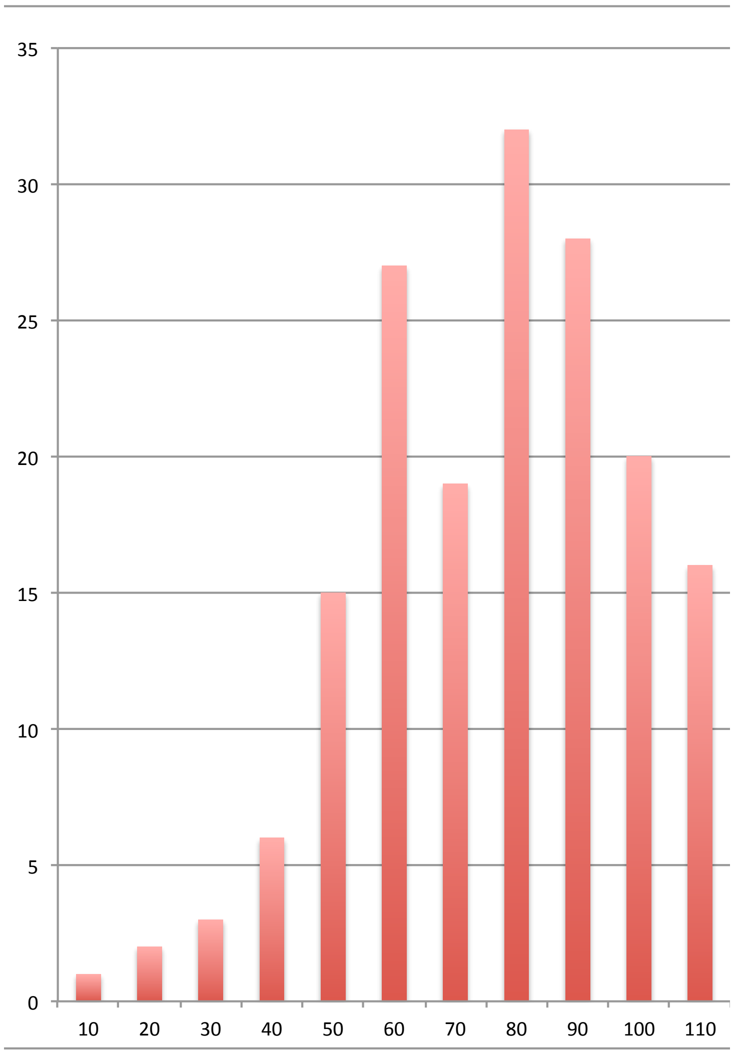
Lecture 10

PHYC 161 Fall 2016

Exam I

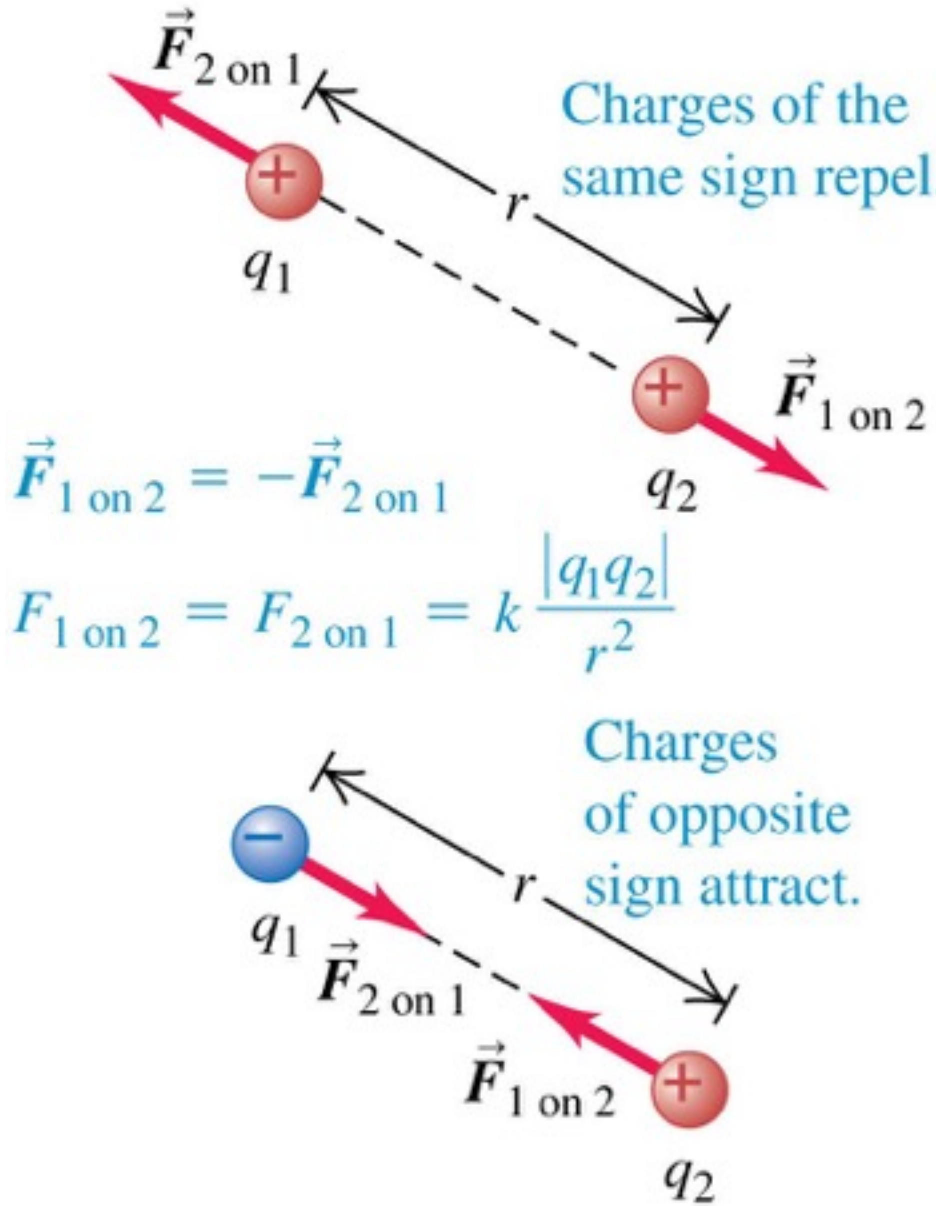


Mean = 76

Coulomb's Law

- **Coulomb's Law**: The magnitude of the electric force between two point charges is directly proportional to the product of their charges and inversely proportional to the square of the distance between them.

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



The electric field of a point charge

- Using a unit vector that points away from the origin, we can write a vector equation that gives both the magnitude and the direction of the electric field:

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}\hat{r}$$

Electric field due to a point charge: $\vec{E}$

Value of point charge: q

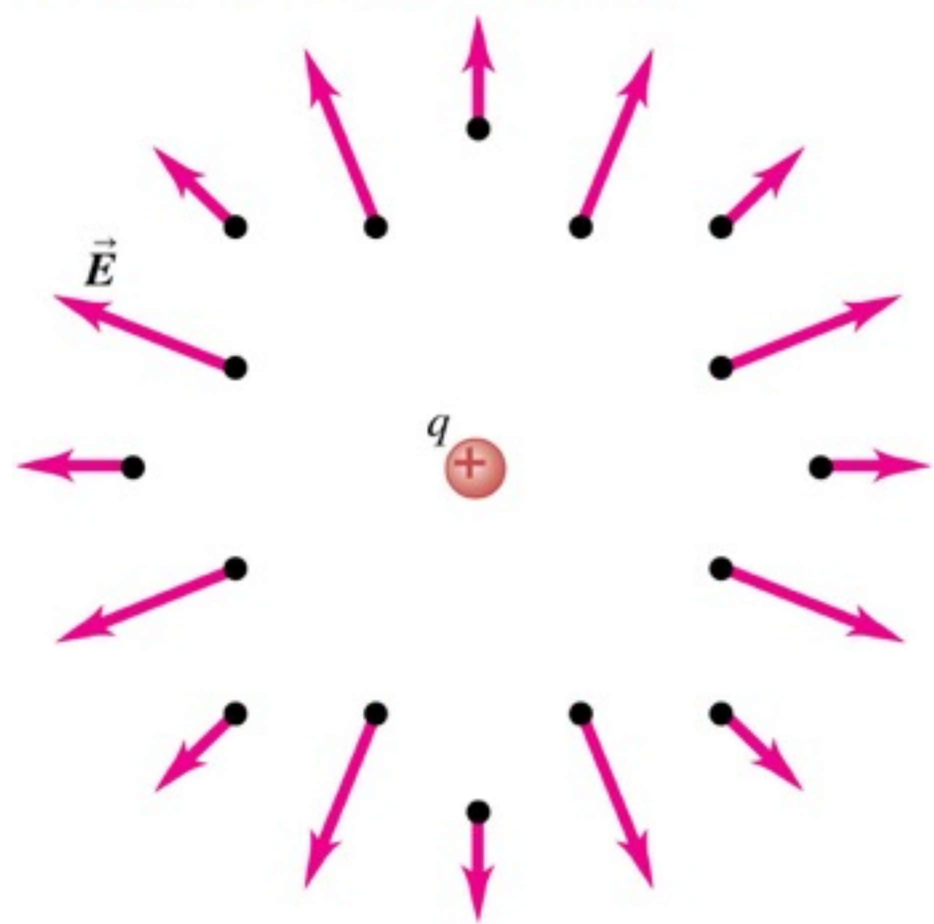
Unit vector from point charge toward where field is measured: $\hat{r}$

Distance from point charge to where field is measured: r

Electric constant: ϵ_0

Electric field of a point charge

- A point charge q produces an electric field at *all* points in space.
- The field strength decreases with increasing distance.
- The field produced by a positive point charge points *away from* the charge.



