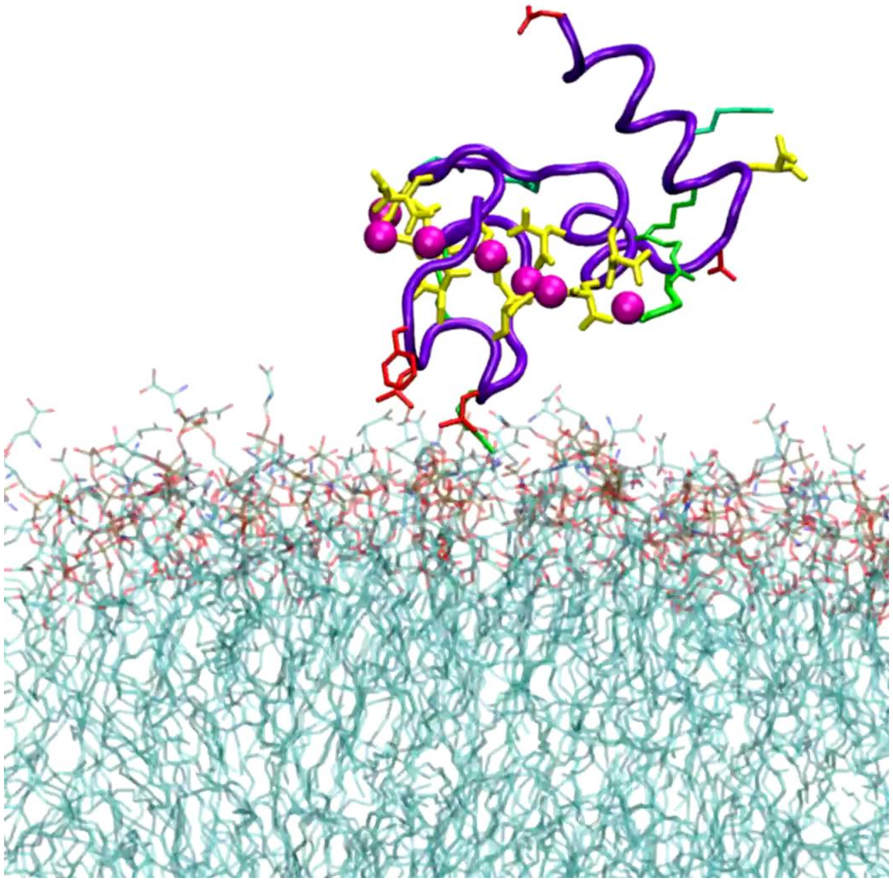
February 15, 2013 Physics 132 Prof. W. Losert

Outline

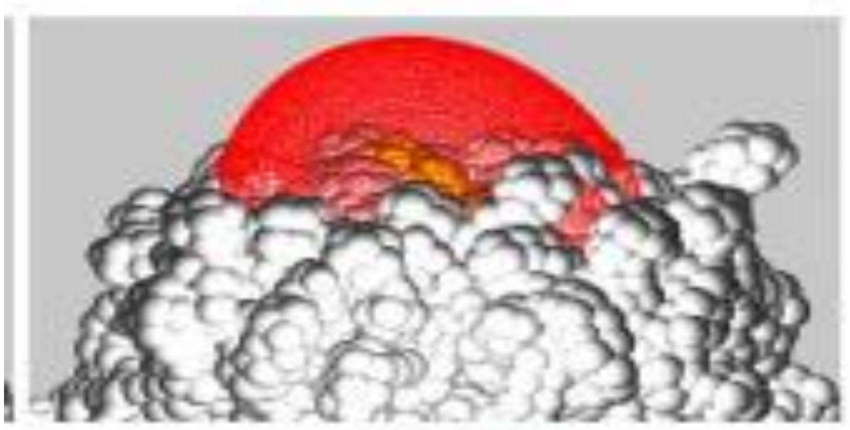
- Review electric Forces
- Review electric Potential

Office hours next week back to:

WEDNESDAY 5-6.30pm Rm 0208 (Course Center)



- Electric charges are key to life!
- Phosphate group is charged and has electric field



- Simulation based on F=ma (Newton’s laws)
  - What are the forces?

