PHYSICS 570 – Master's of Science Teaching

“Electricity”
Lecture 4 – Superposition of Electric Force Vectors

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Lecture 4 – Outline

What's a vector
Adding vectors in one dimension
Coulomb's law and vectors
Adding vectors tip to tail
Four examples of vector addition and the principle of superposition.
An electric force simulation.

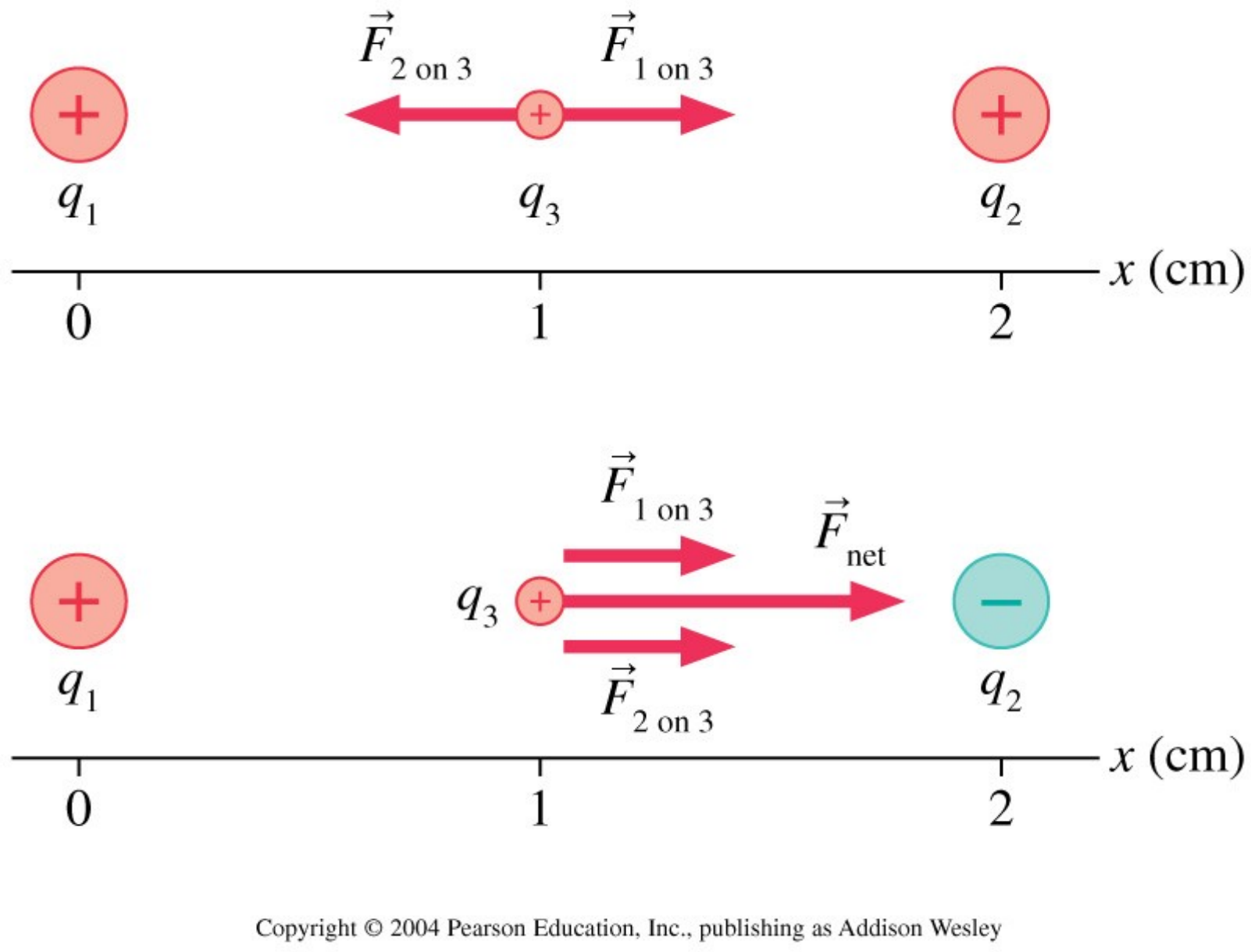
What's a vector? What's a scalar?

A scalar is a physical quantity having only a magnitude (e.g. temperature).

A vector has a magnitude AND a direction. Vectors are represented by arrows, and the arrow gives the direction.

Force is a vector.