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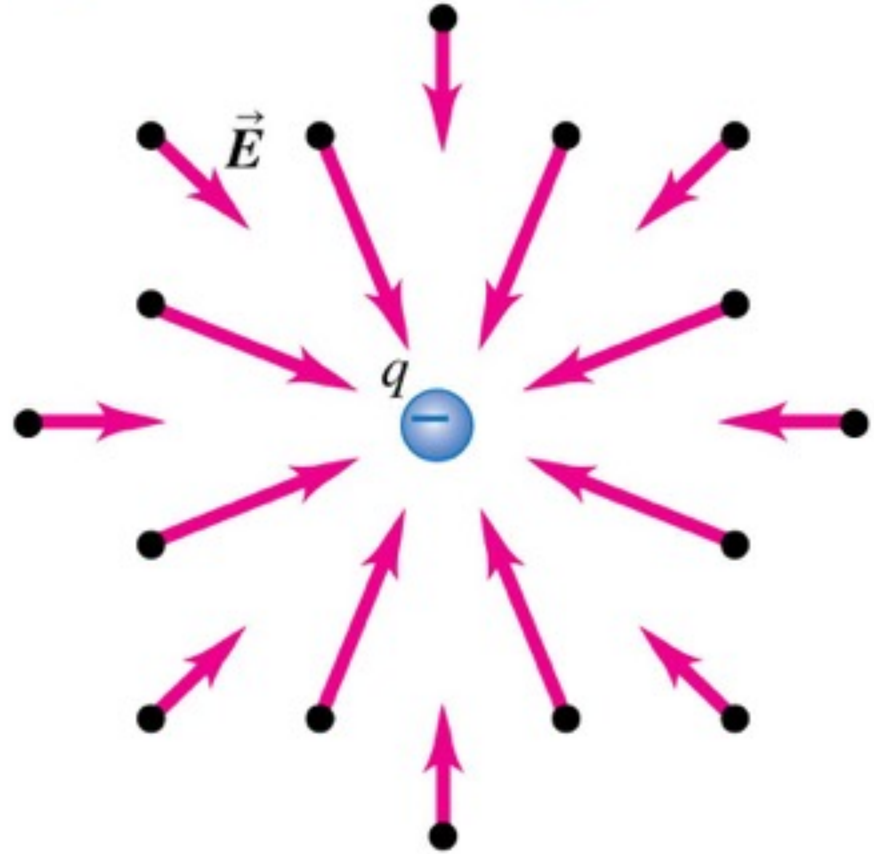
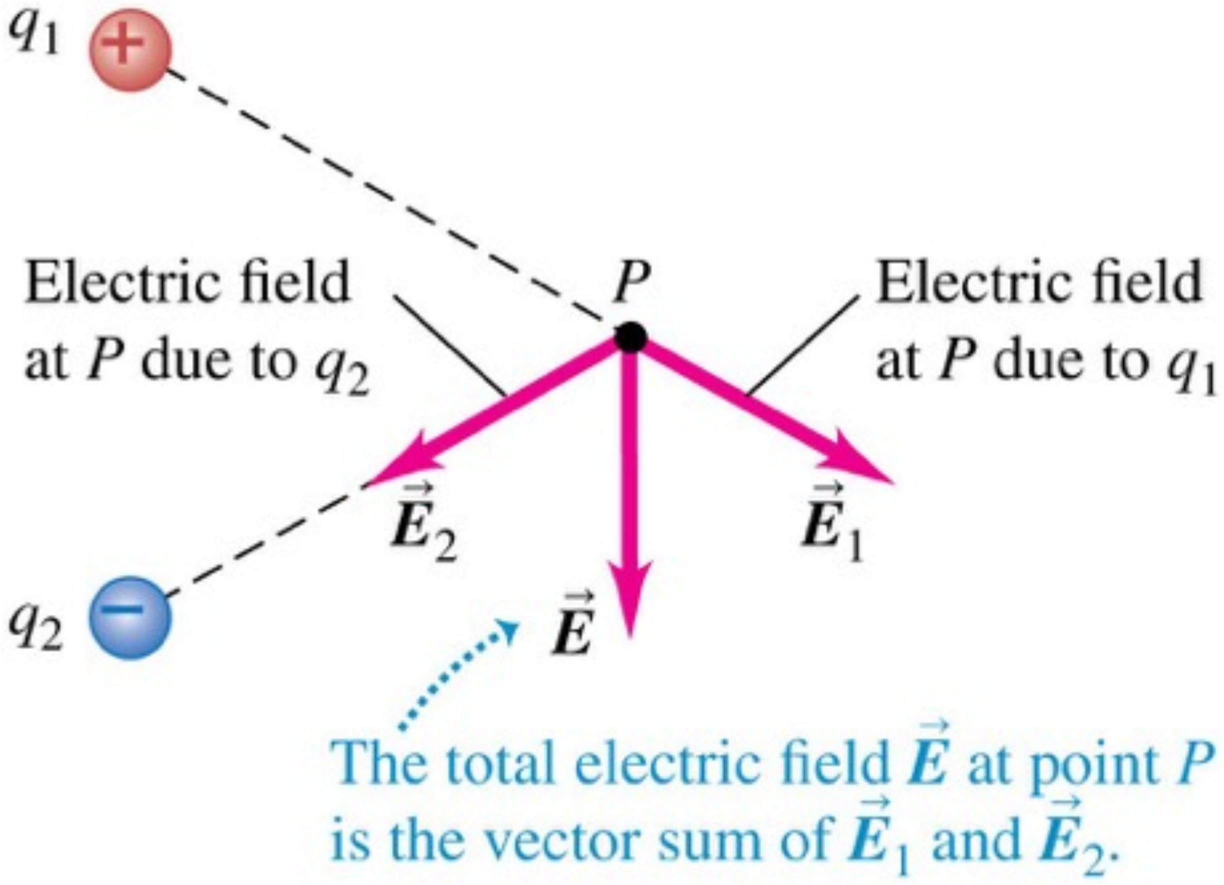


