

10.1 Electric Charge and Electric Force

Name: _____ Class: _____ Date: _____

Total: 10 marks

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 a conserved property in positive and negative types
- state that like charges repel and unlike charges attract
- apply **Coulomb's law** 库仑定律 $F = k \frac{q_1 q_2}{r^2}$
- explain **charge quantization** 电荷量子化—charge in whole multiples of e

1 Worked examples

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

■ Charge and force

Charge comes in two types; **like repel, unlike attract**, and total charge is conserved.

■ Coulomb's law

$F = k \frac{q_1 q_2}{r^2}$ with $k = 8.99 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$ —an inverse-square law like gravity.

■ Quantization

Charge is always a whole multiple of $e = 1.6 \times 10^{-19} \text{ C}$.

■ Example

Two $+2.0 \mu\text{C}$ charges 0.10 m apart: $F = 8.99 \times 10^9 \times \frac{(2.0 \times 10^{-6})^2}{(0.10)^2} = 3.6 \text{ N}$ (repulsive).

2 Practice

2.1 State whether two negative charges attract or repel.

[1]

2.2 Two point charges are moved twice as far apart. State the factor by which the force

between them changes. [1]

2.3 Find the force between a $+3.0\ \mu\text{C}$ and a $-3.0\ \mu\text{C}$ charge $0.20\ \text{m}$ apart ($k = 8.99 \times 10^9$). [2]

3 Exam-style questions

3.1 The Coulomb force between two point charges varies with their separation as [1]

- A $1/r$
 - B $1/r^2$
 - C r
 - D r^2
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3.2 An object carries a charge of $-4.8 \times 10^{-19}\ \text{C}$. The number of excess electrons is [1]

- A 1
 - B 2
 - C 3
 - D 4
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3.3 Two point charges, $+5.0\ \mu\text{C}$ and $+2.0\ \mu\text{C}$, are $0.30\ \text{m}$ apart.

(a) Find the force between them. [3]

(b) State whether the force is attractive or repulsive. [1]

4 Go further

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- work through the **10.1 Electric Charge and Electric Force** lesson on the **Learn** page;
 - read the **Electric Force, Field, and Potential** section of the AP Physics 2 handout on the **Know** page.

Solutions

2.1 repel.

2.2 it becomes one quarter as large ($1/2^2$).

2.3 $F = 8.99 \times 10^9 \times \frac{(3.0 \times 10^{-6})^2}{(0.20)^2} = 2.0 \text{ N}$, attractive.

3.1 B.

3.2 C $-4.8 \times 10^{-19} / 1.6 \times 10^{-19} = 3$.

3.3 (a) $F = 8.99 \times 10^9 \times \frac{(5.0 \times 10^{-6})(2.0 \times 10^{-6})}{(0.30)^2} = 1.0 \text{ N}$. (b) repulsive (both charges positive).