59-240 L3 suppl - most probable speed
Categories: **59-240 Physical Chemistry**

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(L3) supplement, most probable speed

$$f(v) = \underbrace{4\pi \left(\frac{M}{2\pi RT}\right)^{3/2}}_{k} v^2 e^{-Mv^2/2RT}$$

$$\frac{df}{dv} = k\left[2ve^{-Mv^2/2RT} + v^2 e^{-Mv^2/2RT} \cdot \frac{-2Mv}{2RT}\right]$$

$$= k e^{-Mv^2/2RT}\left[2v - \frac{Mv^3}{RT}\right]$$

($k e^{-Mv^2/2RT}$: not zero; $\left[2v - \frac{Mv^3}{RT}\right]$: never reaches zero)

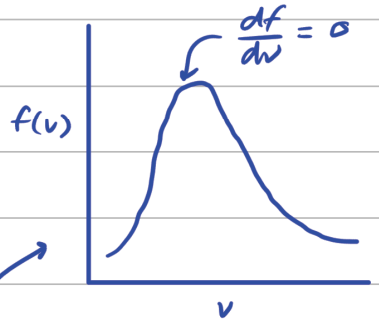
so, if $\frac{df(v)}{dv} = 0$, the only non-trivial solution is

$$\frac{Mv^3}{RT} - 2v = 0$$

$$\frac{Mv^2}{RT} - 2 = 0$$

$$v^2 = \frac{2RT}{M}$$

$$v = \sqrt{\frac{2RT}{M}}$$



$v = c^* = \sqrt{\frac{2RT}{M}}$, the most probable speed.