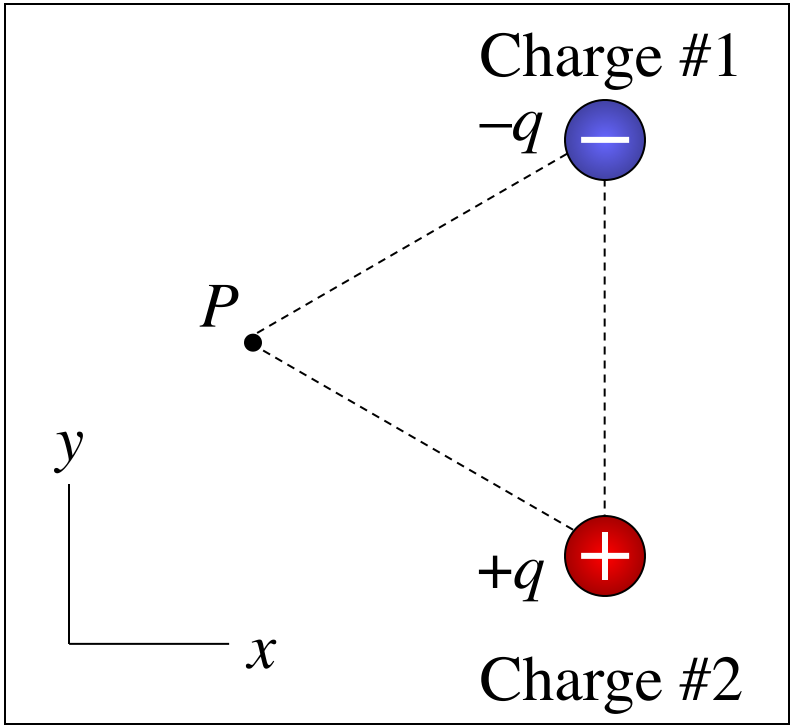
Superposition of electric fields

- The total electric field at a point is the vector sum of the fields due to all the charges present.



Q21.6

Two point charges and a point *P* lie at the vertices of an equilateral triangle as shown. Both point charges have the same magnitude *q* but opposite signs. There is nothing at point *P*. The net electric field that charges #1 and #2 produce at point *P* is in



A. the $+x$-direction.

B. the $-x$-direction.

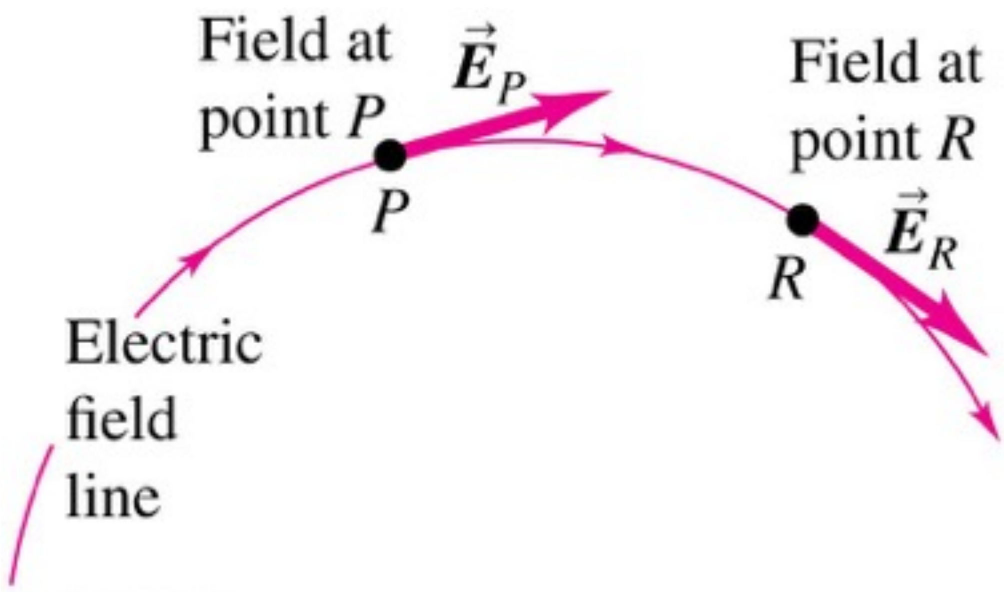
C. the $+y$-direction.

