Direction of Induced Current?

- An loop of wire expands from a radius of 10 cm to a radius of 30 cm in 1.5 seconds. If the loop is in a constant 1.25 T B-Field (perpendicular to the loop),…
  - What is the initial flux?
  - What is the final flux?
  - What is the change in flux?
  - What is the direction of the induced current?

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$$\Phi_B = BA\cos\theta = B\left(\pi r^2\right)\left(1\right)$$

$$\Phi_B = \left(1.25T\right)\left(\pi\left(0.1m\right)^2\right)$$

$$\Phi_B = 0.039\,\mathrm{Wb}$$

Direction of Induced Current?

- An loop of wire expands from a radius of 10 cm to a radius of 30 cm in 1.5 seconds. If the loop is in a constant 1.25 T B-Field (perpendicular to the loop),…
  - What is the final flux?

$$\Phi_B = BA\cos\theta = B\left(\pi r^2\right)\left(1\right)$$

$$\Phi_B = \left(1.25T\right)\left(\pi\left(0.3m\right)^2\right)$$

$$\Phi_B = 0.353\,\mathrm{Wb}$$

Direction of Induced Current?

- An loop of wire expands from a radius of 10 cm to a radius of 30 cm in 1.5 seconds. If the loop is in a constant 1.25 T B-Field (perpendicular to the loop),…
  - What is the change in flux?

$$\Delta\Phi_B = \Phi_{B_{final}} - \Phi_{B_{initial}}$$

$$\Delta\Phi_B = 0.353T - 0.039T$$

$$\Delta\Phi_B = 0.314T$$

Direction of Induced Current?

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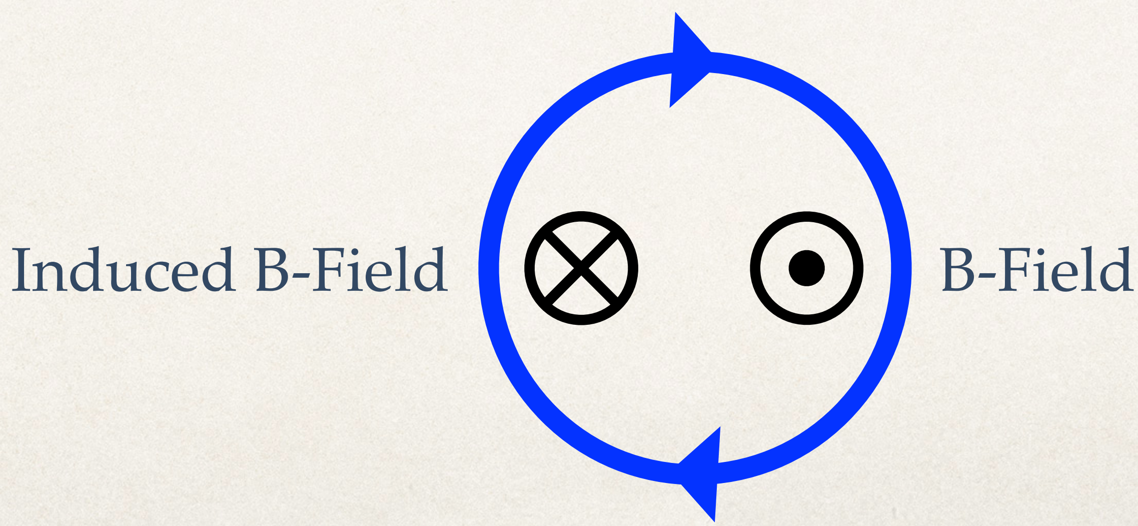
    - What is the direction of the induced current?



Direction of Induced Current?

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$$V = -N\frac{\Delta\Phi_B}{\Delta t}$$

