

# 3.091

Do yourself a solid.

3.091: Introduction to Solid State Chemistry  
Fall 2018  
Practice Problems A: Atoms

The following problems sets are compiled from B. A. Averill and P. Eldredge, *General Chemistry: Principles, Patterns, and Applications*. License: CC BY-NC-SA. Source: [Open Textbook Library](#).

Reading: Averill 1.1-1.7; 7.1; 3.1, 3.3-3.4;

## 1. Atomic symbols practice

*Averill Chapter 1, Section 6, Conceptual Problem 5*

Give the symbol  ${}^A_ZX$  for these elements, all of which exist as a single isotope:

- beryllium
- ruthenium
- phosphorus
- aluminum
- cesium
- praseodymium
- cobalt
- yttrium
- arsenic

## 2. Isotopes and average atomic mass

*Averill Chapter 1, Section 6, Numerical Problem 5*

Copper, an excellent conductor of heat, has two isotopes:  ${}^{63}\text{Cu}$  and  ${}^{65}\text{Cu}$ . Use the following information to calculate the average atomic mass of copper:

Isotope	Percent Abundance (%)	Atomic mass (amu)
${}^{63}\text{Cu}$	69.09	62.9298
${}^{65}\text{Cu}$	30.92	64.9278

## 3. Isotopes and average atomic mass

*Averill Chapter 1, Section 6, Numerical Problem 10*

Complete the following table:

Isotope	Number of protons	Number of neutrons	number of electrons
${}^{57}\text{Fe}$			
${}^{40}\text{X}$		20	
${}^{36}\text{S}$			



Do yourself a solid.

#### 4. Molecular mass/molar mass

*Averill Chapter 3, Section 1, Numerical Problem 3*

Calculate the molecular mass or formula mass (molar mass) of each compound:

- $V_2O_4$  (vanadium(IV) oxide)
- $CaSiO_3$  (calcium silicate)
- $BiOCl$  (bismuth oxychloride)
- $CH_3COOH$  (acetic acid)
- $Ag_2SO_4$  (silver sulfate)
- $Na_2CO_3$  (sodium carbonate)
- $(CH_3)_2CHOH$  (isopropyl alcohol)

#### 5. Grams to moles

*Averill Chapter 3, Section 1, Numerical Problem 8*

Calculate the number of moles in  $5.00 \times 10^2$  g of each substance. How many molecules or formula units are present in each sample?

- CaO (lime)
- $CaCO_3$  (chalk)
- $C_{12}H_{22}O_{11}$  (sucrose/cane sugar)
- NaOCl (bleach)
- $CO_2$  (dry ice)

#### 6. Moles, molecules, and molar mass

*Averill Chapter 3, Section 1, Numerical Problem 16*

Decide whether each statement is true or false and explain your reasoning.

- There are more molecules in 0.5 mol of  $Cl_2$  than in 0.5 mol of  $H_2$ .
- One mole of  $H_2$  has  $6.022 \times 10^{23}$  hydrogen atoms.
- The molecular mass of  $H_2O$  is 18.0 amu.
- The formula mass of benzene is 78 amu.

#### 7. Balancing reactions

*Averill Chapter 3, Section 3, Numerical Problem 2*

Balance each chemical equation.

- $Be(s) + O_2(g) \rightarrow BeO(s)$
- $N_2O(g) + H_2O(l) \rightarrow HNO_2(aq)$
- $Na(s) + H_2O(l) \rightarrow NaOH(aq) + H_2(g)$
- $CaO(s) + HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l)$
- $CH_3NH_2(g) + O_2(g) \rightarrow H_2O(g) + CO_2(g) + N_2(g)$
- $Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$

## 8. Writing balanced equations and finding limiting reagents

*Averill Chapter 3, Section 4, Numerical Problem 12*

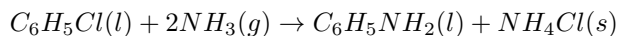
Write a balanced chemical equation for each reaction and then determine which reactant is in excess.

- 2.46 g barium(s) plus 3.89 g bromine(I) in water to give barium bromide
- 1.44 g bromine(I) plus 2.42 g potassium iodide(s) in water to give potassium bromide and iodine
- 1.852 g of Zn metal plus 3.62 g of sulfuric acid in water to give zinc sulfate and hydrogen gas
- 0.247 g of iron metal reacts with 0.924 g of silver acetate in water to give iron(II) acetate and silver metal
- 3.142 g of ammonium phosphate reacts with 1.648 g of barium hydroxide in water to give ammonium hydroxide and barium phosphate

## 9. Determining the yield of a reaction

*Averill Chapter 3, Section 4, Numerical Problem 25*

Aniline ( $C_6H_5NH_2$ ) can be produced from chlorobenzene ( $C_6H_5Cl$ ) via the following reaction:



Assume that 20.0 g of chlorobenzene at 92% purity is mixed with 8.30 g of ammonia.

- Which is the limiting reactant?
- Which reactant is present in excess?
- What is the theoretical yield of ammonium chloride in grams?
- If 4.78 g of  $NH_4Cl$  was recovered, what was the percent yield?
- Derive a general expression for the theoretical yield of ammonium chloride in terms of grams of chlorobenzene reactant, if ammonia is present in excess.

MIT OpenCourseWare  
<https://ocw.mit.edu/>

3.091 Introduction to Solid-State Chemistry  
Fall 2018

For information about citing these materials or our Terms of Use, visit: <https://ocw.mit.edu/terms>.