D. the $-y$-direction.

E. none of the above.

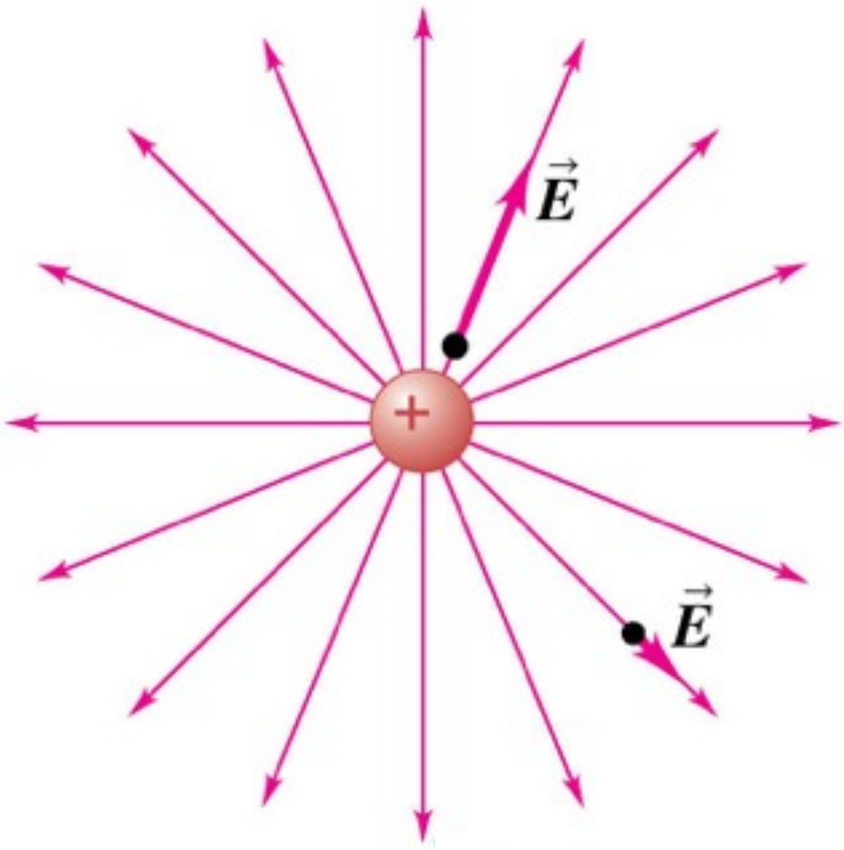
Electric field lines

- An **electric field line** is an imaginary line or curve whose tangent at any point is the direction of the electric field vector at that point.



