Name: ____________________

Lab Quiz 3
Chem 101A

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Information:

$$\Delta E_{electron} = -1312 \text{ kJ/mol} \cdot Z^2 \cdot \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right) \qquad E = \frac{hc}{\lambda} = \frac{1.196 \times 10^5 \text{ nm} \cdot \text{kJ/mol}}{\lambda}$$

$h = 6.626 \times 10^{-34}$ J·s $\qquad c = 2.998 \times 10^8$ m/s $= \nu\lambda \qquad A = \varepsilon \ell c$

1. If you mix equal volumes of 1 *M* HCl and 1 *M* NaOH, you will have the following reaction, for which you can measure ΔH:

$$HCl(aq)\ (1\ M) + NaOH(aq)\ (1\ M) \longrightarrow H_2O(l) + NaCl(aq)\ (0.5\ M) \qquad \Delta H = \Delta H_1$$

Since the two initial solutions dilute each other, the molarity of NaCl produced ends up being one-half of the original concentrations for Na^+ and Cl^- before mixing.

In another experiment, you can measure $\Delta H_{dilution}$ by adding an equal volume of water to a 1 *M* solution of NaCl:

$$NaCl(aq)\ (1\ M) + H_2O(l) \longrightarrow NaCl(aq)\ (0.5\ M) \qquad \Delta H_{dilution} = \Delta H_2$$

How could you use these values (ΔH_1 and ΔH_2 to get ΔH° for the neutralization of HCl(aq) with NaOH(aq)? (3 points)

$$HCl(aq)\ (1\ M) + NaOH(aq)\ (1\ M) \longrightarrow H_2O(l) + NaCl(aq)\ (1\ M) \qquad \Delta H = \Delta H^\circ$$

In the dilution reaction, since H_2O is the solvent, we could just write $NaCl_{(aq)}\ (1M) \rightarrow NaCl_{(aq)}\ (0.5M)$ $\Delta H = \Delta H_{dil.}$

Subtracting the dilution eqn from the first equation (reversing dil eqn and adding) gives the eqn for ΔH^o

So $\Delta H^o = \Delta H_1 - \Delta H_2$

2. For the Lyman series of the H atom emission spectrum, $n_f = 1$. For the Balmer series, $n_f = 2$.

a. What is the shortest (*i.e.* smallest) possible wavelength for a photon in the Balmer series? (2)

Shorter wavelengths correspond to higher energies, so the question involves the biggest energy gap (ΔE) for the Balmer emissions. This would be the $\infty \rightarrow 2$ emission

$$\Delta E = -1312 \frac{kJ}{mol}\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right) = -328\ kJ/mol = -E_{photon}$$

$$E_{photon} = \frac{1.196 \times 10^5\ nm \cdot kJ/mol}{\lambda} = 328 \frac{kJ}{mol}$$

$$\lambda = \frac{1.196 \times 10^5\ nm \cdot \frac{kJ}{mol}}{328\ kJ/mol}$$

$$\lambda = 364\ nm$$

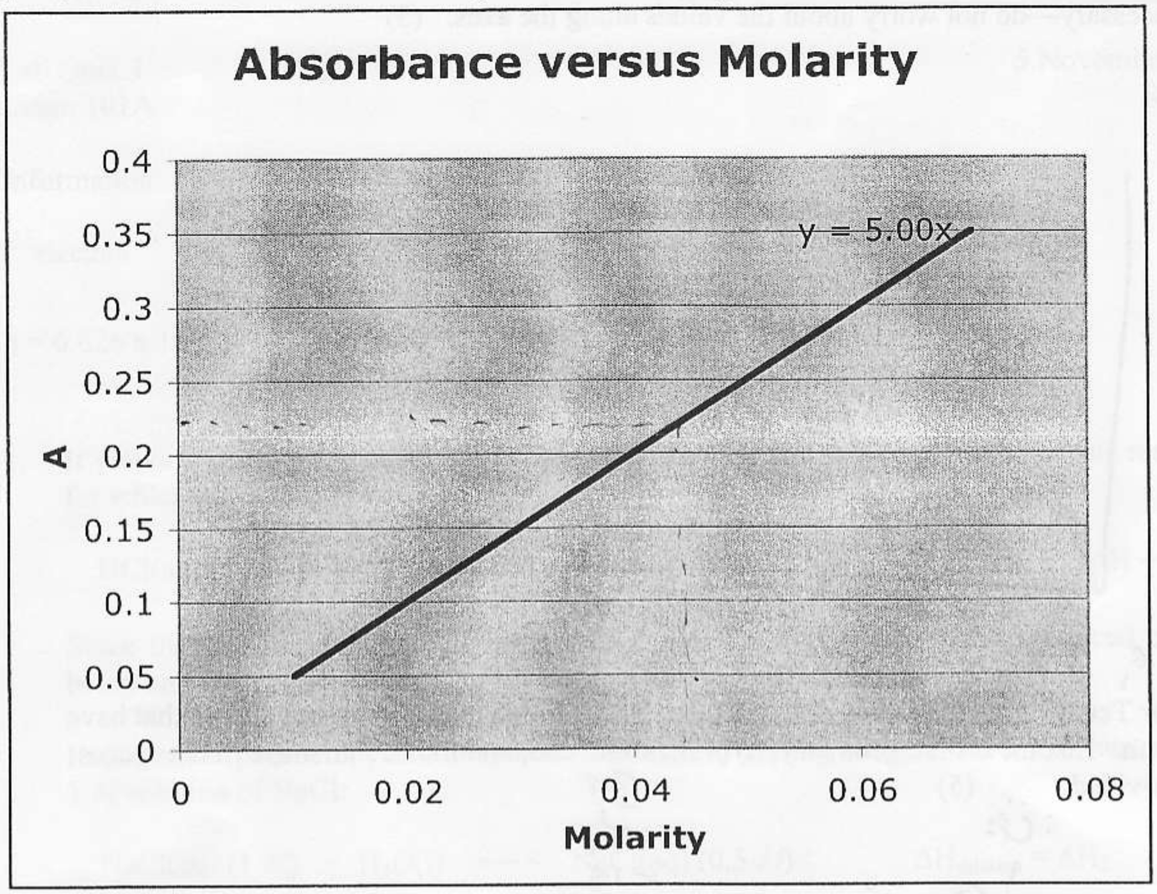
b. What is the lowest possible energy for a photon in the Lyman series? Please give your answer in units of kilojoules per mole. (2)

