Dr. Zellmer | Chemistry 1210 | All Sections
Time: 7 PM Sun. | Autumn Semester 2022 | September 11, 2022
30 min | Quiz II

Name KEY Rec. TA/time _____

1. (3 pts) An element has two naturally occurring isotopes, ^{83}X and ^{85}X, with atomic masses of 82.9118 amu and 84.9092 amu, respectively. The natural abundances of ^{83}X and ^{85}X are 63.15% and 36.85%, respectively. Calculate the atomic weight of this element.

Not on actual quiz. Just for practice.

Atomic weights are a **weighted average** of the masses of all the naturally occurring isotopes of an element. Remember, the percentages add to 100 and the fractions add to 1.

At. wt. = (0.6315) (82.9118 amu) + (0.3685) (84.9092 amu)

= 52.3**5**8801 amu + 31.2**8**9040 amu

At. wt. = 83.6**4**7841 amu = 83.65 amu (4 s.f.)

2. (5 pts) Copper (atomic weight 63.5460) has two naturally-occurring isotopes, the predominant one being ^{63}Cu with an isotopic weight of 62.9298 and an abundance of 69.09%. What is the isotopic weight of the other isotope?

The atomic weight (amu) is the **weighted average** of the masses of the isotopes.

The abundance of the 2nd isotope is 100.00% - 69.09% = 30.91%

At. wt. = (0.6909) (62.9298 amu) + (0.3091) (X) = 63.5460 amu

43.4**7**819 amu + (0.3091) (X) = 63.5460 amu

(0.3091) (X) = 20.0**6**780 amu

X = 64.9**2**33 amu

The isotopic weight of the other isotope is 64.92 amu.

3. (4 pts) Examine the following group of elements.

$_{38}Sr$	$_{34}Se$	$_{18}Ar$
$_{52}Te$	$_{27}Co$	$_{48}Cd$
$_{82}Pb$	$_{7}N$	$_{32}Ge$

The number of **representative (main-group) <u>metals</u>** is(are): 2

The number of **<u>metalloids</u>** (semimetals) is(are): 2

Selenium (Se), Nitrogen (N), and Argon (Ar) are nonmetals.
Strontium (Sr) and Lead (Pb) are **representative metals**.
Cobalt (Co) and Cadmium (Cd) are transition metals.
Germanium (Ge) and Tellurium (Te) are **metalloids** (**semimetals**).

4. (2 pts) Which of the following formulas are possible molecular formulas for the empirical formula $C_3H_5O_2$?

a) $C_5H_{10}O_2$ b) $C_5H_{12}O_4$ c)* $C_6H_{10}O_4$ d) $C_9H_{15}O_3$ e)* $C_9H_{15}O_6$

The molecular formula is always an integer multiple of the empirical formula.

$C_6H_{10}O_4 = (C_3H_5O_2)_2$

$C_9H_{15}O_6 = (C_3H_5O_2)_3$

Also, for molecules containing only C & H or C, H & O the number of H atoms in the empirical formula can be an odd number. However, in the **<u>molecular</u> <u>formula</u>** there has to be an **<u>even number</u>** of **H atoms**.

5. (3 pts) Fill in the blanks in the table below for the isotopes indicated.

Symbol	number of protons	number of neutrons	number of electrons	atomic number	mass number
$^{138}_{56}Ba^{2+}$	56	82	54	56	138

$^{A}_{Z}E$ E = atomic symbol
Z = atomic number = # p (protons)
A = mass number = #p + #n (n is neutron)
charge = #p – #e^-

6. (5 pts) Which of the following pairs of names and formulas is **INCORRECT**?

a) iron (III) bisulfate, $Fe(HSO_4)_3$
b) chlorous acid, $HClO_2$ (aq)
c) trinitrogen pentoxide, N_3O_5
d) zinc dihydrogen phosphate, $Zn(H_2PO_4)_2$
e)* zirconium (IV) hypobromite, $Zr_4(BrO)$

For ionic compounds you need to know the charge on both the cation and anion and the charges have to balance since ionic compounds are neutral (like NaCl). For group 1A and 2A metals the cations formed always have a +1 and +2 charges, respectively. Also, Al, Zn and Ag are always +3, +2 and +1, respectively. Other metals can have multiple charges depending on the compound and their charges are given as Roman Numerals in parentheses in the name. In ionic compounds groups 5A, 6A and 7A have charges of −3, −2 and −1 respectively. You have to memorize some polyatomic ions (names, formulas and charges).

