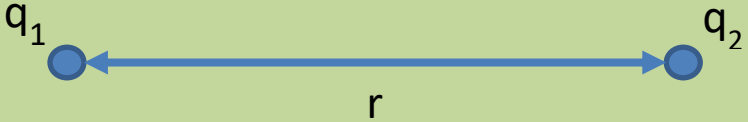


CONCEPT: COULOMB'S LAW

- Electric forces can be _____ or _____.
- Consequence of UNLIKE (+ - / - +) and LIKE (++) / (- -) charges

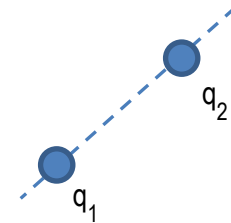
• COULOMB'S LAW gives the force between charges:



- $F = \underline{\hspace{2cm}}$ - $k = \underline{\hspace{2cm}}$ (Coulomb's constant)

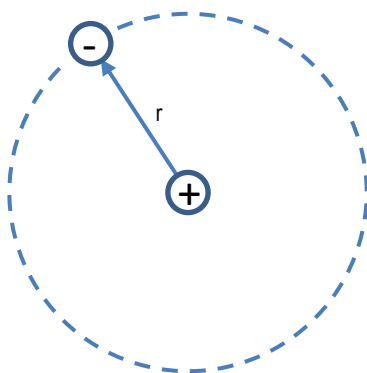
- Units: $\underline{\hspace{2cm}}$

- 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	
$G = 6.67 \times 10^{-11} \frac{\text{m}^3}{\text{kg} \cdot \text{s}^2}$	
$M_{\text{Electron}} = 9.11 \times 10^{-31}$	
$M_{\text{Proton}} = 1.67 \times 10^{-27}$	
$r_{\text{prot-elec}} = 5.3 \times 10^{-11} \text{ m}$	

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

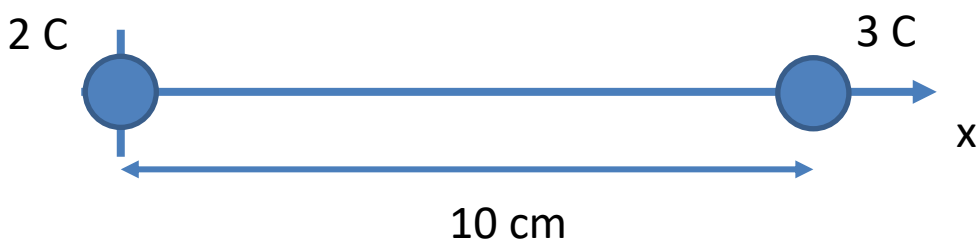


PRACTICE: CHANGING DISTANCE

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 $2d$?

