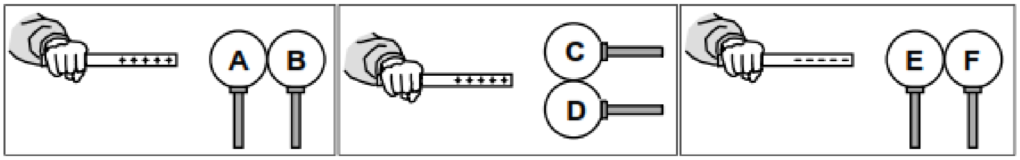
AP Physics 2 – Electric Forces and Fields

D1-RT03: Induced Charges near a Charged Rod—Net Charge

A charged rod is moved to the same distance from a pair of uncharged metal spheres as shown. The spheres in each pair are initially in contact, but they are then separated while the rod is still in place. Then the rod is removed.



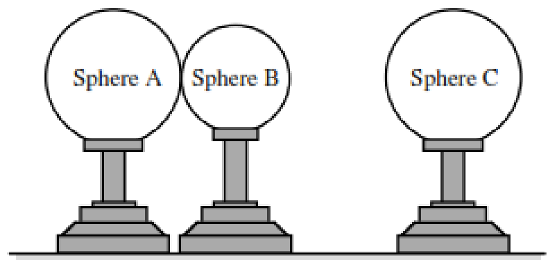
Rank the net charge on each sphere from most positive to most negative after the spheres have been separated and the charged rod removed.

						OR			
1 Greatest	2	3	4	5	6 Least		All the same	All zero	Cannot determine

Explain your reasoning.

D1-QRT05: Three Conducting Spheres—Charge

Two conducting spheres rest on insulating stands. Sphere B is smaller than Sphere A. Both spheres are initially uncharged and they are touching. A third conducting sphere, C, has a positive charge. It is brought close to (but not touching) Sphere B as shown.



(a) Is the net charge on Sphere A at this time (i) *positive*, (ii) *negative*, or (iii) *zero*? _____

Explain your reasoning.

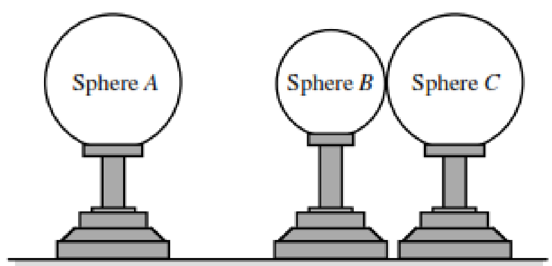
(b) Is the net charge on Sphere B at this time (i) *positive*, (ii) *negative*, or (iii) *zero*? _____

Explain your reasoning.

(c) Is the magnitude of the net charge on Sphere A (i) *greater than*, (ii) *less than*, or (iii) *equal to* the magnitude of the net charge on Sphere B? _____

Explain your reasoning.

Sphere B is now moved to the right so that it touches Sphere C. As a result of this move:



(d) Does the magnitude of the net charge on Sphere A (i) *increase*, (ii) *decrease*, or (iii) *remain the same*? _____

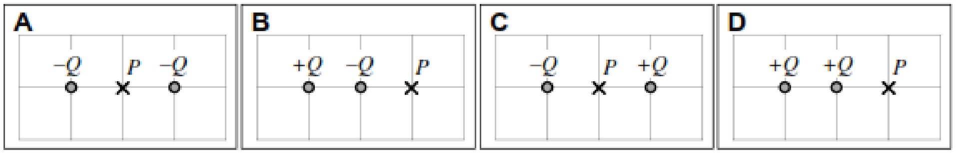
Explain your reasoning.

(e) Does the magnitude of the net charge on Sphere C (i) *increase*, (ii) *decrease*, or (iii) *remain the same*? _____

Explain your reasoning.

D1-RT12: Two Electric Charges—Electric Force

In each figure, two charges are fixed in place on a grid, and a point near those particles is labeled *P*. All of the charges are the same size, *Q*, but they can be either positive or negative.



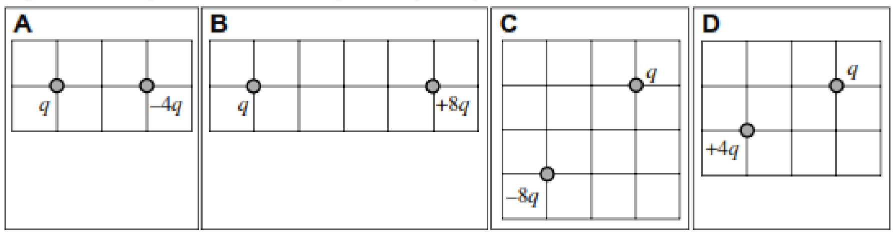
Rank the strength (magnitude) of the electric force on a charge +*q* that is placed at point *P*.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

D1-RT14: Two Charged Particles—Force

In each case, small charged particles are fixed on grids having the same spacing. Each charge *q* is identical, and all other charges have a magnitude that is an integer multiple of *q*.



Rank the magnitude of the electric force on the charge labeled *q* due to the other charge.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

D1-QRT20: Three Charges in a Line I—Force

Three charged particles, *A, B,* and *C*, are fixed in place in a line. Charge *C* is twice as far from charge *B* as charge *A* is. All charges are the same magnitude.

In the chart to the left below, use arrows (← or →) to indicate the direction of the net force on charge *C* due to charges *A* and *B*. If the force is zero, state that explicitly.

In the chart on the right below, use arrows (← or →) to indicate the direction of the net force on charge *B* due to charges *A* and *C*. If the force is zero, state that explicitly.

