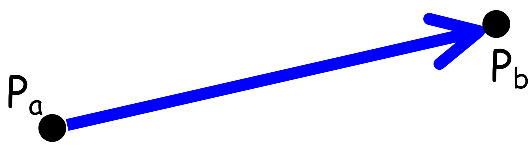
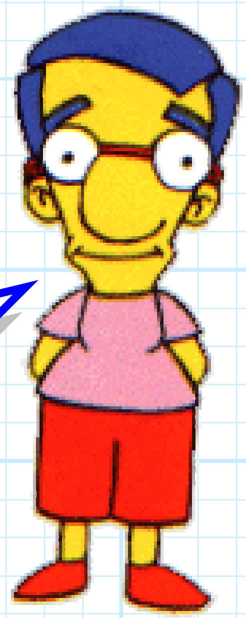
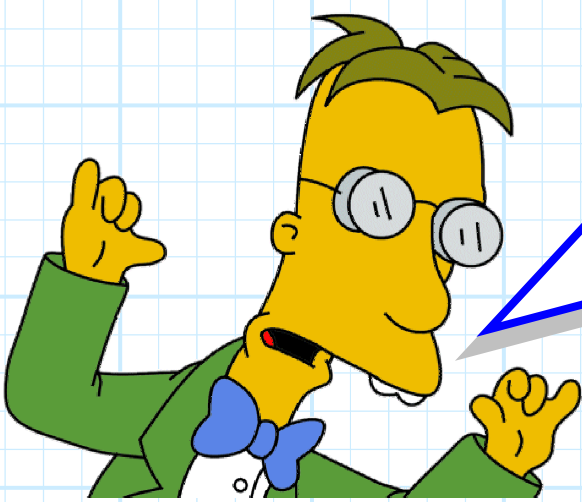
The Directed Distance

Q: *It appears that a discrete vector is an* ***easy*** *concept: it's simply an arrow that extends from* ***one point*** *in space to* ***another point*** *in space—***right?***



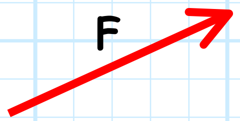




A: *Good heavens* ***NO!*** *Although this is* ***sometimes*** *a valid description of a vector, most of the time it is* ***not****.*

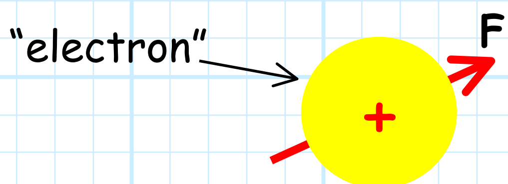
In ***most*** *physical applications, a discrete vector describes a quantity at* ***one specific point*** *in space!*

Remember the arrow representing a discrete vector is **symbolic**. The length of the arrow is **proportional** to the magnitude of the vector quantity; it generally does **not** represent a physical length!

