L 13: March 7.

It's RA Appreciation Day! — Thanks, Steve and Kayla, for being RAs!

Last time: Frictionless falling

Questions?

This time: Incorporating friction

- Newton's 2^{nd} Law :

$$\underbrace{F}_{\substack{\text{force}\\\text{acting on}\\\text{body}}} = \underbrace{m}_{\substack{\text{mass of}\\\text{body}}}\ \underbrace{a}_{\substack{\text{resulting}\\\text{accelerat'n}\\\cancel{\text{caused}}}}$$

- Typically, force is measured in Newtons, N.

$$1\,N = 1\,\frac{kg \cdot m}{s^2}$$

QR.

(a) Mass of an object that weighs 981 N

(use the fact that the acceleration due to gravity is $+9.81\ m/s^2$.)

$$m = \frac{F}{a} = \frac{981\ kg \cdot m/s^2}{9.81\ m/s^2} = 100\ kg.$$

(b) What accel. results when net force 10 N is applied to an object w. mass 5 kg?

$$a = \frac{F}{m} = \frac{10\ kg\ m/s^2}{5\ kg} = 2\ m/s^2.$$

Kinetic fric'n, or drag, is another kind of force:

(1) Stokes's Friction: fric'n on a small particle travelling slowly is approximately prop'l to velocity:

$$\underbrace{F}_{\text{fric'n}} = \underbrace{k}_{\text{const.}}\ \underbrace{v}_{\text{velocity of particle}}$$

const. (dep. on the fluid & on the object travelling through the fluid)

(2) Newtonian Friction:

$$\underbrace{F}_{\text{fric'n}} = \cancel{\ }\ \frac{1}{2}\ \underbrace{C}_{\text{drag coeff. (unitless)}}\ \underbrace{D}_{\text{density of fluid matrix } [kg/m^3]}\ \underbrace{A}_{\text{cross sec'l area in direc'n of movement. } [m^2]}\ \underbrace{v^2}_{\text{velocity}^2.\ [m^2/s^2]}$$

drag coeff. (unitless) ✓

For air, density at sea level is $1.29\ kg/m^3$;

" water, density at 3.98 C is $1\ g/cm^3$.

Typical values of drag coefficient:

- "hydrodynamically good": $C < 1$
- spheres: $C = 1$
- "hydrodynamically inefficient": $C > 1$

To take care of the issue abt. fric'n always opposing the direc'n of mot'n, change formula:

$$F = -\frac{1}{2} C D A |v| v$$