

Notes - Regular Physics - Chapter 3

Two Dimensional Motion and Vectors

I. The nature of physical quantities: scalars and vectors

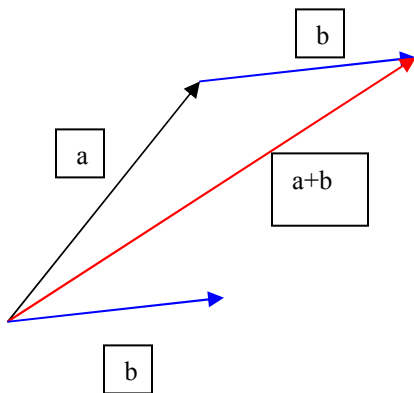
- _____—quantity that describes only magnitude (how much), **NOT** direction; e.g., mass, temperature, time, volume, distance, speed, etc.
- _____—describes magnitude and direction; e.g., displacement, velocity, force, etc.
 - speed is the _____ of velocity; velocity must include both magnitude (speed) and direction
 - on diagrams, arrows are used to represent vector quantities; the direction of the arrow gives the direction of the vector and the magnitude of the vector is proportional to the length of the arrow

Frames of reference—standard for comparison

- Any _____ of position, distance, or speed is made against a frame of reference; “with respect to Earth” is most common; measurements may differ in different frames of references

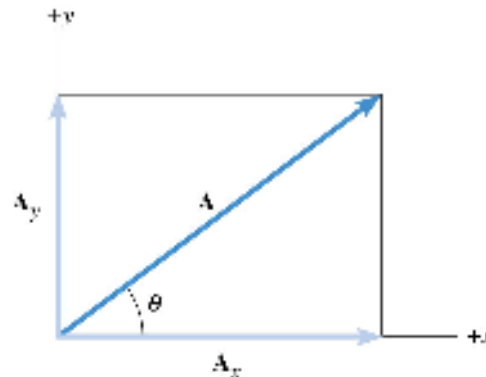
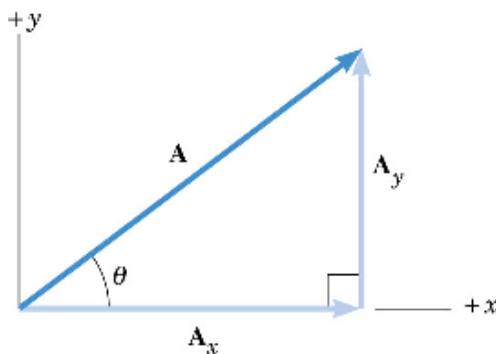
II. Addition of vectors

- **To add vectors**, add x- components to find total displacement in x direction, then add y components to find total displacement in the y direction; use _____ to find the magnitude of the resultant and inverse tangent to find the angle of the resultant
- Two methods we can use to add vectors:
 1. **Graphical Method** (ruler and protractor required for precise results). Notice that to find the vector sum of a and b, you arrange vectors a and b “head-to-tail” and then draw the resultant (a+b) from the origin of the first vector to the tip of the “head-to-tail” arrangement.

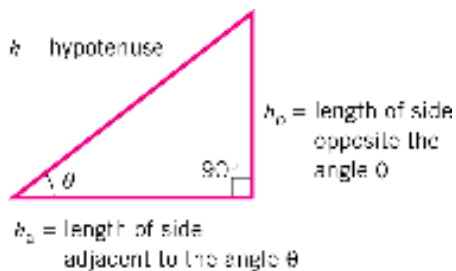


2. Component Method: Addition using components of vectors

You will soon learn that motion in the x direction (horizontal) is independent of motion in the y direction (vertical). Vectors are often described by using only their x (or horizontal) and y (or vertical) components. A _____ **component** is the portion of the vector along the x- or y-axis. **Negative of a vector**—has the same magnitude but opposite direction. The diagrams below show two alternative ways to graphically show components.



