

# Electric Charge and Electrostatics

PH11-11

---

## ORIENTATION

**Lesson goal:** explain charge interactions, charging methods, conservation of charge, and electrostatic force.

The key category separation is charge, force, field, and potential. Do not use these as interchangeable words.

---

## CORE CONTENT

Electric charge is conserved and quantised. Like charges repel and unlike charges attract. Charged objects may interact by contact, friction, induction, or polarisation.

Key model:

$$F = k \frac{|q_1 q_2|}{r^2}$$

This gives the magnitude of the force between point charges. Direction comes from the signs of the charges: attraction for opposite charges and repulsion for like charges.

---

IDEA	MEANING
conservation	total charge in an isolated system remains constant
quantisation	charge occurs in integer multiples of elementary charge
conductor	charges move freely through the material

---

---

IDEA	MEANING
insulator	charges are not free to move through the material
induction	charge separation or charging without direct contact

---

### CONCEPT CHECK

1. Like charges:

- A. attract
- B. repel
- C. cancel mass
- D. become neutral automatically

**Answer: B.**

2. Doubling separation in Coulomb's law changes force by:

- A. half
- B. double
- C. one quarter
- D. four times

**Answer: C.**

3. Charging by induction involves:

- A. direct rubbing only
- B. charge separation without direct contact
- C. creating charge from nothing
- D. destroying electrons

**Answer: B.**

---

### APPLIED PRACTICE

Two point charges,  $+3.0 \text{ } \mu\text{C}$  and  $-2.0 \text{ } \mu\text{C}$ , are separated by  $0.15 \text{ m}$ . Calculate the force magnitude and state the direction type.

1. Formula:

$$F = k \frac{|q_1 q_2|}{r^2}$$

2. Substitute:

$$F = 8.99 \times 10^9 \frac{(3.0 \times 10^{-6})(2.0 \times 10^{-6})}{(0.15)^2}$$

3. Result:

$$F = 2.40 \text{ N}$$

**Final answer:** 2.40 N, attractive.

---

### DEEP PRACTICE AND WRITING

Prompt: explain why charge conservation matters when a neutral object is charged by friction or induction.

---

### MAINTENANCE LOOP

Recall Coulomb's law, the inverse-square distance relation, and the difference between conductor and insulator.

### STUDENT WORKING

---

---

---

---