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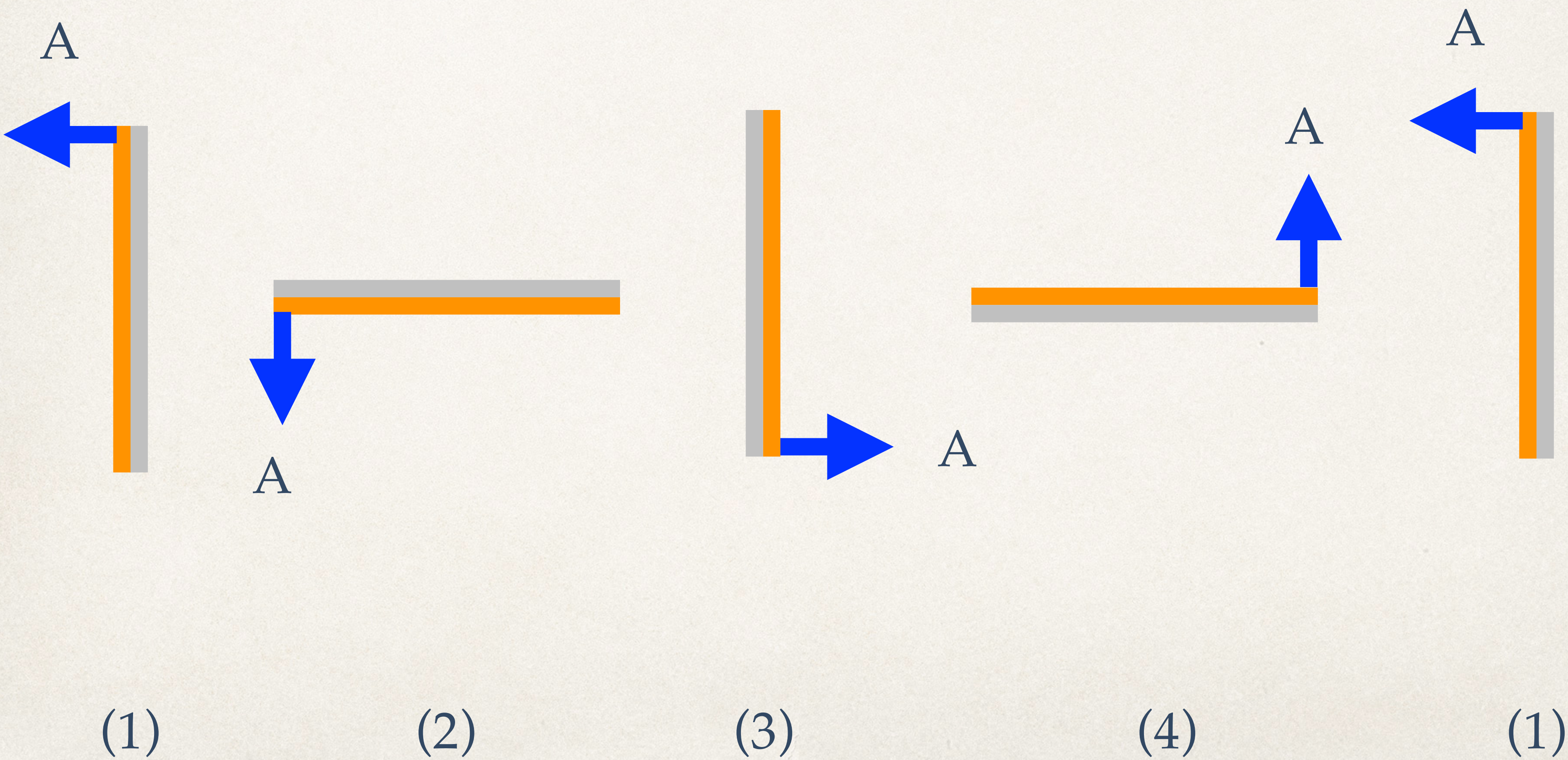
$$V = -N\frac{\Delta\Phi_B}{\Delta t} \qquad I = -\frac{N}{R}\frac{\Delta\Phi_B}{\Delta t}$$

$$V = IR \qquad I = \left(\frac{1}{1}\right)\left(\frac{0.314\ \text{Wb}}{1.5\ \text{s}}\right) \qquad I = 0.21\ \text{A}$$

Practice

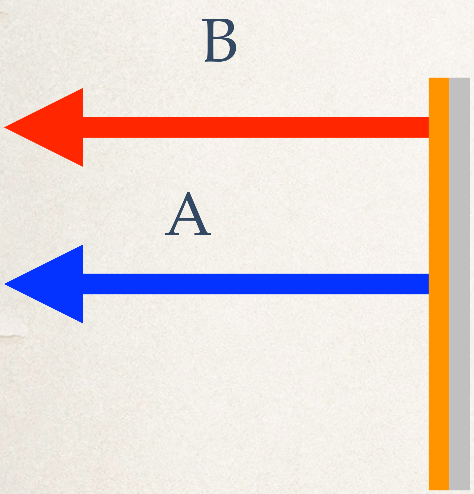
- A square loop of wire (0.25 m per side) falls out of a 3.5 T magnetic field that is coming towards you. The loop falls at a constant speed of 5.0 m/s, what is the *EMF* in the loop. If the loop as a resistance of 0.05 Ω, what is the magnitude and direction of the current in the loop?

