

G12 ADV Physics : *Electricity and Magnetism*



مؤسسة الإمارات للتعليم المدرسي
EMIRATES SCHOOLS ESTABLISHMENT

^{unit} 2 | *Electric field & Gauss's Law*

2. Field lines



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Learning objectives:

Textbook Chapter

Ch 2 - Electric field & Gauss's Law

Field lines

Performance Indicators

- 1- Explain how a positive test charge is used (in principle) to measure the electric field at any given point and thus drawing the electric field lines
- 2- Explain electric field lines, including where they originate and terminate and what their spacing represents
- 3- Identify that the electric field lines never cross each other
- 4- In a sketch, draw a charged particle, indicate its sign, pick a nearby point, and then draw the electric field vector E at that point due to the charged particle, with its tail anchored on the point
- 5- Identify the direction of the electric force vector F resulting from placing a charge(positive or negative) in an electric field of another positive or negative charged particle
- 6- Sketch an electric-field diagram of a single point charge, two-point charges of same or opposite sign, and recognize that for a collection of static-point charges

Electric field lines: imaginary paths represent direction of the force due to the electric field on a small positive test charge.

Electric field line diagrams enable us to visualize the electric field.

The **direction** of electric field is the direction of the force on a **positive test charge**. By convention, it is away from positive source charges (outward) and point toward negative source charges (inward).

For a **positive** charge, electric force, acceleration and motion in the **same** direction of electric field.

For a **negative** charge, electric force, acceleration and motion in **opposite** direction of electric field.

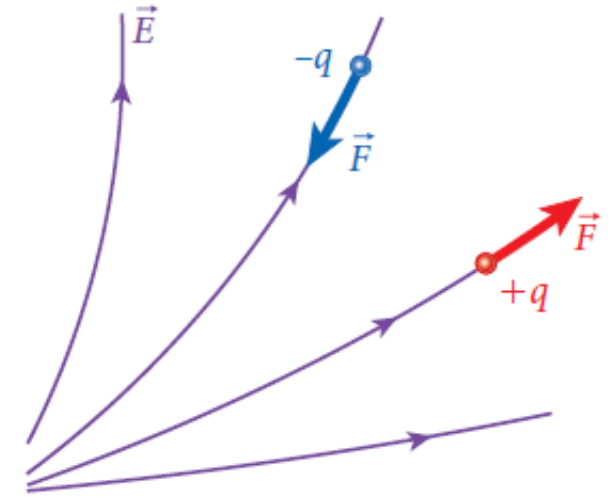
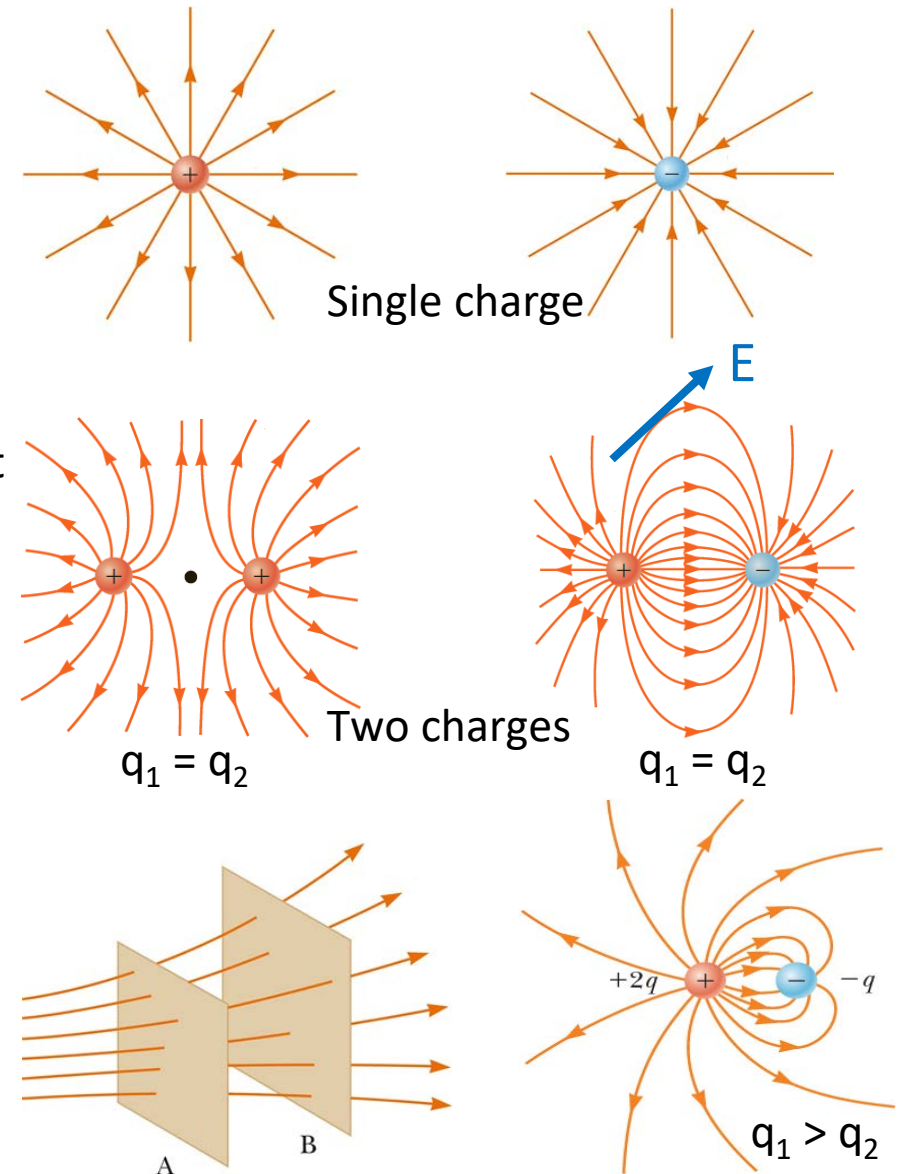


