Exercise walk-through

Magnetic Flux ▪ 13.1

eXercise

You must be able to

- define **magnetic flux 磁通量** through a surface as $\Phi_B = \int \vec{B} \cdot d\vec{A}$
- relate flux to the perpendicular component of $\vec{B}$ and the area
- calculate the flux through a flat loop at different orientations
- see how changing the field, area, or angle changes the flux

Method — Magnetic flux

$\Phi_B = \int \vec{B} \cdot d\vec{A}$. For a uniform field through a flat loop this is $\Phi_B = BA\cos\theta$, where θ is the angle between $\vec{B}$ and the loop's normal.

Method — When flux is largest

Flux is greatest when the loop **faces** the field ($\theta = 0$) and zero when the field lies **in** the plane of the loop.

Method — Central to induction

A **changing** flux is what induces an emf — so flux links magnetic fields to circuits.

Practice 2.1 ▪ 2 marks

Find the flux through a 0.10 m^2 loop placed face-on in a 0.30 T field.

Solution 2.1

Method: Magnetic flux

Worked steps

$\Phi_B = BA = 0.30 \times 0.10 = 0.030$ Wb **M1** **A1**.

Practice 2.2 ▪ 2 marks

State three ways to change the flux through a loop.

Solution 2.2

Method: Magnetic flux

Worked steps

change the field strength B, the area A, or the angle θ B1 B1 *for any two; for all three.*

Practice 2.3 ▪ 1 mark

State what a changing magnetic flux produces.

Solution 2.3

Method: Central to induction

Worked steps

an induced emf B1.

Exam-style 3.1 ▪ 1 mark

Magnetic flux is

A $\int \vec{B} \cdot d\vec{A}$

B $\int \vec{E} \cdot d\vec{A}$

C BIL

D qvB

Solution 3.1

A $\int \vec{B} \cdot d\vec{A}$ ✓

B $\int \vec{E} \cdot d\vec{A}$

C BIL

D qvB

Worked steps

A.

Exam-style 3.2 ▪ 1 mark

The flux through a loop is greatest when its plane is

A parallel to the field

B perpendicular to the field

C at $45°$ to the field

D irrelevant to the field

Solution 3.2

Method: When flux is largest

A parallel to the field

B perpendicular to the field ✓

C at 45° to the field

D irrelevant to the field

Worked steps

B — the plane perpendicular to the field means the loop faces it.

Exam-style 3.3 ▪ 2 marks

A 0.050 m^2 coil sits in a 0.40 T field.
(a) Find the flux when the coil faces the field.
(b) Find the flux when the field lies in the plane of the coil.

Solution 3.3

Method: When flux is largest

Worked steps

(a) $\Phi_B = BA = 0.40 \times 0.050 = 0.020$ Wb **M1** **A1**. (b) zero ($\theta = 90^\circ$) **B1**.