- Determine x and y component for each _____; $\cos \theta$ for x and $\sin \theta$ for y
- Add the components to determine the components of the resultant
- Use _____ to find the magnitude of the resultant and use trig functions to get the angle. The angle is necessary because you must give direction for a vector quantity.
- For example: $\tan \theta = y/x$ so use $\tan^{-1}(y/x)$ to calculate angle θ
- The same procedure will work for other trig functions to get the angle when the sides are known.



$$\sin \theta = \frac{h_o}{h}$$

$$\cos \theta = \frac{h_a}{h}$$

$$\tan \theta = \frac{h_o}{h_a}$$

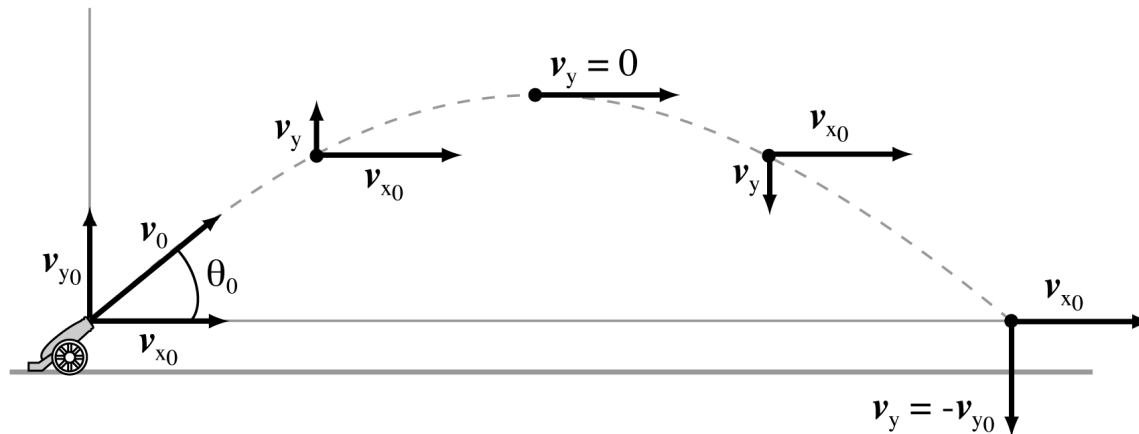
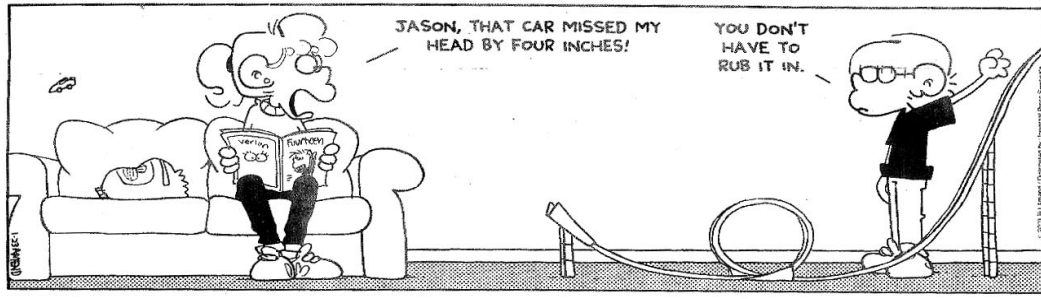
$$c^2 = a^2 + b^2$$

$$h^2 = h_o^2 + h_a^2$$

- **Example 1.** A hiker begins a trip by first walking 25.0 km due east from her base camp. On the second day she walks 40.0 km north, at which point she discovers a forest ranger's tower. Determine the displacement from the camp to the tower.
- **Example 2.** A plane whose airspeed is 200 km/h heads due north. But a 100 km/h east wind (wind blowing to the East) suddenly begins to blow. What is the resulting velocity of the plane with respect to the ground?
- **Example 3.** A boat's speed in still water is 1.85 m/s. If the boat is to travel directly across a river with a current of 1.20 m/s, at what angle must the boat head with respect to the bank upstream?

