Homework 1

Date No.

1. (a) $C_3N_3(OH)_3 \xrightarrow{625E} 3HNCO\uparrow$

$8HNCO + 6NO_2 = 7N_2 + 4H_2O + 8CO_2$

(b) $n(NO_2) = \frac{m(NO_2)}{M(NO_2)} = \frac{1.7\times10^{10}kg \times \frac{10^3g}{1kg}}{46g\cdot mol^{-1}} = \frac{17}{46}\times10^{12}mol$

$4C_3N_3(OH)_3 \sim 12HNCO \sim 9NO_2$

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$n(C_3H_3(OH)_3)$ $\frac{17}{46}\times10^{12}mol$

$\frac{4}{n(C_3N_3(OH)_3)} = \frac{9}{\frac{17}{46}\times10^{12}mol} \Rightarrow n(C_3N_3(OH)_3) = \frac{17}{207}\times10^{12}mol$

$m(C_3N_3(OH)_3) = n(C_3N_3(OH)_3)M(C_3N_3(OH)_3)$

$= \frac{17}{207}\times10^{12}mol\times129g\cdot mol^{-1}$

$\approx 1.1\times10^{13}g = 1.1\times10^{13}g\times\frac{1kg}{10^3g} = \underline{1.1\times10^{10}kg}$

2. (a) $n(AgBr) = \frac{m(AgBr)}{M(AgBr)} = \frac{1.0198g}{187.769g\cdot mol^{-1}} \approx 0.0054314mol$

$XBr_2 + 2AgNO_2 \rightarrow 2AgBr + X(NO_3)_2$

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$n(XBr_2)$ $0.0054314mol$

$\frac{1}{n(XBr_2)} = \frac{2}{0.0054314mol} \Rightarrow n(XBr_2) = 0.002715mol$

$M(XBr_2) = \frac{m(XBr_2)}{n(XBr_2)} = \frac{0.5000g}{0.002715mol} \approx 184.1g\cdot mol^{-1}$

Therefore, the molecular mass (formula mass) of XBr_2 is 184.1

(b) The relative mass of X is $184.1 - 2\times79.9 = \underline{24.3}$

Refering to the Period Table of the Elements, we discovered that Mg's relative mass is 24.3 and according to our common sense, the ion of Mg usually shows the valence of +2. Therefore, the name of X

is magnesium ("镁" in Chinese) and its symbol is Mg.

3. In terms of elements in the main group, those in the same main group have the same number of the electron in the outermost layer, so they usually have similar property including valence.
Analogizing to the simplest binary compound that hydrogen forms with carbone, methane (CH_4), we predict the binary compound that hydrogen forms with germanium is GeH_4.
Analogizing to the binary compound that hydrogen forms with chlorine, hydrochloric acid (HCl), we predict the binary compound that hydrogen forms with fluorine is HF.
Analogizing to the binary compounds that hydrogen forms with oxygen, water (H_2O), we predict the binary compound that hydrogen forms with tellurium is H_2Te.
Analogizing to the binary compound that hydrogen forms with nitrogen, ammonia (NH_3), we predict the binary compound that hydrogen forms with bismuth is BiH_3.

4. (a) $F = \frac{e^2}{4\pi\varepsilon_0 r^2} = \frac{(1.602\times10^{-19}C)^2}{4\pi\times8.854\times10^{-12}C^{-2}J^{-1}m^{-1}\times 2\text{Å}\times\frac{1m}{10^{10}\text{Å}}}$

$\approx 6\times10^{-33}N$

(b) $E = \frac{e^2}{4\pi\varepsilon_0 r} = \frac{(1.602\times10^{-19}C)^2}{4\pi\times8.854\times10^{-12}C^{-2}J^{-1}m^{-1}\times 2\text{Å}\times\frac{1m}{10^{10}\text{Å}}}$

$\approx 1\times10^{-42}J$

5. (a) $F_1 = \frac{e^2}{4\pi\varepsilon_0 r_1^2} = \frac{(1.602\times10^{-19}C)^2}{4\pi\times8.854\times10^{-12}C^{-2}J^{-1}m^{-1}\times 2.12\text{Å}\times\frac{1m}{10^{10}\text{Å}})^2}$

$\approx 5.13\times10^{-33}N$

$F_2 = \frac{e^2}{4\pi\varepsilon_0 r_2^2} = \frac{(1.602\times10^{-19}C)^2}{4\pi\times8.854\times10^{-12}C^{-2}J^{-1}m^{-1}\times(0.529\times\frac{1m}{10^{10}\text{Å}})^2}$

$\approx 8.24\times10^{-32}N$

$\Delta F = F_2 - F_1 = (8.24\times10^{-33} - 5.13\times10^{-33})N \approx 7.73\times10^{-32}N$

(b) $E_1 = -\frac{e^2}{4\pi\varepsilon_0 r_1} = \frac{(1.602\times10^{-19}C)^2}{4\pi\times8.854\times10^{-12}C^{-2}J^{-1}m^{-1}\times(2.12\text{Å}\times\frac{1m}{10^{10}\text{Å}})}$

$\approx -1.09\times10^{-42}J$

$E_2 = -\frac{e^2}{4\pi\varepsilon_0 r_2} = \frac{(1.602\times10^{-19}C)^2}{4\pi\times8.854\times10^{-12}C^{-2}J^{-1}m^{-1}\times(0.529\text{Å}\times\frac{1m}{10^{10}\text{Å}})}$

$\approx -4.36\times10^{-42}J$

$\Delta E = E_2 - E_1 = (-4.36\times10^{-42} + 1.09\times10^{-42})J = -3.27\times10^{-42}J$

(c) $\Delta E = -3.27\times10^{-42}J\times\frac{1eV}{1.602\times10^{-19}J} \approx -2.04\times10^{-23}eV$