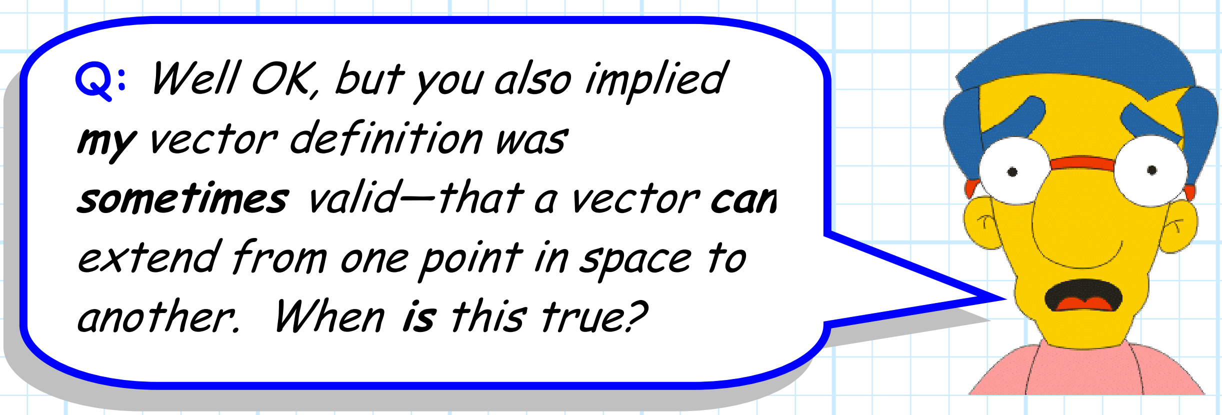


$$|\mathbf{F}| = 2.0 \text{ Newtons}$$

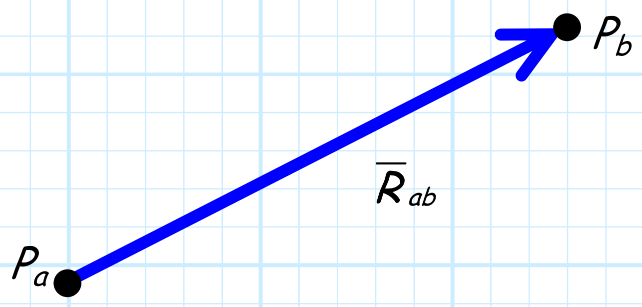
For example, consider a case where we apply a **force** to an **electron**. This force might be due to gravity, or (as we shall see later) an electric field. At any rate, this force is a **vector** quantity; it will have a **magnitude** (in Newtons), and a **direction** (e.g., up, down, left, right).



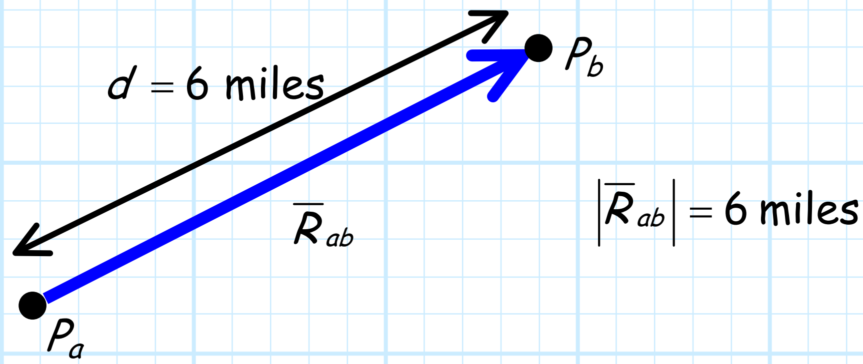
The force described by this vector is applied **at the point** in space where the electron (a **very** small object) is located. The force does **not** "extend" from **one point** in space near the electron to **another point** in space near the electron—it is applied to the electron **precisely** where the electron is located!



A: A vector that extends from one point in space (point *a*) to another point in space (point *b*) is a **special** type of **vector** called a **directed distance**!