Coulomb's Law w/ Vectors



Coulomb's law and the Principle of Superposition

States that the force from multiple charges is the sum of force from individual charges (as if the others weren't there) So long as you mean the VECTOR SUM.

$$\vec{F}_{12} = k\frac{q_1 q_2}{d_{12}^2}\hat{r}_{12}$$

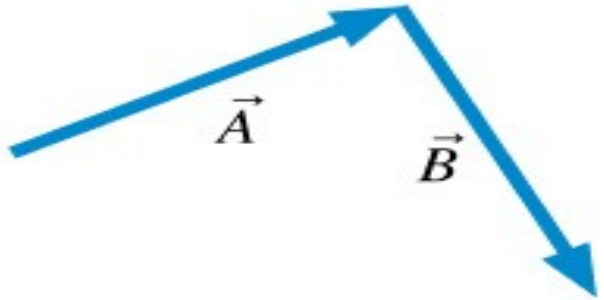
$\hat{r}_{12}$ is math shorthand for “force is along the line joining the charges.”

Addition of vectors by drawing

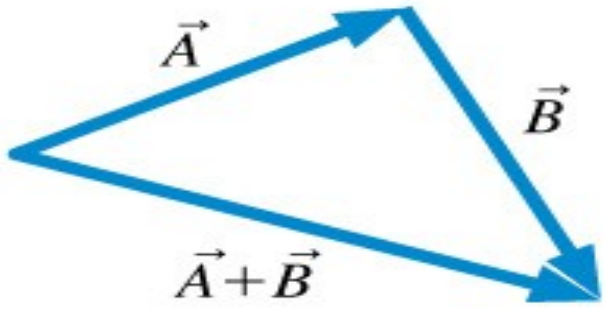
To add $\vec{B}$ to $\vec{A}$:

1. Draw $\vec{A}$.

2. Place the tail of $\vec{B}$ at the tip of $\vec{A}$.



3. Draw an arrow from the tail of $\vec{A}$ to the tip of $\vec{B}$. This is vector $\vec{A} + \vec{B}$.



Steps to solve a superposition problem

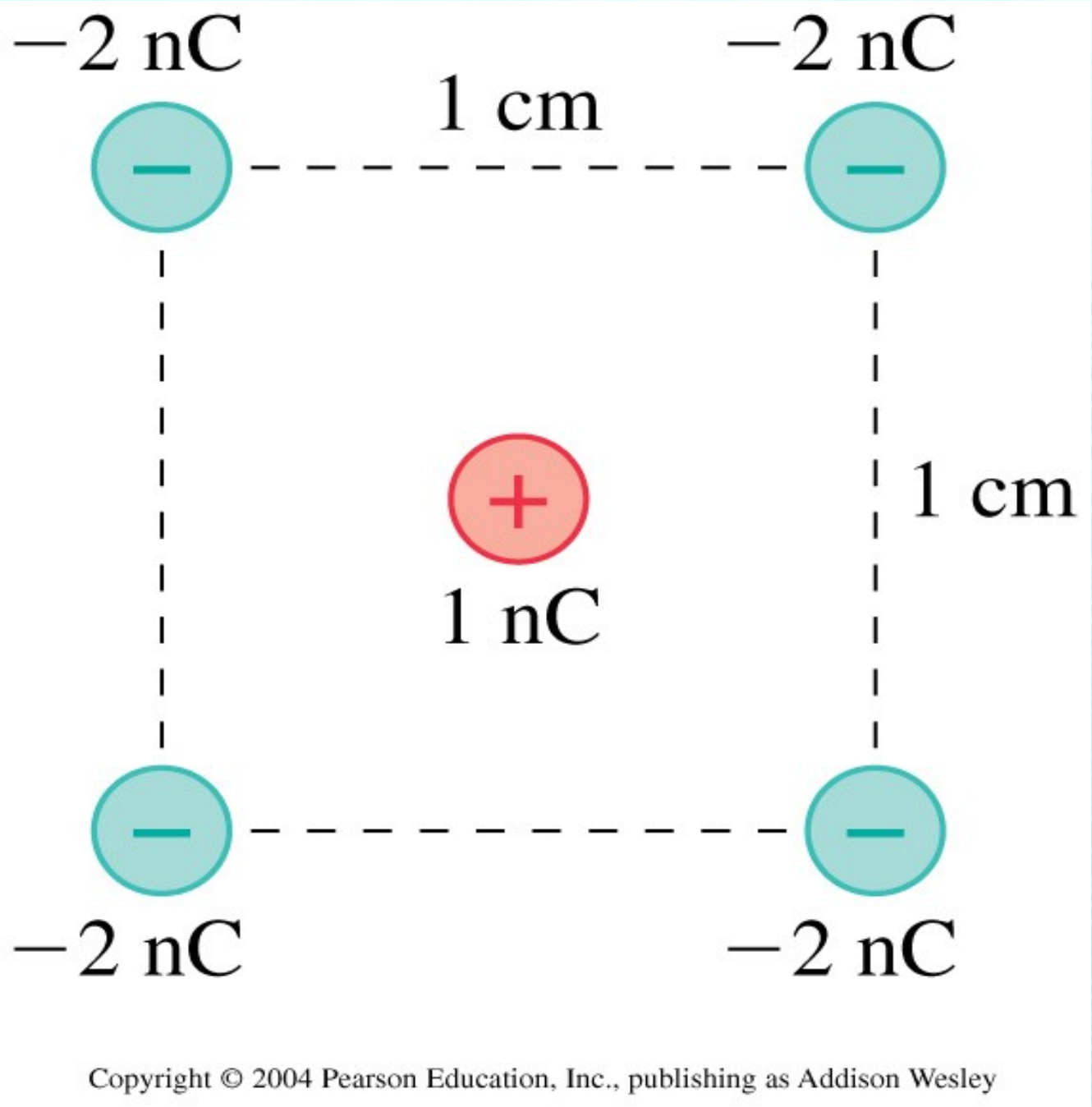
1) Identify the charge at which you want to calculate the force.

