AP PHYSICS C: ELECTRICITY AND MAGNETISM • EXERCISE SHEET

10.1 Electrostatics with Conductors

Name: _____ Class: _____ Date: _____ **Total: 9 marks**

KEY WORDS outer surface 外表面 • conductor 导体 • perpendicular 垂直 • electrostatic equilibrium 静电平衡 • equipotential 等势体

Objective

Build the skills to answer exam questions on **electrostatics with conductors**.

You must be able to:

- explain why the **electric field is zero** inside a conductor in electrostatic equilibrium
- show that excess charge resides on the **outer surface** 外表面
- describe how the field just outside is **perpendicular** to the surface
- explain why a conductor is an **equipotential** 等势体

1 Worked examples

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

■ **A conductor in equilibrium**

- The field **inside** is zero (free charges would move until it is).
- Any **excess charge** sits on the outer surface.
- Just **outside**, the field is **perpendicular** to the surface.
- The whole conductor is a single **equipotential**.

■ **Surface field**

$E = \dfrac{\sigma}{\varepsilon_0}$ just outside. Charge crowds onto sharply curved regions (points), giving the strongest field there — the idea behind a lightning rod.

2 Practice

2.1 State the electric field inside a conductor in electrostatic equilibrium. [1]

2.2 State where excess charge sits on a solid conductor. [1]

2.3 State the direction of the field just outside a charged conductor's surface. [1]

3 Exam-style questions

3.1 Inside a conductor in electrostatic equilibrium, the field is [1]

- **A** σ/ε_0
- **B** zero
- **C** at its maximum
- **D** kq/r^2

3.2 A conductor in electrostatic equilibrium is [1]

- **A** an equipotential
- **B** at a varying potential
- **C** an insulator
- **D** charged throughout its volume

3.3 A hollow metal sphere carries a charge $+Q$.

(a) State the field inside the metal. [1]

(b) State where the charge sits. [1]

(c) Explain why the field just outside the surface is perpendicular to it. [2]

Solutions

2.1 zero.

2.2 on its outer surface.

2.3 perpendicular to the surface.

3.1 B.

3.2 A.

3.3 (a) zero. (b) on the outer surface. (c) any component along the surface would push the surface charges until it vanished, so at equilibrium only the perpendicular component remains.