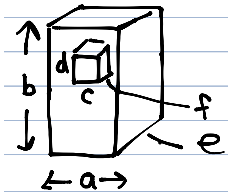
Demo with 6 wooden balls attached to different metal arms.

Which will drop off first, when the arms are heated?

Cu	AL	Bra	Ni	Fe	Stainless steel
385	205	109	91	80	14

Practice with H # 17.99 from HW



What is heat loss rate? we know $T_H, T_C, K_{door}, K_{wind}$

$A_{door} = ab - dc \quad A_{window} = dc$

$$H_{total} = H_{door} + H_{window} = \Delta T \left[\frac{K_{door} A_{door}}{e} + \frac{K_{window} A_{window}}{f} \right]$$

Ch 02 Thermo and gasses

Links macroscopic to the microscopic

bulk pressure	molecular mass
volume	Speed
Temp	K.E.
mass	

State variables   Equation of state $PV = NKT$ or $PV = nRT$

P → pressure
T → temp
V → volume
m → mass   or n(# moles) or N (# molecules)

Application Estimate # of air molecules in this room

$$\tilde{N} = \frac{PV}{KT} = \frac{0.78\,atm \frac{10^5 Pa}{1 atm}\, 3m \cdot 12m \cdot 14m}{1.38 \cdot 10^{-23} \frac{J}{K}\; 293K} = 10^{28}$$

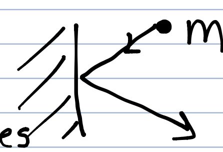
s1.html $P \propto T$ [E] 273°C

s2.html $P = \frac{NKT}{V}$ [C] and [C]

s3.html [C]

s4.html $T = \frac{PV}{NK}$ [B] is hottest

Gas at the molecular level



speed v

As a particle bounces off a wall, it undergoes $\Delta p_x = m \Delta v = m 2 v_x$

an eleastic collision, and thus a change in momentum. p

pressure due to the particle $= \frac{F}{A} = \frac{\Delta p/\Delta t}{A} = \frac{m 2 V_x/\Delta t}{A}$

since K.E. of a particle $= \frac{1}{2} m V_{avg}^2 = \frac{3}{2} nRT = \frac{3}{2} kT$ see §22

typical speed $v = \sqrt{\frac{3kT}{m}}$

Explains why there is hardly any H in Earth's atmosphere: small $m \rightarrow$ large velocity!

Atmosphere	%
N_2	78
O_2	21
Ar	1

O_2 in this room

$T = 293\ K$
$m = 2 \times 16 \times m_p = 5.34 \cdot 10^{-26} kg$ } $V_{O_2} = 476\ m/s$

H_2 in this room

$T = 293 K$
$m = 2 m_p = 3.34 \cdot 10^{-27} kg$ } $V_{H_2} = 1906\ m/s$

Example The Lagoon Nebula has a 45 light year diameter, it glows at 7500K, and has a density of 80 H atoms per cm^3.

a) Find the pressure of the gas

$$P = \frac{N}{V} kT = 80\ cm^{-3} \left(\frac{100\ cm}{1\ m}\right)^3 1.38 \cdot 10^{-23} J/K\ 7500\ K$$
$$= 8.28 \cdot 10^{-12}\ Pa = 8.17 \cdot 10^{-17}\ atm$$

b) Is it reasonable for sci-fi movies to show spacecraft being buffeted in nebula

This is a small #, however, we need to consider how fast spaceships move

"Ram pressure" is the pressure felt by an object moving through a gas.

$P_{Ram} = \rho v^2$

Earth's atmosphere

$\rho_{air} = 1.20\ Kg/m^3$

$V_{plane} = 600\ mph \approx 300\ m/s$

$P_{Ram} = 1.08 \cdot 10^5\ Pa \approx 1\ atm$

Lagoon Nebula

$\rho_{nebula} = 80\ cm^{-3}\ 1.67 \cdot 10^{-27} kg = 1.34 \cdot 10^{-19}\ Kg/m^3$

$v_{spaceship} \approx 10\% \ c = 3 \cdot 10^7\ m/s$

$P_{Ram} = 1.2 \cdot 10^{-4}\ Pa = 1.2 \cdot 10^{-9}\ atm$

55.html

1) $P = NkT/V$ don't know N → [illegible]

2) $N = \frac{PV}{kT}$ don't know P → $\boxed{E}$

3) $\boxed{C}$

4) $KE = \frac{1}{2} m v_{av}^2 = \frac{3}{2} kT$ True! $\boxed{A}$

5) $v_{rms} = \sqrt{\frac{3kT}{m}}$ → don't know m → $\boxed{C}$