2) Draw an arrow (a vector) representing the Force Vector at the charge along a line joining it with each of the other charges.

3) Make the length of the vectors proportional to the force between the charges (shorter arrows for more distance charges)

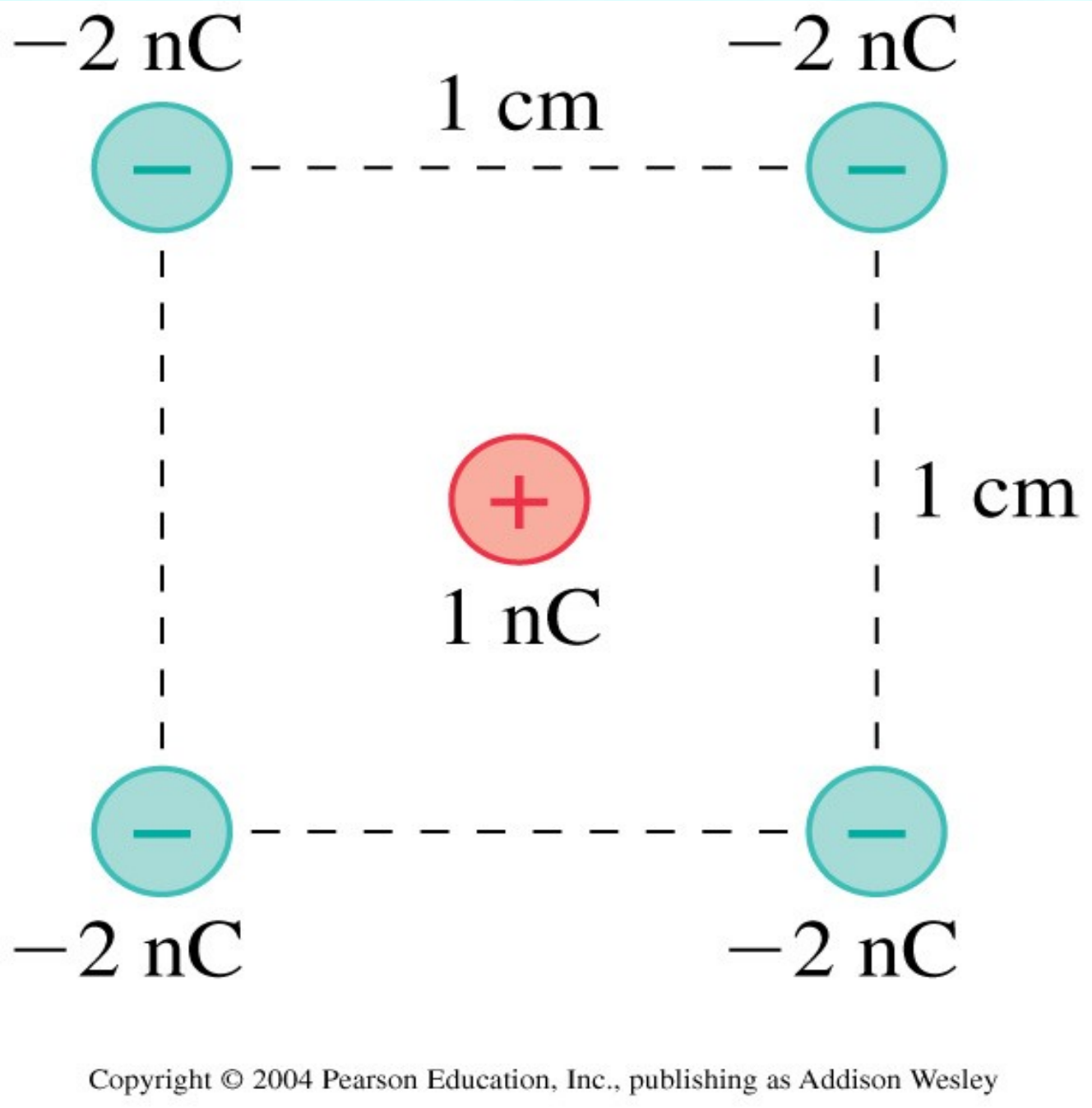
4) Add the vectors using the tip to tail method to find the *resultant*.

