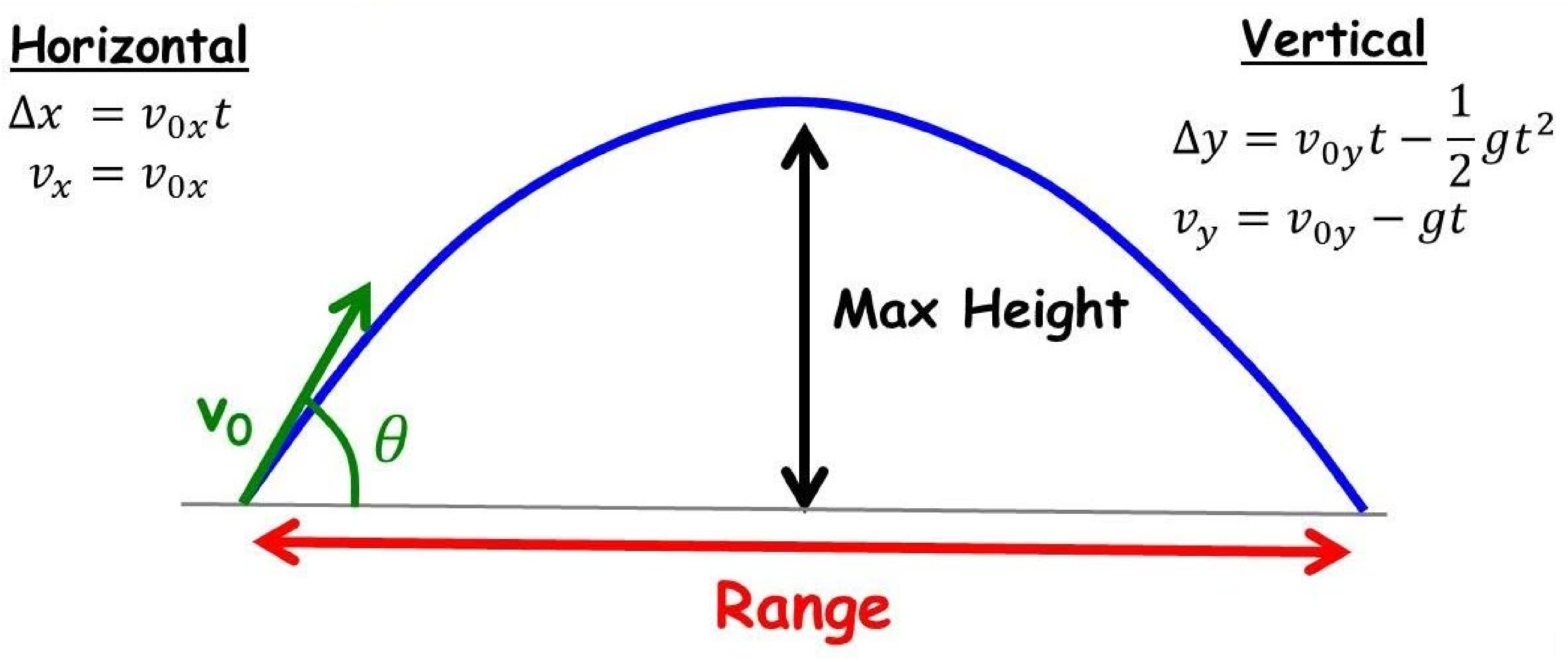
PHY151H1F Practicals 6 Intro Video Slides

- When analyzing projectiles in an introductory physics course, we are often asked to "neglect air resistance".
- If you do, the answer is pretty easy. The trick is just to separate your x and y components.



The Drag Equation

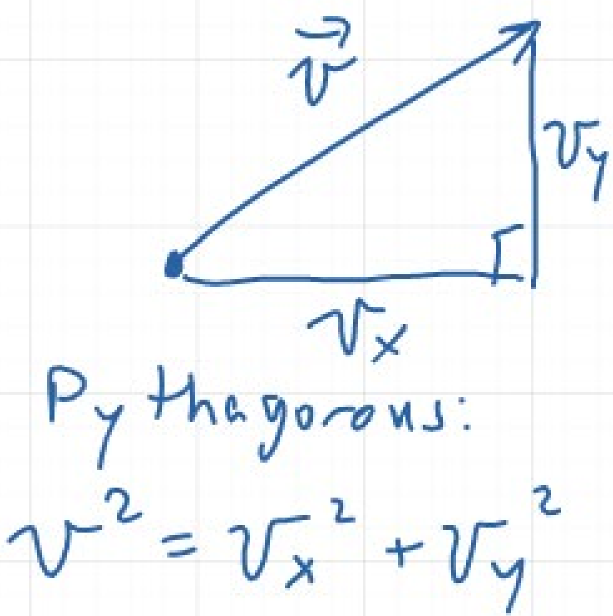
- Lord Rayleigh (1842-1919) came up with an equation describing the force of drag acting on an object when it moves without rotating through a fluid it is fully immersed in:

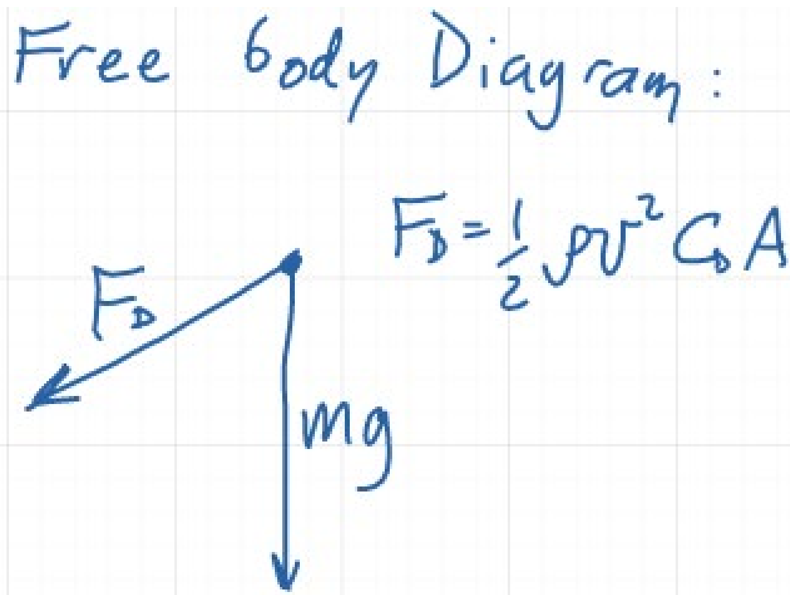
$$F_D = \frac{1}{2}\rho v^2 C_D A$$

- ρ is the density of the fluid [kg m^{-3}]
- v is the speed of the object [m s^{-1}]
- A is the cross-sectional area of the object, measured perpendicular to the velocity [m^2]
- C_D is a dimensionless "drag coefficient", related to the shape and smoothness of the object.
- The direction of $\vec{F}_D$ is opposite that of the velocity $\vec{v}$.

Projectile Motion with Simple Drag

- A ball moves without rotating through the air with velocity $\vec{v}$, with known components v_x and v_y, where x is horizontal and $+y$ is up.
- What is the acceleration of the object? Express the acceleration components a_x and a_y in terms of components of the velocity v_x and v_y.





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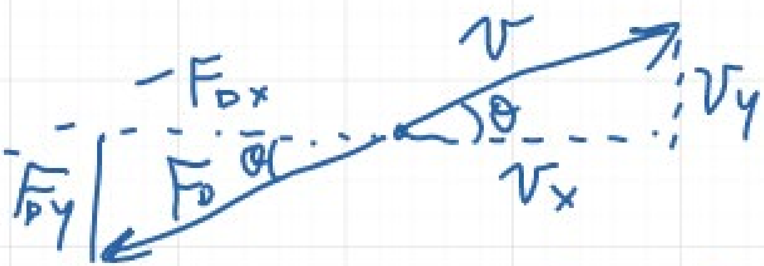

$$\sin\theta = \frac{v_y}{v} = \frac{-F_{Dy}}{F_D}$$

$$F_{Dy} = -F_D \frac{v_y}{v}$$

$$\cos\theta = \frac{v_x}{v} = -\frac{F_{Dx}}{F_D}$$

$$F_{Dx} = -F_D \frac{v_x}{v}$$

$$a_x = \frac{F_{Dx}}{m} = -\frac{1}{2m}\left(C_D \rho A v_x \frac{v^2}{v}\right) = -\frac{1}{2m}\left(C_D \rho A v_x \sqrt{v_x^2 + v_y^2}\right)$$

$$a_y = \frac{-mg + F_{Dy}}{m} = -g - \frac{1}{2m}\left(C_D \rho A v_y \sqrt{v_x^2 + v_y^2}\right)$$