AC Generator (Overview)



AC Generator

- Step 1

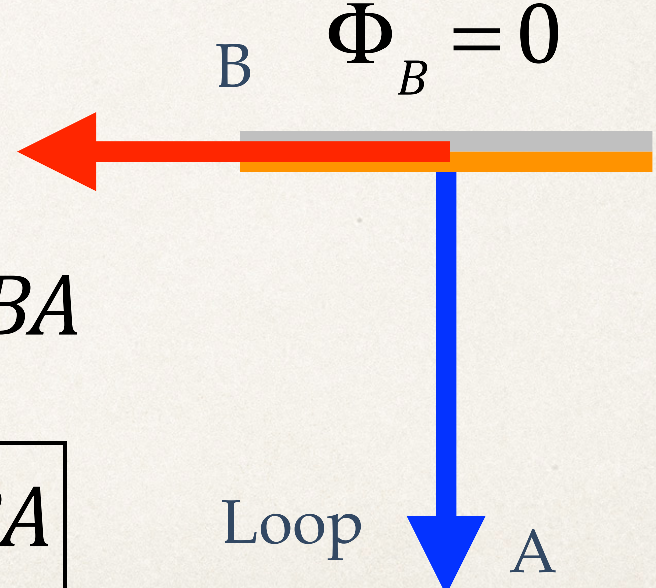


$$\Phi_B = BA$$

Loop

(1)

$$\Phi_B = 0$$



Loop

(2)

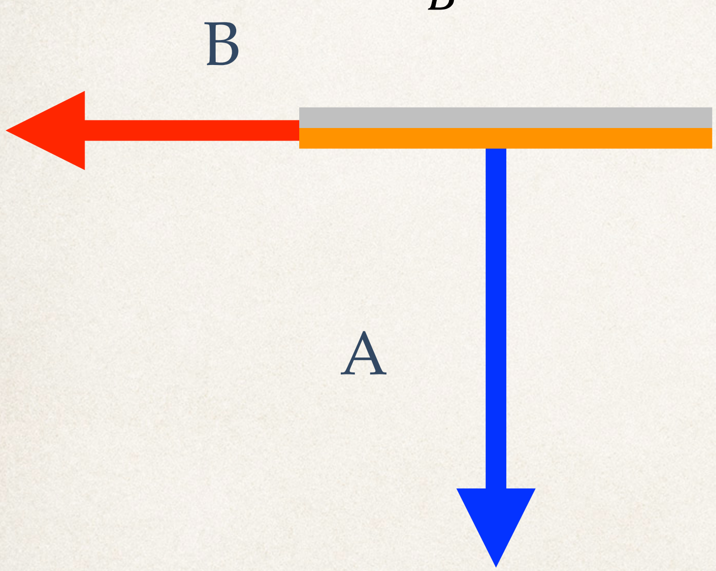
$$\Delta\Phi_{B_{1\to 2}} = 0 - BA$$

$$\boxed{\Delta\Phi_{B_{1\to 2}} = -BA}$$

AC Generator

- Step 2

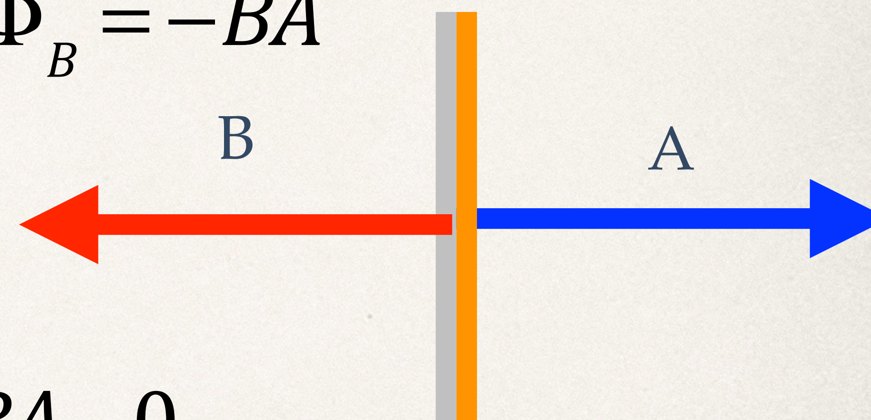
$$\Phi_B = 0$$



Loop

(2)

$$\Phi_B = -BA$$



Loop

(3)

