Physics 20

Unit A: Motion in one and two dimensions

Relative motion and projectiles

A kayak pointed north on the Bow

- A kayak near Prince’s Island points north at 2.00 m/s relative to the water while the Bow River current is 1.50 m/s east.
- The shore sees both of those velocities at once, so the two arrows add as vectors.

Projectile components

- The kayak's velocity past the shore equals its velocity through the water plus the water's velocity past the shore.
- A component is the part of the velocity along east or along north.
- Measure the angle from the axis you named, and keep it under 90 degrees.
- Projectile motion keeps a steady horizontal component and a vertical component with acceleration 9.81 m/s^2 downward.

Key terms

relative velocity

Relative velocity is the velocity of one object measured by an observer who may also be moving. In v_AC, A is the object and C is the observer. (v_AC = v_AB + v_BC)

component

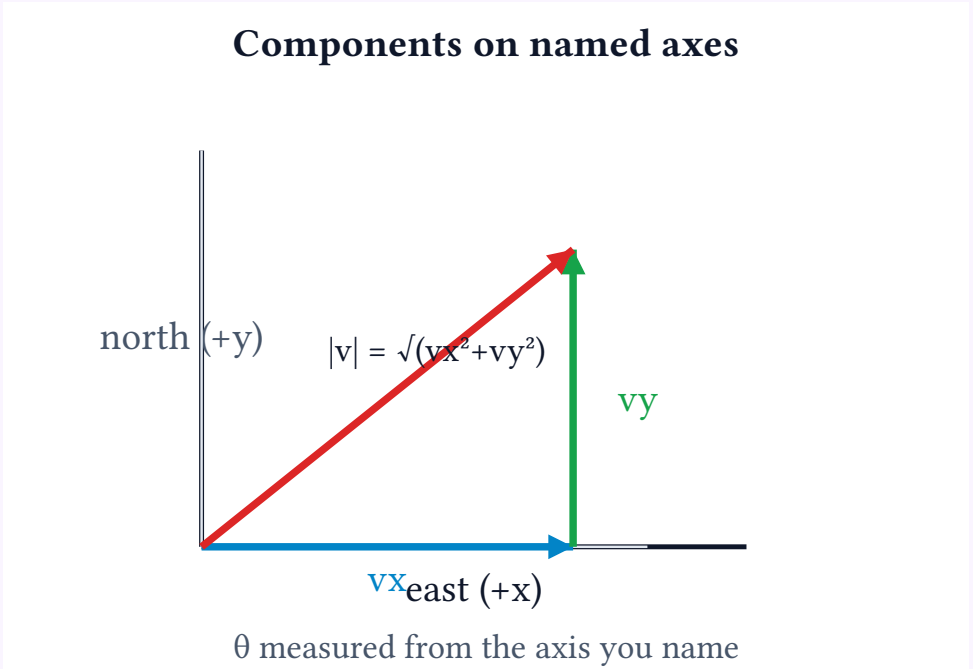
A component is the signed part of a vector along one named axis, such as north or horizontal.

projectile motion

Projectile motion near Earth splits into a steady horizontal velocity and a vertical motion with acceleration 9.81 m/s² downward.

Components along named axes

- Place each velocity on its own axis before you combine the arrows.
- The magnitude is the square root of the sum of the squared components.
- State the angle from the axis you named, such as 37 degrees east of north.



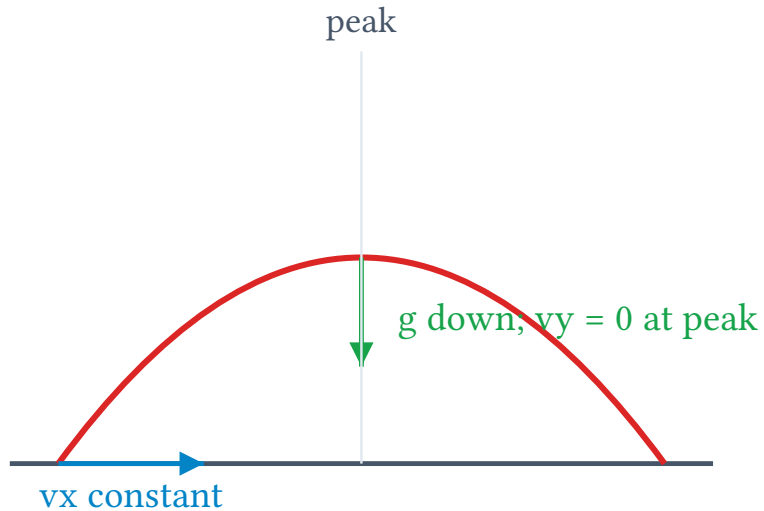
Shore velocity of the Bow kayak

- The kayak component relative to the water is 2.00 m/s north.
- The current component relative to the shore is 1.50 m/s east.
- The shore resultant is 2.50 m/s at 36.9 degrees east of north.

Horizontal rate and vertical free motion

- With air left out, the horizontal velocity stays the same for the whole flight.
- The vertical velocity changes steadily. g is 9.81 m/s squared downward.
- Time of flight comes from the vertical motion, and range is the horizontal velocity times that time.

Horizontal and vertical motion split



g = 9.81 m/s² down sets flight time; range = vx·t

A parcel from a loading dock

- A parcel is tossed horizontally at 5.00 m/s from a dock 1.77 m above the pavement.
- The vertical displacement determines the time of flight.
- The range is the horizontal velocity times that time.

A kick at forty degrees

- A football at McMahon is kicked at 16.0 m/s at 40 degrees above the horizontal.
- Upward is positive, so the vertical acceleration is $-9.81\ \text{m/s}^2$.
- Find the time of flight and the range.