Name ______________________________ AP Chemistry

HW 2: Due 1/8/16 Complete both free response questions. One will be graded. Show all work. Box and clearly label all final answers

In order to start most reactions involving fluorine gas involves breaking the F–F bond, which has a bond energy of 154 kJ mol^{-1}.
(a) Calculate the amount of energy, in joules, needed to break a single F–F bond.
(b) Calculate the longest wavelength of light, in meters, that can supply the energy per photon necessary to break the F–F bond.
(c) A major line in the emission spectrum of neon corresponds to a frequency of $4.34 \times 10^{14}\ s^{-1}$. Calculate the wavelength, in nanometers, of light that corresponds to this line.
(d) In the upper atmosphere, ozone molecules decompose as they absorb ultraviolet (UV) radiation, as shown by the equation below. Ozone serves to block harmful ultraviolet radiation that comes from the Sun.

$$O_3(g) \xrightarrow{UV} O_2(g) + O(g)$$

A molecule of $O_3(g)$ absorbs a photon with a frequency of $1.00 \times 10^{15}\ s^{-1}$.

(i) How much energy, in joules, does the $O_3(g)$ molecule absorb per photon?

(ii) The minimum energy needed to break an oxygen-oxygen bond in ozone is 387 kJ mol^{-1}. Does a photon with a frequency of $1.00 \times 10^{15}\ s^{-1}$ have enough energy to break this bond? Support your answer with a calculation.

a. $\frac{154\ KJ}{mol} \times \frac{1\ mol}{6.022 \times 10^{23}\ molecules} \times \frac{1000\ J}{1\ KJ}$ = $\boxed{2.56 \times 10^{-19}}$

b. $E = \frac{hc}{\lambda}$ $2.56 \times 10^{-19} = \frac{(6.626 \times 10^{-34})(3.0 \times 10^{8})}{\lambda}$

$\boxed{\lambda = 7.77 \times 10^{-7}\ M}$

c. $c = \lambda \nu$ $3.0 \times 10^{8} = 4.34 \times 10^{14}\ \lambda$ $\lambda = 6.91 \times 10^{-7}\ M$

$\boxed{691\ nm}$

d. $E = h\nu$

$E = (6.626 \times 10^{-34})(1.00 \times 10^{15})$

$\boxed{E = 6.626 \times 10^{-19}\ J}$

$\frac{6.626 \times 10^{-19}\ J}{molecule} \times \frac{6.022 \times 10^{23}\ molecules}{1\ mol} = \boxed{399\ KJ}$

yes. It has enough energy. 387 < 399 KJ of energy available

2. In water, hydrazoic acid, HN_3, is a weak acid that has an equilibrium constant, K_a, equal to 2.8×10^{-5} at 25°C. A 0.300-liter sample of a 0.050-molar solution of the acid is prepared.

(a) Write the expression for the equilibrium constant, K_a, for hydrazoic acid.

(b) Calculate the pH of this solution at 25°C.

(c) To 0.150 liter of this solution, 0.80 gram of sodium azide, NaN_3, is added. The salt dissolves completely. Calculate the pH of the resulting solution at 25°C if the volume of the solution remains unchanged.

(d) To the remaining 0.150 liter of the original solution, 0.075 liter of 0.100-molar NaOH solution is added. Calculate the $[OH^-]$ for the resulting solution at 25°C.

$HN_3 + H_2O \rightleftharpoons H_3O^+ + N_3^{1-}$

a. $K_a = \frac{[H_3O^+][N_3^{1-}]}{[HN_3]}$

b. $2.8 \times 10^{-5} = \frac{x^2}{0.050}$ $x = 0.00118$ M $[H_3O^+]$

pH = 2.93

c. 0.80 g ÷ 65.0 = 0.0123 mol ÷ 0.150 = 0.0821 M

$2.8 \times 10^{-5} = \frac{[x][0.0821]}{[0.050]}$ $x = 1.71 \times 10^{-5}$

pH = 4.77

$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{2.8 \times 10^{-5}}$

$K_b = 3.57 \times 10^{-10}$

d. $OH^- + HN_3 \rightleftharpoons H^+ + N_3^{1-}$

	OH^-	HN_3		N_3^{1-}
I_M	0.10	0.050		
I_{vol}	0.075	0.150		
I_{mol}	0.0075	0.0075		
C	−x	−x		+x
E_{mol}	∅	∅		0.0075
E_{vol}				0.225
E_M				0.0333

$3.57 \times 10^{-10} = \frac{x^2}{0.033}$

$x = 3.43 \times 10^{-6}$