Superposition problem #1

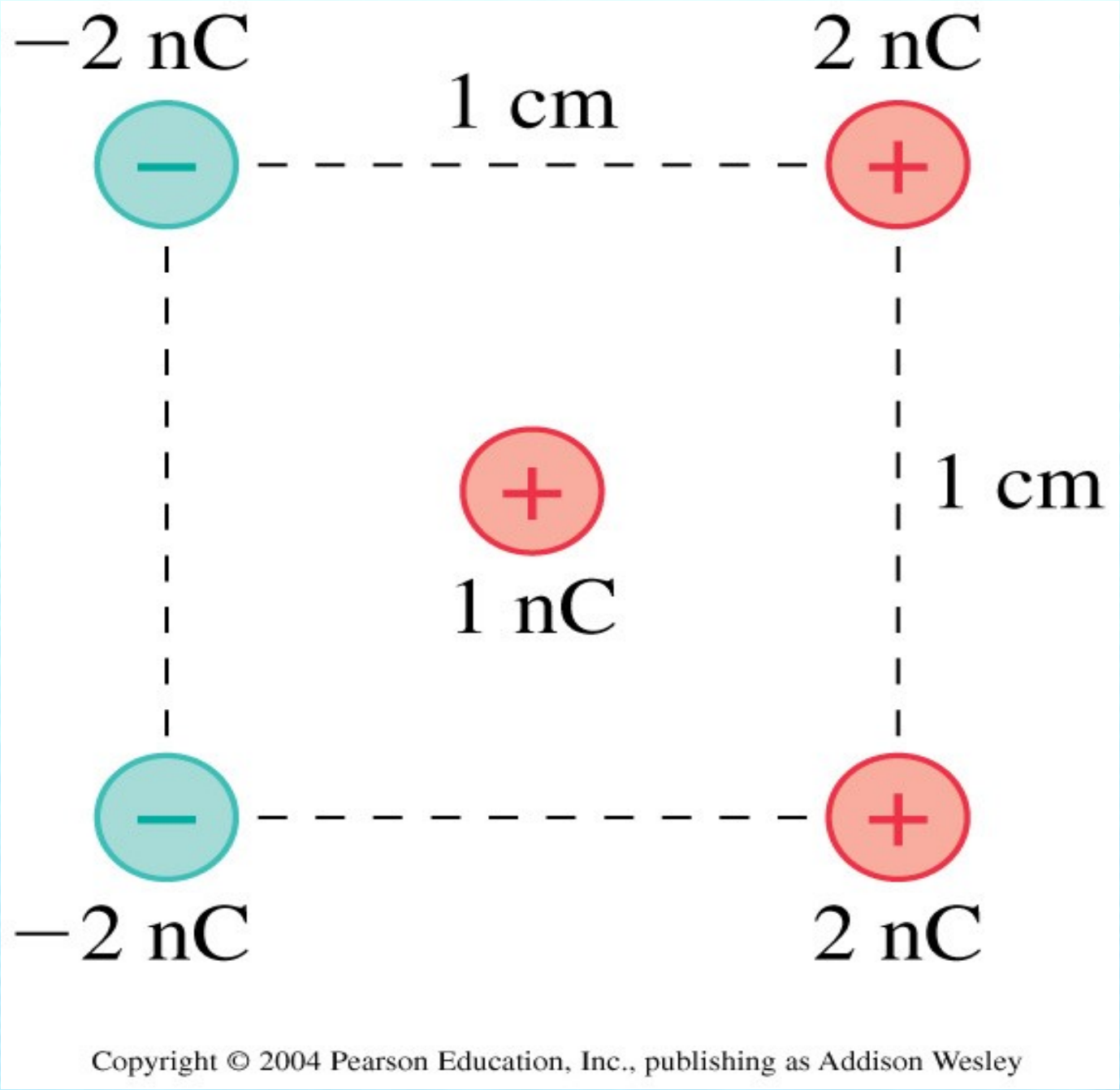


Estimate the direction and magnitude of the force on the central charge due to the other four charges.