FIGURE 22.4 A nonuniform electric field. A positive charge $+q$ and a negative charge $-q$ placed in the field experience forces as shown. Each force is tangent to the electric field line.

Properties of Electric Field Lines:

- 1- The lines are directed toward negative charges and away from positive charges. The direction of the force exerted on the positive test charge.
- 2- The number of field lines is proportional to the magnitude of that charge. A charge of $2q$ will have twice as many lines as a charge of q .
- 3- At every point in space, The direction of the electric field at that point is tangent to the field line at that same point.
- 4- The field line density at any point in space is proportional to the magnitude of the field at that point in space. the number of field lines per unit area passing through a small cross-sectional area perpendicular to the electric field.
- 5- The electric field lines will **never intersect** (cross) with each other.

The field line represents the direction of the field at a given point, if two field lines crossed, that implies the electric field was pointing in **two different directions** at a single point. This means that the net force on a test charge placed at that point would point in two different directions, which is unrealistic.



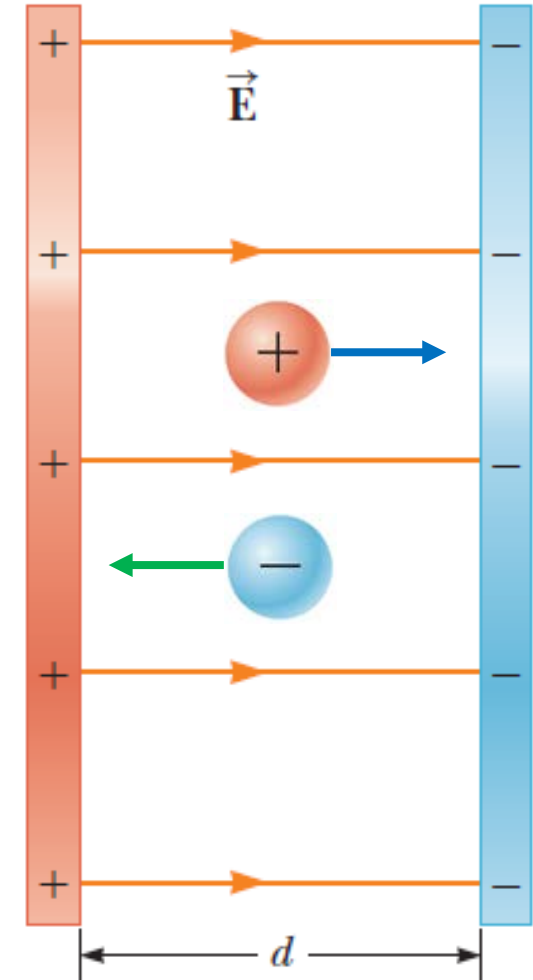
Uniform Electric Field: is a field that has constant magnitude and the constant direction.

