

# 13.2 Electromagnetic Induction

Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_ **Total: 10 marks**

**KEY WORDS** induced current 感应电流 • emf 电动势 • lenz's law 楞次定律  
• faraday's law 法拉第定律 • motional emf 动生电动势

## Objective

Build the skills to answer exam questions on **electromagnetic induction**.

**You must be able to:**

- state **Faraday's law** 法拉第定律,  $\varepsilon = -\frac{d\Phi_B}{dt}$
- apply **Lenz's law** 楞次定律 to find the direction of an induced current
- explain Lenz's law as **conservation of energy**
- calculate the **motional emf** 动生电动势 of a moving conductor,  $\varepsilon = BLv$

## 1 Worked examples

Study these first. Each one shows the method for a question type used later.

### ■ Faraday's law

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

### ■ Lenz's law

The induced current flows so as to **oppose** the change in flux (the minus sign) — a consequence of energy conservation.

### ■ Motional emf

A rod of length  $L$  moving at speed  $v$  across a field  $B$  generates  $\varepsilon = BLv$ .

## 2 Practice

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

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

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

## 3 Exam-style questions

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

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

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

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

**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]

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

## Solutions

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**2.1** the induced emf equals the negative rate of change of magnetic flux.

**2.2**  $\varepsilon = BLv = 0.50 \times 0.20 \times 3.0 = 0.30 \text{ V}$ .

**2.3** the induced current opposes the change in flux that produces it.

**3.1 A.**

**3.2 B.**

**3.3** (a)  $|\varepsilon| = N \left| \frac{\Delta\Phi_B}{\Delta t} \right| = 200 \times \frac{0.020 - 0.005}{0.10} = 30 \text{ V}$ . (b) Lenz's law (it opposes the change).