III. Projectile Motion

FOX TROT

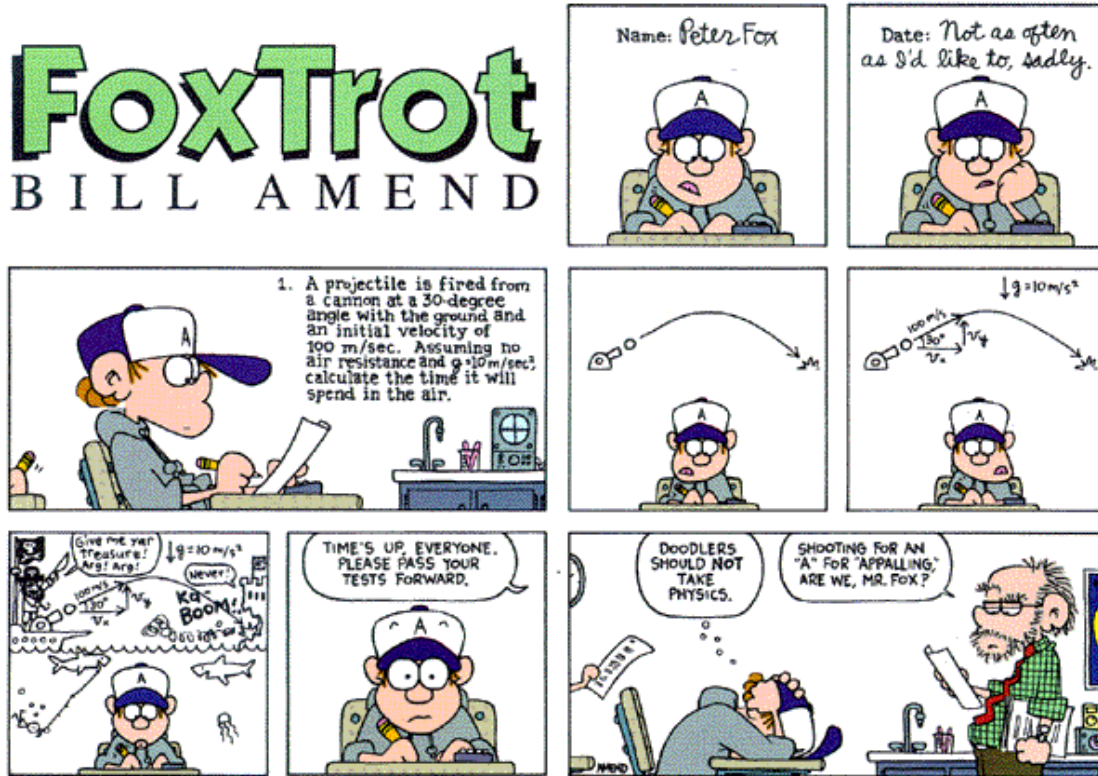


- Projectile _____ – refers to objects that are thrown or launched into the air and are subject to gravity. **Motion in the x direction (horizontal) is independent of motion in the y direction (vertical)**
- When solving projectile problems, motion in the horizontal is analyzed independently of motion in the vertical (vector analysis).
- Since air resistance is ignored, there is ***no acceleration in the horizontal direction so the x-component of velocity remains constant for the entire time of flight. The vertical motion is not constant velocity...IT IS _____! It is the same as a free falling object with the acceleration of gravity.***
- Time is the key that ties the motions together! ***Time of flight for vertical and horizontal component is the same.*** To play with some numbers and try them out on a virtual projectile lab go to:
http://galileoandstein.physics.virginia.edu/more_stuff/Applets/ProjectileMotion/jarapple.t.html
- . The table below lists the equations used to solve projectile problems

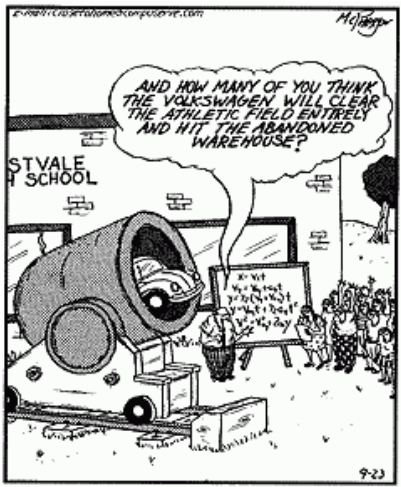
<i>X Component Equation</i>	<i>Equations Given on Test</i>	<i>Y Component Equations</i>
$x = v_{ox}t$	$x = x_o + v_o t + \frac{1}{2}at^2 \quad \rightarrow$	$y = y_o + v_{oy}t + \frac{1}{2}gt^2$
	$v = v_o + at \quad \rightarrow$	$v_y = v_{oy} + gt$
	$v^2 = v_o^2 + 2a(x - x_o) \quad \rightarrow$	$v_y^2 = v_{oy}^2 + 2g(y - y_o)$

FoxTrot

BILL AMEND



- Example 4.** A football is kicked at an angle of 37.0° with a velocity of 20.0 m/s. Calculate the maximum height, the time of travel before the football hits the ground, how far away it hits the ground. You will need to find the x and y components of the initial velocity to use in this problem!



Thanks to the innovative labs of teacher Herb Krenley, physics quickly became Westvale High's most popular course.

- Example 5.** A baseball rolls off a 0.70 m high desk and strikes the floor 0.25 m away from the base of the desk. How fast was the ball rolling when it left the desk?