Exercise walk-through

Electromagnetic Induction ▪ 13.2

eXercise

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, $\varepsilon = BLv$

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.

Method — Lenz's law

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

Method — Motional emf

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

Practice 2.1 ▪ 1 mark

State Faraday's law.

Solution 2.1

Worked steps

the induced emf equals the negative rate of change of magnetic flux B1.

Practice 2.2 ▪ 2 marks

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.

Solution 2.2

Method: Motional emf

Worked steps

$\varepsilon = BLv = 0.50 \times 0.20 \times 3.0 = 0.30$ V **M1** **A1**.

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

Faraday's law says the induced emf equals

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

B BIL

C $\mu_0 nI$

D qvB

Solution 3.1

A $-\dfrac{d\Phi_B}{dt}$ ✓

B BIL

C $\mu_0 nI$

D qvB

Worked steps

A.

Exam-style 3.2 ▪ 1 mark

Lenz's law is a consequence of conservation of

A charge

B energy

C momentum

D flux

Solution 3.2

Method: Lenz's law

A charge

B energy ✓

C momentum

D flux

Worked steps

B.

Exam-style 3.3 ▪ 3 marks

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

Solution 3.3

Worked steps

(a) $|\varepsilon| = N\left|\dfrac{\Delta\Phi_B}{\Delta t}\right| = 200 \times \dfrac{0.020 - 0.005}{0.10} = 30\ \text{V}$ M1 M1 A1. (b) Lenz's law (it opposes the change) B1.