Uniform electric fields can be usually created by setting up a potential difference between two charged or conducting **parallel plates** which are kept at a certain distance from each other.

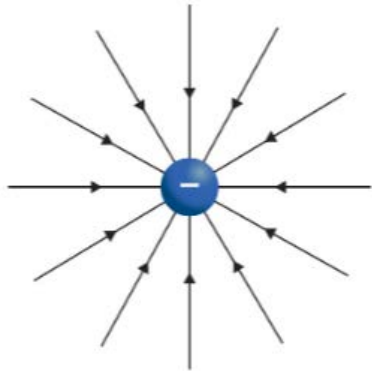
The electric field will be uniform at the **center** of the plates. However, it might vary at the end of the plates or be non-uniform

A negative charge will be attracted to the positive side (it will move **opposite** to the electric field).

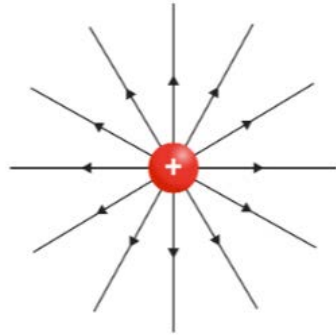
A positive charge will be attracted to the negative side (it will move **with** the electric field).



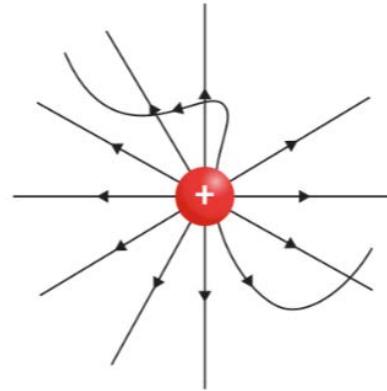
Ex. Which picture is showing an incorrect diagram of the electric field lines?



