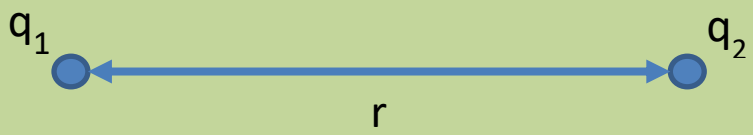
CONCEPT: COULOMB'S LAW

● Electric forces can be _____ or _____.

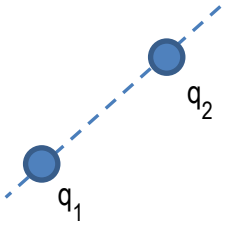
- Consequence of UNLIKE (+ - / - +) and LIKE (++ / - -) charges

● COULOMB'S LAW gives the force between charges:



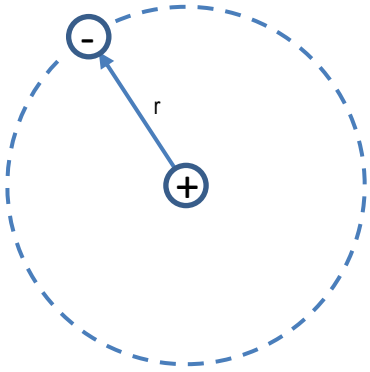
- F = _____ - k = _____ (Coulomb's constant)
- Units: _____

- Force always points along _____
- Like charges [ATTRACT / REPEL], unlike charges [ATTRACT / REPEL]



- **PRO-TIP:** Always find magnitude of Coulomb force by using + numbers → find direction using attract/repel rules.

EXAMPLE: What is the ratio of the electric to the gravitational forces in a hydrogen atom?



Hydrogen Atom
$G = 6.67\times10^{-11}\ \frac{m^3}{kg\cdot s^2}$
$M_{Electron} = 9.11\times10^{-31}$
$M_{Proton} = 1.67\times10^{-27}$
$r_{prot\text{-}elec} = 5.3\times10^{-11}$ m

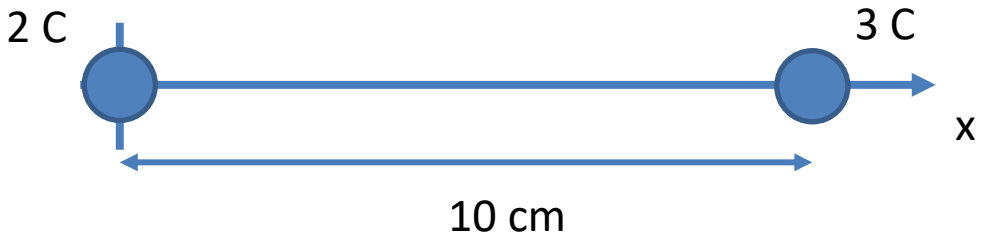
EXAMPLE: If two identical charges are connected by a 5 cm wire with a 10 N tension, what is magnitude of the charges?

PRACTICE: CHANGING DISTANCE

If the force between two charges is *F* when the distance is *d*, what will the force between the two charges be if they were moved to a distance of *2d*?

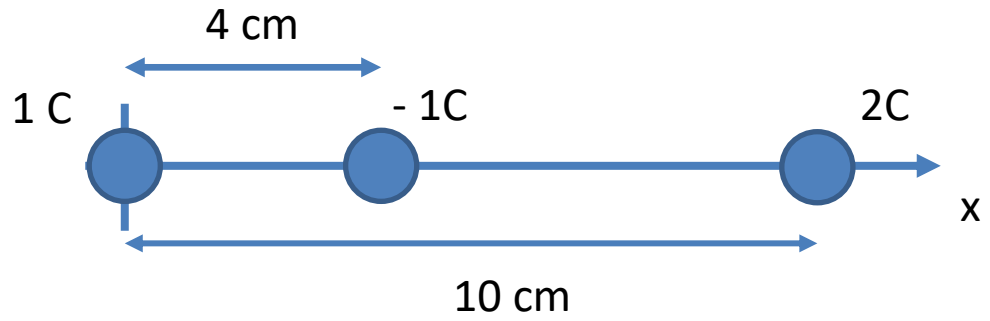
EXAMPLE: CHARGES IN A LINE

Where should we put a 1C charge so that the force on it is zero?



