$$\boxed{V_{rms}^{H_2} = \sqrt{\frac{3 \cdot 8.31 \cdot 293}{2 \cdot 10^{-3}}} = 1910\ m/s}$$

If earth a small asteroid.. gas escapes

(skip intermolecular collisions)

<u>Heat Capacity</u> (constant volume).

Monatomic Ideal Gas: all stored energy is translational kinetic energy!

total energy

$$\rightarrow E = K = \frac{3}{2}nRT = \frac{3}{2}NkT$$

$$dQ = nC_v dT = dE = \frac{3}{2}nRdT$$

constant volume

$$\boxed{C_v = \frac{3}{2}R}$$

per mole

ideal monatomic gas.

Diatomic Molecule

$\frac{1}{2}kT$ $\frac{1}{2}kT$ $\frac{1}{2}kT$ $\underbrace{\frac{1}{2}kT \quad \frac{1}{2}kT}$

transl x y z

2 degrees of freedom, ROTATION!

3'rd axis unmeasurable

$$E_1 = \frac{5}{2}kT$$

per mole: $E = N_A E_1 = \frac{5}{2}(N_A \cdot k)T$

$$\boxed{E = \frac{5}{2}RT}$$

diatomic $\boxed{C_V = \frac{5}{2}R}$

Vibration — Quantum Mechanics "Freezes Out" these

$\frac{1}{2}kT \ll$ Energy needed (Room Temp)

Solid: 3 translational

3 vibrational (solid generally not frozen out)

Fig 18.18

$\boxed{C_V \simeq 3R}$ per mole, $\sim 25 \frac{J}{K \cdot mole}$

Molecular Speeds

- molecules have a variety of velocities
- What is the distribution of ...

velocities, speeds

↑ ↑

3-d

$+\ -$!

$\underbrace{\geq 0,\ 1\ \text{dimensional}}_{\text{Test scores}}$

- Boltzmann Factor ... a molecule
  - → in thermal equilibrium
  - → temperature T (absolute)

1 molecule : $P(E) \propto e^{\frac{-E}{kT}}$

monatomic gas : $E = \frac{1}{2} m (v_x^2 + v_y^2 + v_z^2)$

$$P(v_x, v_y, v_z) \propto e^{\frac{-m(v_x^2+v_y^2+v_z^2)}{2kT}}$$

$M = N_A k$

$$\propto e^{\frac{-M(v_x^2+v_y^2+v_z^2)}{2RT}}$$

$R = N_A k$