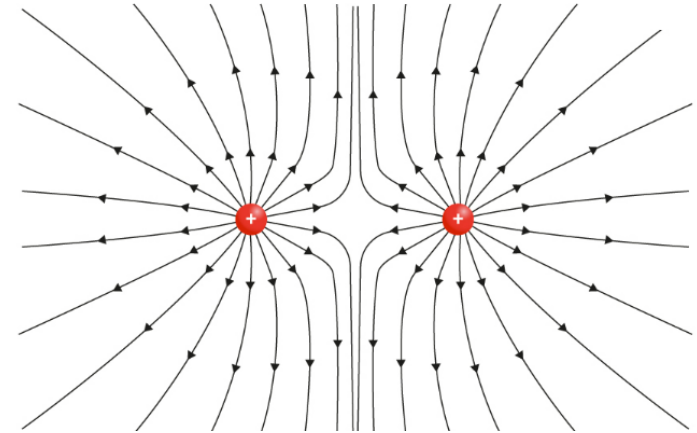
A



B



C



D

Ex: Electric field lines

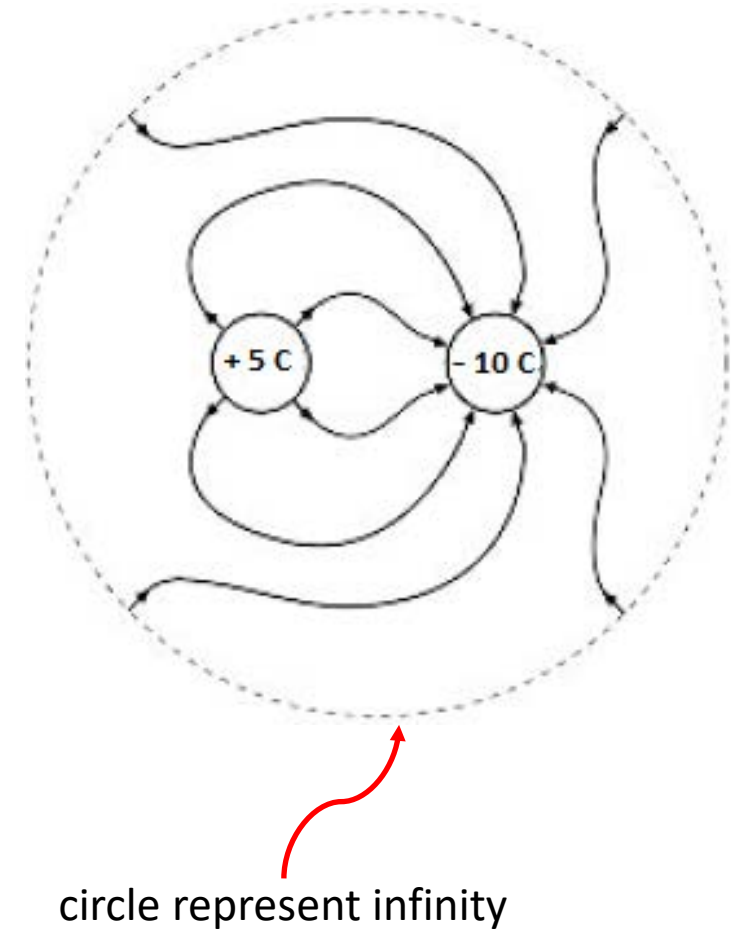
Draw electric field lines for two charges of $+5\text{ C}$ and -10 C .

Electric field due to point charge is **radial**.

The field lines **start** from positive charge and **terminate** at negative charge.

The number of field lines **proportional** with magnitude of charge.

Field lines do **not cross**



Ex: From the electric field vector at a point, one can determine which of the following?

- I. The direction of the electrostatic force on a test charge of known sign at that point
- II. The magnitude of the electrostatic force exerted per unit charge on a test charge at that point
- III. The electrostatic charge at that point

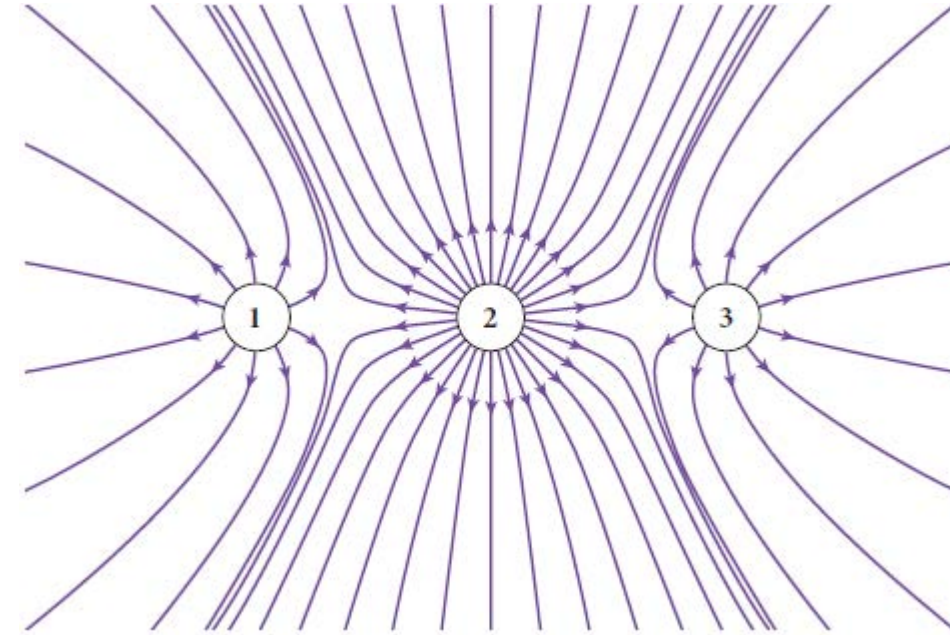
(A) I only (B) III only (C) I and II only (D) II and III only (E) I, II, and III

Ex: A charged particle traveling with a velocity v in an electric field E experiences a force F that must be

- (A) parallel to v (B) perpendicular to v (C) parallel to $v \times E$
(D) parallel to E (E) perpendicular to E

Q2.11 What are the signs of the charges in the configuration shown in the figure?

- a) Charges 1, 2, and 3 are negative.
- b) Charges 1, 2, and 3 are positive.**
- c) Charges 1 and 3 are positive, and 2 is negative.
- d) Charges 1 and 3 are negative, and 2 is positive.
- e) All that can be said is that the charges have the same sign.



Practice question