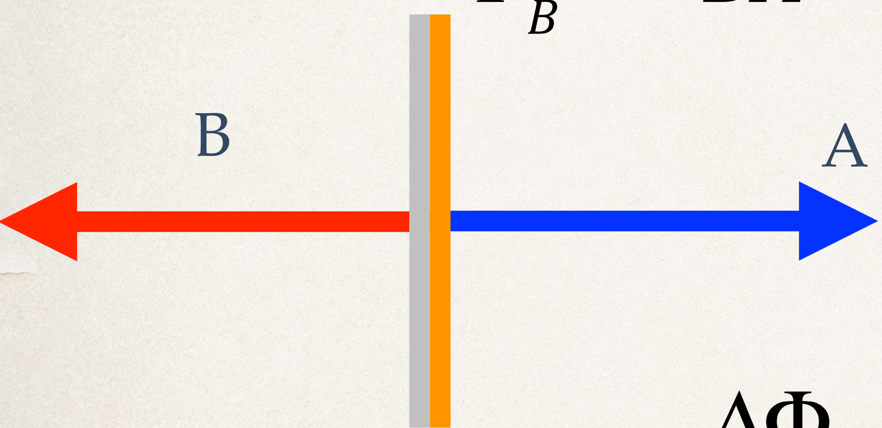
$$\Delta\Phi_{B_{2\to3}} = -BA - 0$$

$$\boxed{\Delta\Phi_{B_{2\to3}} = -BA}$$

AC Generator

- Step 3

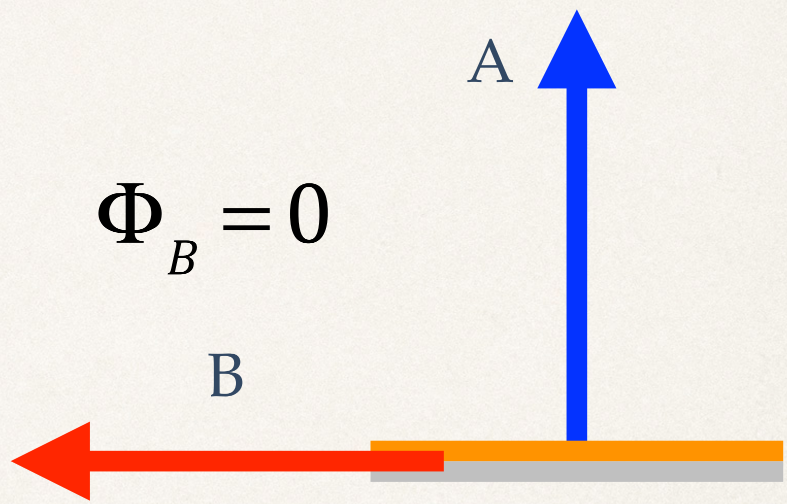
$$\Phi_B = -BA$$



Loop

(3)

$$\Phi_B = 0$$



Loop

(4)

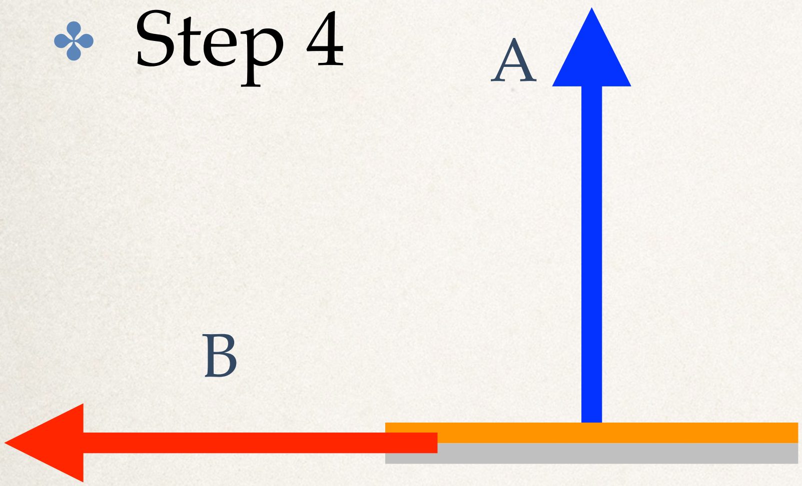
$$\Delta\Phi_{B_{3\rightarrow4}} = 0 - \left(-BA\right)$$