This will correspond to the smallest gap ($|\Delta E|$) in energy, the $2 \rightarrow 1$ emission

$$E_{photon} = -\Delta E_e = 1312\ kJ/mol\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = 1312 \frac{kJ}{mol}\left(\frac{3}{4}\right)$$

$$E_{photon} = 984\ kJ/mol$$

3. Shown below is a Beer-Lambert plot for an ion in aqueous solution:



a. Given that the path length of light through the sample is 0.50 cm, determine the value for ε, including units. (3)

$A = \varepsilon l c$
$y = m x$

Slope $= m = \varepsilon l = 5.00\ M^{-1}$

$\varepsilon = \dfrac{5.00\ M^{-1}}{0.50\ cm} = 10.\ M^{-1} cm^{-1}$

b. You have a sample of this ion dissolved in water, but you don't know the concentration. You measure the absorbance and find that it is 0.215. Use this information to find the molarity of the solution. (2)

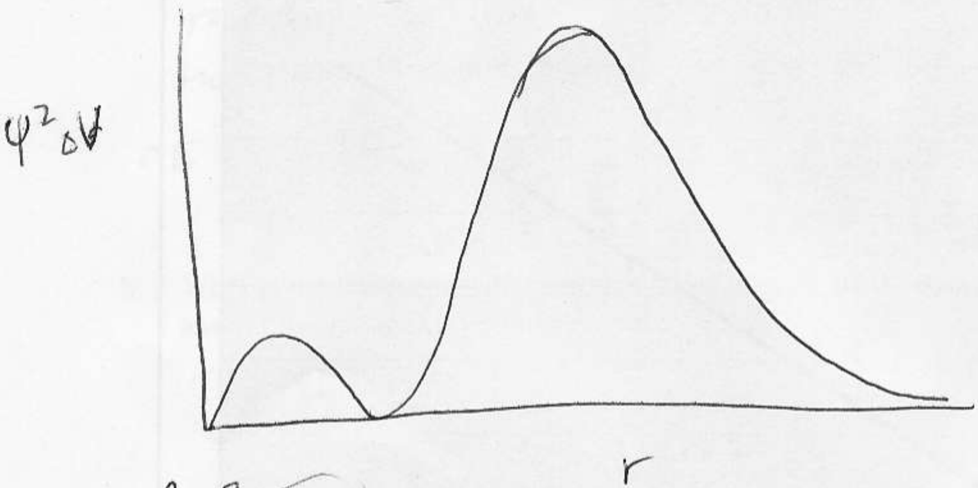
By visually looking at the x value (conc) corresponding fo y = 0.215 (A), the conc. will be around 0.045 M.

We can get the value more precisely using the line equ. and substituting 0.215 in for y to solve for x

$0.215 = 5.00\ M^{-1} x$

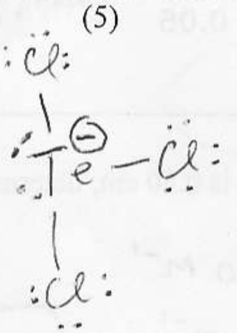
$x = \dfrac{0.215}{5.00\ M^{-1}} = 0.0430\ M$

4. Sketch the graph of $\Psi^2\Delta V$ versus r for a hydrogen 2s orbital. Only a qualitative picture is necessary—do not worry about the values along the axes. (3)



6, 7 (28 ve)

5. For $TeCl_3^-$, give the Lewis dot structure. Show formal charges for any atoms that have them. List the orbital geometry, hybridization, and, and molecular shape in the spaces provided. (5)



28
−6
22
−18
4

Orbital geometry: trigonal bipyramidal Hybridization: sp^3d Molecular Shape: T-shaped