CHEM 121
Spring 2006
Quiz 1

Name: ____

1a. (10 Points) What is the energy, in joules, associated with one photon of light that has a wavelength of 425.0 nm? You are given the equations E = h·ν, λ·ν = c and the fundamental constants h = 6.62608×10^{-34} J·s and c = 2.99792458×10^{8} m·s^{-1}.

Start with $\lambda \cdot \nu = c$ and solve for ν to give $\nu = \frac{c}{\lambda}$. Substitute this expression into Planck's equation, $E = h \cdot \nu$, to give $E = \frac{h \cdot c}{\lambda}$.

Substitute values for h, c and λ.

$$E = \frac{h \cdot c}{\lambda} = \frac{\left(6.62608\text{x}10^{-34}\ \text{J} \cdot \text{s}\right)\left(2.99792458\text{x}10^{8}\ \text{m} \cdot \text{s}^{-1}\right)}{425.0\text{x}10^{-9}\ \text{m}} = 4.674\text{x}10^{-19}\ \text{J}$$

The energy of one photon with a wavelength of 425.0 nm is 4.674×10^{-19} J.

b. (5 Points) What is the energy of this light in wavenumbers (cm^{-1})? You are given the conversion factor 1 cm^{-1} = 1.9865×10^{-23} J. If you didn't get an answer to part a, set up this problem for partial credit.

Convert energy in joules to energy in wavenumbers.

$$4.674\text{x}10^{-19}\ \text{J}\left(\frac{1\ \text{cm}^{-1}}{1.9865\text{x}10^{-23}\ \text{J}}\right) = 2.353\text{x}10^{4}\ \text{cm}^{-1}$$

This light has an energy of 2.353×10^{4} cm^{-1}.

Continued on reverse →

2. (5 Points) Fill in the blanks. Under the "Solubility in Water" column write "Y" if the compound is soluble in water, "N" if it is not soluble in water and "NA" if we have not yet learned how to predict its solubility. Remember that the presence of waters of hydration do not affect the compound's solubility.

Name	**Chemical Formula**	**Solubility in Water**
potassium sulfite	$\mathbf{K_2SO_3}$	**Y**
phosphorous tribromide	$\mathbf{PBr_3}$	**NA**
lithium hydroxide monohydrate	$\mathbf{LiOH \cdot H_2O}$	**Y**
magnesium sulfate	$\mathbf{MgSO_4}$	**Y**
iron(II) perchlorate	$\mathbf{Fe(ClO_4)_2}$	**Y**
ammonium hydrogenphosphate	$(NH_4)_2HPO_4$	**Y**
copper(II) oxide	CuO	**N**
chlorine	Cl_2	**N**
boron trifluoride	BF_3	**NA**
zinc acetate dihydrate	$Zn(C_2H_3O_2)_2 \cdot 2H_2O$	**Y**

4. (10 Points) Which contains more Na^+, 2.00 L of a 0.100 M NaCl solution or 1.00 L of a 0.100 M Na_2CO_3 solution? Show your calculations for full credit.

Determine the amount of Na^+ *in each solution.*

$$2.00\ \text{L}\left(\frac{0.100\ \text{mole NaCl}}{1\ \text{L}}\right)\left(\frac{1\ \text{mole Na}^+}{1\ \text{mole NaCl}}\right)=0.200\ \text{mole Na}^+$$

$$1.00\ \text{L}\left(\frac{0.100\ \text{mole Na}_2\text{CO}_3}{1\ \text{L}}\right)\left(\frac{2\ \text{mole Na}^+}{1\ \text{mole Na}_2\text{CO}_3}\right)=0.200\ \text{mole Na}^+$$

Both solutions contain exactly the same amount of Na^+.

5. (10 Points) Please attach problem 9-34 to this sheet.

Start with the relationship for the amount of heat lost by the Ni and gained by the H_2O derived from the First Law of Thermodynamics.

$$q_{Ni} = -q_{H_2O}$$

There is no chemical reaction. So, $q = C \cdot m \cdot \Delta T$ for both the Ni and the H_2O.

$$C_{Ni} \cdot m_{Ni} \cdot \Delta T_{Ni} = -C_{H_2O} \cdot m_{H_2O} \cdot \Delta T_{H_2O}$$

From here on, it is simply algebra. Here is one way to solve it; your way may differ. Solve for ΔT_{H_2O} in terms of ΔT_{Ni} (it doesn't matter which we choose).

$$\Delta T_{H_2O} = -\frac{C_{Ni} \cdot m_{Ni}}{C_{H_2O} \cdot m_{H_2O}} \Delta T_{Ni} = -\frac{\left(0.444 \frac{J}{^\circ C \cdot g}\right)(15.0 \text{ g})}{\left(4.184 \frac{J}{^\circ C \cdot g}\right)(55.0 \text{ g})} \Delta T_{Ni}$$

$$\Delta T_{H_2O} = -0.0289_{41} \Delta T_{Ni}$$

Now substitute in the initial temperatures and solve for T_{final}.

$$T_{final} - 23.0\ ^\circ\text{C} = -0.0289_{41}\left(T_{final} - 100.0\ ^\circ\text{C}\right)$$

$$T_{final} - 23.0\ ^\circ\text{C} = -0.0289_{41} T_{final} + 2.89_{41}\ ^\circ\text{C}$$

$$1.0289_{41} T_{final} = 25.8_9\ ^\circ\text{C}$$

$$T_{final} = 25.2\ ^\circ\text{C}$$

The temperature at thermal equilibrium is 25.2 °C.

This makes sense because 1) it says that the Ni cools down and the water warms up (just like we expect) and 2) the Ni's temperature changes a lot because of its small heat capacity while water's temperature changes very little because of its large heat capacity.