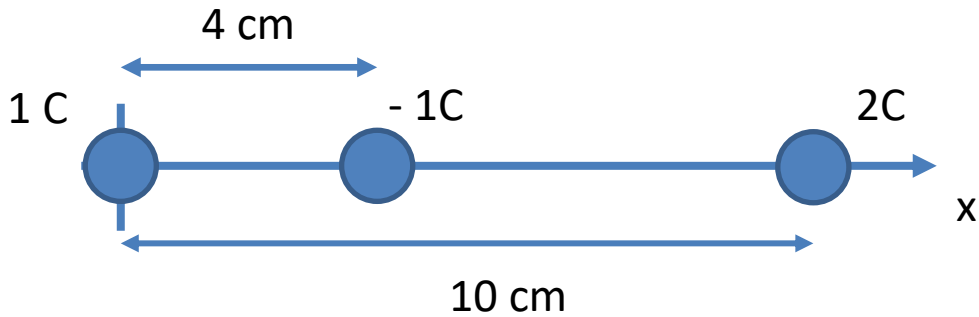
EXAMPLE: CHARGES IN A LINE

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



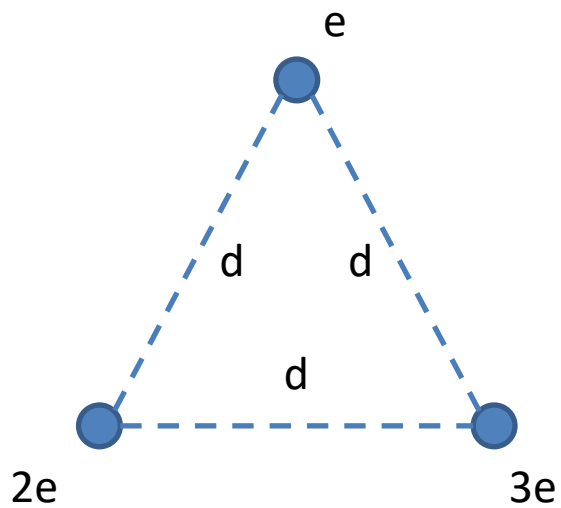
PRACTICE: 3 CHARGES IN A LINE

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



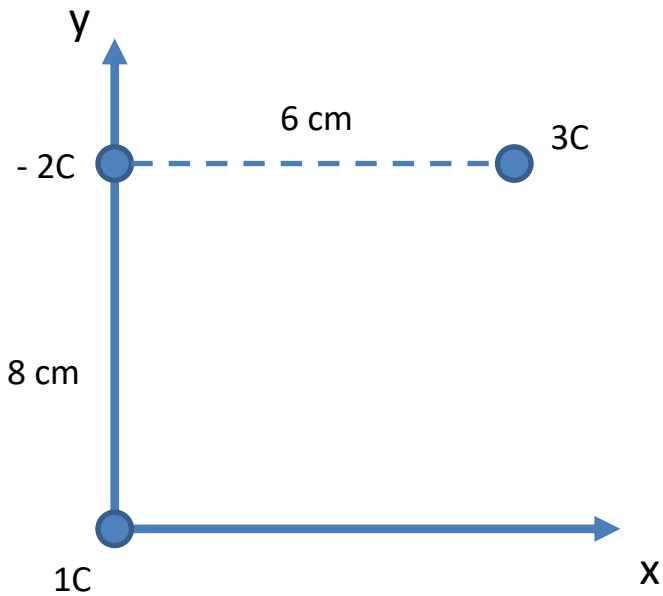
EXAMPLE: CHARGES IN A TRIANGLE

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



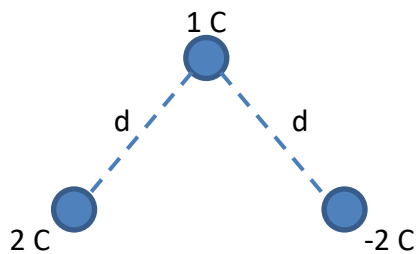
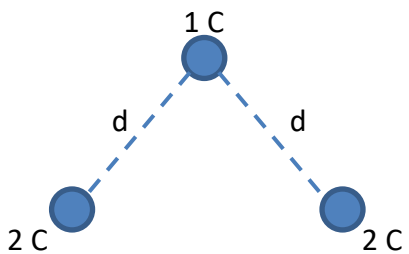
EXAMPLE: CHARGES IN A PLANE

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



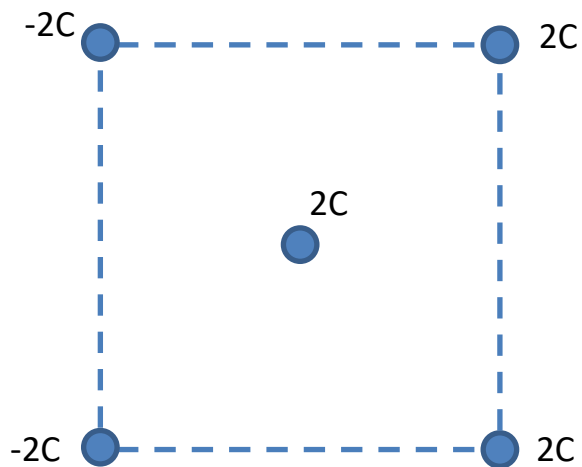
EXAMPLE: EXPLOITING SYMMETRY IN ELECTRIC FORCES

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?

