(1) $H_2O \longrightarrow H^+ + OH^-$

$\Delta H^\circ = 55.836\ kJ/mol$
$\Delta S^\circ \quad -80.66\ J/mol$

Temperature	K_w	pK_w	pH
20	6.79×10^{-15}	14.17	7.08
30	1.45×10^{-14}	13.84	6.92
60	1.07×10^{-13}	12.97	6.49

$10^{-14} = e^{-\Delta H/RT} e^{\Delta H/S}$ solve for T

T = 298.028 K
T = 25.028 C if you use 0°C = 273
T = 24.878 C if you use 0°C = 273.15

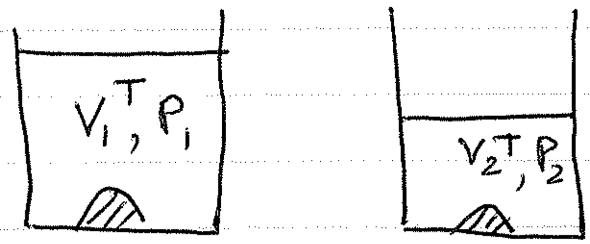
(2) New Scale

Reference points (if we use water at 1 atm) — ~~100~~ 100°C (99.97°) boiling; 0°C (0) freezing; $\Delta/100$

Absolute Temp — −273.15 C (adjustment)

$$K = \frac{\left(\frac{100}{\Delta}\right)}{\left(\frac{\text{new scale}}{\Delta}\right)} \left[X - X_{@\text{lower ref}} \right] + \left[\text{Temp of lower scale in C} \right]$$

3



$V_1^{air} = V_1^T - V_{sample}$

$V_2^{air} = V_2^T - V_{sample}$

$P_1 (V_1^T - V_s) = P_2 (V_2^T - V_s)$

$$\boxed{V_s = \frac{P_1 V_1^T - P_2 V_2^T}{P_1 - P_2}}$$

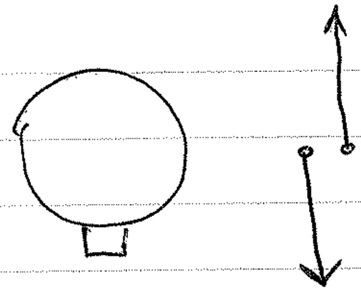
4

$$e^x = \sum_{n=0}^{\infty} \frac{x^n}{n!} = 1 + x + \frac{x^2}{2!} + \frac{x^3}{3!} + \ldots$$

n	$\frac{x^n}{n!}$	$\sum$ running
0	1	1
1	5	6
2	$\frac{25}{2}$	18.5
3	125/6	39.33
4	625/24	65.37
5	3125/120	91.42
6	15625/720	113.121
7	78125/5040	128.62
8	390625/40320	138.31
9	1953125/362880	143.69
10	9765625/3628800	146.38

$e^5 = 148.413$

#5



$F_{bouyance} = \rho V_{ballon} \cdot g_{venus}$

$F_g = M_{ballon} \cdot g_{venus}$

If $F_b \geq F_g$ Ballon will float.

$$PV = nRT = \left(\frac{\#g}{MW}\right) \cdot RT \rightarrow$$

$$\rho = \frac{\#g}{V} = \frac{P(MW)}{RT} = \text{density} = 71.7 \ \frac{kg}{m^3}$$

$$M \cancel{g_V} = \rho V_b \cancel{g_V} \implies V_b = \frac{M}{\rho} = \frac{10^3}{71.7}$$

$$\boxed{V_b \leq 13.9 \ m^3}$$

#6 Isotherm $P_1 = 1bar \rightarrow P_2 = 5bar$

$$w = -\int p\,dV = -nRT \int \frac{dV}{V} = -nRT \ln\left(\frac{V_2}{V_1}\right)$$

$$w = +nRT \ln\left(\frac{5\times10^5}{1\times10^5}\right) = +nRT \ln\left(\frac{P_1}{P_2}\right)$$

$$w = +(1)(8.314)(300K) \ln(5)$$

$$= \boxed{4014.26 \ J}$$

#7 $Mg \longrightarrow Mg^{+2} + 2e$ $\qquad \mathcal{E}_0 = 2.360$

$Al^{+3} + 3e \longrightarrow Al_{(s)}$ $\qquad \mathcal{E}_0 = -1.677$

$\mathcal{E}_0$ must be positive thus Mg^0 is being oxidized

$\Delta \mathcal{E} = 0.683$ volts.

$$3Mg + 2Al^{+3} \xrightarrow{6\bar{e}} 3Mg^{+2} + 2Al^0$$

$\Delta S^\circ = 197.6\,J$

$\Delta H^\circ = -336.6\,kJ$

$\Delta G^\circ = -336.6 - (298)(.1976) = -395.48\,kJ$

$\mathcal{E}^\circ = -\Delta G^\circ / nF = -395.48 / (96{,}500 \cdot 6)$

$\boxed{\mathcal{E}^\circ = 0.683}$

Variations due to differences in standard tables and the lack of use of activities since concent. set to 1 for ΔG°.

