205 Problem Set 1 KEY

2.10 (a) 6.500 g compound – 0.384 g hydrogen = 6.116 g sulfur

(b) *Conservation of mass*

(c) According to postulate 3 of the atomic theory, atoms are neither created nor destroyed during a chemical reaction. If 0.384 g of H are recovered from a compound that contains only H and S, the remaining mass must be sulfur.

2.12 (a) 1: $\frac{3.56\text{ g fluorine}}{4.75\text{ g iodine}} = 0.749\text{ g fluorine/1 g iodine}$

2: $\frac{3.43\text{ g fluorine}}{7.64\text{ g iodine}} = 0.449\text{ g fluorine/1 g iodine}$

3: $\frac{9.86\text{ g fluorine}}{9.41\text{ g iodine}} = 1.05\text{ g fluorine/1 g iodine}$

(b) To look for integer relationships among these values, divide each one by the smallest.

If the quotients aren't all integers, multiply by a common factor to obtain all integers.

1: $0.749/0.449 = 1.67;\ 1.67 \times 3 = 5$

2: $0.449/0.449 = 1.00;\ 1.00 \times 3 = 3$

3: $1.05/0.449 = 2.34;\ 2.34 \times 3 = 7$

The ratio of g fluorine to g iodine in the three compounds is 5:3:7. These are in the ratio of small whole numbers and, therefore, obey the *law of multiple proportions*. This integer ratio indicates that the combining fluorine "units" (atoms) are indivisible entities.

2.16 (a) The droplets carry different total charges because there may be 1, 2, 3, or more electrons on the droplet.

(b) The electronic charge is likely to be the lowest common factor in all the observed charges.

(c) Assuming this is so, we calculate the apparent electronic charge from each drop as follows:

A: $1.60 \times 10^{-19} / 1 = 1.60 \times 10^{-19}$ C

B: $3.15 \times 10^{-19} / 2 = 1.58 \times 10^{-19}$ C

C: $4.81 \times 10^{-19} / 3 = 1.60 \times 10^{-19}$ C

D: $6.31 \times 10^{-19} / 4 = 1.58 \times 10^{-19}$ C

The reported value is the average of these four values. Since each calculated charge has three significant figures, the average will also have three significant figures.

$(1.60 \times 10^{-19}\text{ C} + 1.58 \times 10^{-19}\text{ C} + 1.60 \times 10^{-19}\text{ C} + 1.58 \times 10^{-19}\text{ C}) / 4 = 1.59 \times 10^{-19}\text{ C}$

2.18 (a) $r = d/2;\ r = \frac{2.7 \times 10^{-8}\text{ cm}}{2} \times \frac{1\text{ Å}}{1 \times 10^{-8}\text{ cm}} = 1.35 = 1.4\text{ Å}$

$$r = \frac{2.7 \times 10^{-8}\text{ cm}}{2} \times \frac{1\text{ m}}{100\text{ cm}} = 1.35 \times 10^{-10} = 1.4 \times 10^{-10}\text{ m}$$

(b) Aligned Rh atoms have **diameters** touching. $d = 2.7 \times 10^{-8}$ cm $= 2.7 \times 10^{-10}$ m

$$6.0\ \mu\text{m} \times \frac{1 \times 10^{-6}\text{ m}}{1\ \mu\text{m}} \times \frac{1\text{ Rh atom}}{2.7 \times 10^{-10}\text{ m}} = 2.2 \times 10^{4}\text{ Rh atoms}$$

(c) $V = 4/3\ \pi r^3;\ r = 1.35 \times 10^{-10} = 1.4 \times 10^{-10}$ m

$V = (4/3)[(\pi(1.35 \times 10^{-10})^3]\text{ m}^3 = 1.031 \times 10^{-29} = 1.0 \times 10^{-29}\text{ m}^3$

2.20 (a) The nucleus has most of the mass **but occupies very little** of the volume of an atom.

(b) True

(c) The number of electrons in a neutral atom is equal to the number of **protons** in the atom.

(d) True

2.22 (a) $^{31}_{16}X$ and $^{32}_{16}X$ are isotopes of the same element, because they have identical atomic numbers.

(b) These are isotopes of the element sulfur, S, atomic number = 16.

2.24 (a) ^{32}P has 15 p, 17 n

(b) ^{51}Cr has 24 p, 27 n

(c) ^{60}Co has 27 p, 33 n

(d) ^{99}Tc has 43 p, 56 n

(e) ^{131}I has 53 p, 78 n

(f) ^{201}Tl has 81 p, 120 n

2.26

Symbol	^{65}Zn	^{96}Sr	^{87}Sr	^{81}Kr	^{235}U
Protons	30	38	38	36	92
Neutrons	35	58	49	45	143
Electrons	30	38	38	36	92
Mass No.	65	96	87	81	235

2.28 Since the two nuclides are atoms of the same element, by definition they have the same number of protons, 54. They differ in mass number (and mass) because they have different numbers of neutrons. ^{129}Xe has 75 neutrons and ^{130}Xe has 76 neutrons.

2.30 (a) 12 amu

(b) The atomic weight of carbon reported on the front-inside cover of the text is the abundance-weighted average of the atomic masses of the two naturally occurring isotopes of carbon, ^{12}C, and ^{13}C. The mass of a ^{12}C atom is exactly 12 amu, but the atomic weight of 12.011 takes into account the presence of some ^{13}C atoms in every natural sample of the element.

2.32 Atomic weight (average atomic mass) = Σ fractional abundance $\times$ mass of isotope

Atomic weight = 0.7215(84.9118) + 0.2785(86.9092) = 85.4681 = 85.47 amu

(The result has 2 decimal places and 4 sig figs because each term in the sum has 4 sig figs and 2 decimal places.)

2.34 (a) The purpose of the magnet in the mass spectrometer is to change the path of the moving ions. The magnitude of the deflection is inversely related to mass, which is the basis of the discrimination by mass.

(b) The atomic weight of Cl, 35.5, is an average atomic mass. It is the average of the masses of two naturally occurring isotopes, weighted by their abundances.

(c) The single peak at mass 31 in the mass spectrum of phosphorus indicates that the sample contains a single isotope of P, and the mass of this isotope is 31 amu.

2.36 (a) Three peaks: $^{1}H - {}^{1}H$, $^{1}H - {}^{2}H$, $^{2}H - {}^{2}H$

(b) $^{1}H - {}^{1}H = 2(1.00783) = 2.01566$ amu

$^{1}H - {}^{2}H = 1.00783 + 2.01410 = 3.02193$ amu