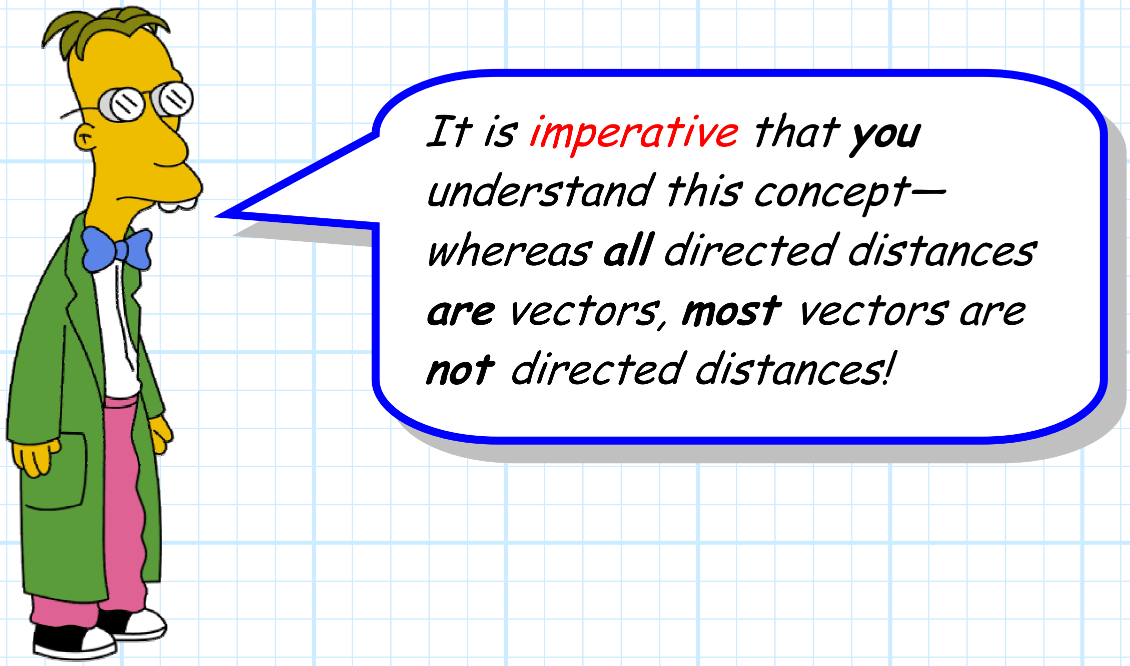


The arrow that represents a **directed distance** vector is **more** than just symbolic—its length (i.e., magnitude) is **equal** to the distance between the two points!

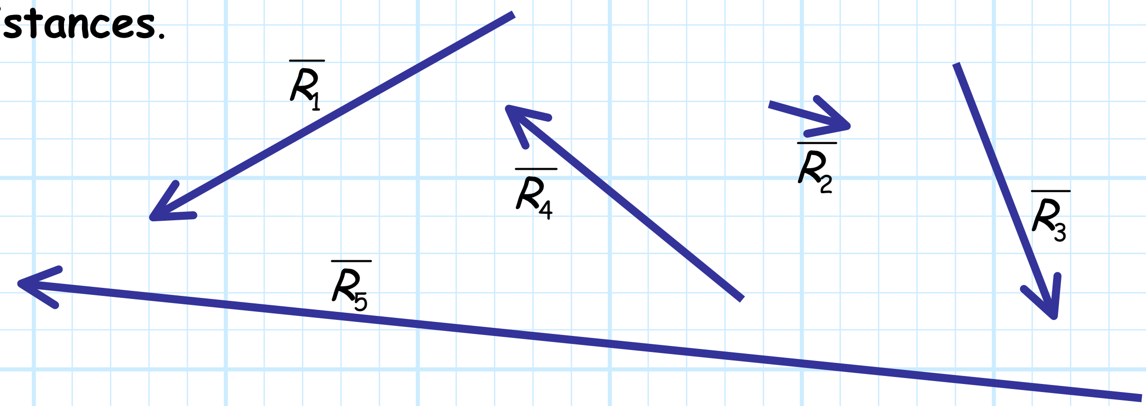


Note the **direction** of the directed distance vector $\bar{R}_{ab}$ indicates the direction of point P_b with respect to point P_a.

Thus, a directed distance vector is **used** to indicate the **location** (both its distance and direction) of one point with respect to another.



