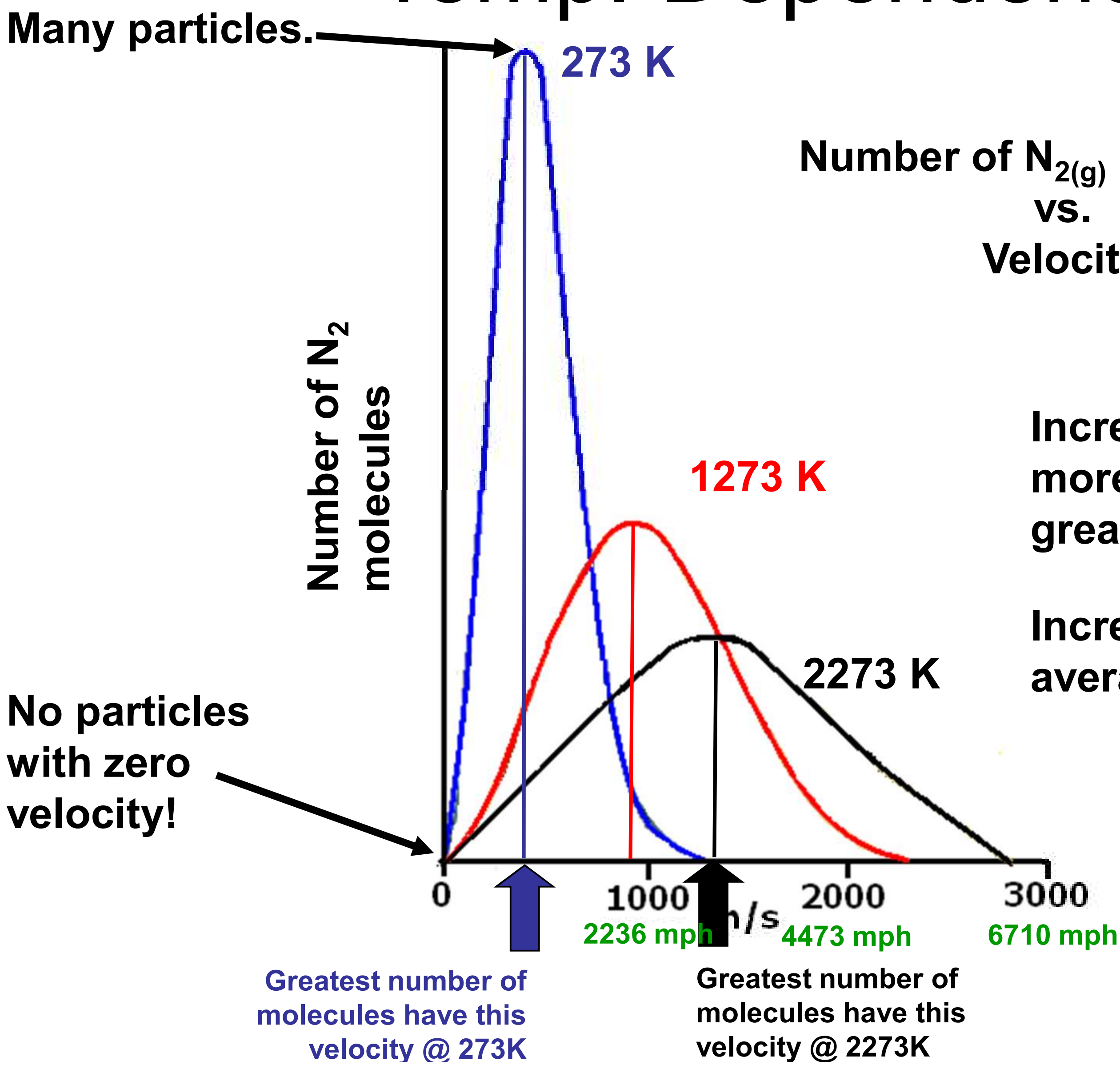
Particle Velocity: Temp. Dependence



Number of $N_{2(g)}$ molecules vs. Velocity

Increase temperature ⇒ more molecules will have greater velocities.

Increase Temperature ⇒ average velocity increases.

