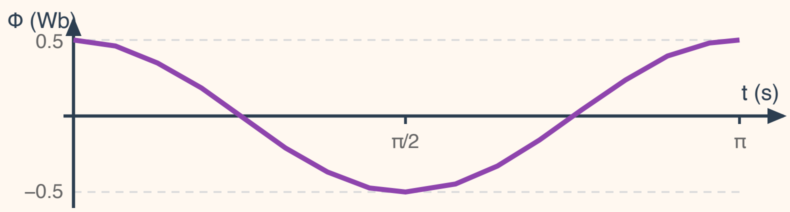
INDUCTION DAY 2: FARADAY & LENZ

WARMUP Where the EMF Peaked

Yesterday you sketched the spinning loop's flux; here it is. Today's law reads its DERIVATIVE, $d\Phi/dt$. Mark directly on the curve: the points where $|d\Phi/dt|$ is largest, and the points where it is zero. One line below: why not at the peaks?



Day 1's flux for the spinning loop: $\Phi = 0.5\cos(2t)$ Wb, one full period.

FARADAY'S LAW + LENZ'S SIGN

$$\varepsilon = -N \cdot d\Phi/dt$$

Faraday: the induced EMF is the RATE of flux change, times the turns. If B climbs at a constant rate — an electromagnet's supply turned up smoothly, dB/dt fixed — the EMF is steady: $\varepsilon = NA \cdot dB/dt$.

Lenz (the minus sign): the induced current opposes the CHANGE — its own flux fights the growth or props up the decay. If it worked the other way, the induced current would feed the change that created it — energy from nowhere. The minus sign is energy conservation.

WE DO Exercise 1: Ramp Numbers

A 200-turn coil, $A = 0.01$ m², sits inside an electromagnet whose field climbs at a steady 0.5 T/s. **(a)** $\varepsilon = NA \cdot dB/dt$ = ________. **(b)** The coil's resistance is 4.0 Ω: I = ________. **(c)** Viewed from above (B up, growing): current direction = ________.

LENZ REPS AND FALLING FLUX

WE DO **Exercise 2: Direction Drills**

For each change, give the induced current's direction (viewed from above; B points up through the loop): **(a)** B increasing. **(b)** B decreasing. **(c)** loop area shrinking in steady B. **(d)** a bar magnet's north pole approaching from above.

YOU DO **Exercise 3: Read a Flux Graph**

A single loop's flux falls linearly from 0.08 Wb to zero in 0.2 s. Find the EMF during the fall — and the EMF after the flux reaches zero and stays there.

CALC **Exercise 4: Non-Constant Rate**

A single loop of area 0.5 m^2 sits in $B(t) = 0.2t^2$ T. Find $\varepsilon(t) = -A \cdot dB/dt$, then evaluate at t = 3.0 s. (Differentiate first, plug in second.)

PAPER PRACTICE

PRACTICE PROBLEMS

P1 Ramp EMF

A single 0.2 m^2 loop in a field climbing at a steady 0.4 T/s: find ε in millivolts.

P2 Turns Multiply

The same ramp through a 500-turn coil of the same area: find ε.

P3 Solve the Ramp

A 100-turn coil ($A = 0.02\ m^2$) must output 3.0 V. What dB/dt?

P4 The Dropped Magnet

A magnet falls through a copper tube and descends noticeably slower than in free fall. Chain the argument: what changes, what is induced, what does Lenz require, and where does the lost gravitational energy go?