AP PHYSICS 2 • EXERCISE SHEET

12.4 Electromagnetic Induction and Faraday's Law

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

Objective

Build the skills to answer exam questions on **electromagnetic induction and Faraday's law**.

You must be able to:

- define **magnetic flux** 磁通量 as $\Phi = BA\cos\theta$
- state **Faraday's law** 法拉第定律: a changing flux induces an emf, $\varepsilon = -\dfrac{\Delta\Phi}{\Delta t}$
- use **Lenz's law** 楞次定律 to find the direction of an induced current
- describe how generators and transformers use induction

1 Worked examples

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

Magnetic flux

$\Phi = BA\cos\theta$, measured in webers, where θ is the angle between the field and the loop's normal. Flux is greatest when the loop faces the field ($\theta = 0$).

Faraday's law

$\varepsilon = -\dfrac{\Delta\Phi}{\Delta t}$: a **changing** flux induces an emf. A faster change means a larger emf.

Lenz's law

The induced current flows so as to **oppose** the change in flux that produced it (the minus sign).

2 Practice

2.1 Find the magnetic flux through a 0.20 m^2 loop lying face-on in a 0.50 T field. [2]

2.2 State what is needed to induce an emf in a coil. [1]

2.3 State Lenz's law. [1]

3 Exam-style questions

3.1 Magnetic flux is [1]

- **A** $BA\cos\theta$
- **B** $BI\ell$
- **C** qvB
- **D** $\dfrac{\mu_0 I}{2\pi r}$

3.2 The rule that an induced current opposes the change that causes it is [1]

- **A** Ohm's law
- **B** Faraday's law
- **C** Lenz's law
- **D** Kirchhoff's law

3.3 The flux through a coil falls from 0.40 Wb to 0.10 Wb in 0.20 s.

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

(b) Name the law used. [1]

4 Go further

- work through the **12.4 Electromagnetic Induction and Faraday's Law** lesson on the **Learn** page;

- read the **Magnetism and Electromagnetic Induction** section of the AP Physics 2 handout on the **Know** page.

Solutions

2.1 $\Phi = BA\cos 0^\circ = 0.50 \times 0.20 = 0.10$ Wb.

2.2 a changing magnetic flux through the coil.

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

3.1 **A**.

3.2 **C**.

3.3 (a) $|\varepsilon| = \left|\dfrac{\Delta\Phi}{\Delta t}\right| = \dfrac{0.40 - 0.10}{0.20} = 1.5$ V. (b) Faraday's law.