Average Kinetic Energy

R=8.314 J/mol K

$$\overline{K.E.} = \bar{E}_k = \frac{3}{2} \times \frac{R}{N_a} \times T$$

$N_a = 6.022 \times 10^{23}$

$$\overline{K.E.} = \bar{E}_k \propto T$$

Average Kinetic Energy is proportional to the Temperature (K)

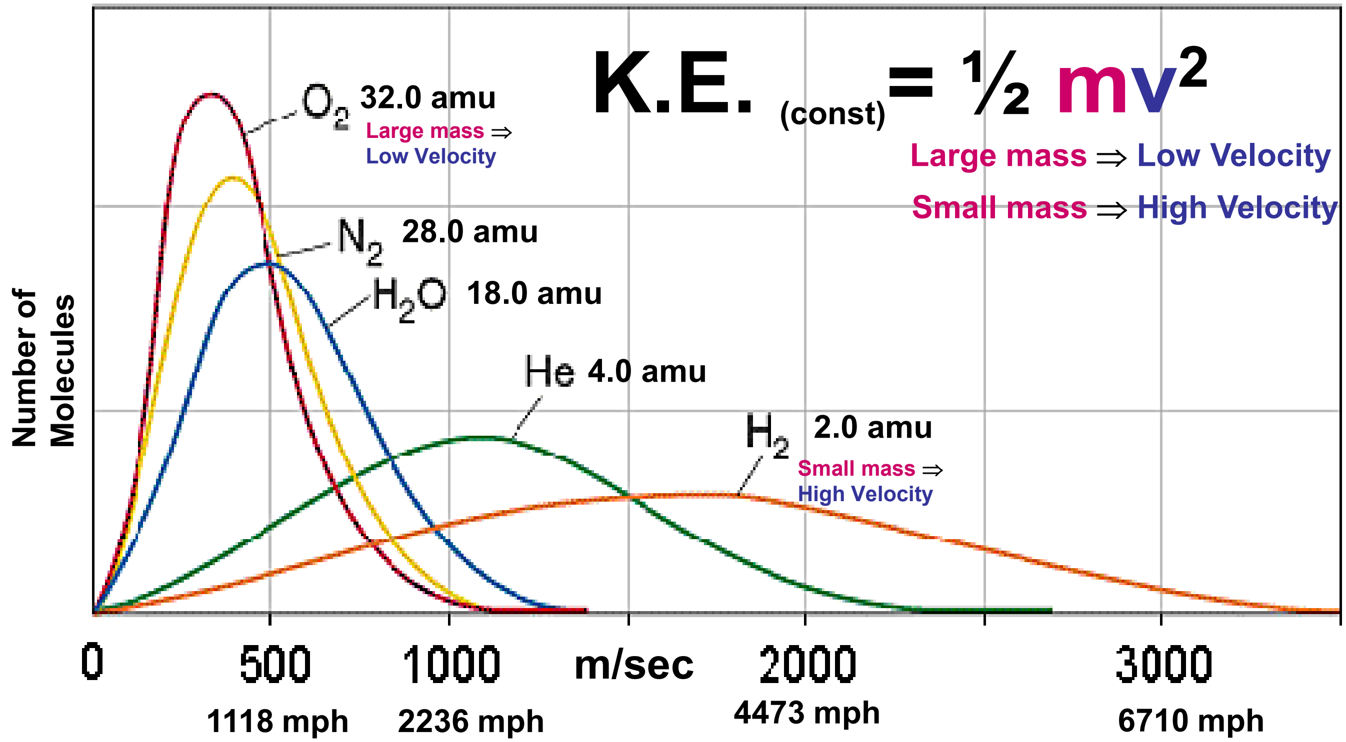
...that is, as the temperature increases, so does the average kinetic energy of the molecule...

Particle Velocity: Mass Dependence

273 K: Constant Temperature

Consider the following molecules to have the same K.E.

