Homework 1

1.A possible practical way to eliminate oxides of nitrogen (such as NO_2) from automobile exhaust gases uses cyanuric acid, $C_3N_3(OH)_3$. When heated to the relatively low temperature of 625°F, cyanuric acid converts to gaseous isocyanic acid (HNCO). Isocyanic acid reacts with NO_2 in the exhaust to form nitrogen, carbon dioxide, and water, all of which are normal constituents of the air.

(a) Write balanced equations for these two reactions.

(b) If the process described earlier became practical, how much cyanuric acid (in kilograms) would be required to absorb the 1.7×10^{10} kg NO_2 generated annually in auto exhaust in the United States?

2. A sample of a substance with the empirical formula XBr_2 weighs 0.5000 g. When it is dissolved in water and all its bromine is converted to insoluble AgBr by addition of an excess of silver nitrate, the mass of the resulting AgBr is found to be 1.0198 g. The chemical reaction is $XBr_2 + 2AgNO_3 \rightarrow 2AgBr + X(NO_3)_2$

(a) Calculate the molecular mass (that is, formula mass) of XBr_2.

(b) Calculate the atomic mass of X and give its name and symbol.

3. Use the group structure of the periodic table to predict the empirical formulas for the binary compounds that hydrogen forms with the elements germanium, fluorine, tellurium, and bismuth.

4. An electron is located at the origin of the coordinates, and a second electron is brought to a position 2 Å from the origin.

(a) Calculate the force between the two electrons.

(b) Calculate the potential energy of the two electrons.

5. The electron in a hydrogen atom is initially at a distance 2.12 Å from the proton, and then moves to a distance 0.529 Å from the proton.

(a) Calculate the change in the force between the proton and the electron.

(b) Calculate the change in the potential energy between the proton and the electron.

(c) Calculate the change in the velocity of the electron.