Exercise walk-through

Electric Flux ▪ 8.5

eXercise

You must be able to

- define **electric flux 电通量** through a surface as $\Phi_E = \int \vec{E} \cdot d\vec{A}$
- relate flux to the component of $\vec{E}$ perpendicular to the surface
- calculate the flux through flat surfaces in a uniform field
- see how a convenient **Gaussian surface 高斯面** simplifies a flux calculation

Method — Electric flux

$\Phi_E = \int \vec{E} \cdot d\vec{A}$. For a **uniform** field through a **flat** surface this is $\Phi_E = EA\cos\theta$, where θ is the angle between $\vec{E}$ and the area vector (the normal).

Method — Only the perpendicular part counts

Flux is greatest when the surface **faces** the field ($\theta = 0$) and zero when the field lies **along** the surface ($\theta = 90^\circ$).

Method — Closed surface

The **net** flux out of a closed surface depends on how much field enters versus leaves — the basis of Gauss's law.

Practice 2.1 ▪ 2 marks

Find the flux through a 0.20 m^2 flat surface placed face-on to a uniform 500 N C^{-1} field.

Solution 2.1

Method: Electric flux

Worked steps

$\Phi_E = EA = 500 \times 0.20 = 100$ N m^2 C^{-1} **M1** **A1**.

Practice 2.2 ▪ 1 mark

State when the flux through a flat surface is zero, relative to the field.

Solution 2.2

Method: Electric flux

Worked steps

when the field is parallel to the surface (perpendicular to its normal) B1.

Practice 2.3 ▪ 1 mark

State what the net flux through a closed surface depends on.

Solution 2.3

Method: Closed surface

Worked steps

the net charge enclosed by the surface B1.

Exam-style 3.1 ▪ 1 mark

The electric flux through a flat surface in a uniform field is

A EA

B $EA\cos\theta$

C E/A

D EA^2

Solution 3.1

Method: Electric flux

A EA

B $EA\cos\theta$ ✓

C E/A

D EA^2

Worked steps

B.

Exam-style 3.2 ▪ 1 mark

The flux through a surface is zero when the field is

A perpendicular to the surface

B parallel to the surface (grazing it)

C very strong

D uniform

Solution 3.2

A perpendicular to the surface

B parallel to the surface (grazing it) ✓

C very strong

D uniform

Worked steps

B.

Exam-style 3.3 ▪ 2 marks

A uniform field of 300 N C^{-1} passes through a 0.40 m^2 square.
(a) Find the flux when the square faces the field.
(b) Find the flux when the square is tilted so its normal is 60° from the field.

Solution 3.3

Method: Electric flux

Worked steps

(a) $\Phi_E = EA = 300 \times 0.40 = 120$ N m^2 C^{-1} M1 A1. (b) $\Phi_E = EA\cos 60^\circ = 120 \times 0.5 = 60$ N m^2 C^{-1} M1 A1.