O_2, N_2, H_2O, He, H_2

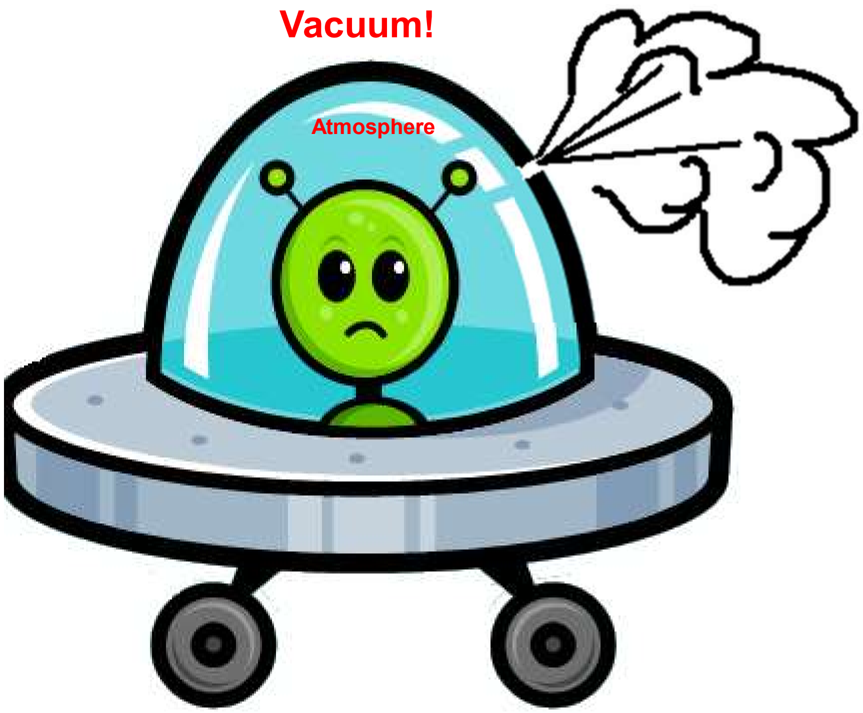


http://itl.chem.ufl.edu/2045/lectures/lec_d.html

Different velocity distributions! Why?

Graham's Law of Effusion

Effusion: Gas expanding through a small hole into vacuum.



"My atmosphere is a mixture of Ar and He gas"

"$He_{(g)}$ will leave 3.2 times more quickly than $Ar_{(g)}$"

$$Rate_{effusion} \propto \frac{1}{\sqrt{M}}$$

Small low-mass molecules effuse with higher rates that is, more quickly than high mass species

...or...