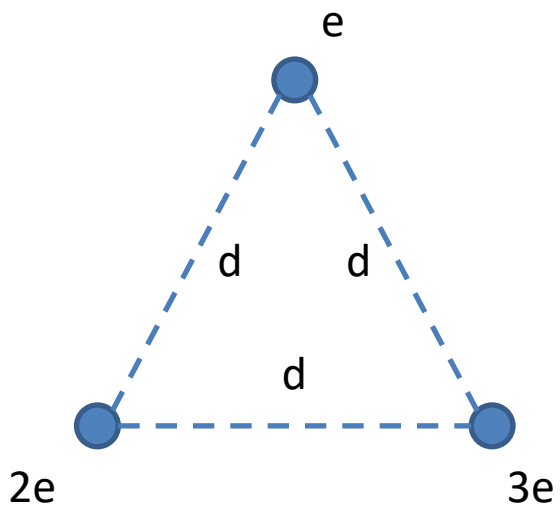
PRACTICE: 3 CHARGES IN A LINE

In which direction will the – 1 C charge move? If it has a mass of 10 g, what will its initial acceleration be?



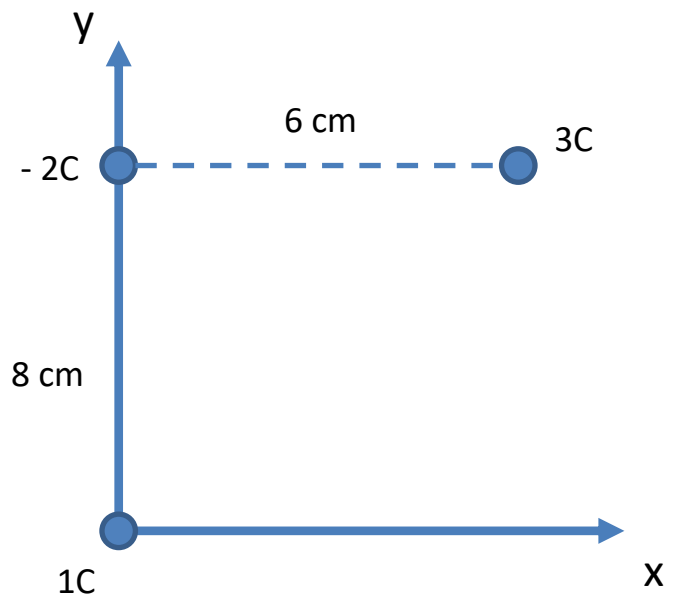
EXAMPLE: CHARGES IN A TRIANGLE

Rank all of the possible pairs of charges in the following figure by which pair has the greatest electric force.



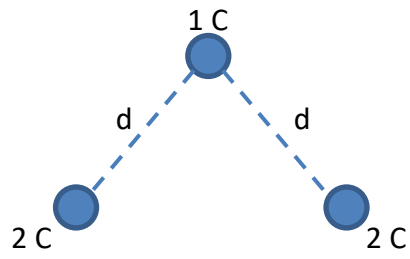
EXAMPLE: CHARGES IN A PLANE

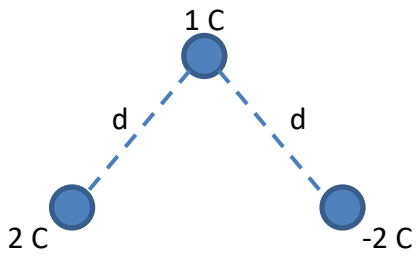
Find the net force on the 3 C charge in the following figure.



EXAMPLE: EXPLOITING SYMMETRY IN ELECTRIC FORCES

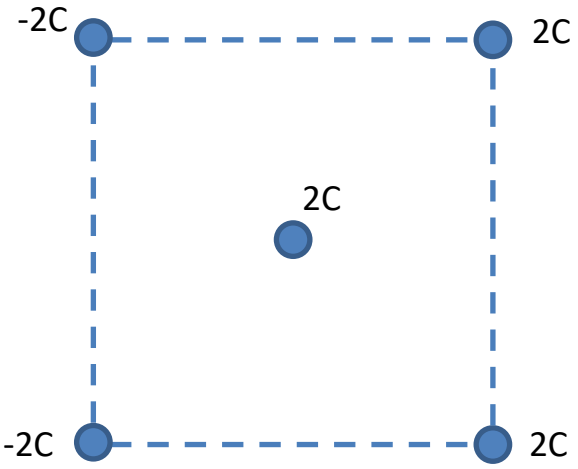
For each of the following, what is the direction of the net force on the 1 C charge:





PRACTICE: DIRECTION OF NET FORCE

What is the direction of the net force on the charge at the center of the square in the following figure?



EXAMPLE: ELECTROSCOPE

Two identical charges at the end of an electroscope's leaves each have a mass of 50 g. If the electroscope leaves are deflected by 30° as shown in the figure, what is the charge at the end of each leaf?