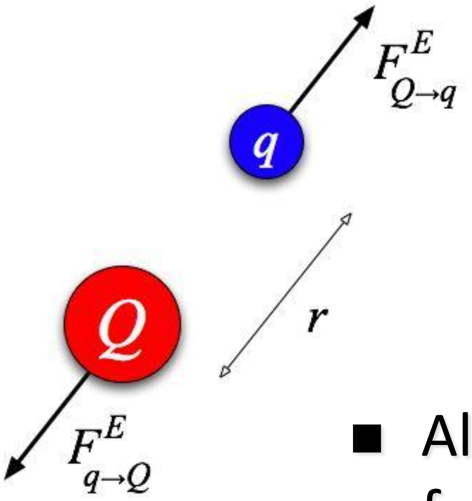
Pastor Biophys J 2006

Model: Charge
A hidden property of matter

- Matter is made up of two kinds of electric charges (positive and negative) that have equal magnitude and that cancel when they are together and hide matter's electrical nature.
- Like charges repel, unlike charges attract.
- The net charge (postive minus negative charges) is a constant
- Matter with an equal balance is called neutral.

Can Charges Move?

- Insulators
  - Charges are bound and cannot move around freely.
  - Excess charge tends to just sit there.
- Conductors
  - Charges can move around throughout the object.
  - Excess charge redistributes itself or flows off
    - Solid: Electrons move
    - Fluid: Charged atoms move
- Unbalanced charges attract neutral matter (polarization)



Foothold idea: Coulomb’s Law

- All objects attract or repel each other with a force whose magnitude is given by

$$\vec{F}_{q\to Q} = \frac{k_C qQ}{r_{qQ}^2}\,\hat{r}_{q\to Q}$$

$$k_C = 9 \times 10^9 \text{ N-m}^2/\text{C}^2$$

What does $\hat{r}$ mean?

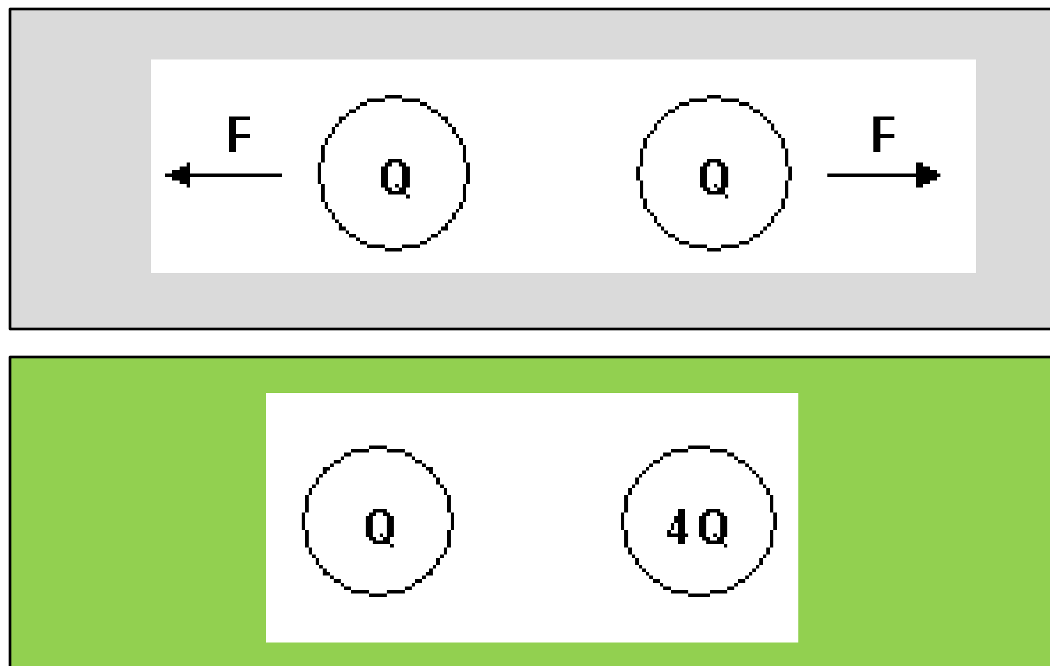
1. Vector length 1, dimension length
2. Scalar length 1, dimension length
3. Vector length 1, dimensionless
4. Scalar length 1, dimensionless
5. Don’t know

Questions: When two objects with the same sign of charge but different magnitudes are put together, they accelerate _____?

