Solutions to:

Atoms and Elements Homework Problem Set
Chemistry 145, Chapter 2

1. How many protons, neutrons and electrons are present in the following:

a. ^{1}H

From the information given,

$at\_number := 1$ $at\_mass := 1$ $charge := 0$

note: The atomic number is from looking up H (hydrogen) on the periodic table, this is usually given above the symbol of the element. The atomic mass is given by the superscript 1 before the H (^{1}H). The charge is given as a superscript number after the atomic symbol, since none is given it is assumed to be 0.

Calculations,

$proton := at\_number$ $neutron := at\_mass - at\_number$ $electron := at\_number - charge$

Answers,

$proton = 1$ $neutron = 0$ $electron = 1$

b. ^{2}H

From the information given,

$at\_number := 1$ $at\_mass := 2$ $charge := 0$

Calculations,

$proton := at\_number$ $neutron := at\_mass - at\_number$ $electron := at\_number - charge$

Answers,

$proton = 1$ $neutron = 1$ $electron = 1$

c. ^{3}H

From the information given,

$at\_number := 1$ $at\_mass := 3$ $charge := 0$

Calculations,

$proton := at\_number$ $neutron := at\_mass - at\_number$ $electron := at\_number - charge$

Answers,

$proton = 1$ $neutron = 2$ $electron = 1$

d. ^{12}C

From the information given,

at_number := 6   at_mass := 12   charge := 0

Calculations,

proton := at_number   neutron := at_mass − at_number   electron := at_number − charge

Answers,

proton = 6   neutron = 6   electron = 6

e. ^{13}C

From the information given,

at_number := 6   at_mass := 13   charge := 0

Calculations,

proton := at_number   neutron := at_mass − at_number   electron := at_number − charge

Answers,

proton = 6   neutron = 7   electron = 6

f. ^{2}H

From the information given,

at_number := 6   at_mass := 14   charge := 0

Calculations,

proton := at_number   neutron := at_mass − at_number   electron := at_number − charge

Answers,

proton = 6   neutron = 8   electron = 6

g. ^{35}Cl

From the information given,

at_number := 17   at_mass := 35   charge := 0

Calculations,

proton := at_number   neutron := at_mass − at_number   electron := at_number − charge

Answers,

proton = 17   neutron = 18   electron = 17

h. $^{37}Cl^{1-}$

From the information given,

$at\_number := 17$ $at\_mass := 37$ $charge := -1$

Calculations,

$proton := at\_number$ $neutron := at\_mass - at\_number$ $electron := at\_number - charge$

Answers,

$proton = 17$ $neutron = 20$ $electron = 18$

i. ^{262}Ns

From the information given,

$at\_number := 107$ $at\_mass := 262$ $charge := 0$

Calculations,

$proton := at\_number$ $neutron := at\_mass - at\_number$ $electron := at\_number - charge$

Answers,

$proton = 107$ $neutron = 155$ $electron = 107$

2. What is the Atomic Weight of chlorine given that there are two isotopes and:

The exact mass of ^{35}Cl is 34.9689 and the relative abundance is 75.53 %

The exact mass of ^{37}Cl is 36.9659 and the relative abundance is 24.47 %

Is this the answer that you expected?

The information given,

$mass_{35} := 34.9689$ $abundance_{35} := 75.53 \cdot \%$ $abundance_{35} = 0.755$

$mass_{37} := 36.9659$ $abundance_{37} := 24.47 \cdot \%$ $abundance_{37} = 0.245$

The average atomic mass (atomic weight)

$$mass_{35} \cdot abundance_{35} + mass_{37} \cdot abundance_{37} = 35.458$$

Comparing this result with the value given in the periodic table of 35.4527 agrees to the expected number of significant figures (4).

What is the Atomic Weight of Osmium given the following information:

The information given,

$mass_{184} := 183.953$ $abundance_{184} := 0.018 \cdot \%$ $abundance_{184} = 1.800 \cdot 10^{-4}$

$mass_{186} := 185.954$ $abundance_{186} := 1.59 \cdot \%$ $abundance_{186} = 0.016$

$mass_{187} := 186.956$ $abundance_{187} := 1.64 \cdot \%$ $abundance_{187} = 0.016$

$mass_{188} := 187.956$ $abundance_{188} := 13.3 \cdot \%$ $abundance_{188} = 0.133$

$mass_{189} := 188.958$ $abundance_{189} := 16.1 \cdot \%$ $abundance_{189} = 0.161$

$mass_{190} := 189.958$ $abundance_{190} := 26.4 \cdot \%$ $abundance_{190} = 0.264$

$mass_{192} := 191.962$ $abundance_{192} := 41 \cdot \%$ $abundance_{192} = 0.410$

The average atomic mass (atomic weight)

$$\begin{aligned} & mass_{184} \cdot abundance_{184} \; ... \quad = 190.330 \\ & + mass_{186} \cdot abundance_{186} \; ... \\ & + mass_{187} \cdot abundance_{187} \; ... \\ & + mass_{188} \cdot abundance_{188} \; ... \\ & + mass_{189} \cdot abundance_{189} \; ... \\ & + mass_{190} \cdot abundance_{190} \; ... \\ & + mass_{192} \cdot abundance_{192} \end{aligned}$$

Comparing this result (190.330) with the value given in the periodic table of 190.2 agrees to the expected number of significant figures (2). Notice that the atomic weights (average atomic mass) is not known to the same precision for all elements. This is largely because the natural abundance of each isotope varies more for some elements. It is possible to measure the exact mass and the abundance with VERY great precision.