For molecular compounds the less electronegative element is generally written first in the formula and is named first in the name. The second element (more electronegative element) in the formula is named by using the stem of the name and the suffix -ide. Numerical prefixes, indicating the numbers of each atom, precede the names of both elements. Common exceptions are for compounds containing H and an element from groups 3A, 4A and 5A (BH_3, CH_4, NH_3, etc.).

How can you tell if the compound is molecular and not ionic? Generally if the compound is composed of a metal and nonmetal it is ionic. Generally if the compound contains only nonmetals or nonmetal and semimetal it is molecular. The most common exceptions to this is when a compound contains ammonium ions, NH_4^+, such as NH_4Cl, $(NH_4)_2SO_4$, etc. All the elements in the compounds listed (and others with NH_4^+ ions) contain all nonmetals but are ionic because of the presence of the NH_4^+ ions.

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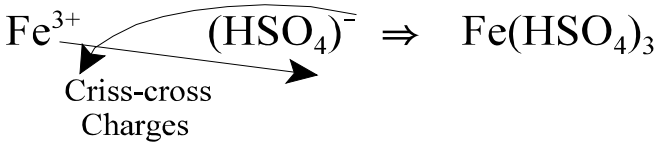
6. (cont.)

The following are the correct formulas for the names given:

a) **iron(III) bisulfate** (Ionic)



Charge on iron is +3 (a Roman Numeral is needed since Fe can be +2 or +3 in compounds). You should know that SO_4^{2-} is sulfate with a −2 charge. Adding 1 H^+ to sulfate gives bisulfate (or hydrogen sulfate), HSO_4^-. Since there is a +3 charge on the Fe and the HSO_4^- has a −1 charge there has to be 3 HSO_4^- ions for every one Fe^{3+}. This gives a total positive charge of +3 and a total negative charge of −3.

b) **chlorous acid** (molecular acid since it as (aq))

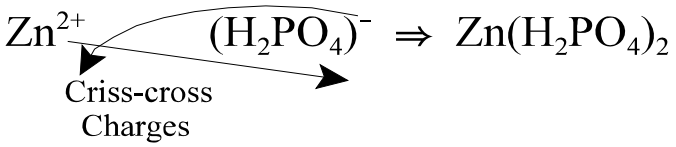
$HClO_2$ (aq) from chlorite, ClO_2^-. When enough H^+ is added to an -ite anion to make it a neutral molecule it is named as an -ous acid (when it is in solution).

c) **trinitrogen pentoxide** (molecular)

N_3O_5

The name for a binary molecular compound uses Greek prefixes to indicate the number of atoms of each type are in the molecule.

d) **zinc(II) dihydrogen phosphate** (Ionic)



Charge on zinc is +2 (no Roman Numeral is needed since Zn is always +2 in compounds). You should know that PO_4^{3-} is sulfate with a −3 charge. Adding 1 H^+ to phosphate gives hydrogen phosphate, HPO_4^{2-}. Adding 1 H^+ to this gives dihydrogen phosphate, $H_2PO_4^-$. Since there is a +2 charge on the Zn and the $H_2PO_4^-$ has a −1 charge there has to be 2 $H_2PO_4^-$ ions for every one Zn^{2+}. This gives a total positive charge of +2 and a total negative charge of −2.

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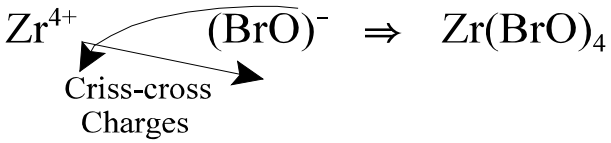
6. (cont.)

e) zirconium(IV) hypobromite (Ionic) This one had the incorrect formula for the name given.



Charge on zirconium is +4 (given as Roman Numeral IV in name). You should know that BrO_3^- is bromate with a −1 charge and one fewer oxygen is an -ite, BrO_3^- and one fewer than the -ite is hypo-ite, BrO^-. Criss-cross the charges and you get the correct subscripts in this case. The 1 zirconium provides a total positive charge of +4. The 4 hypobromites gives a total negative charge of −4.

7. What are the formulas of two compounds, one composed of chromium and nitrite and another composed of chromium and selenate (Se is selenium), if the charge on the Cr is the same as in CrN. (Assume the charge on Cr is the same in all cases.)

Not on actual quiz. Just for practice.

