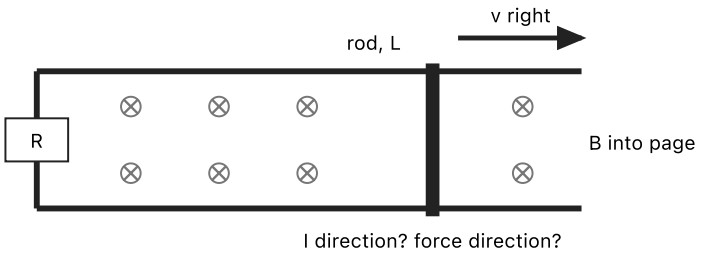
MAGNETISM DAY 11: MOTIONAL EMF, RODS & GENERATORS

CED 12.4 · Skill 2.B · FRQ: MR

PREDICT BEFORE PUSHING

A conducting rod slides right on rails through a uniform field into the page. If the rod moves twice as fast, the induced emf is **A half / B unchanged / C twice** as large. Commit before the current and force arrows are revealed.

MOVING ROD IN A COMPLETED CIRCUIT



MOTIONAL EMF

Magnetic force separates charge along the moving rod until an electric potential difference is established.

$$\varepsilon = BLv \qquad I = \varepsilon/R$$

The induced current creates a magnetic force that opposes the motion producing the flux change.

NOTES / REASONING

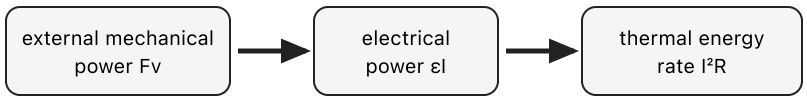
ANCHOR ROD: NUMBERS AND ENERGY

A rod of length 0.50 m moves at 3.0 m/s through a 0.40 T field into the page. The total circuit resistance is 0.30 Ω.

WE DO

1. Find the induced emf and current.
2. Find the magnetic force on the rod.
3. Compare Fv, εI, and I^2R.

ENERGY ACCOUNTING AT CONSTANT SPEED

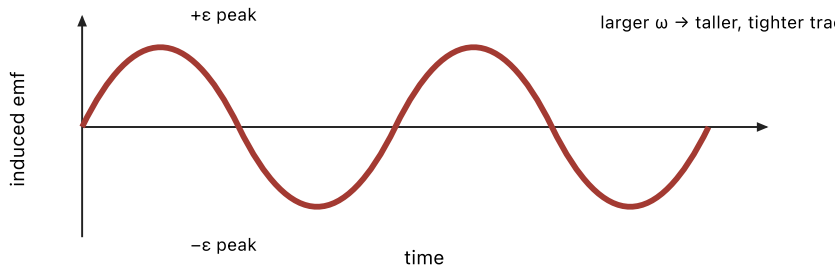


ROTATING-LOOP GENERATOR

$$\varepsilon(t) = NBA\omega \sin(\omega t) \qquad \varepsilon_{peak} = NBA\omega$$

Flux is largest when the loop's area normal is parallel to B. At that instant the flux slope and emf are zero. The emf magnitude is largest when the flux passes through zero most rapidly.

A GENERATOR PRODUCES ALTERNATING EMF



1. A generator has N = 80, B = 0.25 T, A = 0.015 m², and ω = 20 rad/s. Find the peak emf.

2. On the trace, mark one instant when the flux magnitude is maximum.

PRACTICE

3. A 0.40 m rod moves at 2.5 m/s through a 0.30 T field. Find ε.

4. If the circuit resistance is 0.50 Ω, find I, the retarding force, and the required external power.

5. A generator has N = 50, B = 0.20 T, A = 0.018 m², and ω = 25 rad/s. Find ε_{peak}.

6. Explain why doubling ω changes both the height and spacing of the emf peaks on a time graph.