current.
- Learn the loudspeaker chain, then run it backwards for the microphone.

Exam technique

- Describe the sound wave as 'pressure variations': examiners look for this phrase.
- In 'compare' questions, give at least one similarity and one difference, using 'whereas'.
- Link every step to the next: sound → diaphragm → coil → magnetic field → induced pd → current.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 4

Name the parts of a moving-coil microphone

A diaphragm attached to a coil, which sits in the magnetic field of a permanent magnet.

Grade 5

State that microphones use the generator effect

Sound makes a coil move in a magnetic field, which induces a pd.

Grade 6

Explain how sound makes the coil move

The pressure variations of the sound wave make the diaphragm, and the coil attached to it, vibrate.

Grade 7

Explain how an alternating current is produced

The coil moves back and forth in the field, so the induced pd keeps changing direction.

Grade 7

Link a microphone's current to the sound

The current has the same frequency as the sound; a louder sound gives a bigger current.

Grade 8

Compare a microphone with a loudspeaker

Both have a coil in a magnet's field; a microphone uses the generator effect and a loudspeaker the motor effect.

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