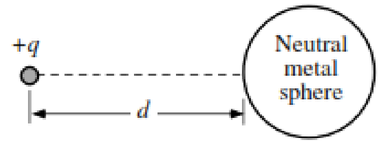
A	*B*	*C*	$\Sigma\vec{F}$ on charge *C*
+	+	+	Direction:
+	+	−	Direction:
+	−	+	Direction:
+	−	−	Direction:
−	+	+	Direction:
−	+	−	Direction:
−	−	+	Direction:
−	−	−	Direction:

A	*B*	*C*	$\Sigma\vec{F}$ on charge *B*
+	+	+	Direction:
+	+	−	Direction:
+	−	+	Direction:
+	−	−	Direction:
−	+	+	Direction:
−	+	−	Direction:
−	−	+	Direction:
−	−	−	Direction:

Explain your reasoning.

D1-WWT26: Neutral Metal Sphere near a Positive Point Charge—Force

A positive point charge is placed a distance *d* away from a neutral metal sphere.



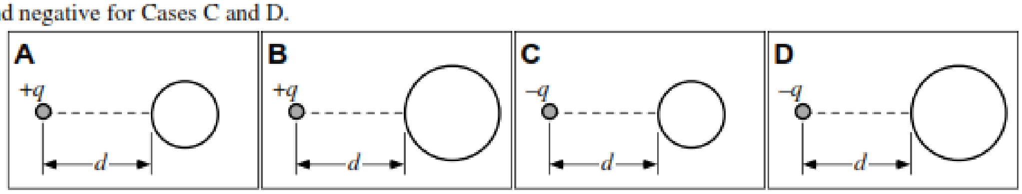
A student makes the following statement:

"The electric force is zero. Coulomb's law states that the electric force between two objects is proportional to the product of the charges. Since the charge of the sphere is zero, and zero times anything gives zero, the force between the point charge and the sphere is zero."

What, if anything, is wrong with this statement? If something is wrong, explain the error and how to correct it. If the statement is valid, explain why.

D1-RT27: Neutral Metal Sphere near a Point Charge—Force

A point charge is placed a distance *d* away from a neutral metal sphere. The diameters of the spheres in Cases A and C are the same and smaller than the equal diameters in Cases B and D. The point charge is positive for Cases A and B, and negative for Cases C and D.



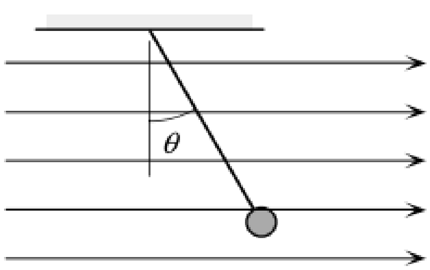
Rank the magnitude of the force exerted on the point charge by the sphere.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

D1-RT43: Suspended Charges in an Electric Field—Angle

A charged sphere is suspended from a string in a uniform electric field directed horizontally. There is an electric force on the sphere to the right and a gravitational force pointing downward. As a result, the sphere hangs at an angle θ from the vertical. Combinations of sphere mass and electric charge are listed in the chart for four cases, all in the same uniform electric field.



	Mass	Charge
A	3 g	8 nC
B	6 g	4 nC
C	9 g	2 nC
D	6 g	8 nC

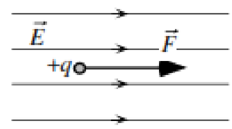
Rank the angle θ that the string forms with the vertical for these different spheres.

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.

D1-LMCT33: Positive Charge in a Uniform Electric Field—Electric Force

A particle with a charge $+q$ is placed in a uniform electric field.



Identify from choices (i)–(vi) how each change described in (a) to (e) will affect the electric force on the particle.

This change will:

(i) change only the **direction** of the electric force.
(ii) **increase** the magnitude of the electric force.
(iii) **decrease** the magnitude of the electric force.
(iv) **increase** the magnitude and change the **direction** of the electric force.
(v) **decrease** the magnitude and change the **direction** of the electric force.
(vi) **not affect** the electric force.

All of these modifications are changes to the initial situation shown in the diagram.

(a) The charge q on the particle is doubled. _____
Explain your reasoning.

(b) The sign of the charge q on the particle is changed to the opposite sign. _____
Explain your reasoning.

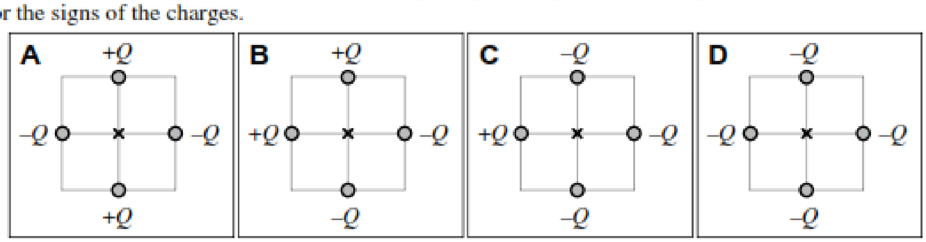
(c) The particle is given a push, causing a leftward initial velocity. _____
Explain your reasoning.

(d) The magnitude of the uniform electric field is halved. _____
Explain your reasoning.

(e) The direction of the uniform electric field is rotated 90° clockwise. _____
Explain your reasoning.

D1-RT49: Four Point Charges in Two Dimensions—Electric Field

In each case, four charged particles, each with a charge magnitude Q, are fixed on grids. The cases are identical except for the signs of the charges.



Rank the magnitude of the electric field at the location marked with an "x."

				OR			
1 Greatest	2	3	4 Least		All the same	All zero	Cannot determine

Explain your reasoning.