

# 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  $\theta$  is the angle between  $\vec{B}$  and the loop's normal.

### ■ When flux is largest

Flux is greatest when the loop **f**aces the field ( $\theta = 0$ ) and zero when the field lies **i**n 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<sup>2</sup> 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<sup>2</sup> 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

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

### 2.1

- $\Phi_B = BA = 0.30 \times 0.10 = 0.030 \text{ Wb}$

### 2.2

- change the field strength  $B$ , the area  $A$ , or the angle  $\theta$

### 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)

- $\Phi_B = BA = 0.40 \times 0.050 = 0.020 \text{ Wb}$

(b)

- zero ( $\theta = 90^\circ$ )