General Chemistry I
Tutorial 01

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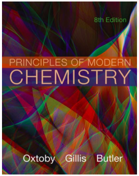
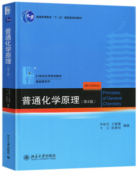
Outline

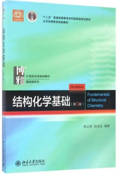
Recommended Textbooks

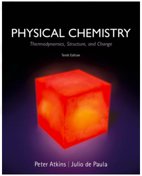
For recitation:





For deeper comprehension:





Number of Significant Figures

Definition 2.1

The number of **significant figures** is the minimum number of digits needed to write a given value in **scientific notation** without loss of precision.

Given Example:

1.427×10^2	4 significant figures
1.4270×10^2	5 significant figures
0.001427	4 significant figures
0.0014270	5 significant figures

Zeros are significant when:

- in the middle of a number or
- at the end of a number on the right-hand side of a decimal point

Question:
How many significant figures are there in 100 and 1.00×10^2?

Addition and Subtraction

Rounding should only be done on the **final answer**, to avoid accumulating round-off errors.

Remark 3.1

The answer goes to the same decimal place as in any of the individual numbers.

$$
\begin{array}{rl}
18.998\,403\,2 & (\text{F}) \\
+\ 18.998\,403\,2 & (\text{F}) \\
+\ 83.798 & (\text{Kr}) \\
\hline
121.794\,\underbrace{806\,4}_{\text{Not significant}} &
\end{array}
$$

Round-off rule: Look at all digits beyond the last place desired.

- More than halfway: round up
- Less than halfway: round down
- Exactly halfway: to the nearest even digit

$$
\begin{array}{r}
1.632 \times 10^5 \\
+\ 4.107 \times 10^3 \\
+\ 0.984 \times 10^6 \\
\hline
\end{array}
\quad \rightarrow \quad
\begin{array}{rr}
1.632 & \times 10^5 \\
+\ 0.041\,07 & \times 10^5 \\
+\ 9.84 & \times 10^5 \\
\hline
11.51 & \times 10^5
\end{array}
$$

Multiplication and Division

Remark 3.2

Limited to the number of digits contained in the number with the **fewest significant figures**.

Given example:

$$\begin{array}{r} 3.26 \times 10^{-5} \\ \times\, 1.78 \qquad\quad \\ \hline 5.80 \times 10^{-5} \end{array} \qquad \begin{array}{rr} 4.317\,9 & \times\, 10^{12} \\ \times\, 3.6 & \times\, 10^{-19} \\ \hline 1.6 & \times\, 10^{-6} \end{array} \qquad \begin{array}{r} 34.60 \\ \div\, 2.462\,87 \\ \hline 14.05 \end{array}$$

Logarithms and Antilogarithms

If $n = 10^a$, then we say that a is the base 10 **logarithm** of n, n is the **antilogarithm** of a.

A logarithm is composed of a **characteristic** and a **mantissa**.

Remark 3.3

The number of significant figures in mantissa should equals to the number of significant figures in logarithm.

Given example:

$$\log 339 = \underbrace{2}_{\substack{\text{Characteristic} \\ = 2}}.\underbrace{530}_{\substack{\text{Mantissa} \\ = 0.530}} \qquad \log 3.39 \times 10^{-5} = \underbrace{-4}_{\substack{\text{Characteristic} \\ = -4}}.\underbrace{470}_{\substack{\text{Mantissa} \\ = 0.470}}$$

Reversely,

$$10^{\underbrace{-3.42}_{\text{2 digits}}} = \underbrace{3.8}_{\text{2 digits}} \times 10^{-4}$$

Name ions

- **Metal cations**

  For single-valence metal cations:

  Cation's name = element

Na^{+}	sodium
Ca^{2+}	calcium
K^{+}	potassium

  For multi-valance metal cations:

  Cations name = element(valence)

Fe^{2+}	iron(II)
Cr^{3+}	chromium(III)

  Higher oxidation state: Latin+ic Lower oxidation state: Latin+ous

Fe^{2+}	ferrous
Fe^{3+}	ferric

- **Polyatomic cations:**

NH_4^{+}	ammonium ion
H_3O^{+}	hydronium ion

Name ions

- **Nonmetal anions**
  For monatomic anions:
  Anion's name = root+ide

Cl^-	chloride
Br^-	bromide
O^{2-}	oxide
O_2^{2-}	peroxide

For multiatomic anions:

