

Exercise walk-through

8.1

Electric Charge and Electric Force

AP Physics C: Electricity and Magnetism

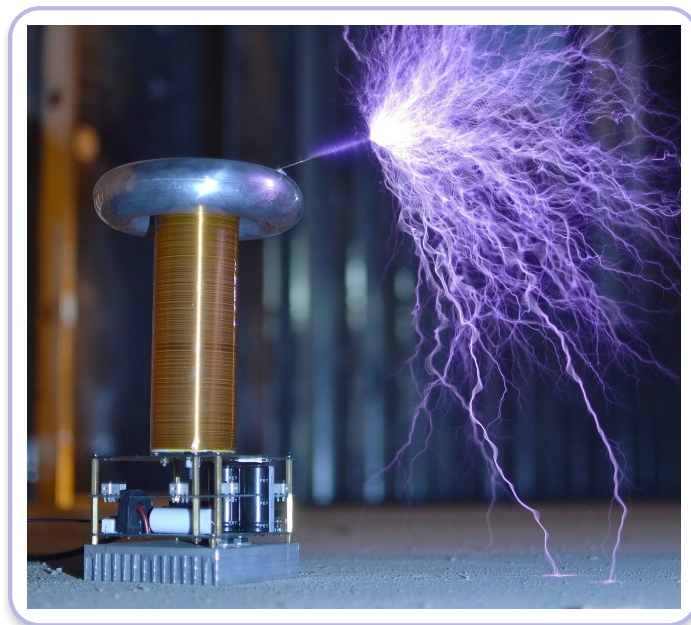
Charge and Coulomb's law

Charge is **quantized** ($q = ne$)
and **conserved** :

A vector, inverse-square force

$$\vec{F} = k \frac{q_1 q_2}{r^2} \hat{r}, \quad k = \frac{1}{4\pi\epsilon_0}$$

Forces from many charges add by **superposition** – the vector sum.



Tesla coil discharge

Charge is quantized, and it is conserved

quantized

every charge is a whole-number multiple of the **elementary charge**
 $e = 1.6 \times 10^{-19} \text{ C}$

conservation of charge

charge is never created or destroyed, only moved – the total of an isolated system is fixed

point charge

a model that ignores the size of the object; Coulomb's law is exact only for these

ϵ_0

the **permittivity of free space**

$$9.0 \times 10^9 \text{ N m}^2/\text{C}^2$$

$$; k = \frac{1}{4\pi\epsilon_0} =$$

Charge is a **fundamental property** of matter, like mass. Like charges repel, opposites attract – and no experiment has ever produced a fraction of e in isolation.

Exercises 2.1-2.3

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]

Exercises 2.1-2.3

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

2.1

- $$F = k \frac{q_1 q_2}{r^2} = 8.99 \times 10^9 \times \frac{(2.0 \times 10^{-6})^2}{(0.30)^2} = 0.40 \text{ N}$$

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

2.2

- the electrostatic force (by far)

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

2.3

- $$N = \frac{8.0 \times 10^{-19}}{1.6 \times 10^{-19}} = 5$$

Exercises 3.1-3.2

3.1 The Coulomb force between two point charges is proportional to

[1]

☐

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 only the nearest charge

B vector superposition of all the forces

C the average of the forces

D the largest force only

Exercises 3.1-3.2

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3.1 C

- $1/r^2$.

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[1]

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A only the nearest charge

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3.2 B

- vector superposition of all the forces.

Exercise 3.3 (a)

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]

Exercise 3.3 (a)

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]

(a)

- $$F = 8.99 \times 10^9 \times \frac{(3.0 \times 10^{-6})(1.0 \times 10^{-6})}{(0.10)^2} = 2.7 \text{ N}$$

Exercise 3.3 (b)

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 $x = 0.10 \text{ m}$.

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

[2]

Exercise 3.3 (b)

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 $x = 0.10 \text{ m}$.

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

(b)

- zero – the two outer charges push the middle charge with equal forces in opposite directions, which cancel