#8 Need to consider

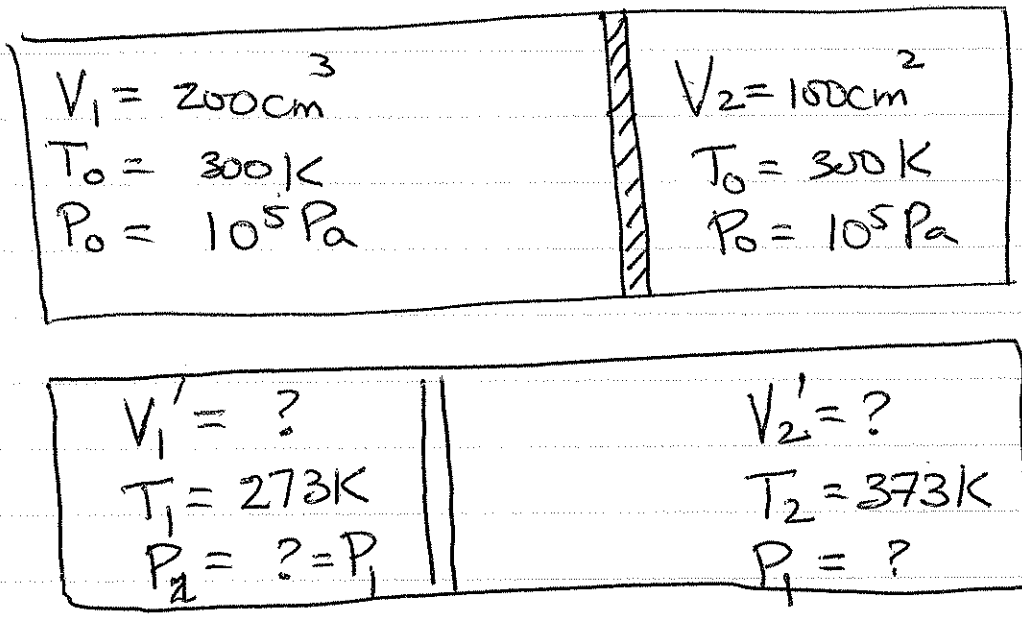
(a) Density dependence of mercury as function of temperature,

(b) Workable range of temperature.

(c) Non-linearity of height / temp scale

(d) Need to seal both ends but problems (vaporization / back pressure etc)

#9



Piston is in equilibrum thus $P_2 = P_1$, the amount of gas in each compartment is unchanged

In compartment 1 In compartment 2

(1) $$\frac{P_0 V_1}{T_0} = \frac{P_1 V_1'}{T_1}$$ (2) $$\frac{P_0 V_2}{T_0} = \frac{P_1 V_2'}{T_2}$$

Divide (1)/(2) and cancel

$$\frac{V_1}{V_2} = \frac{V_1'}{T_1} \cdot \frac{T_2}{V_2'} = \left(\frac{T_2}{T_1}\right)\left(\frac{V_1'}{V_2'}\right) =$$ Solve for new volumes

$$\left(\frac{V_1'}{V_2'}\right) = \left(\frac{T_1}{T_2}\right)\left(\frac{V_1}{V_2}\right) = \left(\frac{273}{373}\right)\left(\frac{200}{100}\right) = 1.46$$

$V_1' = 1.46 V_2'$ but $V_1' + V_2' = 300 cm$ $V_2' = 122 cm^3$

$$P_1 = P_0\left(\frac{T_2}{T_0}\right)\left(\frac{V_2}{V_2'}\right) = 10^5 \cdot \left(\frac{373}{300}\right)\left(\frac{100}{122}\right) = 1.02 \times 10^5 \text{ Pa}$$

#10 $$\frac{d}{dx} ax^3 dx = 3ax^2$$

$$\equiv \lim_{h\to 0} \left\{ \frac{a(x+h)^3 - ax^3}{h} \right\}$$

$$= \lim_{h\to 0} \left\{ \frac{\cancel{a}[\cancel{x^3} + 3x^2h + 3xh^2 + h^3] - \cancel{ax^3}}{h} \right.$$

$$\lim_{h\to 0} a\,\frac{(3x^2h + 3xh^2 + h^3)}{h}$$

$$\lim_{h\to 0} \left\{ 3x^2\cdot a + 3x\cancelto{0}{h}\cdot a + \cancelto{0}{ah^2} \right\}$$

$$= 3ax^2$$