$$\boxed{\Delta\Phi_{B_{3\rightarrow4}} = +BA}$$

AC Generator

- Step 4

$$\Phi_B = BA$$



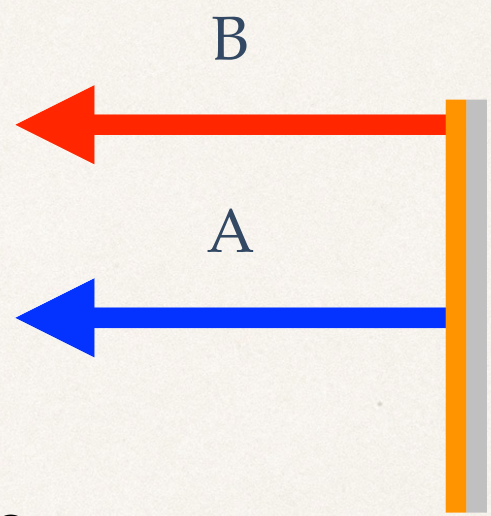
$$\Phi_B = 0$$

$$\Delta\Phi_{B_{4\rightarrow 1}} = BA - 0$$

Loop

(4)

$$\boxed{\Delta\Phi_{B_{4\rightarrow 1}} = +BA}$$



Loop

(1)

AC Generator Summary

	$\Delta\phi$	ε
(1)➛(2)	$-BA$	$+BA/\Delta t$
(2)➛(3)	$-BA$	$+BA/\Delta t$
(3)➛(4)	$+BA$	$-BA/\Delta t$
(4)➛(1)	$+BA$	$-BA/\Delta t$

Transformers

- An application of Faraday's Law

$$V_S = N_S\left(\frac{\Delta\Phi_B}{\Delta t}\right) \qquad V_P = N_P\left(\frac{\Delta\Phi_B}{\Delta t}\right)$$

$$\frac{V_S}{N_S} = \left(\frac{\Delta\Phi_B}{\Delta t}\right) \qquad \frac{V_P}{N_P} = \left(\frac{\Delta\Phi_B}{\Delta t}\right)$$

Transformers

- An application of Faraday's Law

$$\frac{V_S}{N_S} = \left(\frac{\Delta\Phi_B}{\Delta t}\right) = \frac{V_P}{N_P}$$

$$\frac{V_S}{N_S} = \frac{V_P}{N_P}$$

P = Primary (Input)

$$\boxed{\frac{V_S}{V_P} = \frac{N_S}{N_P}}$$

S = Secondary (Output)

Transformers

- Power in transformers

$$P = IV$$

$$P_{in} = P_{out} \qquad P_P = P_S$$

$$I_P V_P = I_S V_S$$

$$\frac{I_P}{I_S} = \frac{V_S}{V_P} \qquad \text{but …} \qquad \frac{V_S}{V_P} = \frac{N_S}{N_P}$$

Transformers

- Power in transformers

so …

$$\frac{I_P}{I_S} = \frac{N_S}{N_P}$$

$$\boxed{\frac{I_S}{I_P} = \frac{N_P}{N_S}}$$

Transformers

- Notice…

$$\boxed{\frac{V_S}{V_P} = \frac{N_S}{N_P}}$$

$$\boxed{\frac{I_S}{I_P} = \frac{N_P}{N_S}}$$

Transformers

$$\frac{V_S}{V_P} = \frac{N_S}{N_P}$$

- A step-down transformer has 3,500 coils in it's secondary and takes voltage from 2,250 V to 440 V, how many coils in the primary?

Chapter 23

- A wire loop is laying flat on the table. Which situation will result in the highest magnetic flux through the wire loop? (The magnet in each scenario is identical)

  A. A magnet laying flat on the table. (Poles laying across the table)

  B. A vertical magnet standing on end on the table. (North Pole sticking up)

  C. A vertical magnet falling towards the wire loop.

  D. A flat magnet moving quickly parallel to the table.

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Chapter 23

- A 0.10 m square wire held at a 45° angle in a 0.25 T magnetic field. What is the flux through that wire loop?

    A. 1.77×10^{-6} T/m^2

    B. 3.54×10^{-6} T/m^2

    C. 1.77×10^{-3} T/m^2

    D. 3.54×10^{-3} T/m^2

Chapter 23

- A 0.10 m by 0.10m, square wire loop held at a 45° angle in a 0.25 T magnetic field. What is the flux through that wire loop?

A. 1.77×10^{-6} T/m²

B. 3.54×10^{-6} T/m²

C. 1.77×10^{-3} T/m²

D. 3.54×10^{-3} T/m²

Chapter 23

- Which of the following is NOT a factor in the EMF induced in a moving conductor?

  A. Magnetic Field

  B. Length

  C. Velocity

  D. Area of loop

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Chapter 23

- When europeans travel to the U.S. for vacation they need a step up transformer to take the voltage from 120V to 220V. If the primary coil has 250 loops, how many loops does the secondary coil have?

  A. 106

  B. 137

  C. 459

  D. 14 million

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