$$\frac{Rate_{gas1}}{Rate_{gas2}} = \frac{\sqrt{M_2}}{\sqrt{M_1}}$$

$$\frac{Rate_{He}}{Rate_{Ar}} = \frac{\sqrt{M_{Ar}}}{\sqrt{M_{He}}}$$

$$\frac{Rate_{He}}{Rate_{Ar}} = \frac{\sqrt{39.9\ amu}}{\sqrt{4\ amu}}$$

$$\frac{Rate_{He}}{Rate_{Ar}} = 3.2$$

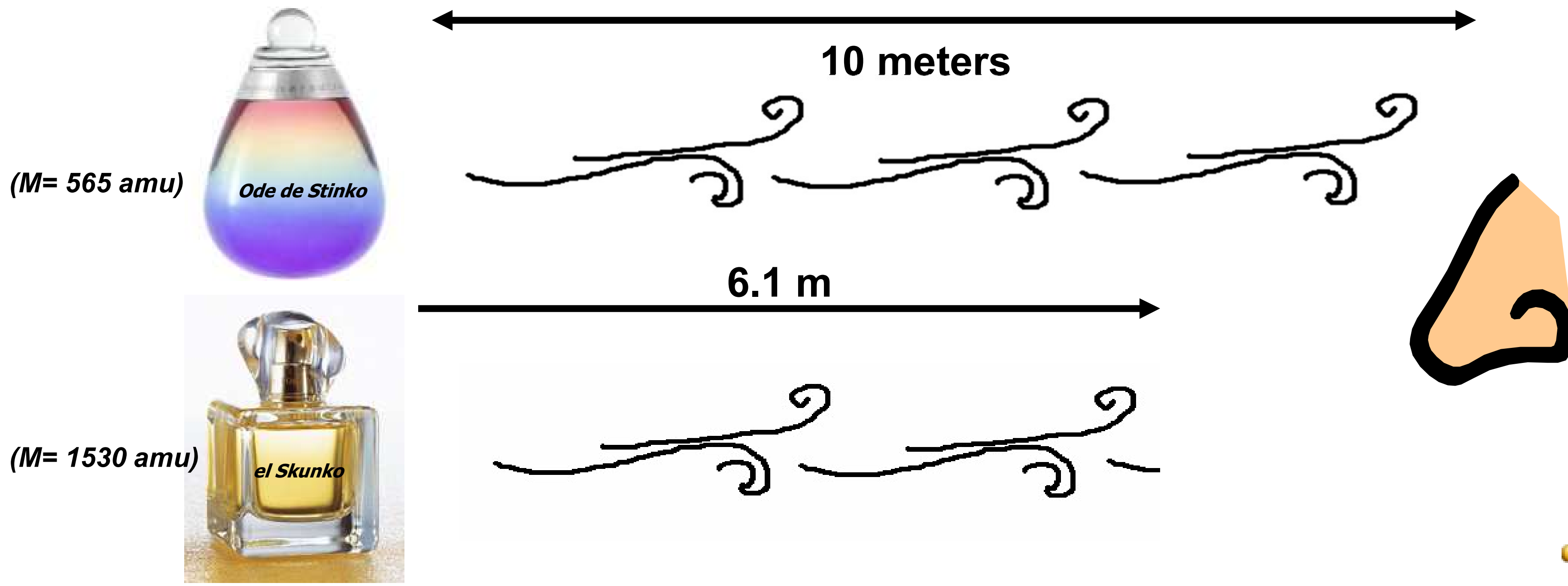
Diffusion

The movement of one gas (or liquid) through another.

Graham's Law Applies:

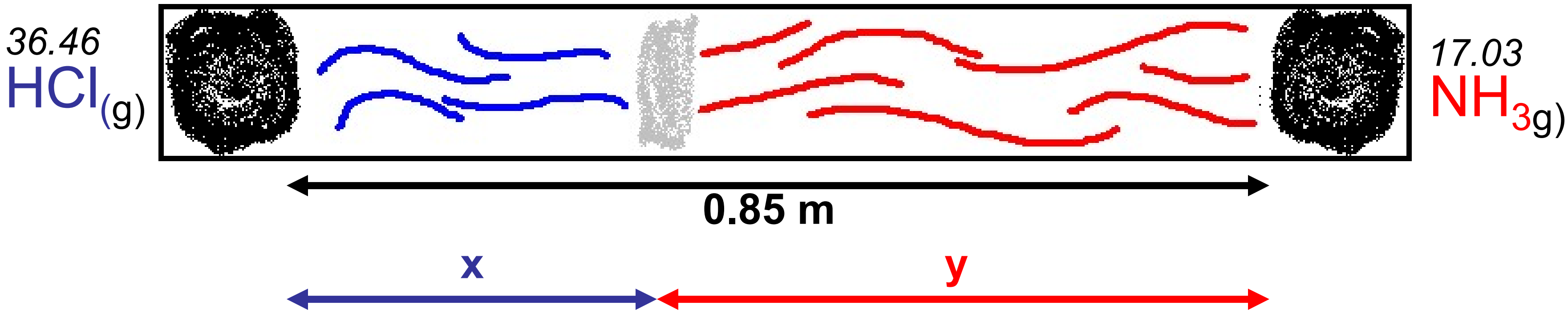
$$\frac{Rate_{gas1}}{Rate_{gas2}} = \frac{\sqrt{M_2}}{\sqrt{M_1}} \qquad \frac{Rate_{skunko}}{Rate_{stinko}} = \frac{\sqrt{M_{stinko}}}{\sqrt{M_{skunko}}} = \frac{\sqrt{565}}{\sqrt{1530}} = 0.61$$

Two lovely new fragrances!



Diffusion:

$$HCl_{(g)} + NH_{3(g)} \rightarrow NH_4Cl_{(s)}$$



$$x + y = 0.85m \qquad y = 0.85m - x$$

$$\frac{Rate_{NH3}}{Rate_{HCl}} = \frac{\sqrt{36.46\text{ amu}}}{\sqrt{17.03\text{ amu}}} = 1.46 \qquad \frac{y/t}{x/t} = \frac{y}{x} = 1.46$$

$$\frac{(0.85 - x)}{x} = 1.46 \qquad 1.46\,x = (0.85 - x)$$

x = 0.35 m **y = 0.50 m**