1. with the same acceleration
2. With different acceleration -
   Larger charge has higher acceleration
3. With different acceleration –
   Smaller charge = higher acceleration
4. Not enough information

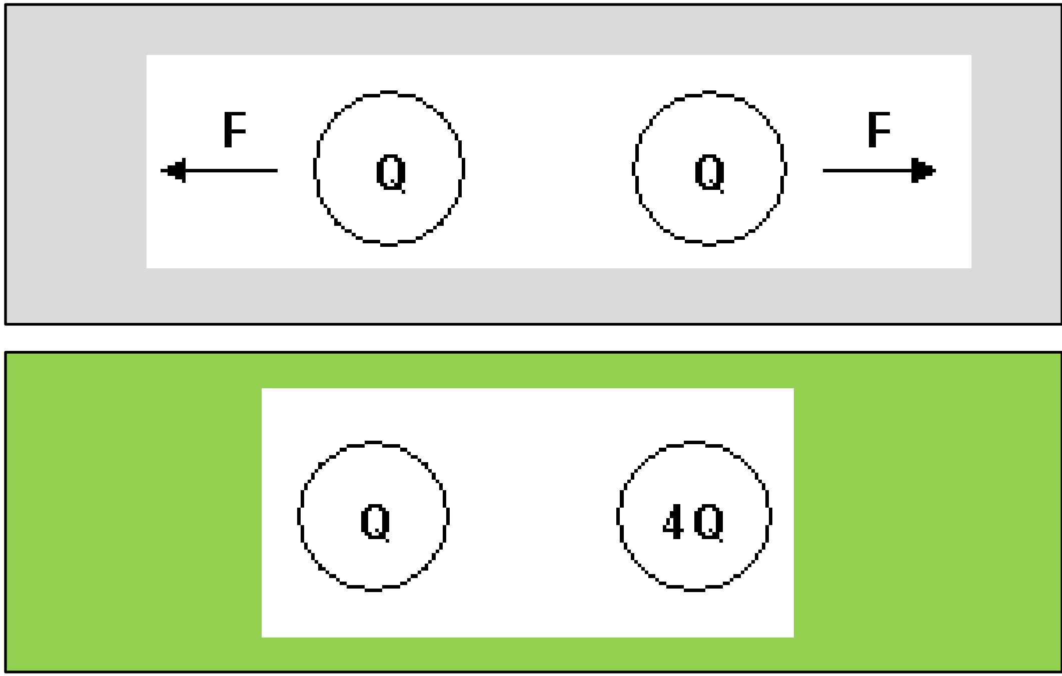
Two small objects each with a net charge of Q (positive) exert a force of magnitude F on each other. We replace one of the objects with another whose net charge is 4Q. The original magnitude of the force on the Q charge was F; what is the magnitude of the force on the Q now?

1. 16F
2. 4F
3. F
4. F/4
5. other

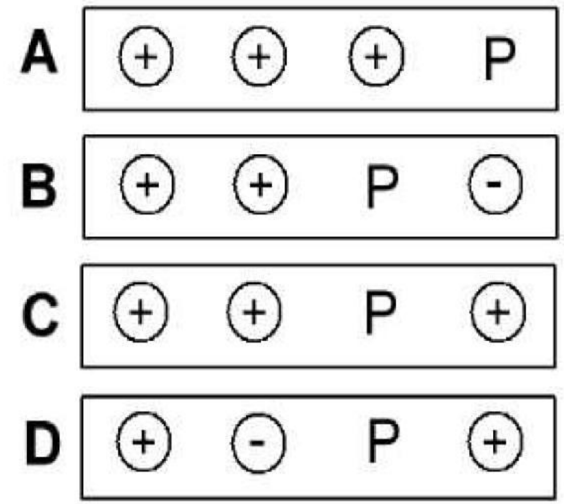


What is the magnitude of the force on the 4Q charge?