Superposition problem #1

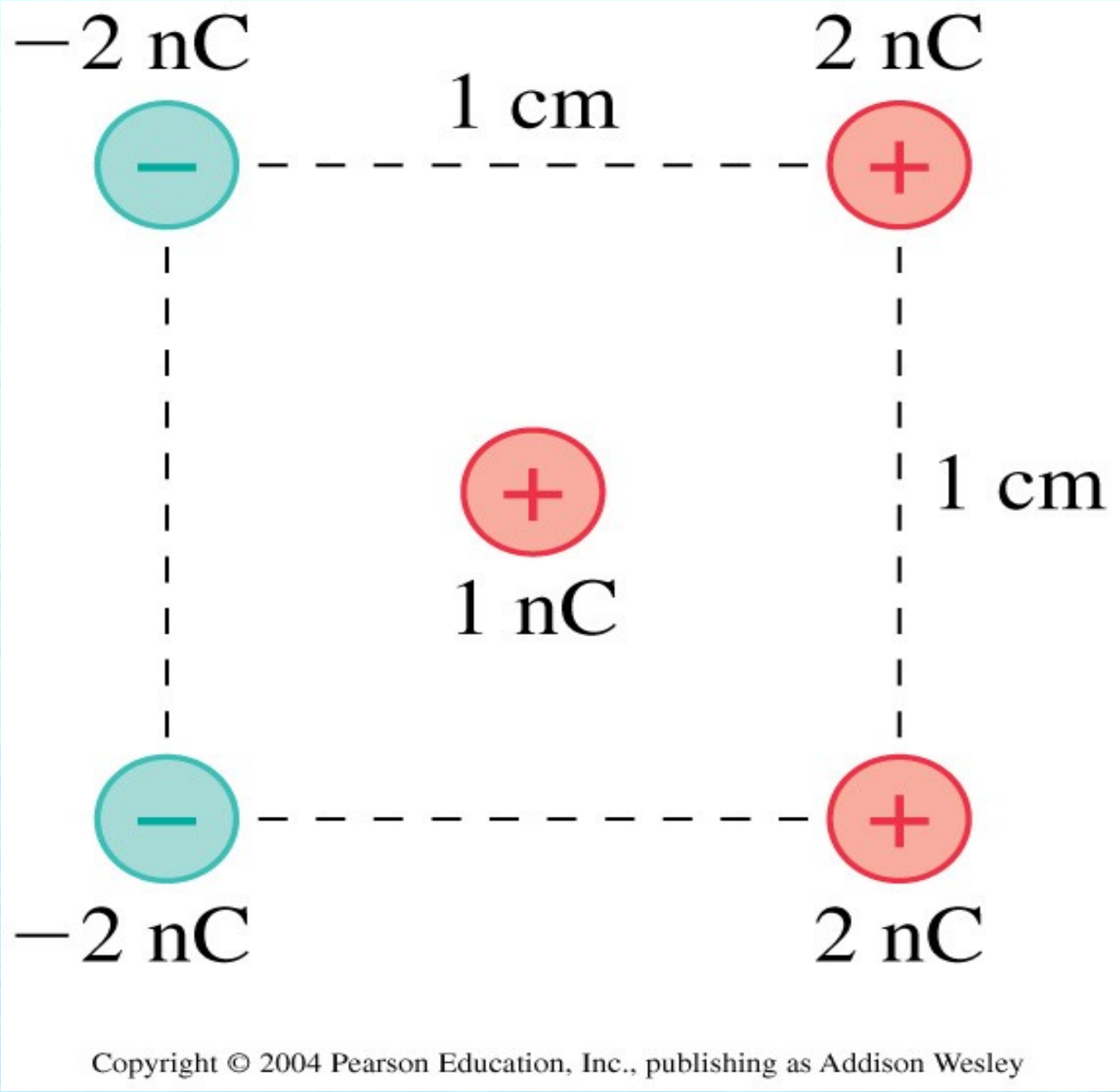


Superposition problem #2

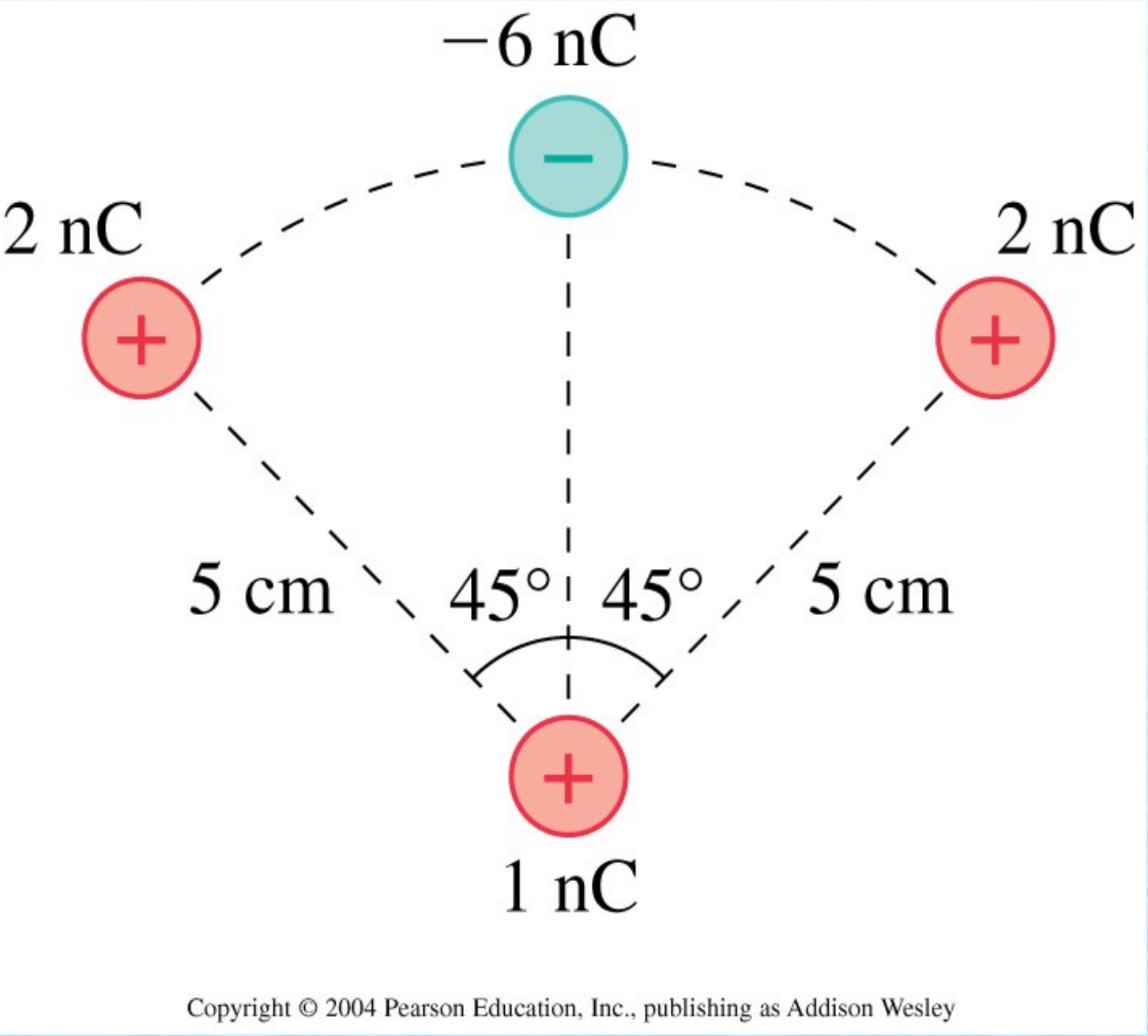


Estimate the direction and magnitude of the force on the central charge due to the other four charges.

