13.1 Magnetic Flux

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

KEY WORDS magnetic flux • emf

Objective

Build the skills to answer exam questions on **magnetic flux**.

You must be able to:

- define **magnetic flux** 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

1 Key knowledge and worked examples

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

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.

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.

Central to induction

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

2 Practice

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

2.2 State three ways to change the flux through a loop. [2]

2.3 State what a changing magnetic flux produces. [1]

3 Exam-style questions

3.1 Magnetic flux is [1]

- **A** $\int \vec{B} \cdot d\vec{A}$
- **B** $\int \vec{E} \cdot d\vec{A}$
- **C** BIL
- **D** qvB

3.2 The flux through a loop is greatest when its plane is [1]

- **A** parallel to the field
- **B** perpendicular to the field
- **C** at 45° to the field
- **D** irrelevant to the field

3.3 A 0.050 m^2 coil sits in a 0.40 T field.

(a) Find the flux when the coil faces the field. [2]

(b) Find the flux when the field lies in the plane of the coil. [1]

Solutions

Each answer shows the steps, then the **result**.

2.1

- $\Phi_B = BA = 0.30 \times 0.10 = 0.030$ Wb

2.2

- change the field strength B, the area A, or the angle θ

2.3

- an induced emf

3.1 A

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

3.2 B

- the plane perpendicular to the field means the loop faces it

3.3

(a)

- $\Phi_B = BA = 0.40 \times 0.050 = 0.020$ Wb

(b)

- zero ($\theta = 90°$)