AP PHYSICS C: ELECTRICITY AND MAGNETISM • EXERCISE SHEET

8.5 Electric Flux

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

KEY WORDS electric flux 电通量 • gaussian surface 高斯面 • gauss's law 高斯定律 • area vector 面积矢量 • uniform 均匀

Objective

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

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

1 Worked examples

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

■ 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).

■ 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 ($\theta = 90°$).

■ Closed surface

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

2 Practice

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

2.2 State when the flux through a flat surface is zero, relative to the field. [1]

2.3 State what the net flux through a closed surface depends on. [1]

3 Exam-style questions

3.1 The electric flux through a flat surface in a uniform field is [1]

- **A** EA
- **B** $EA\cos\theta$
- **C** E/A
- **D** EA^2

3.2 The flux through a surface is zero when the field is [1]

- **A** perpendicular to the surface
- **B** parallel to the surface (grazing it)
- **C** very strong
- **D** uniform

3.3 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. [2]

(b) Find the flux when the square is tilted so its normal is 60° from the field. [2]

Solutions

2.1 $\Phi_E = EA = 500 \times 0.20 = 100$ N $m^2\,C^{-1}$.

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

2.3 the net charge enclosed by the surface.

3.1 B.

3.2 B.

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