

8.1 Electric Charge and Electric Force

Name: _____ Class: _____ Date: _____

Total: 11 marks

KEY WORDS conserved 守恒 • superposition 叠加 • coulomb's law 库仑定律
• electric charge 电荷 • gravitational force 引力

Objective

Build the skills to answer exam questions on **electric charge** and **electric force**.

You must be able to:

- describe **electric charge** 电荷 as **quantized** in multiples of e and **conserved** 守恒
- apply **Coulomb's law** 库仑定律 $F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2}$
- use the **superposition principle** 叠加原理 to find the net force from several charges
- compare the electrostatic force with the **gravitational force** 引力

1 Worked examples

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

■ Coulomb's law

$$F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} = k \frac{q_1 q_2}{r^2}, \text{ with } k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}.$$

■ Superposition

The net force on a charge is the **vector sum** of the Coulomb forces from every other charge.

■ Charge is quantized and conserved

Any charge is a whole multiple of $e = 1.6 \times 10^{-19} \text{ C}$, and total charge is conserved. The electric force vastly exceeds gravity between two charged particles.

2 Practice

2.1 Two $+2.0 \mu\text{C}$ charges are 0.30 m apart. Find the force between them. [2]

2.2 State which is stronger for two charged particles: the electrostatic force or the gravitational force. [1]

2.3 An object carries a charge of $8.0 \times 10^{-19} \text{ C}$. Find the number of elementary charges. [2]

3 Exam-style questions

3.1 The Coulomb force between two point charges is proportional to [1]

- | | |
|---|---|
| A | B |
| C | D |
- A** r
B $1/r$
C $1/r^2$
D r^2

3.2 To find the net force on a charge from several others, you use [1]

- | | |
|---|---|
| A | B |
| C | D |
- A** only the nearest charge
B vector superposition of all the forces
C the average of the forces
D the largest force only

3.3 Charges of $+3.0 \mu\text{C}$ sit at $x = 0$ and $x = 0.20 \text{ m}$. A $+1.0 \mu\text{C}$ charge is placed at the midpoint $x = 0.10 \text{ m}$.

(a) Find the force on the middle charge from **one** of the outer charges. [2]

(b) State the net force on the middle charge, and explain why. [2]