13.2 Electromagnetic Induction

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

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, $\varepsilon = -\dfrac{d\Phi_B}{dt}$
- 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**

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

■ **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 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** $-\dfrac{d\Phi_B}{dt}$
- **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]

4 Go further

- work through the **13.2 Electromagnetic Induction** lesson on the **Learn** page;
- read the **Electromagnetic Induction** section of the AP Physics C: E&M handout on the **Know** page.

Solutions

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

2.2 $\varepsilon = BLv = 0.50 \times 0.20 \times 3.0 = 0.30$ V.

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

3.1 A.

3.2 B.

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