Chemistry 230 -- Quiz 2
September 14, 2001 — Tellinghuisen

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Note: If you want your paper returned folded (*i.e.*, score concealed), please print your name on the back.

1. (8) **Short problems:**

(a) Evaluate $\int_2^\infty V^{-2}\, dV$:

$= -\frac{1}{V}\Big|_2^\infty = \frac{1}{2}$

(b) Calculate $\log_{10}(3.79\times10^{987})$:

$= 987 + \log_{10} 3.79 =$

987.579

(c) Calculate $\log_{22} 8$:

$22^x = 8$

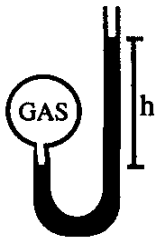
$\hookrightarrow \quad x = 0.6727$

(d) Find dy/dx if $xy = y - 2$:

$\frac{dy}{dx} = \frac{2}{(1-x)^2} \quad \left(= \frac{y}{1-x}\right)$

2. (3) A sample of gas is contained in the mercury manometer shown at right. If the atmospheric pressure is 744 torr and $h = 55$ mm, what is the pressure of the trapped gas (in torr) ?

799 torr



3. (10) Give the van der Waals equation for a real gas, and use it to calculate the pressure of a sample of CO_2 at 311K and a concentration of 1.000 mol/L. For CO_2, $a = 3.59\times10^6$ cm^6 atm mol^{-2} and $b = 42.7$ cm^3/mol. (See board for R values.)

$$\left[P + a\left(\frac{n}{V}\right)^2\right][V - nb] = nRT \Rightarrow P = \frac{nRT}{V-nb} - a\left(\frac{n}{V}\right)^2$$

$$P = \frac{RT}{V/n - b} - a\left(\frac{n}{V}\right)^2$$

$= 23.07$ atm $(= 23.37$ bar$)$

4. (5) A hypothetical gas obeys the equation of state $PV = nRT(1 + aP + bP^2)$, where a and b are constants. Give the definition of κ and use it to obtain an expression for κ for this gas.

$$\kappa \equiv -\frac{1}{V}\left(\frac{\partial V}{\partial P}\right)_T \quad ; \quad V = nRT\left(\frac{1}{P} + a + bP\right)$$

$$\left(\frac{\partial V}{\partial P}\right)_T = nRT\left(-\frac{1}{P^2} + b\right)$$

$$\hookrightarrow \quad \kappa = \frac{(1/P^2 - b)}{(1/P + a + bP)} = \frac{1 - bP^2}{P(1 + aP + bP^2)}$$