Superposition problem #2



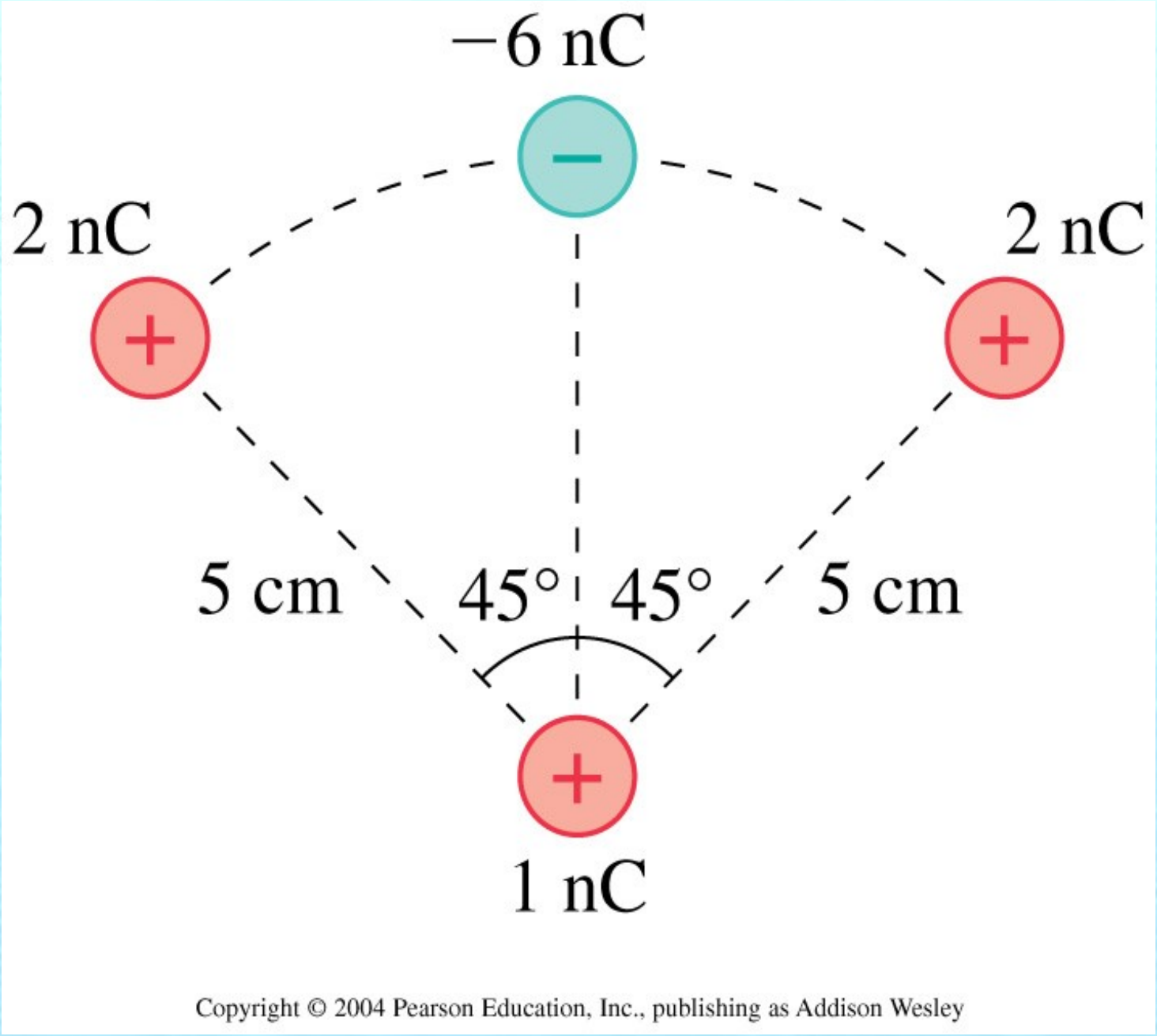
Superposition problem #3



