Welcome to our CHEM 4 lecture

Review clicker question: Mole-to-mole ratios
Go to LearningCatalytics.com **Session ID =**

1) A sample of magnesium hydroxide has a mass of 15.8 mg. How many atoms are in the sample?

A) 1.63×10^{20} atoms

B) 2×10^{20} atoms

C) 8.16×10^{20} atoms

D) 8×10^{20} atoms

E) 4.89×10^{20} atoms

F) 5×10^{20} atoms

See work shown on next slide…

Work shown for question from previous slide…

1) A sample of magnesium hydroxide has a mass of 15.8 mg. How many atoms are in the sample?

Answer:

There are 5 atoms in each $Mg(OH)_2$

Flowchart: mg $Mg(OH)_2$ → g $Mg(OH)_2$ → moles $Mg(OH)_2$ → **# $Mg(OH)_2$ → # atoms**

If you stop at this step, you have found "how many $Mg(OH)_2$ are in the sample"

Calculation:

$$(15.8\ \text{mg Mg-})\left(\frac{10^{-3}\ \text{g Mg–}}{1\ \text{mg Mg–}}\right)\left(\frac{1\ \text{mol Mg–}}{58.33\ \text{g Mg–}}\right)\left(\frac{6.022 \times 10^{23}\ \text{Mg–}}{1\ \text{mol Mg–}}\right)\left(\frac{5\ \text{atoms}}{1\ \text{Mg–}}\right) = 8.1559746 \times 10^{20}\ \text{atoms}$$

3sf *∞ sf* *4sf* *4sf* *∞ sf*

Keep 3sf

= **8.16×10^{20} atoms**

Could also have done:

mg $Mg(OH)_2$ → g $Mg(OH)_2$ → **moles $Mg(OH)_2$ → moles atom** → # atoms

Common error from previous slide:

This is wrong!

$$(15.8\ \text{mg}\ \text{Mg(OH)}_2)\left(\frac{10^{-3}\ \text{g}\ \text{Mg(OH)}_2}{1\ \text{mg}\ \text{Mg(OH)}_2}\right)\left(\frac{1\ \text{mol}\ \text{Mg(OH)}_2}{58.33\ \text{g}\ \text{Mg(OH)}_2}\right)\left(\frac{6.022\ \text{x}\ 10^{23}\ \text{atoms}}{1\ \text{mol}\ \text{Mg(OH)}_2}\right)$$

The last conversion factor *appears* to get us from $Mg(OH)_2$ → atoms, but when we use a conversion factor with "mole", the numerator and the denominator must have the same units.

For example:

This is correct!

$$\left(\frac{6.022\ \text{x}\ 10^{23}\ \text{Mg(OH)}_2}{1\ \text{mol}\ \text{Mg(OH)}_2}\right)$$

or

This is correct!

$$\left(\frac{6.022\ \text{x}\ 10^{23}\ \text{atoms}}{1\ \text{mol}\ \text{atoms}}\right)$$

but not

This is wrong!

$$\left(\frac{6.022\ \text{x}\ 10^{23}\ \text{atoms}}{1\ \text{mol}\ \text{Mg(OH)}_2}\right)$$

That would be like saying….

