PROBLEMAS DE TEORIA CINÉTICA DE GASES

(1) $\bar{c} = \left(\frac{8kT}{\pi m}\right)^{1/2} = \left(\frac{8RT}{\pi M}\right)^{1/2}$

ex° H_2 a 298K: $\bar{c} = \left(\frac{8 \times 8.314 \times 298}{\pi \times 0.002}\right)^{1/2} \approx 1776\ m.s^{-1}$

ex° O_2 a 1000 K: $\bar{c} = \left(\frac{8 \times 8.314 \times 1000}{\pi \times 0.032}\right)^{1/2} \approx 813\ m.s^{-1}$, etc..

(2) $\bar{c} \approx 515\ m.s^{-1}$

$\Lambda = \frac{kT}{P\sqrt{2}\sigma} = \frac{1.381 \times 10^{-23} \times 500}{0.1 \times 10^{6} \times \sqrt{2} \times \pi \times (3.64 \times 10^{-10})^2} \approx 1160 \times 10^{-10}\ m$

$\nu = \frac{\bar{c}}{\Lambda} = 444 \times 10^{9}$ colisões/s

$Z_{AA} = \frac{1}{2}\left(\frac{N}{V}\right)\nu = \frac{1}{2} \times \frac{10^5}{1.38 \times 10^{-23} \times 500} \times 444 \times 10^{9} \approx 3.2 \times 10^{34}\ s^{-1} \cdot P/m^3$

$PV = NkT$

$\frac{N}{V} = \frac{P}{kT}$

(3) $V = \frac{4}{3}\pi r^3 \Leftrightarrow r = \left(\frac{3V}{4\pi}\right)^{1/3} = \left(\frac{3 \times 1 \times 10^{-3}\ m^3}{4\pi}\right)^{1/3} \approx 0.06\ m$

logo $d = 0.12m$ (~12cm)

$\sigma = 0.36\ nm^2 \times \left(\frac{1m}{1 \times 10^{9}\ nm}\right)^2 \approx 3.6 \times 10^{-19}\ m^2$

$P = \frac{kT}{\Lambda\sqrt{2}\sigma} = \frac{1.38 \times 10^{-23}\ Pa.m^3K^{-1} \times 298.15\ K}{0.12\ m \times \sqrt{2} \times 3.6 \times 10^{-19}\ m^2} \approx 0.067\ Pa$

Valor mito baixo (~7×10^{-7} atm)

(4) $T = 217\ K$
$p = 0.05\ atm$
$\sigma = 0.43\ nm^2$

$p = 0.05\ \cancel{atm} \times \frac{101325\ Pa}{1\ \cancel{atm}} \simeq 5066\ Pa$

$\sigma = 4.3 \times 10^{-19}\ m^2$

$$\Lambda = \frac{kT}{p\sqrt{2}\sigma} = \frac{1.38 \times 10^{-23} \times 217}{5066 \times \sqrt{2} \times 4.3 \times 10^{-19}} \simeq 9.8 \times 10^{-7}\ m$$

ou cerca de 980 nm

(5) $$\bar{c} = \left(\frac{8RT}{\pi M}\right)^{1/2} = \left(\frac{8 \times 8.314 \times 217}{\pi \times 0.028}\right)^{1/2} \simeq 405\ m.s^{-1}$$

$$\nu = \frac{\bar{c}}{\Lambda} = \frac{405\ m.s^{-1}}{9.8 \times 10^{-7}\ m} \simeq 4.1 \times 10^{8}\ s^{-1}$$ (ou collisões por segundo)

(6) $$\Lambda = \frac{kT}{p\sqrt{2}\sigma} = \frac{1.38 \times 10^{-23} \times 298.15}{10^{6} \times \sqrt{2} \times 4.3 \times 10^{-19}} \simeq 6.7 \times 10^{-9}\ m$$

ou 6.7 nm

etc.

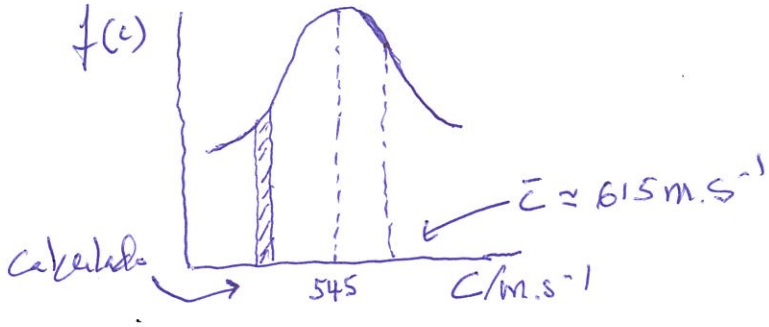
(7) $$f(c) = 4\pi \left(\frac{M}{2\pi RT}\right) \times c^2 \times e^{-\frac{Mc^2}{2RT}}$$

Considerando um valor médio, $\bar{c} = \frac{290 + 300}{2} = 295\ m.s^{-1}$

$$\int_{c_1}^{c_2} f(c)\,dc \simeq f(\bar{c}) . \Delta c \quad \text{com} \quad \Delta c = 10\ m.s^{-1}$$

$$f = 10 \times f(\bar{c}) = 10 \times 4\pi \times \left(\frac{28 \times 10^{-3}}{2\pi \times 8.314 \times 500}\right) \times 295^2 \times \exp\left(\frac{-28 \times 10^{-3} \times 295^2}{2 \times 8.314 \times 500}\right)$$

$$f \simeq 9.05 \times 10^{-3}$$ (ou cerca de 1%)