Chromium nitride is CrN

Since the charge on nitride, $\mathbf{N^{3-}}$, is −3, the charge on the Cr must be +3

Nitrite: NO_2^- (NO_3^- is nitrate. One fewer O atom is an -ite)

Selenate: SeO_4^{2-} (Se is under S in group 6A so it's based on sulfate, SO_4^{2-})

chromium nitrite: Cr^{3+} NO_2^- ⇒ $Cr(NO_2)_3$

chromium selenate: Cr^{3+} SeO_4^{2-} ⇒ $Cr_2(SeO_4)_3$

8. (6 pts) Balance the following equation. What is the sum of the coefficients of the **REACTANTS**? (If present, don't forget the coefficients of 1.)

$$C_{12}H_{22}O_6 + O_2 \rightarrow CO_2 + H_2O$$

A) Balance C

$$C_{12}H_{22}O_6 + O_2 \rightarrow 12\ CO_2 + H_2O$$

(# C's in $C_{12}H_{22}O_6$)

B) Balance H

$$C_{12}H_{22}O_6 + O_2 \rightarrow 12\ CO_2 + 11\ H_2O$$

(½ # H's in $C_{12}H_{22}O_6$)

C) Balance O 6 – O + (Need 29 O atoms from O_2) → 24 – O + 11 – O = (35 – O on rt.)
Use 29/2 O_2 (½ of 29 O = O gives 29 O atoms)

$$C_{12}H_{22}O_6 + (29/2)\ O_2 \rightarrow 12\ CO_2 + 11\ H_2O$$

D) Multiply by 2:

$$\mathbf{2}\ C_{12}H_{22}O_6 + \mathbf{29}\ O_2 \rightarrow \mathbf{24}\ CO_2 + \mathbf{22}\ H_2O$$

The sum of the coefficients of the **reactants** = 2 + 29 = 31

9. (5 pts) Balance the following equation. What is the sum of the coefficients of the **REACTANTS AND PRODUCTS** in the balanced equation? (If present, don't forget the coefficients of 1.)

$$Na_2SiO_3 + HF \rightarrow H_2SiF_6 + NaF + H_2O$$

A) Balance Na (While F appears in greatest amount the Na is in only 1 cmpd on each side)

$$Na_2SiO_3 + HF \rightarrow H_2SiF_6 + 2\ NaF + H_2O$$

B) Balance F (Si is already bal., leave oxygen until end when possible)

$$Na_2SiO_3 + 8\ HF \rightarrow H_2SiF_6 + 2\ NaF + H_2O$$

B) Balance O (The O atom appears in only 1 reactant and product - 3 O on left)

$$Na_2SiO_3 + 8\ HF \rightarrow H_2SiF_6 + 2\ NaF + 3\ H_2O$$

C) Balance H (The H is now balanced as well)

$$\mathbf{1}\ Na_2SiO_3 + \mathbf{8}\ HF \rightarrow \mathbf{1}\ H_2SiF_6 + \mathbf{2}\ NaF + \mathbf{3}\ H_2O$$

(coefficients of **1**'s in front of the compounds are usually not shown)

The sum of the coefficients of the **reactants AND products** = 1 + 8 + 1 + 2 + 3 = **15**

10. (5 pts) Balance the following equation and choose the answer which is the sum of the coefficients of the **REACTANTS**. (If present, don't forget the coefficients of 1.)

$$Sc(NO_3)_3 + NH_3 + H_2O \rightarrow Sc(OH)_3 + NH_4NO_3$$

A) Balance NO_3 (balance as a unit since it appears on both sides)

$$Sc(NO_3)_3 + NH_3 + H_2O \rightarrow Sc(OH)_3 + 3\ NH_4NO_3$$

B) Balance remaining N (3 N in NH_4 on right - need 3 NH_3 on left)

$$Sc(NO_3)_3 + 3\ NH_3 + H_2O \rightarrow Sc(OH)_3 + 3\ NH_4NO_3$$

C) Balance O in $Sc(OH)_3$ (other O atoms are balanced - need 3 H_2O - H then also bal)

$$\mathbf{1}\ Sc(NO_3)_3 + \mathbf{3}\ NH_3 + \mathbf{3}\ H_2O \rightarrow \mathbf{1}\ Sc(OH)_3 + \mathbf{3}\ NH_4NO_3$$

The sum of the coefficients of the **reactants** = 1 + 3 + 3 = 7