3.1) Maxwell distribution

$$g(\vec{v}) = \left(\frac{m}{2\pi k_B T}\right)^{3/2} e^{-\frac{1}{2}m\vec{v}^2/k_B T}$$

$$\langle \vec{v}^2 \rangle = 3\frac{k_B T}{m} \qquad \sqrt{\langle \vec{v}^2 \rangle} = \sqrt{3\frac{k_B T}{m}} = V_{Rms}$$

a) $m = 3.32 \times 10^{-27}\,kg$ $\qquad T = 300K$

$V_{Rms} = 1934\ m/s$

b) $m = 6.65 \times 10^{-27}\,kg$

$V_{Rms} = 1367\ m/s$

c) $m = 7.31 \times 10^{-26}\,kg$

$V_{Rms} = 412\ m/s$

3.2) a) $g(\vec{v}) = \frac{m}{2\pi k_B T} e^{-\frac{m}{2}(v_x^2+v_y^2)/k_B T}$

b) $\langle \vec{v}^2 \rangle = \langle v_x^2 \rangle + \langle v_y^2 \rangle = 2 \frac{k_B T}{m}$

$V_{Rms} = \langle \vec{v}^2 \rangle^{1/2} = \sqrt{2 \frac{k_B T}{m}}$

c) $\underline{P} = \int_{V_{min}}^{\infty} dv\, v \int_0^{2\pi} d\varphi \frac{m}{2\pi k_B T} e^{-\frac{m}{2} v^2/k_B T}$

with $V_{min} = 2\sqrt{2 \frac{k_B T}{m}}$

$\underline{P} = \frac{m}{k_B T} \int_{V_{min}}^{\infty} dv\, v\, e^{-\frac{m}{2} v^2/k_B T}$   $u = \frac{1}{2} v^2$

$u_{min} = 4 \frac{k_B T}{m}$

$\underline{P} = \frac{m}{k_B T} \int_{u_{min}}^{\infty} du\, e^{-m u/k_B T}$

$\underline{P} = e^{-m u_{min}/k_B T} = e^{-4}$

3.3 a) $\langle \omega \rangle = \omega_0 \left( 1 - \frac{\langle v_x \rangle}{c} \right) = \omega_0$ by symmetry

b) $\langle \omega^2 \rangle = \omega_0^2 \left\langle \left( 1 - \frac{v_x}{c} \right)^2 \right\rangle$

$$= \omega_0^2 \left( 1 - \frac{2\langle v_x \rangle}{c} + \frac{\langle v_x^2 \rangle}{c^2} \right)$$

$$= \omega_0^2 \left( 1 + \frac{1}{c^2} \frac{k_B T}{m} \right)$$

$$\sigma_\omega^2 = \langle \omega^2 \rangle - \langle \omega \rangle^2 = \frac{\omega_0^2}{c^2} \frac{k_B T}{m}$$