Exercise walk-through

Electromagnetic Induction and Faraday's Law ▪ 12.4

eXercise

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

Method — 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 ($\theta = 0$).

Method — Faraday's law

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

Method — Lenz's law

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

Practice 2.1 ▪ 2 marks

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

Solution 2.1

Method: Magnetic flux

Worked steps

$\Phi = BA\cos 0^\circ = 0.50 \times 0.20 = 0.10$ Wb M1 A1.

Practice 2.2 ▪ 1 mark

State what is needed to induce an emf in a coil.

Solution 2.2

Worked steps

a changing magnetic flux through the coil B1.

Practice 2.3 ▪ 1 mark

State Lenz's law.

Solution 2.3

Worked steps

the induced current opposes the change in flux that produces it B1.

Exam-style 3.1 ▪ 1 mark

Magnetic flux is

A $BA\cos\theta$

B $BI\ell$

C qvB

D $\dfrac{\mu_0 I}{2\pi r}$

Solution 3.1

Method: Magnetic flux

A $BA\cos\theta$ ✓

B $BI\ell$

C qvB

D $\dfrac{\mu_0 I}{2\pi r}$

Worked steps

A.

Exam-style 3.2 ▪ 1 mark

The rule that an induced current opposes the change that causes it is

A Ohm's law

B Faraday's law

C Lenz's law

D Kirchhoff's law

Solution 3.2

Method: Lenz's law

A Ohm's law

B Faraday's law

C Lenz's law ✓

D Kirchhoff's law

Worked steps

C.

Exam-style 3.3 ▪ 3 marks

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.
(b) Name the law used.

Solution 3.3

Method: Lenz's law

Worked steps

(a) $|\varepsilon| = \left|\dfrac{\Delta\Phi}{\Delta t}\right| = \dfrac{0.40 - 0.10}{0.20} = 1.5$ V **M1** **M1** **A1**. (b) Faraday's law **B1**.