18.1.1 The Force on a Point Charge Due to Two or More Other Point Charges
The forces are vectors, so they must be treated as such

**Example 1:** Pr. 13 An equilateral triangle has sides 0.15 m, Charges of –9.0 +8.0 and +2.0 $\mu$C at each corner. Find the magnitude of the net force electric force on the particle with a charge of +2.0 $\mu$C.

18.2 The Electric Field
Fields
- **Action at a Distance**
- **Conceptual cue from Sound**
- **Apply Sound model to Action-at-a-distance**
  - Gravitational Example
  - Electrical Demo: Vander Graff Generator and tin foil ball.

**18.2.1 Definition.**

**Ex 2.** There are three charged particles arranged as shown. Particle 1, with the +4.0 $\mu$C charge then ended-up subject to a net electrical force of magnitude $F = 23$ N and pointing $24^\circ$ up off the x-axis. What is the electric field at the location of Particle 1?

- Field leads to Force
  - Demo: Vander Graff Generator & charged Rabbit hair

**Ex 3. Fields of Multiple Sources:** Two positive point charges, $q_1 = +16\mu$C and $q_2 = +4.0 \mu$C are separated in a vacuum by a distance of 3.0 m. Find the spot on the line between them where the net electric field is zero.

- **Analogy to g in Gravitation**
  - Gravitational Field
    - Mathematical Convenience
    - Property of Space, not mass

18.3 Electric Field Lines
- Rules
- **Point Charge**
  - Water Analog
  - Demo: Pascal’s principle water squirter
- Dipole
18.3.1 Dipole Moment
18.3.2 Examples drawing Field Lines
- Parallel plates
26. Review Conceptual Example 12 as an aid in working this problem. Charges of -4q are fixed to diagonally opposite corners of a square. A charge of +5q is fixed to one of the remaining corners and a charge of +3q is fixed to the last corner. Assuming that ten electric field lines emerge from the +5q charge, sketch the field lines in the vicinity of the four charges.

29. Two charges are placed on the x axis. One charge \( q_1 = +8.5 \, \mu \text{C} \) is at \( x_1 = +3.0 \, \text{cm} \) and the other \( q_2 = -21 \, \mu \text{C} \) is at \( x_2 = +9.0 \, \text{cm} \). Find the net electric field (magnitude and direction) at (a) \( x = 0 \, \text{cm} \) and (b) \( x = +6.0 \, \text{cm} \).

32. A charge of \( q = +7.50 \, \mu \text{C} \) is located in an electric field. The x and y components of the electric field are \( E_x = 6.00 \times 10^3 \, \text{N/C} \) and \( E_y = 8.00 \times 10^3 \, \text{N/C} \), respectively. (a) What is the magnitude of the force on the charge? (b) Determine the angle that the force makes with the +x axis.