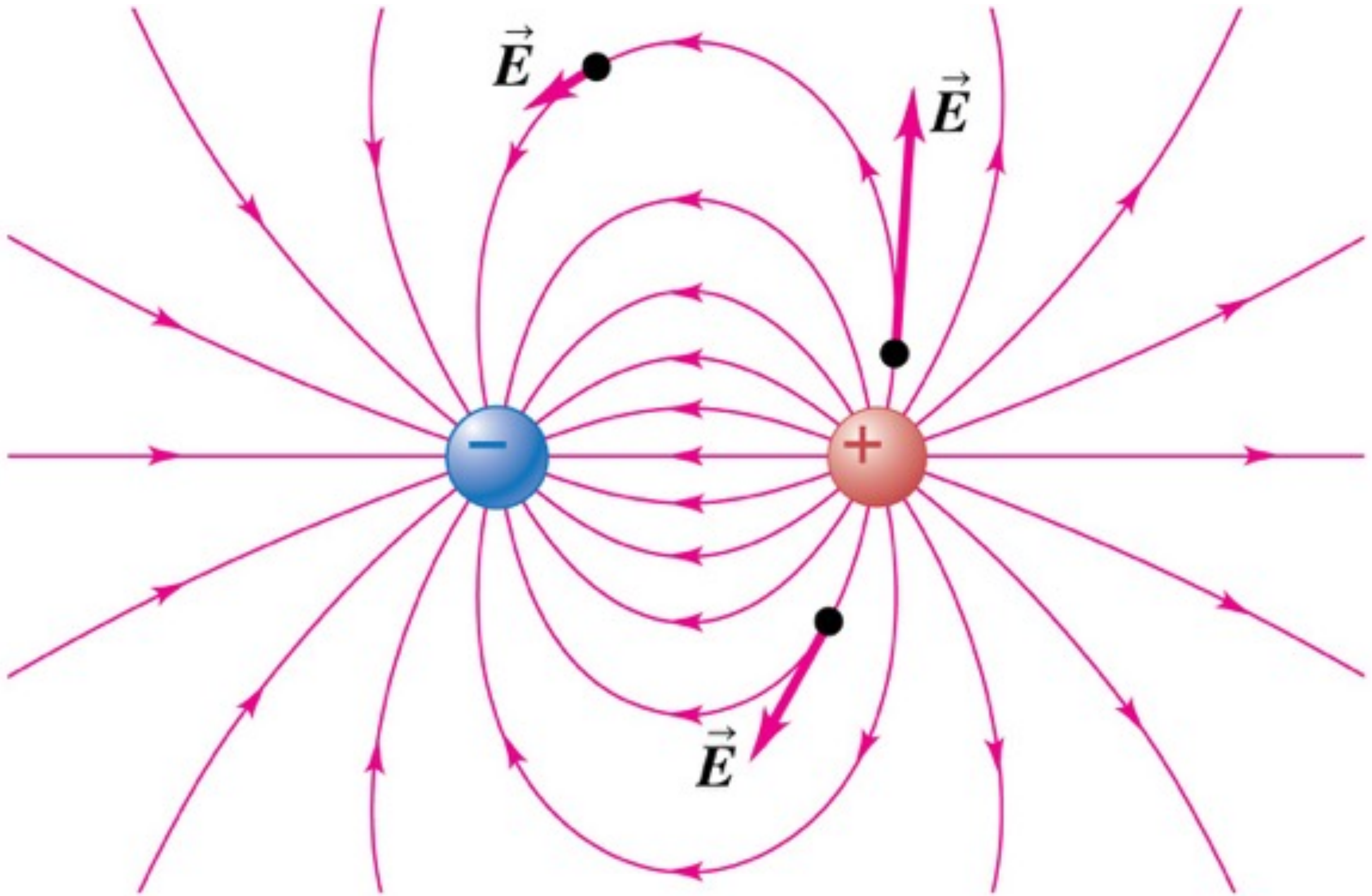
Electric field lines of a point charge

- Electric field lines show the *direction* of the electric field at each point.
- The spacing of field lines gives a general idea of the *magnitude* of the electric field at each point.



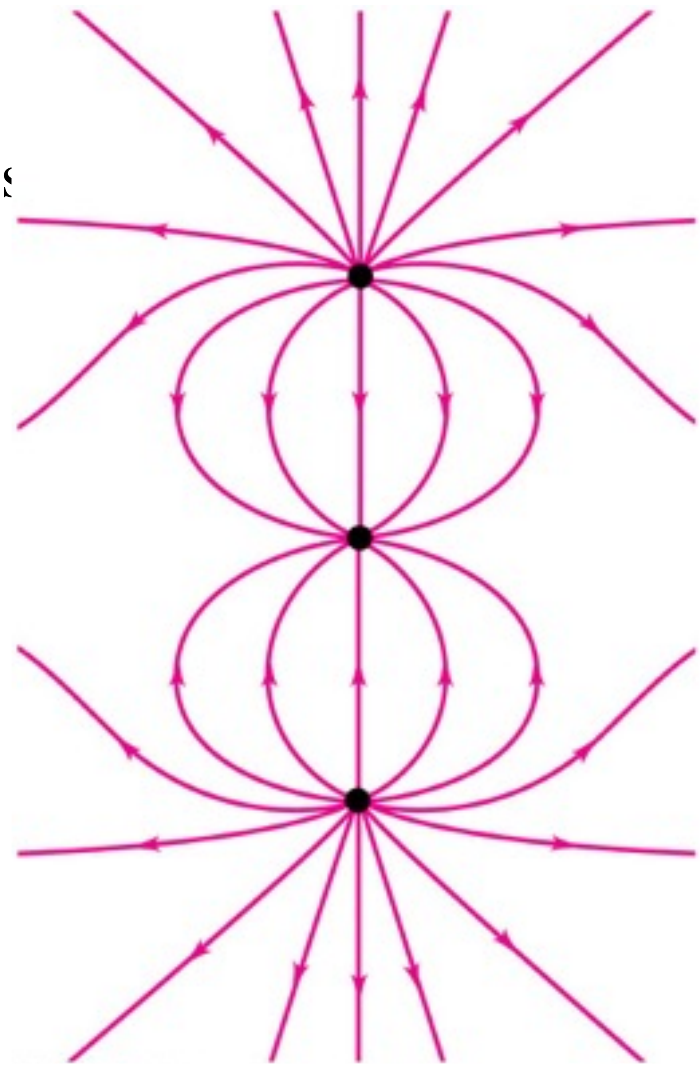
Electric field lines of a dipole

- Field lines point away from + charges and toward – charges.