ClO^-	hypochlorite
ClO_2^-	chlorite
ClO_3^-	chlorate
ClO_4^-	perchlorate

Name compound

- **Ionic compound**

  Compound's name = cation + anion

NaCl	sodium chloride
Fe_2O_3	iron(III) oxide
$KMnO_4$	potassium permanganate
Pb_3O_4	lead(II,IV) oxide; trilead tetraoxide

- **Covalent compound**

  If a pair of element can only form one compound:

  Write from left to right with the second element given by root+ide.

H_2S	hydrogen sulfide
BN	boron nitride

Name compound

If more than one compound can be formed:
Prefixes are added.(mono- is often omitted)

Number	Prefix
1	mono-
2	di-
3	tri-
4	tetra-
5	penta-
6	hexa-
7	hepta-
8	octa-
9	nona-
10	deca-

N_2O	dinitrogen oxide
N_2O_5	dinitrogen pentaoxide
CO	carbon **mono**xide
CO_2	carbon dioxide

Lewis Diagram

Remark 5.1

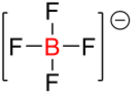
- *Count total # of electrons*
- *Calculate # of electrons required if each atom has its noble-gas electron configuration*
- *# of bonds* $= \frac{1}{2}$*(Calculated e - Total e)*
- *Assign bond to atoms*
- *Assign remaining electrons to atoms*
- *Determine formal charge / coordinate bond*
- *More than one possible diagram: smallest magnitude of formal charges & negative charges on more electronegative atoms.*

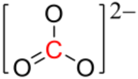
Remark 5.2

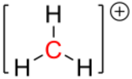
Formal charge $=$ *# of valence e - # of e in lone pairs -* $\frac{1}{2}$*(of e in bonding pairs)*

Quiz

(1.4 pt) Give the formal charge of the red atom in the following ion or molecule.

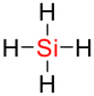
(a) 

(b) 

(c) 

(d) $[N{=}N{=}N]^{\ominus}$

(e) $C{\equiv}O$

(f) 

(g) $[O{-}Cl]^{\ominus}$

PS1.1

More than half of all the atoms in naturally occurring zirconium are ^{90}Zr. The other four stable isotopes of zirconium have the following relative atomic masses and abundances:

Isotope	**% Abundance**	**Atomic Mass**
^{91}Zr	11.27	90.9056
^{92}Zr	17.17	91.9050
^{94}Zr	17.33	93.9063
^{96}Zr	2.78	95.9083

Compute the relative atomic mass of ^{90}Zr to four significant digits, using the tabulated relative atomic mass 91.224 for natural zirconium.

PS1.2

A dark brown binary compound contains oxygen and a metal. It is 13.38% oxygen by mass. Heating it moderately drives off some of the oxygen and gives a red binary compound that is 9.334% oxygen by mass. Strong heating drives off more oxygen and gives still another binary compound, which is only 7.168% oxygen by mass.

(a)Compute the mass of oxygen that is combined with 1.000 g of the metal in each of these three oxides.

(b) Assume that the empirical formula of the first compound is MO_2 (where M represents the metal). Give the empirical formulas of the second and third compounds.

(c) Name the metal and give its element symbol.

PS1.3

The attached research paper describes the determination of the atomic weight of rubidium by a chemical method. Go through the highlighted parts of this paper, and answer the following questions.

(a) Write down the key chemical equation that the authors used for determining the relative atomic mass of rubidium.

(b) In Table 1, how was the relative atomic mass of rubidium (5 significant figures) calculated from the masses of rubidium bromide and silver (6 significant figures)? Write down the calculation process.

(c) The authors concluded that "The atomic weight of rubidium cannot therefore be far from 85.481". How does this number compare with the currently accepted value for rubidium? What do you think could be the source(s) of error? Give your reasons.

PS1.4

Draw Lewis dot diagrams (including covalent bonds and lone pairs) for the following molecules or ions, and give the formal charge of the atoms in red:

(a)NO_3^-; (b)H_3O^+; (c)CN^-; (d) H_2CO;
(e)SiH_4; (f)OCl^-; (g)KrF^+; (h)P_4;

Thanks for listening!