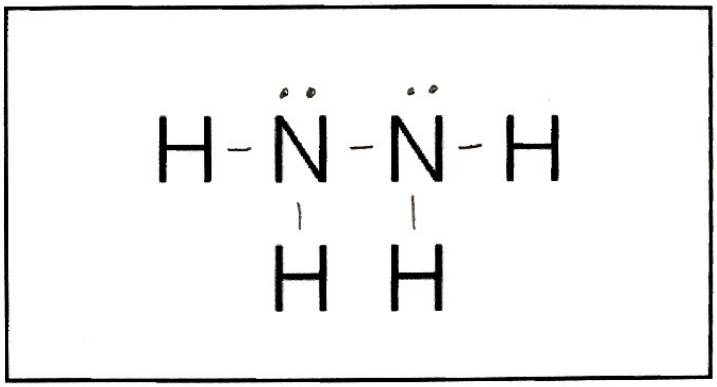
FR Practice #2 (2011 #5, 8 points)

2. Hydrazine is an inorganic compound with the formula N_2H_4.

a. In the box below, complete the Lewis electron-dot diagram for the N_2H_4 molecule by drawing in all the electron pairs. (1 pt)



b. On the basis of the diagram you completed in part (a), do all six atoms in the N2H4 molecule lie in the same plane? Explain. (1 pt)

c. The normal boiling point of N_2H_4 is 114°C, whereas the normal boiling point of C_2H_6 is −89°C. Explain, in terms of the intermolecular forces present in each liquid, why the boiling point of N_2H_4 is so much higher than that of C_2H_6. (2 pt)

d. Write a balanced chemical equation for the reaction between N_2H_4 and H_2O that explains why a solution of hydrazine in water has a pH greater than 7. (1 pt)

N_2H_4 reacts in air according to the equation below.

$$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2\,H_2O(g) \qquad \Delta H^\circ = -534\ \text{kJ mol}^{-1}$$

e. Is the reaction an oxidation-reduction, acid-base, or decomposition reaction? Justify your answer. (1 pt)

f. Predict the sign of the entropy change, ΔS, for the reaction. Justify your prediction. (1 pt)

g. Indicate whether the statement written in the box below is true or false. Justify your answer. (1 pt)

The large negative ΔH° for the combustion of hydrazine results from the large release of energy that occurs when the strong bonds of the reactants are broken.

b.) Nope, because the molecular geometry around both N's is trigonal pyramidal, which is not planar, + so the molecule as a whole can't be planar.

c) N_2H_4 is polar + has LDFs, dipole-dipole forces, + hydrogen bonding forces between molecules, whereas C_2H_6 is non-polar + has only LDFs between molecules. It takes more energy to overcome the stronger IMFs in N_2H_4, resulting in a higher boiling point.

d) $N_2H_4 + H_2O \rightarrow N_2H_5^+ + OH^-$

e) Redox, b/c the oxidation state of N changes from $-2 \rightarrow 0$ (oxidation) and that of O changes from $0 \rightarrow -2$ (reduction)

f) $+\Delta S$, b/c 1 mole of liquid + 1 mole of gas produces 3 moles of gas, so the net increase in gas particles results in the products having greater entropy than the reactants.

g) False! Two reasons:

only 1 reason needed to earn point

1) energy is NOT released when bonds are broken, but rather when they're formed
2) bonds in reactants are relatively weak compared to product bonds