Q21.9

The illustration shows the electric field lines due to three point charges (shown by the black dots). The electric field is strongest



A. where adjacent field lines are closest together.

B. where adjacent field lines are farthest apart.

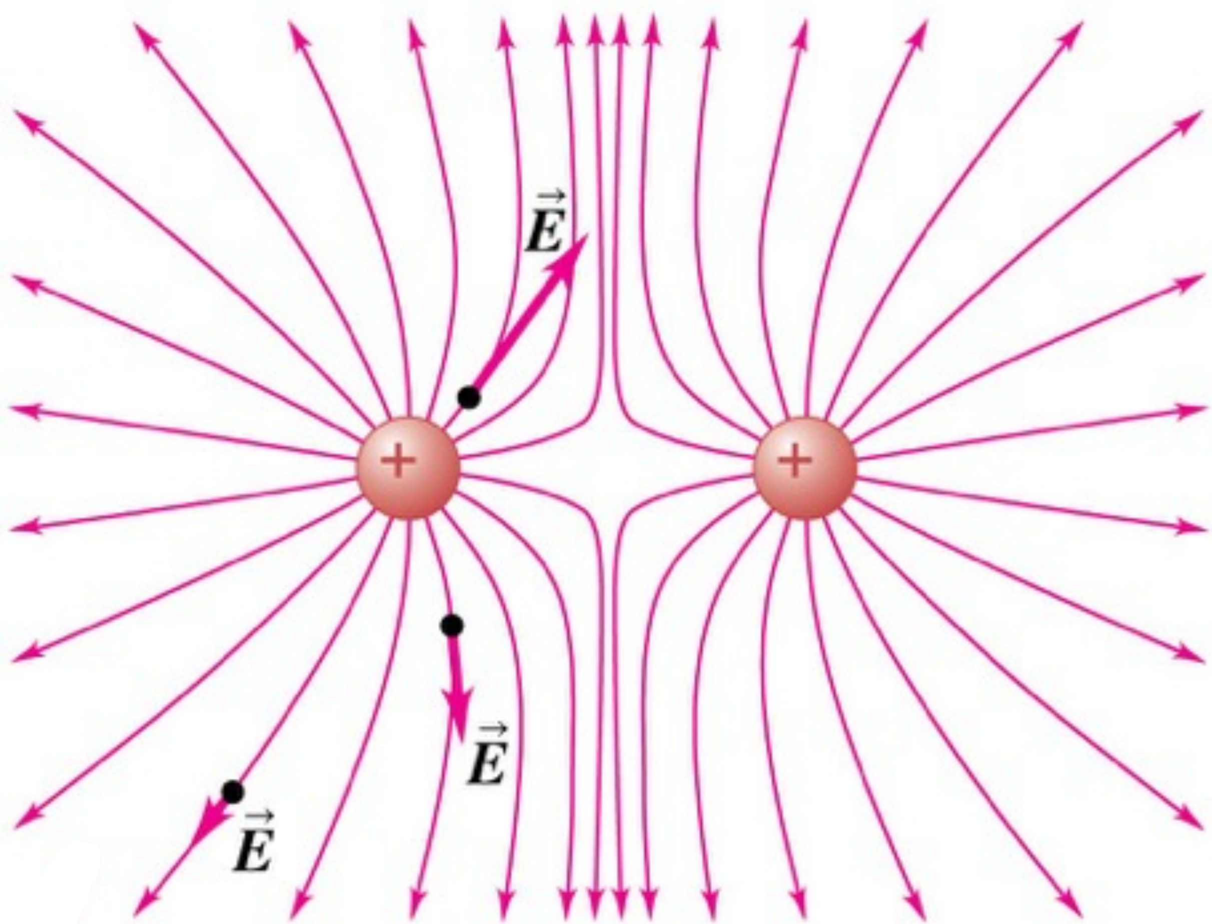
C. where adjacent field lines are parallel.

D. where the field lines are most strongly curved.

E. at none of the above locations.

Electric field lines of two equal positive charges

- At any point, the electric field has a unique direction, so *field lines never intersect*.



Q21.10

Positive charge is uniformly distributed around a semicircle. The electric field that this charge produces at the center of curvature *P* is in

