13: rms Momentum Transfer

1 $x_j^2 = 27^2,\ 4^2,\ 39^2$

$$\overline{x^2} = \frac{1}{3}(27^2+4^2+39^2)$$

$$= \frac{1}{3}(2266) \rightarrow \sqrt{\overline{x^2}} = \sqrt{\frac{2266}{3}}$$

$$\boxed{\sqrt{\overline{x^2}} = 27.48 = \text{RMS of } \{27, 4, -39\}}$$

2 $T_C = \frac{5}{9}(T_F - 32) = \frac{5}{9}(60-32)$

$$T_K = \frac{5}{9}(28) + 273.15 = 288.7\,K$$

$$m = 9\,\text{amu}\left(\frac{1.66E-27\ kg}{1\,\text{amu}}\right) = 1.494E-26\ kg$$

$$v_{RMS} = \sqrt{\frac{3k_BT}{m}} = \sqrt{\frac{(3)(1.38E-23)(288.7)}{1.494E-26}}$$

$$\boxed{v_{RMS} = 894.4\ m/s}$$

3 Use proportional reasoning

$$v_{RMS} \sim \sqrt{\frac{T}{m}} \qquad \frac{v_2}{v_1} = \sqrt{\frac{m_1}{m_2}}$$

~~INVERSELY~~ INVERSLEY PROPORTIONAL TO SQUARE ROOT OF MASS

$$\boxed{v = \sqrt{\frac{7}{22}}(289) = 163\ m/s}$$

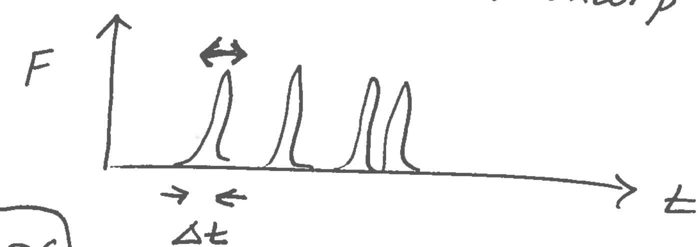
– Heavier atoms are slower.

4 Force to turn around a single particle in time Δt:

$$F = ma = \frac{m\Delta v}{\Delta t} = \frac{2mv}{\Delta t}$$

(since $v = v_f = -v_i$ and $\Delta v = v_f - v_i = v - -v = 2v$)

For brief forces, Δt is small, making $F = F(t)$ sharp peaks:



The average of N collisions "spreads out" the peaks if they overlap

$$F_{AVE} = \overline{F} = \frac{2mv}{\Delta t}N$$

$$= \frac{(2)(8.97E-6)(37)(889)}{2.42}$$

$$\boxed{= .244\,N} = F_{AVE}$$