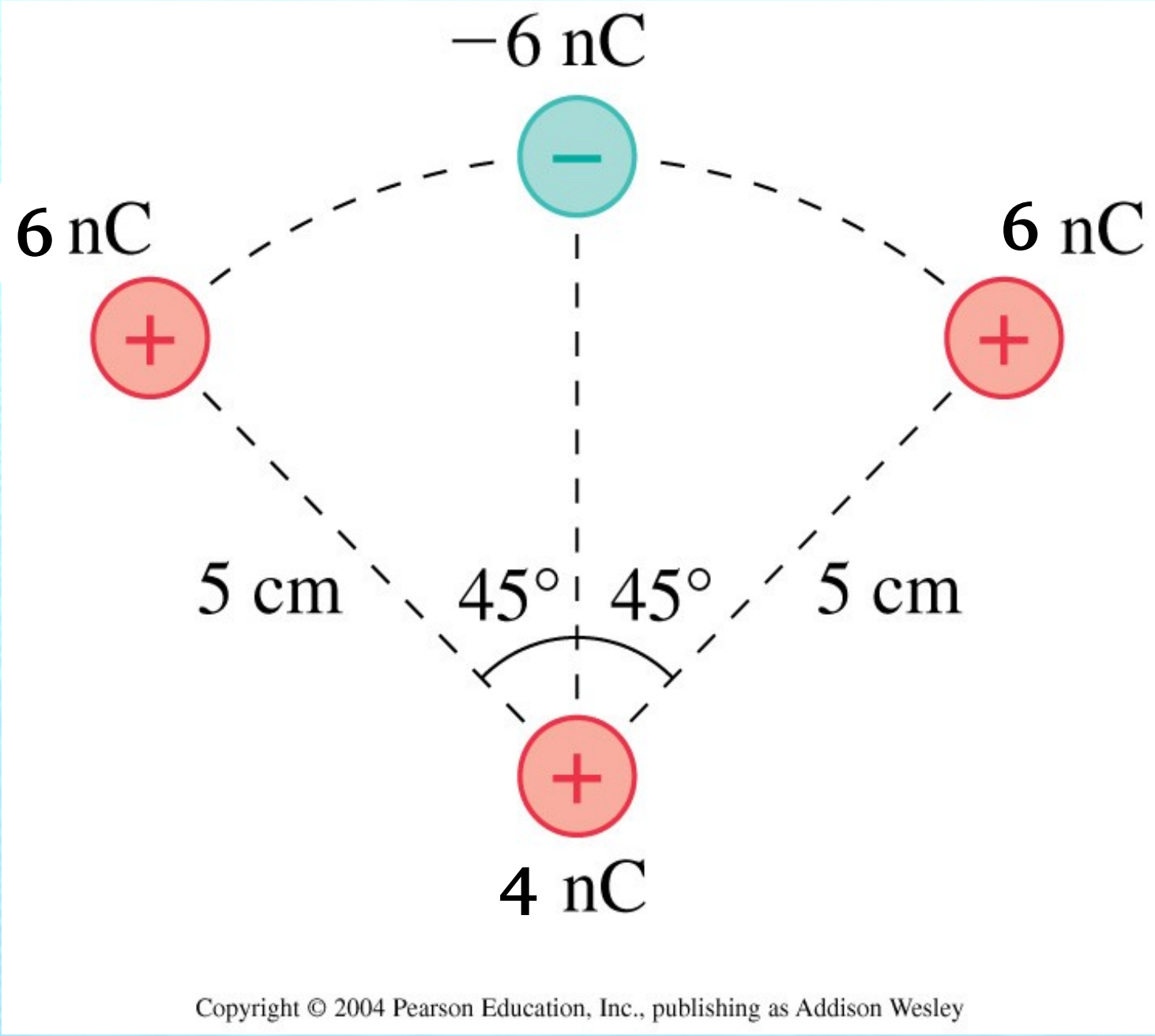
What is the direction of the force on the
1 nC charge?