4. Calculate the number of moles in:

a. 20.1797 g of Ne

$mass := 20.1797 \cdot gm$ (given in the problem)

$at\_weight := 20.1797 \cdot gm \cdot mole^{-1}$ (from the periodic table)

$mass = moles \cdot at\_weight$ (KNOW THIS EQUATION!!)

$mol := \frac{mass}{at\_weight}$ (by rearanging the above equation)

$mol = 1.00000000 \cdot mole$ (how many significant figures should this have?)

b. 40.3594 g of Ne

$mass := 40.3594 \cdot gm$ (given in the problem)

$at\_weight := 20.1797 \cdot gm \cdot mole^{-1}$ (from the periodic table)

$mol := \frac{mass}{at\_weight}$ (by rearanging the above equation)

$mol = 2.00000000 \cdot mole$ (how many significant figures should this have?)

c. 0.98669 g of Ne

$mass := 0.98669 \cdot gm$ (given in the problem)

$at\_weight := 20.1797 \cdot gm \cdot mole^{-1}$ (from the periodic table)

$mol := \frac{mass}{at\_weight}$ (by rearanging the above equation)

$mol = 0.04889518 \cdot mole$ (how many significant figures should this have?)

d. 0.98669 g of Ta

$mass := 0.98669 \cdot gm$ (given in the problem)

$at\_weight := 180.9479 \cdot gm \cdot mole^{-1}$ (from the periodic table)

$mol := \frac{mass}{at\_weight}$ (by rearanging the above equation)

$mol = 0.00545290 \cdot mole$ (how many significant figures should this have?)

5. Calculate the mass of:

a. 1.00 mol of Fe

$mol := 1.00$ (from the problem)

$at\_weight := 55.847 \cdot gm \cdot mole^{-1}$ (from the periodic table, under Fe)

$mass := mol \cdot at\_weight$ (from the above equation)

$mass = 55.847 \cdot gm$ (how many SF's should the solution have?)

b. 2.00 mol of Fe

$mol := 2.00$ (from the problem)

$at\_weight := 55.847 \cdot gm \cdot mole^{-1}$ (from the periodic table, under Fe)

$mass := mol \cdot at\_weight$ (from the above equation)

$mass = 111.69400000 \cdot gm$ (how many SF's should the solution have?)

c. $4.362x10^{-5}$ mol of Fe

$mol := 4.362 \cdot 10^{-5}$ (from the problem)

$at\_weight := 55.847 \cdot gm \cdot mole^{-1}$ (from the periodic table, under Fe)

$mass := mol \cdot at\_weight$ (from the above equation)

$mass = 0.00243605 \cdot gm$ (how many SF's should the solution have?)

d. $4.362x10^{-5}$ mol of Li

$mol := 4.362 \cdot 10^{-5}$ (from the problem)

$at\_weight := 6.941 \cdot gm \cdot mole^{-1}$ (from the periodic table, under Li)

$mass := mol \cdot at\_weight$ (from the above equation)

$mass = 3.02766420 \cdot 10^{-4} \cdot gm$ (how many SF's should the solution have? compare with the mass for the same number of moles of Fe.)

6. Using a blank periodic table, fill in the atomic number, name, atomic symbol, and atomic weight of the first 36 elements. Also label the noble gases, the halogens, the alkali metals, the metals, and the non-metals.

This may be a bit tedious, but you will use these elements frequently throughout the course, and in any future chemis courses. You need to know the symbols for AT LEAST the first 36 elements from memory and will be responsible fo them on future exams, quizzes, and homework.

7. Use the mass spectrum for chromium given below to determine the atomic weight.

For previous problems like this you were given the exact mass and the abundance for each isotope of an element. T information is obtained from the mass spectrum of the element. In this problem, you are given the mass spectrum ar need to determine the exact mass and abundance of each isotope. In the mass spectrum the total abundance of eac peak is scaled so that the larges has a signal of 100.

From the spectrum I obtain the following values (yours may differ slightly, that is OK)

$mass_{50} := 49.95$ $mass_{52} := 51.95$ $mass_{53} := 52.95$

$intensity_{50} := 5$ $intensity_{52} := 100$ $intensity_{53} := 10$

Next to determine the percent abundance.

$$intensity_{total} := intensity_{50} + intensity_{52} + intensity_{53}$$

$$intensity_{total} = 115.000$$

$abundance_{50} := \frac{intensity_{50}}{intensity_{total}}$ $abundance_{52} := \frac{intensity_{52}}{intensity_{total}}$ $abundance_{53} := \frac{intensity_{53}}{intensity_{total}}$

$abundance_{52} = 86.957 \cdot \%$ $abundance_{50} = 4.348 \cdot \%$ $abundance_{53} = 8.696 \cdot \%$

Finally, calculate the atomic weight (average atomic mass),

$$mass_{50} \cdot abundance_{50} \ldots + mass_{52} \cdot abundance_{52} \ldots + mass_{53} \cdot abundance_{53} = 51.950$$

This is very close to the value given in the periodic table (51.9961). How many significant figures does this solution have?

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