(8) $\eta = 19\,\mu Pa\,s$ $\quad \eta = \frac{2}{3\sigma}\left(\frac{mKT}{\pi}\right)^{1/2}$

$T = 298\,K$

$p = 0.1\,MPa$ $\quad m = \frac{M}{N_A} = \frac{0{,}028\ kg.mol^{-1}}{6.022\times10^{23}\ mol^{-1}} \approx 4.65\times10^{-26}\ kg$

$$19\times10^{-6} = \frac{2}{3\sigma}\left(\frac{4.65\times10^{-26}\times1.38\times10^{-23}\times298}{\pi}\right)^{1/2}$$

$\sigma = 2.74\times10^{-19}\ m^2$ ou $\sigma = 0.27\ nm^2$; Como $\sigma = \pi d^2$

$d \approx 2.95\times10^{-10}\ m$ (ou cerca de $2.95\ \text{Å}$)

(9) A superfície do filamento é $S = 2\pi \times 0.1\times10^{-3} \times 5\times10^{-2}$

$S \approx 3.14\times10^{-5}\ m^2$

$$p = 50\ torr \times \frac{1\ atm}{760\ torr} \approx 0.066\ atm \times 101325\ \frac{Pa}{atm} \approx 6666\ Pa$$

$$Z_w = \frac{pS}{(2\pi mKT)^{1/2}} = \frac{6666\times3.14\times10^{-5}}{\left(2\pi\left(\frac{40\times10^{-3}}{6.022\times10^{23}}\right)\times1.38\times10^{-23}\times1273\right)^{1/2}}$$

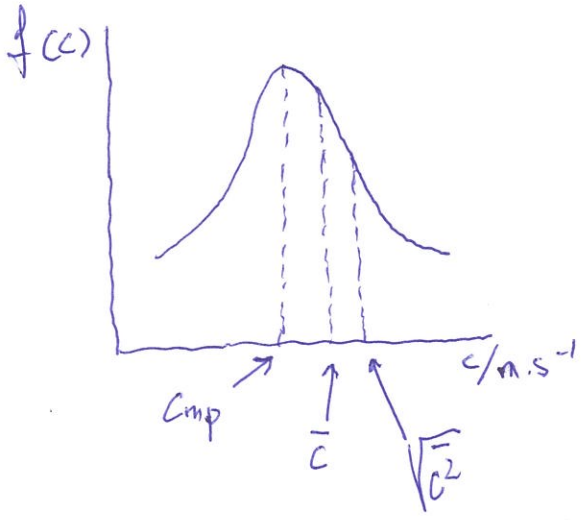
$Z_w \approx 2.45\times10^{21}\ s^{-1}$

(10) $\bar{c} = \left(\frac{8RT}{\pi M}\right)^{1/2} \approx 469\ m.s^{-1}$

$c_{mp} = \left(\frac{2RT}{M}\right)^{1/2} \approx 415\ m.s^{-1}$

$\sqrt{\bar{c^2}} = \left(\frac{3RT}{M}\right)^{1/2} \approx 509\ m.s^{-1}$

↑ Para o O_2 a 60°C



(11)

$T/^\circ C$	0	490	850
$\eta/\mu Pa.s$	13.9	33.0	43.6

a) $\eta \propto T^{1/2}$ Sim! $y = 2\times10^{-6}x + 1\times10^{-5}$ $R^2 \approx 0.999$

logo $\frac{2}{3\pi}\left(\frac{mK}{\pi}\right)^{1/2} \approx 2\times10^{-6}$

$$\sigma = \frac{2}{3\times2\times10^{-6}} \times \left[\frac{(0.044/6.022\times10^{23}) \times 1.38\times10^{33}}{\pi}\right]^{1/2}$$

$\sigma \approx 0.20\ nm^2$

(12) $\lambda = \frac{KT}{P\sqrt{2}\sigma}$ mas $PV = NKT$ ou $\frac{KT}{P} = \frac{V}{N}$

logo $\lambda = \frac{V}{N\sqrt{2}\sigma}$, não varia

(13) $-\frac{dN}{dt} = \frac{PS}{(2\pi m KT)^{1/2}}$ Como $PV = NKT$

$N = \frac{V}{KT} \times P$ e $dN = \frac{V}{KT}dp$

$$\frac{V}{KT}dp = -\frac{PS}{(2\pi m KT)^{1/2}}dt$$

$$\int_{t_0}^{t} dt = \int_{P0}^{P} -\frac{(2\pi m KT)^{1/2} V}{S KT} \times \frac{1}{P}dp$$

$$t = \frac{V}{S}\left(\frac{2\pi m}{KT}\right)^{1/2} \times \ln\frac{P^\circ}{P}$$

$$t = \frac{3}{\pi(1\times10^{-3})^2} \times \left(\frac{2\pi\left(\frac{32\times10^{-3}}{6.022\times10^{23}}\right)}{1.38\times10^{-23}\times298}\right)^{1/2} \times \ln\frac{0.8}{0.7} \approx 1148\ s$$

$t \approx 19$ min considerando $t = 25^\circ C$