1. 16F
2. 4F
3. F
4. F/4
5. other

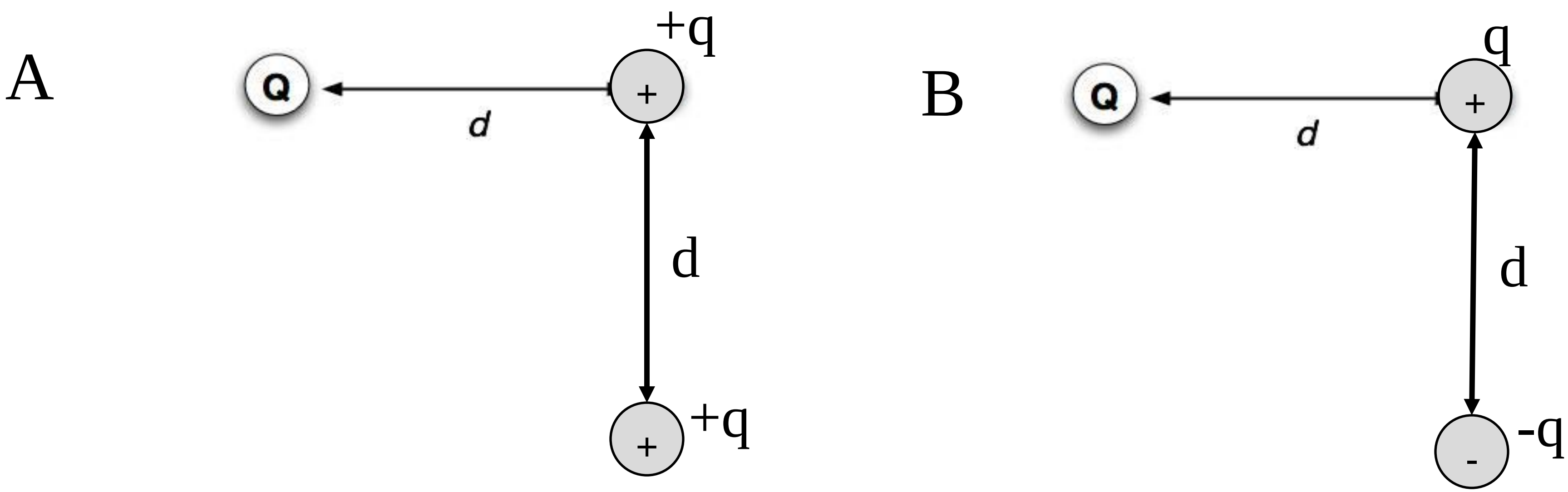


In the figure are shown four arrangements of charge. Each charge has the same magnitude, but some are + and some are -. All distances are to the same scale. In which arrangement would the magnitude of the force felt by a positive test charge placed at P be the largest?



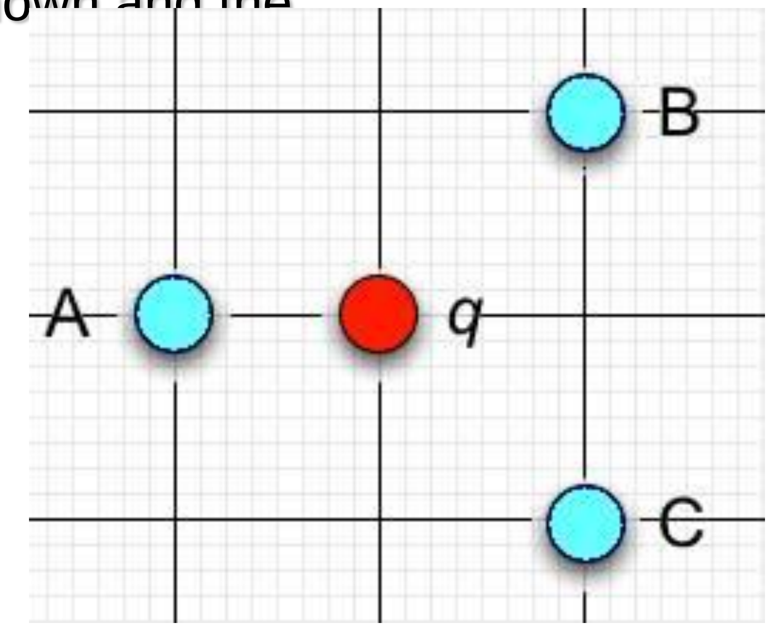
1. A
2. B
3. C
4. D
5. You can't tell.

Compare the magnitude and direction of the net force exerted on Q



1. Same direction
2. Same magnitude
3. Same direction and magnitude
4. Same magnitude, opposite direction
5. neither

A test charge (labeled *q*) is placed in a situation in which it feels the electrical force from three other charges (of opposite sign to it) labeled A, B, and C. (The charges are on a uniform grid as shown and the positions are to scale.) Which of the following combinations of forces has the greatest magnitude?



1. $\vec{F}_{A \to q}$
2. $\vec{F}_{B \to q} + \vec{F}_{C \to q}$
3. $\vec{F}_{A \to q} + \vec{F}_{B \to q} + \vec{F}_{C \to q}$
4. There is not enough information to tell.

Foothold ideas: Energies between charge clusters

- Atoms and molecules are made up of charges.
- The potential energy between two charges is

$$U_{12}^{elec} = \frac{k_C Q_1 Q_2}{r_{12}}$$

No vectors!

See the system below. How do you calculate the electric potential energy of the system?