The Physics of Superheroes: Deconstructing Superman
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What is a Superhero?
- “A fictional hero having extraordinary or superhuman powers; also an exceptionally skillful or successful person.”
- Examples include Superman, the Flash, Batman, Iron Man, and many others.
- Cartoon Animation influenced the development and creation of superhuman abilities.
- From Wil E. Coyote defying Gravity to Tom cheating death and Bugs Bunny outrunning a baseball he threw, “Cartoon Physics” allowed for the advent of superhero superpowers.

Who is Superman?
- Superman is Clark Kent
  - Alien from Krypton
  - Super Human Abilities
  - Powers:
    - X-ray Vision
    - Heat Vision
    - Flight
    - Super Speed
    - Super Strength
    - Cold Breath
    - Enhanced Hearing
  - Flown to Earth because his home world is on the verge of destruction

Superman’s ability to jump
- Superman can leap over very tall buildings in a single bound
- When an object moves through the air it experiences a Drag Force
  \[ F_{\text{Drag}} = bv + cv^2 \]
- For most projectiles like a cannonball, a golf ball, and a human in free fall we neglect \( bv \)
- The problem is what is Superman’s speed when he leaps an \( \frac{1}{2} \) of a mile upward (60 story building) upward
- Utilize the Recursion Relation for velocity and position to determine velocity and position
  \[ v_{i+1} = -\left( \frac{K}{m} v_i^2 + g \right) i \Delta t + v_i \]
  \[ y_{i+1} = v_i i \Delta t + y_i \]
- Drag Force for a Human is:
  \[ F_{\text{Drag}} = \frac{1}{2} \rho AC_D v^2 \]
- We can rewrite our recursion relation as follows:
  \[ v_{i+1} = -\left( \frac{\rho AC_D}{2m} v_i^2 + g \right) i \Delta t + v_i \]
- Then using a computer program where inputs are velocity and time steps the height can be determined and then compared to the height of the building
- He jumps with an initial velocity of \( 82 \frac{m}{s} \)

Gravity on Krypton
- Superman and Dwight Howard crouch 55 cm before they jump
- Their acceleration can be calculated using kinematics
  \[ a = \frac{v^2}{2 \Delta x} \]
- Their accelerations are \( a_{\text{Dwight}} = 17.84 \frac{m}{s^2} \) & \( a_{\text{Superman}} = 6,112,73 \frac{m}{s^2} \)
- We can create a ratio with acceleration and gravity of Earth to Krypton to find the gravity on Krypton
  \[ a_{\text{Superman}} = \frac{a_{\text{Dwight}}}{g_{\text{Earth}}} g_{\text{Krypton}} \]
- \( g_{\text{Krypton}} = 342.6 \times 9.81 \frac{m}{s^2} = 3,361 \frac{m}{s^2} \)
- Krypton is supposedly the same radius as the Earth so we can rewrite Newton’s Law of Gravity Equation:
  \[ F = m_1 g = G \frac{m_1 m_2}{R^2} \Rightarrow g = \frac{4}{3} \rho \pi R \]
- Plugging in values we get a density of \( \rho = 1,888.193 \frac{g}{cm^3} \)
- We know of no matter this dense however this could be the reason as to why Krypton was destroyed

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