Gravity Part II: near-surface projectiles

- Can ignore the curvature of Earth's surface - pretend it's flat
- Can ignore variations of the strength and direction of the gravitational force - pretend it's always mg straight down, with $g = 9.8$ m/s^2 fixed.
- Need to distinguish 2 directions: "Horizontal" = x (along Earth's surface) and "Vertical" = y (up and down).
- Position described by **two** functions $x(t)$, $y(t)$.
  Velocity has also **two** components: $v_x(t)$ and $v_y(t)$.
  Acceleration is **only** in $-y$ – direction.

Main point

- Motion in horizontal direction is completely decoupled from motion in vertical direction as long as we can ignore air resistance (break down all vectors - forces, accelerations, velocities into their x- and y-components).
- Horizontal equations:
  $a_x = 0$; v_x= const.; $x(t) = x_0 + v_x\, t$
- Vertical equations:
  $a_y = -g$; $v_y(t) = v_{y0} - gt$
  $y(t) = y_0 + v_{y0}\, t - {}^1/_2\, gt^2$
- Example: stone dropped from tree *vs*. thrown stone; sack dropped from airplane.

More examples

- Horizontal launch: $|\mathbf{v}_0| = 9$ m/s ; $x_0 = 0$ m ; $y_0 = 150$ m => t_{impact} ? $\mathbf{v}_{impact}$? x_{impact} ?
- Launch at an angle:
  - Time in flight (largest for straight up)
  - Distance traveled (equal for 30^o and 60^o, maximum for 45^o) see interactive Figure
- Shoot the monkey
- Ball launched from moving cart
- Ball launched from accelerated cart
  - Pulling force
  - Inclined track