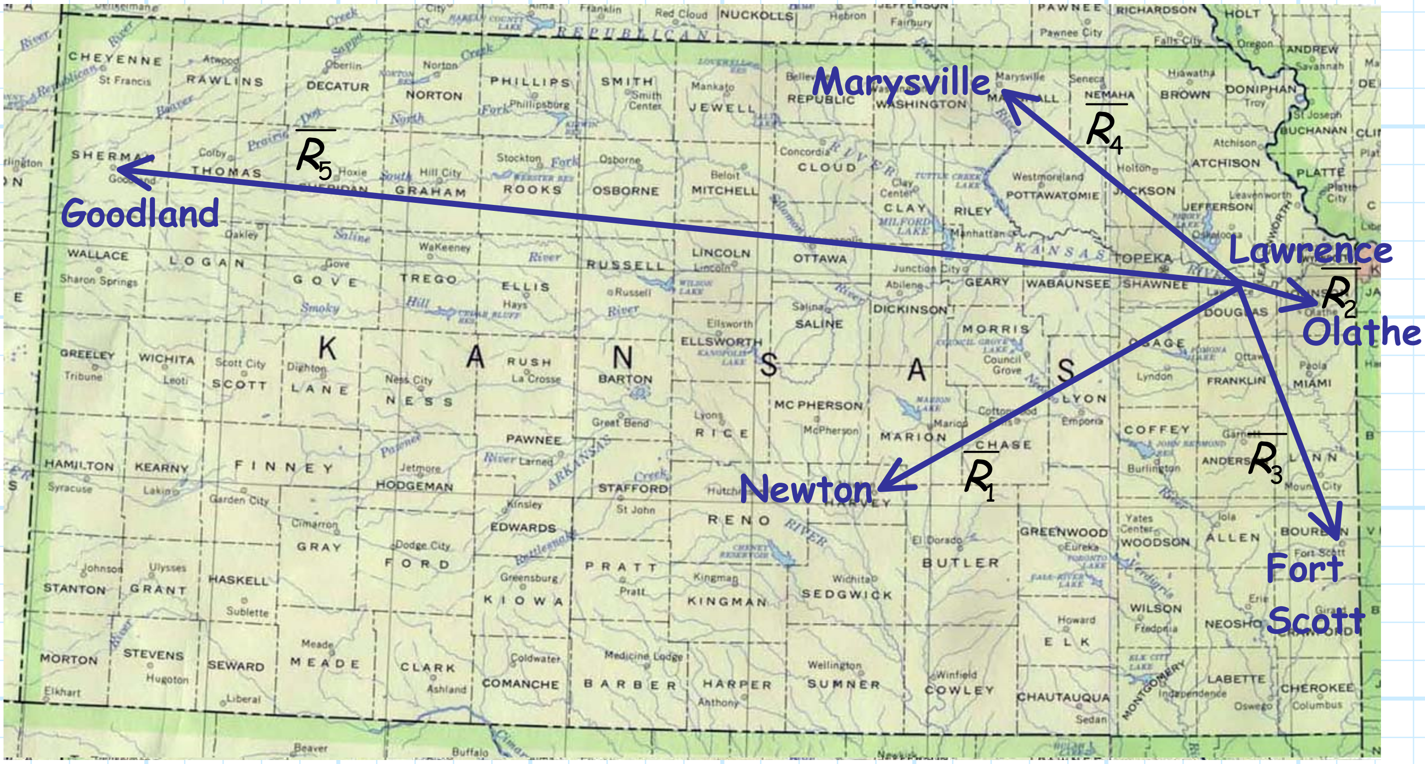
For example, the **vectors** below are all examples of **directed distances**.



Q: *What the heck do these vectors* ***tell*** *us ??*

A: The **location** of some of your hometowns !

These directed distances represent the **direction** and **distance** to towns in Kansas, with **respect to** our location here in Lawrence.



For example:

a) Newton is **150 miles southwest** of Lawrence.
b) Olathe is **30 miles east** of Lawrence.
c) Fort Scott is **100 miles south** of Lawrence.
d) Marysville is **100 miles northwest** of Lawrence.
e) Goodland is **350 miles west** of Lawrence.

The location of each town is identified with both a **distance** and **direction**. Therefore a **vector**, specifically a **directed distance**, can be used to indicate the location of each town.

Typically, we will use directed distances to identify points in **three-dimensions** of space, as opposed to the two-dimensional examples given here.