Is it
(A) Up
(B) Down
(C) Zero
(D) Left
(E) Right

Superposition problem #3



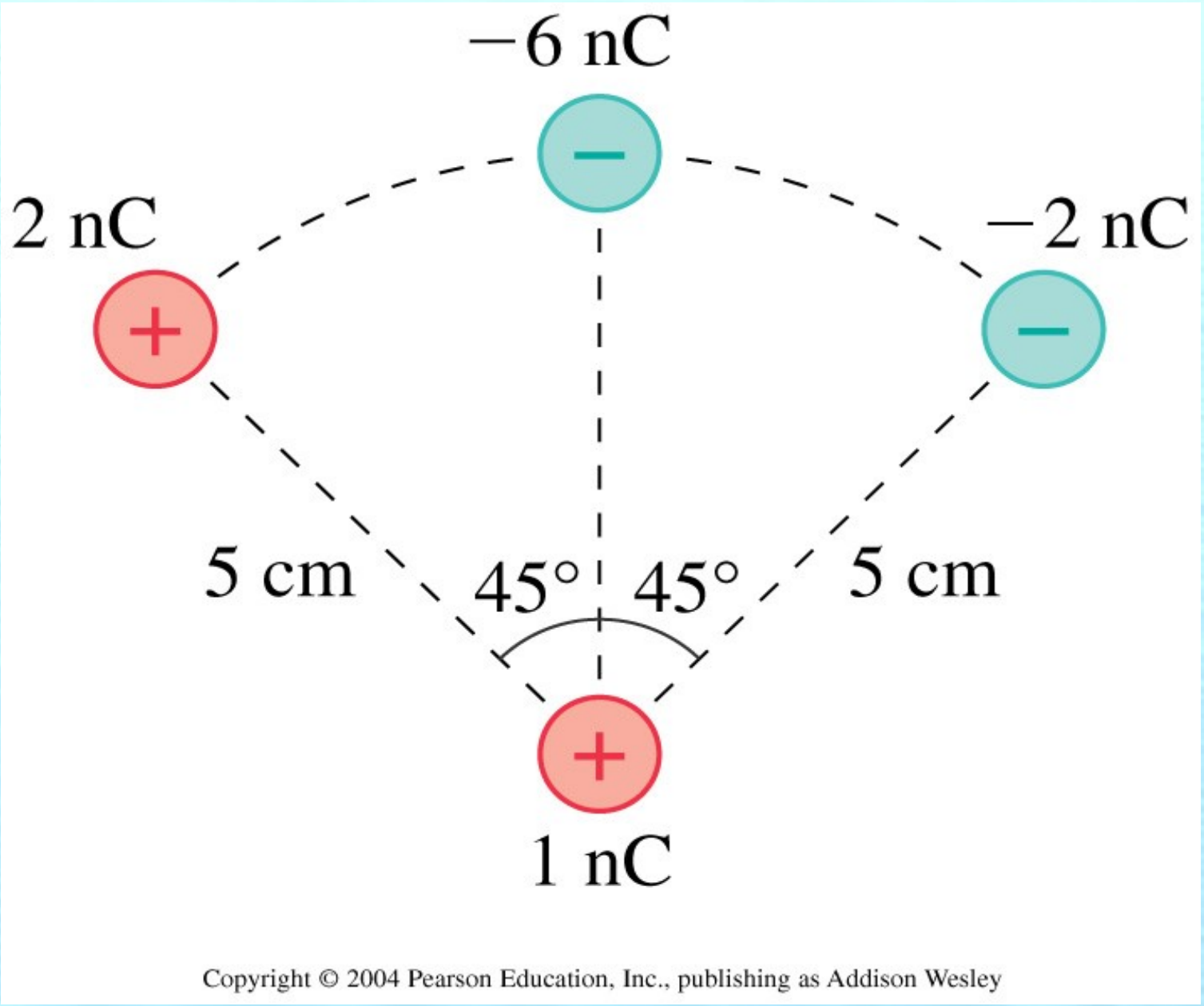
Superposition problem #4



What is the direction of the force on the
4 nC charge?

Is it
(A) Up
(B) Down
(C) Zero
(D) Left
(E) Right

Superposition problem #5



What is the direction of the force on the 1 nC charge?

Too difficult just to do with sketching Need components

Using a simulator to add vectors

http://phet.colorado.edu/en/simulation/charges-and-fields

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