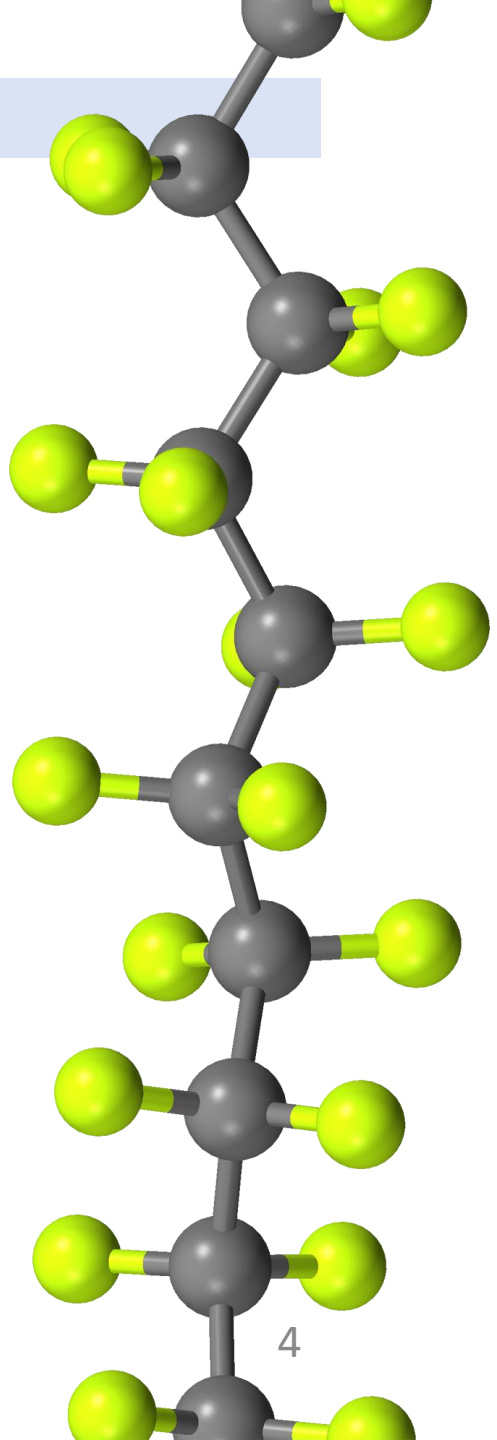
$$\left(\frac{12\ \text{apples}}{1\ \text{dozen}\ \text{donuts}}\right)$$

This is wrong!

Need to make changes in how you study for CHEM 4?

Here's our checklist of key behaviors that lead to success in CHEM 4:

- ✓ Study efficiently with a focus on the homework:
  - ✓ (1) do the assigned reading, then (2) attend lecture, then (3) review the lecture slides or video. You should then be ready to do the homework.
  - ✓ If you do (1) - (3) and start the required homework and have trouble, then put aside the homework and redo (1) and (3). Then try the optional homework.
  - ✓ If you still have trouble, put the homework aside and come to my office hours.
  - ✓ Remember is it okay if the homework is late, the most important thing is that you are really understanding the homework.
- ✓ Get help when needed:
  - ✓ Put together a weekly study group.
  - ✓ Jeff's office hours: MWF 9 – 9:30 am and 11 – 11:30 am; and by appointment.
  - ✓ PAL office hours: link is on our CHEM 4 website.
- ✓ Complete all of the practice exams.
- ✓ Visit our CHEM 4 website regularly: tinyurl.com/SacStateChem4



CHEM 4 lecture

Friday – November 13, 2020

Sec 6.6 - 6.7

Mass Percent

Reading clicker question: Mass percent (Sec 6.6 - 6.7)
Go to LearningCatalytics.com Session ID =

2) Which of the following correctly shows how to calculate the *mass percent* of element X in a compound based on the chemical formula?

A) $\left(\frac{\text{mass of element X in 1 mole of compound}}{\text{mass of the sample of the compound}}\right) \times 100\%$

B) $\left(\frac{\text{mass of element X in 1 mole of compound}}{\text{mass of 1 mol of compound}}\right) \times 100\%$

C) $\left(\frac{\text{mass of X in a sample of the compound}}{\text{mass of the sample of the compound}}\right) \times 100\%$

D) $\left(\frac{\text{mass of X in a sample of the compound}}{\text{mass of 1 mol of compound}}\right) \times 100\%$

This is also a formula for finding mass percent, but is used when you have experimental data instead of the chemical formula.

Sample calculation: Determining the mass % of an element when we know the formula of the compound.

Ex: Determine the mass % of silver in silver sulfide.

Answer: Formula = Ag_2S

$$\text{Mass \% Ag} = \left(\frac{\text{mass of Ag in 1 mole of } Ag_2S}{\text{mass of 1 mol of } Ag_2S}\right) \text{x } 100\%$$

There are 2 Ag in each Ag_2S

This is the mass of 1 mol of Ag (from periodic table)

$$= \left(\frac{2(107.9 \text{ g Ag})}{247.9 \text{ g } Ag_2S}\right) \text{x } 100\% = 87.05\% \text{ Ag}$$

(keep 4 sf)

This is the mass of 1 mol of Ag_2S (from periodic table)

Mass % is very useful because <u>any</u> size sample of Ag_2S is 87.05% Ag

Sample calculation: Using the mass %

Ex: How much Ag_2S would you need if you wanted to isolate 200.0 g of Ag?

