Vectors

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CONCEPT 1 Vectors

In order to solve two dimensional problems it is necessary to break all vectors into their x and y components. Different dimensions do not 'talk' to each other. Thus one must use the equations of Motion (from One-Dimensional Motion chapter) once for the x-direction and once for the y-direction. For example, when working with the x-direction, one only includes the x-component values of the vectors in the calculations. Note that if an object is 'launched horizontally', then the full value is in the x-direction and there is no component in the y-direction.

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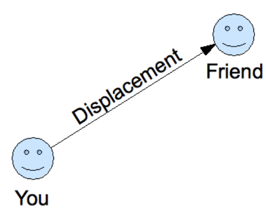
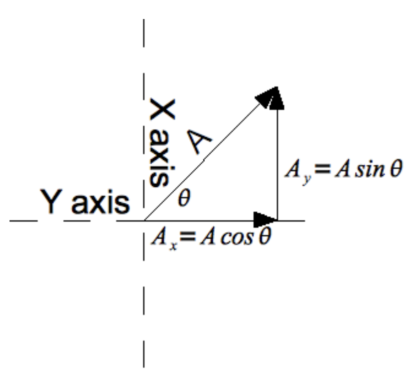
Key Equations

Vectors The first new concept introduced here is that of a vector: a scalar magnitude with a direction. In a sense, we are almost as good at natural vector manipulation as we are at adding numbers. Consider, for instance, throwing a ball to a friend standing some distance away. To perform an accurate throw, one has to figure out both where to throw and how hard. We can represent this concept graphically with an arrow: it has an obvious direction, and its length can represent the distance the ball will travel in a given time. Such a vector (an arrow between the original and final location of an object) is called a displacement:



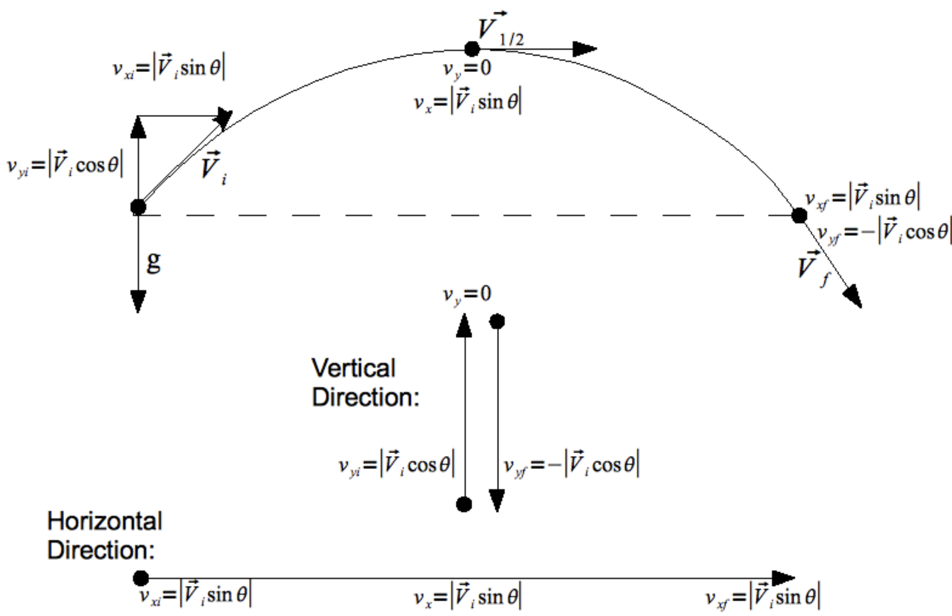
Vector Components From the above examples, it should be clear that two vectors add to make another vector. Sometimes, the opposite operation is useful: we often want to represent a vector as the sum of two other vectors. This is called breaking a vector into its components. When vectors point along the same line, they essentially add as scalars. If we break vectors into components along the same lines, we can add them by adding their components. The lines we pick to break our vectors into components along are often called a **basis**. Any basis will work in the way described above, but we usually break vectors into *perpendicular* components, since it will frequently allow us to use the Pythagorean theorem in time-saving ways. Specifically, we usually use the x and y axes as our basis, and therefore break vectors into what we call their x and y components:



A final reason for breaking vectors into perpendicular components is that they are in a sense independent: adding vectors along a component perpendicular to an original component one will *never* change the original component, just like changing the y-coordinate of a point can never change its x-coordinate.

Guidance

Break the Initial Velocity into its Components



Example 1 A tennis ball is launched 32° above the horizontal at a speed of 7.0 m/s. What are the horizontal and vertical velocity components?

Question: v_x and $v_y = ?\ [m/s]$

Given: $v = 7.0\ m/s$

$\theta = 32°$

Equation: $v_x = v\cos\theta \qquad v_y = v\sin\theta$

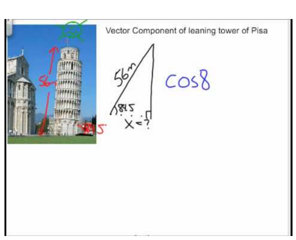
Plug n' Chug: $v_x = v\cos\theta = (7.0\ m/s)\cos(32°) = 5.9\ m/s$

$v_y = v\sin\theta = (7.0\ m/s)\sin(32°) = 3.7\ m/s$

Answer:

$$\boxed{\mathbf{5.9\ m/s, 3.7\ m/s}.}$$

Watch this Explanation



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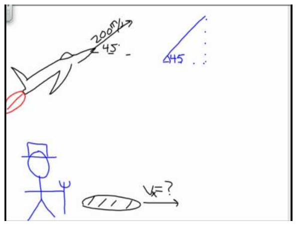

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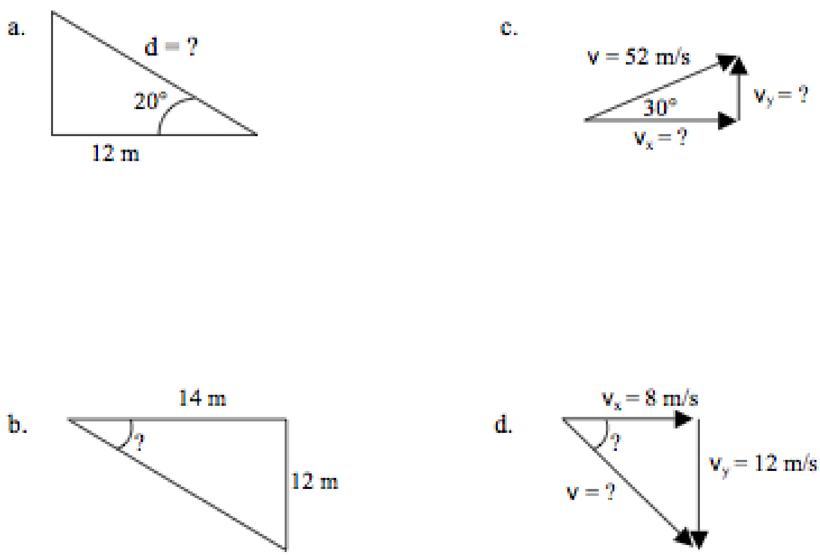
Time for Practice

1. Find the missing legs or angles of the triangles shown.



2. Draw in the $x-$ and $y-$velocity components for each dot along the path of the cannonball. The first one is done for you.