Charges and Coulomb's Law

Checklist to avoid mistakes:

- ☐ The question will state which particle is being evaluated. **Use correct distances and angles** for each equation.
- ☐ In the denominator, you need to **square** r!
- ☐ Your calculator's angle setting should be on degrees. On lon-capa problems, you need to enter the unit as deg when it is in degrees.
- ☐ Use absolute values to calculate magnitudes, show the directions of each force based on attraction (same-sign charges) or repulsion (opposite-sign charges).
- ☐ If there are two forces with the same magnitude in opposite directions, cancel them out to avoid complication.
- ☐ Avoid misreading or using the wrong formula. Let's have a look:

	Electrostatic Force	Electric Field	Electric Potential
Point charges	$F = k\frac{\lvert q_1\rvert\lvert q_2\rvert}{r_{12}^2}$	$E = k\frac{\lvert q\rvert}{r^2}$	$V = k\frac{q}{\lvert r\rvert}$
Capacitors	Draw a free body diagram and apply: $\vec{F} = m\vec{a}$ $\vec{F} = q\vec{E}$ Neglect the weight of a proton, electron or point charge if the mass is not given.	$E = \frac{Q}{A\,\epsilon_0} = \frac{\eta}{\epsilon_0}$ Here Q is the charge on the positive plate, A is the area facing the space between plates.	
Vector or Scalar	vector	vector	scalar
Unit	N	N/C or V · m	V
Direction and sign	Same sign charges repel and opposites attract. Neutral objects do not attract each other.	Assume a positive test charge at the given point and the direction of E will be the same as that of F.	No direction Do not forget the charge value is not absolute, negative charges have negative potential.

Tips

Plastic charge and glass charge: The textbook uses this notation so that you don't need to memorize if the charges are positive or negative after two different materials are rubbed together (such as wool, silk, balloon, hair, can).

Plastic and glass charges have opposite signs.

Upon touching, the charges will be exchanged between objects. If they keep in touch, the final charge will be the direct sum of each individual charge.

When a plastic or glass object is brought close to a neutral conductor, the neutral conductor will get polarized. This means it will stay neutral, however, it will have two poles with equal amounts of glass and plastic charge.

Electroscopes: An electroscope is an instrument for detecting the presence of an electric charge. There is 2 ways to use it:

1) Touching with a charged object: the leaves spread apart due to the charge conducted from the object. Since the leaves receive the same sign charge, they repel each other and thus separate from each other.
2) Electrostatic induction: As the charged object is brought near the electroscope terminal, the leaves spread apart due to the induced charge caused by the electric field from the object, and the charged leaves repel each other. The opposite-sign charge is attracted to the nearby object and collects on the terminal disk, while the same-sign charge is repelled from the object and collects on the leaves.

The amount of separation depends on the amount of charge collected on the leaves: the more charge collected on the leaves, the more separation occurs.

For more information or to book an appointment

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