Remember, we just saw that Ag_2S is always **87.05% Ag**. Because "%" also means "per 100" we can use mass % as a conversion factor:

Rewrite **87.05% Ag** as: $\dfrac{87.05\text{ g Ag}}{100\text{ g Ag}_2\text{S}}$

Answer:

$$(200.0\text{ g of Ag})\left(\frac{100\text{ g Ag}_2\text{S}}{87.05\text{ g Ag}}\right) = \mathbf{229.8\text{ g Ag}_2\text{S}}$$

4sf *4sf*

Keep 4sf

[This answer makes sense… the mass of the whole sample should be greater than the mass of just the silver.]

Clicker question: Determining mass %
Go to LearningCatalytics.com Session ID =

3) Calculate the mass % of O in a 32.0 g sample of carbonic acid.

A) 61.02% O
B) 81.90% O
C) 13.20% O
D) 72.28% O
E) 77.39% O
F) 45.26% O

Answer: **Formula =** H_2CO_3 (aq)

Calculation: Mass % of O = $\frac{3(16.00)}{2(1.008)+1(12.01)+3(16.00)}$ x 100% = 77.39% O

Notes:

- The mass of the sample (32.0 g) doesn't matter.
- Could also find mass % of H = 3.250% and mass % of C = 19.36%
- All of the mass %'s add up to 100%

Clicker question: Using mass %

Go to LearningCatalytics.com Session ID =

4) How many grams of C is present in a sample of H_2CO_3 that has 16.0 g of O?
[Remember we just saw that H_2CO_3 is 77.39% O, 3.250% H, and 19.36% C. Consider writing these %'s out at "per 100 g" conversion factors.]

A) 31.9 g C
B) 8.02 g C
C) 6.15 g C
D) 4.00 g C
E) 16.0 g C
F) 24.3 g C

Answer:

Based on the mass % of O

Based on the mass % of C

Method #1: $$(16.0\text{ g O})\left(\frac{100.0\text{ g } H_2CO_3}{77.39\text{ g O}}\right)\left(\frac{19.36\text{ g C}}{100.0\text{ g } H_2CO_3}\right)= 4.00\text{ g C}$$

Method #2: $$(16.0\text{ g O})\left(\frac{1\text{ mol O}}{16.00\text{ g O}}\right)\left(\frac{1\text{ mol } H_2CO_3}{3\text{ mol O}}\right)\left(\frac{1\text{ mol C}}{1\text{ mol } H_2CO_3}\right)\left(\frac{12.01\text{ g C}}{1\text{ mol C}}\right)= 4.00\text{ g C}$$

Clicker question: Conceptual understanding of mass %
Go to LearningCatalytics.com Session ID =

5) Which of the following has the highest mass percent of copper? See if you can determine the answer without doing any calculations.

A) 100-g sample of $Cu(NO_3)_2$

B) 75-g sample of CuO

C) 200-g sample of $CuCO_3$

D) 25-g sample of CuS

Answer:

All of the 4 samples will have the same numerator

$$\text{Mass \% Cu} = \left(\frac{\text{mass of Cu in 1 mole of compound}}{\text{mass of 1 mol of compound}}\right) \times 100\%$$

We want this to be large

We want the smallest denominator

The sample masses don't matter. Because our calculations for mass % would each have 1 x Cu in the numerator, if we want the highest mass % of Cu, we want the compound with the smallest molar mass.

Clicker question: Determining the mass % from experimental data

Go to LearningCatalytics.com Session ID =

6) Aspirin contains only C, H and O. A 500. mg aspirin is found to have 299.5 mg of C, 22.5 mg of H. What is the mass % of O in aspirin?

$$\text{Mass \% of X} = \left(\frac{\text{mass of X in a sample of the compound}}{\text{mass of the sample of the compound}}\right) \times 100\%$$

A) 36% O

B) 64.4% O

C) 60% O

D) 35.6% O

E) 59.9% O

F) 40.10% O

Answer: We weren't given the formula for aspirin, but we do have experimental data. Taking the total mass of the aspirin and subtracting the masses of C and H will give us the mass of O. If all the masses have the same units, then we can use any unit and we don't have to convert them to g.

Mass O = 500. mg aspirin – 299.5 mg C – 22.5 mg H = 178 mg

$$\text{Mass \% of O} = \frac{178 \text{ mg O}}{500. \text{ mg aspirin}} \times 100\% = 35.6\% \text{ O}$$