Exercise walk-through

# 13.2
# Electromagnetic Induction

AP Physics C: Electricity and Magnetism

# You must be able to

- state **Faraday's law** , $\varepsilon = -\frac{d\Phi_B}{dt}$
- apply **Lenz's law** to find the direction of an induced current
- explain Lenz's law as **conservation of energy**
- calculate the **motional emf** of a moving conductor, $\varepsilon = BLv$

# 1 The method

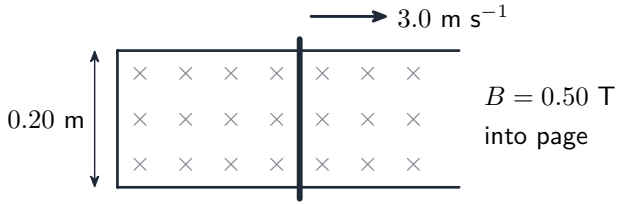
# Method — Faraday's law

$\varepsilon = -\dfrac{d\Phi_B}{dt}$; for a coil of $N$ turns, $\varepsilon = -N\dfrac{d\Phi_B}{dt}$. A faster flux change gives a bigger emf.

# Exercises 2.1·2.2

**2.1** State Faraday's law. [1]

**2.2** A rod of length 0.20 m moves at 3.0 m $s^{-1}$ perpendicular to a 0.50 T field. Find the motional emf. [2]



# Exercises 2.1–2.2

**2.1** State Faraday's law. [1]

**2.1**

- the induced emf equals the negative rate of change of magnetic flux

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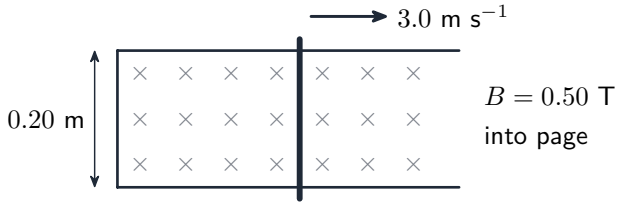


**2.2**

- motional emf:

$$\varepsilon = BLv = (0.50\ \text{T})(0.20\ \text{m})(3.0\ \text{m s}^{-1})$$

- $\varepsilon = \mathbf{0.30}\ \text{V}$

# Exercises 2.3·3.1

**2.3** State Lenz's law. [1]

**3.1** Faraday's law says the induced emf equals [1]

- **A** $-\dfrac{d\Phi_B}{dt}$
- **B** $BIL$
- **C** $\mu_0 nI$
- **D** $qvB$

# Exercises 2.3·3.1

**2.3** State Lenz's law. [1]

**2.3**

- the induced current opposes the change in flux that produces it

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**3.1** Faraday's law says the induced emf equals [1]

- ☐ **A** $-\dfrac{d\Phi_B}{dt}$
- **B** $BIL$
- **C** $\mu_0 nI$
- **D** $qvB$

**3.1 A**

- $-\dfrac{d\Phi_B}{dt}$.

# Exercise 3.2

**3.2** Lenz's law is a consequence of conservation of [1]

- **A** charge
- **B** energy
- **C** momentum
- **D** flux

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**3.2** Lenz's law is a consequence of conservation of [1]

- **A** charge
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**3.2 B**

- energy.

# Exercise 3.3 (a)

**3.3** A coil of 200 turns has its flux change from 0.020 Wb to 0.005 Wb in 0.10 s.

(a) Find the size of the induced emf. [3]

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(a) Find the size of the induced emf. [3]

(a)

- Faraday's law for $N$ turns:

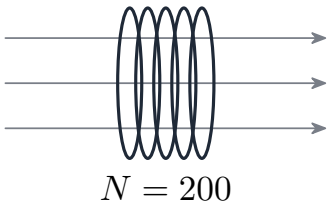
$$|\varepsilon| = N\left|\frac{\Delta\Phi_B}{\Delta t}\right| = 200 \times \frac{0.020\ \text{Wb} - 0.005\ \text{Wb}}{0.10\ \text{s}}$$

- $|\varepsilon| = \mathbf{30}\ \text{V}$

# Exercise 3.3 (b)

**3.3** A coil of 200 turns has its flux change from 0.020 Wb to 0.005 Wb in 0.10 s.

(b) State what determines the direction of the induced current. [1]




$\Phi_B$: 0.020 Wb $\rightarrow$ 0.005 Wb

in 0.10 s

# Exercise 3.3 (b)

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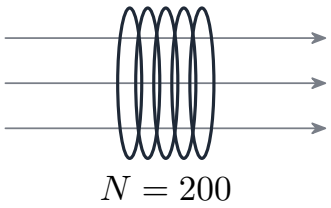


$\Phi_B$: 0.020 Wb $\rightarrow$ 0.005 Wb

in 0.10 s

(b)

- Lenz's law (it opposes the change)