LECTURE 13

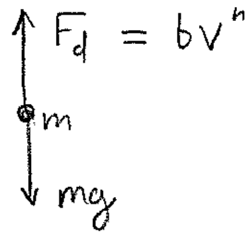
- DRAG FORCE & TERMINAL VELOCITY, A STUDY OF ONE SPECIAL TYPE OF VELOCITY DEPENDENT FORCE. (§5.2 Tipler)

The formula for force due to drag by some gas/liquid generally takes the form

$$F_{drag} = bv^n$$

(question: does b depend on m for real physical cases?)

where the direction is opposite the motion. This relation is the macroscopic manifestation of a host of molecular interactions.... often the value for n is taken to be 1 or 2 but different phenomena are better modeled by other n. Consider case of falling mass m,



$$ma_y = -mg + bv^n$$

Note, mg is a constant (it's the weight of m) so as v increases the $-mg$ stays fixed whereas bv^n increases until they balance and give $a_y \approx 0$.
When $F_d \approx mg$ we've reached <u>terminal velocity</u>

$$0 = -mg + bV_T^n$$

$$\hookrightarrow \quad V_T = \sqrt[n]{\frac{mg}{b}}$$

(note: if $b \neq b(m)$ then V_T is larger for larger m. The real story, is complicated)

E1 If $b = \frac{9.81\,N}{m/s}$ and $F_d = bV$ then V_T for $m = 3kg$ is found by $0 = -mg + bV_T \rightarrow V_T = \frac{mg}{b} = \frac{(3kg)(9.81\,\frac{m}{s^2})}{9.81\,\frac{Ns}{m}}$

$$\boxed{V_T = 3\,m/s}$$

Remark: see **E16** of Lecture 4 for mathematically complete sol^{n} of F_d-force problem