MAGNETISM DAY 8: MAGNETIC FLUX

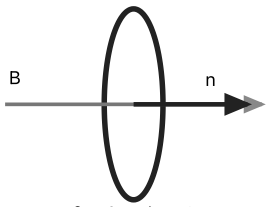
CED 12.4 · Skill 1.B · FRQ: TBR

PREDICT BEFORE ROTATING

A loop remains in the same uniform magnetic field. Compare two orientations: its area normal is parallel to $\vec{B}$, then perpendicular to $\vec{B}$. Predict the flux magnitude in each: **maximum / zero / unchanged**.

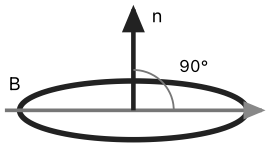
THE ANGLE IS MEASURED FROM B TO THE AREA NORMAL

NORMAL PARALLEL TO B



θ = 0°; |Φ| = ?

NORMAL PERPENDICULAR TO B



θ = 90°; Φ = ?

FLUX MEASURES FIELD THROUGH AN AREA

$$\Phi = BA\cos\theta \qquad 1\,\text{Wb} = 1\,\text{T}\,\text{m}^2$$

θ is the angle between $\vec{B}$ and the chosen area normal, not the angle between $\vec{B}$ and the plane of the loop.

NOTES / REASONING

AREA AND ANGLE

Convert area before substituting:

$$1\,\text{cm}^2 = 10^{-4}\,\text{m}^2$$

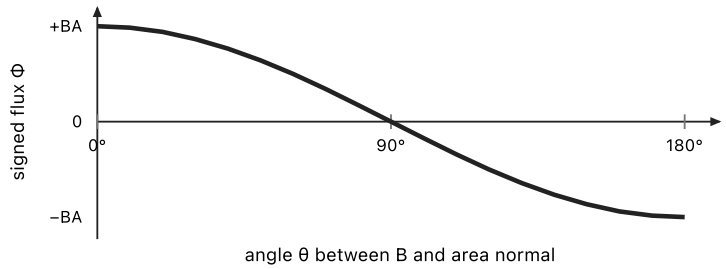
WE DO A loop of area $80\,\text{cm}^2$ is in a $0.30\,\text{T}$ field. The angle between the field and area normal is 60°. Find the magnetic flux.

0°: $\cos 0^\circ = 1$; maximum positive flux for the chosen normal.

90°: $\cos 90^\circ = 0$; zero flux.

SIGNED FLUX

ONE FIXED AREA NORMAL; ROTATE THROUGH 180°



The sign records whether $\vec{B}$ points generally with or against the chosen area normal. Reversing the normal reverses the sign convention but not the physical loop.

COMPARE A fixed loop rotates from $\theta = 30^\circ$ to 120° with B and A unchanged. Write $\Delta\Phi = \Phi_f - \Phi_i$ in terms of BA.

PRACTICE

1. Find Φ for $B = 0.35\,\text{T}$, $A = 70\,\text{cm}^2$, and $\theta = 0^\circ$.

2. Find Φ for $B = 0.50\,\text{T}$, $A = 30\,\text{cm}^2$, and $\theta = 90^\circ$.

3. A loop has $\Phi = 1.05\,\text{mWb}$ in $B = 0.28\,\text{T}$ at $\theta = 60^\circ$. Find its area in cm^2.

4. State the signed flux at $\theta = 180^\circ$ in terms of BA, using the same area normal as at 0°.

5. Explain how flux can change while the field magnitude and loop area remain fixed.