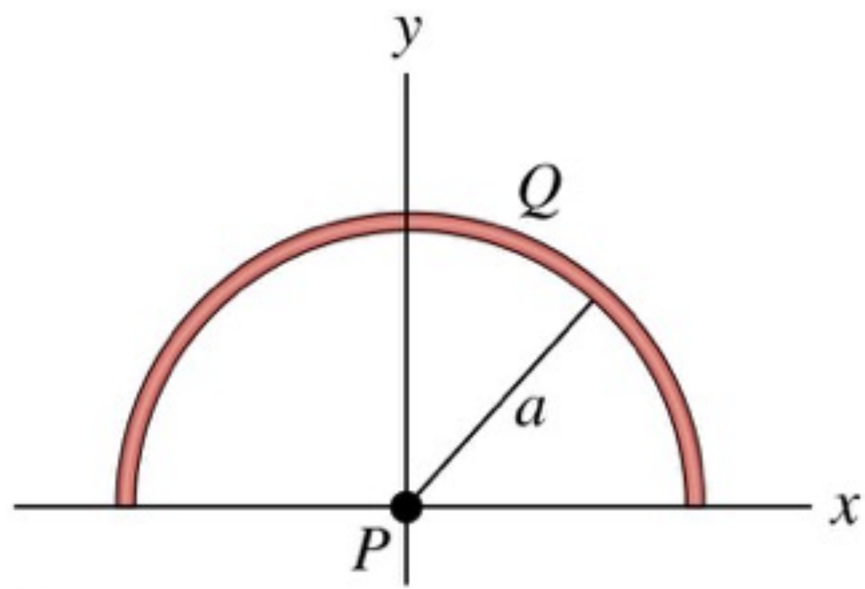
A. the +*x*-direction.

B. the –*x*-direction.

C. the +*y*-direction.

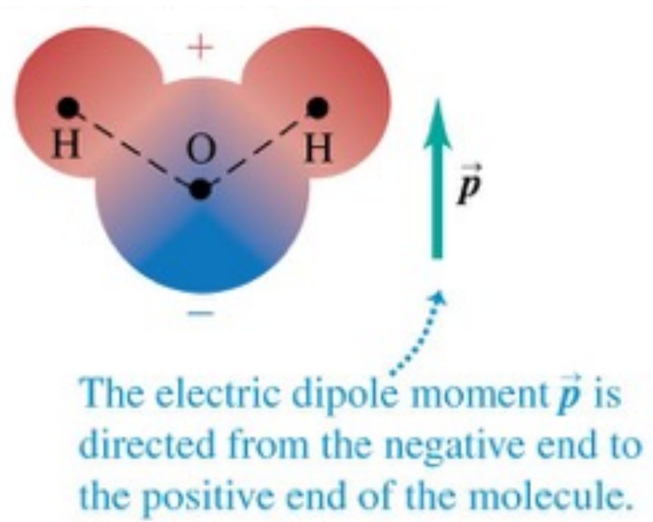
D. the –*y*-direction.

E. none of the above.



The water molecule is an electric dipole

- The water molecule as a whole is electrically neutral, but the chemical bonds within the molecule cause a displacement of charge.
- The result is a net negative charge on the oxygen end of the molecule and a net positive charge on the hydrogen end, forming an electric dipole.

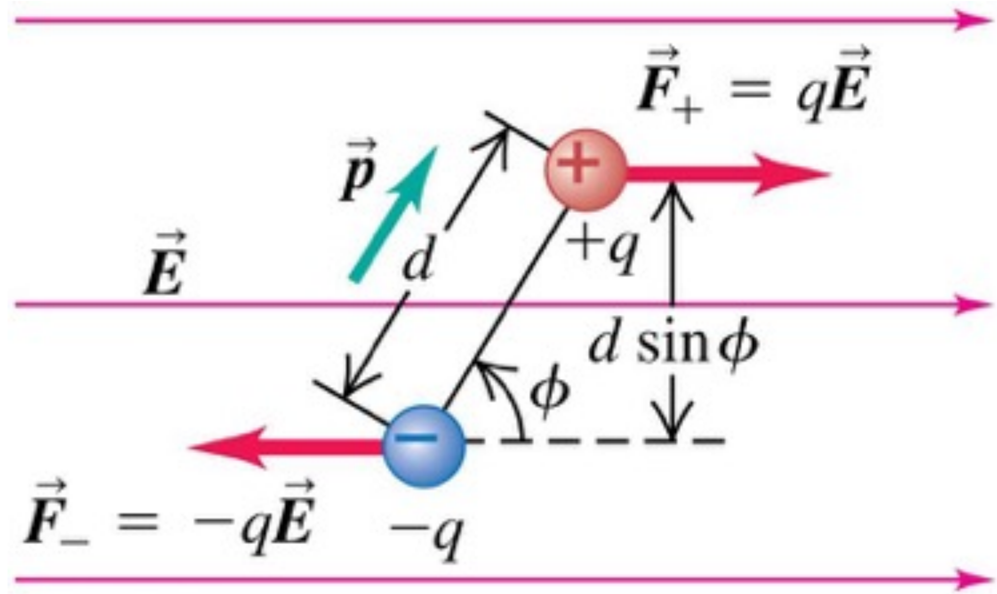


The water molecule is an electric dipole

- When dissolved in water, salt dissociates into a positive sodium ion and a negative chlorine ion, which tend to be attracted to the negative and positive ends of water molecules.
- This holds the ions in solution.
- If water molecules were not electric dipoles, water would be a poor solvent, and almost all of the chemistry that occurs in aqueous solutions would be impossible!

Force and torque on a dipole

- When a dipole is placed in a uniform electric field, the net *force* is always zero, but there can be a net *torque* on the dipole.



$$\vec{F}_g = m_0\vec{g}$$