Welcome to our CHEM 4 lecture

Review clicker question: Mole and molar mass

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1) How many ethanol molecules (C_2H_5OH) are in a 0.105-L sample of ethanol? The density of ethanol is 0.79 g/cm^3.

A) 1.1×10^{24} ethanol molecules

B) 3.0×10^{-24} ethanol molecules

C) 6.0×10^{24} ethanol molecules

D) 1.1×10^{21} ethanol molecules

E) 6.0×10^{21} ethanol molecules

F) 5.4×10^{22} ethanol molecules

Answer: Flowchart: L → cm^3 → g → mole → molecules

(all steps in this flowchart refer to ethanol, C_2H_5OH)

Molar mass of C_2H_5OH = 46.07 g/mol

$$(0.105\ \cancel{L})\left(\frac{1000\ \cancel{cm^3}}{1\ \cancel{L}}\right)\left(\frac{0.79\ \cancel{g}}{1\ \cancel{cm^3}}\right)\left(\frac{1\ \cancel{mole}}{46.07\ \cancel{g}}\right)\left(\frac{6.022 \times 10^{23}\ C_2H_5OH}{1\ \cancel{mole}}\right) = 1.0842737 \times 10^{24}\ C_2H_5OH$$

3sf *∞ sf* *2sf* *4sf* *4sf*

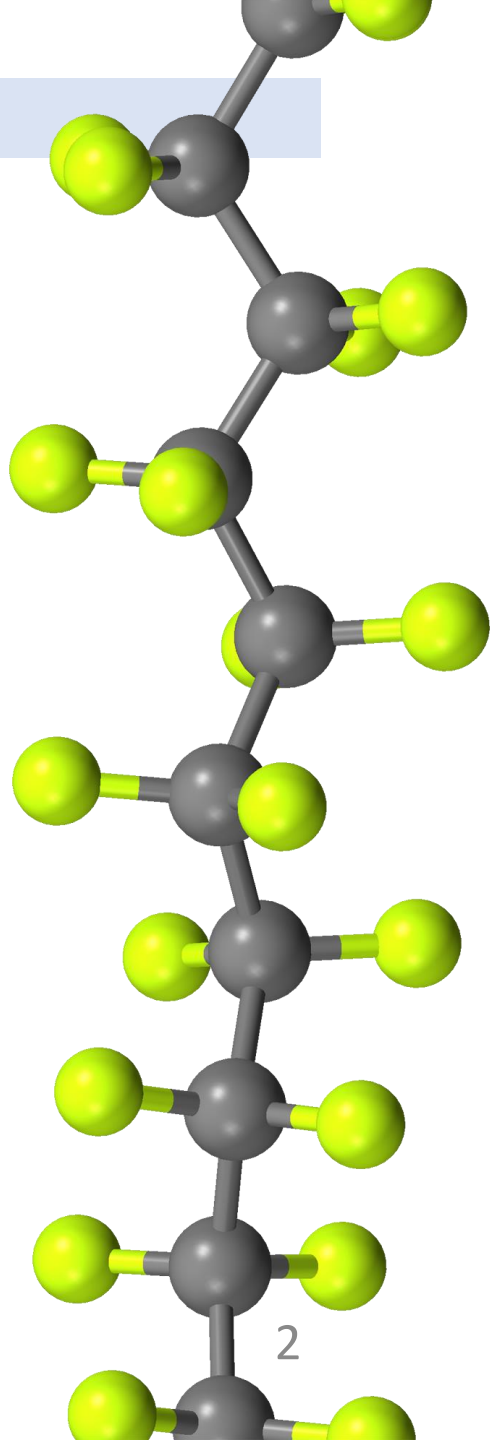
Keep 2sf

Exam #2 results

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

- ✓ Visit our CHEM 4 website regularly: tinyurl.com/SacStateChem4
- ✓ 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.

- ✓ Everyone deserves a second chance! C2S program allows you to drop lowest exam.



CHEM 4 lecture

Monday – November 9, 2020

Sec 6.5

Moles-to-mole ratios

Reading clicker question: Mole-to-mole ratios (Sec 6.5)
Go to LearningCatalytics.com Session ID =

2) Which of these samples would contain the greatest number of moles of oxygen atoms?

A) 3.0 moles of H_2O

B) 2.0 moles of CO

C) 2.0 moles of CO_2

D) 1.0 mole of HNO_3

Answer:

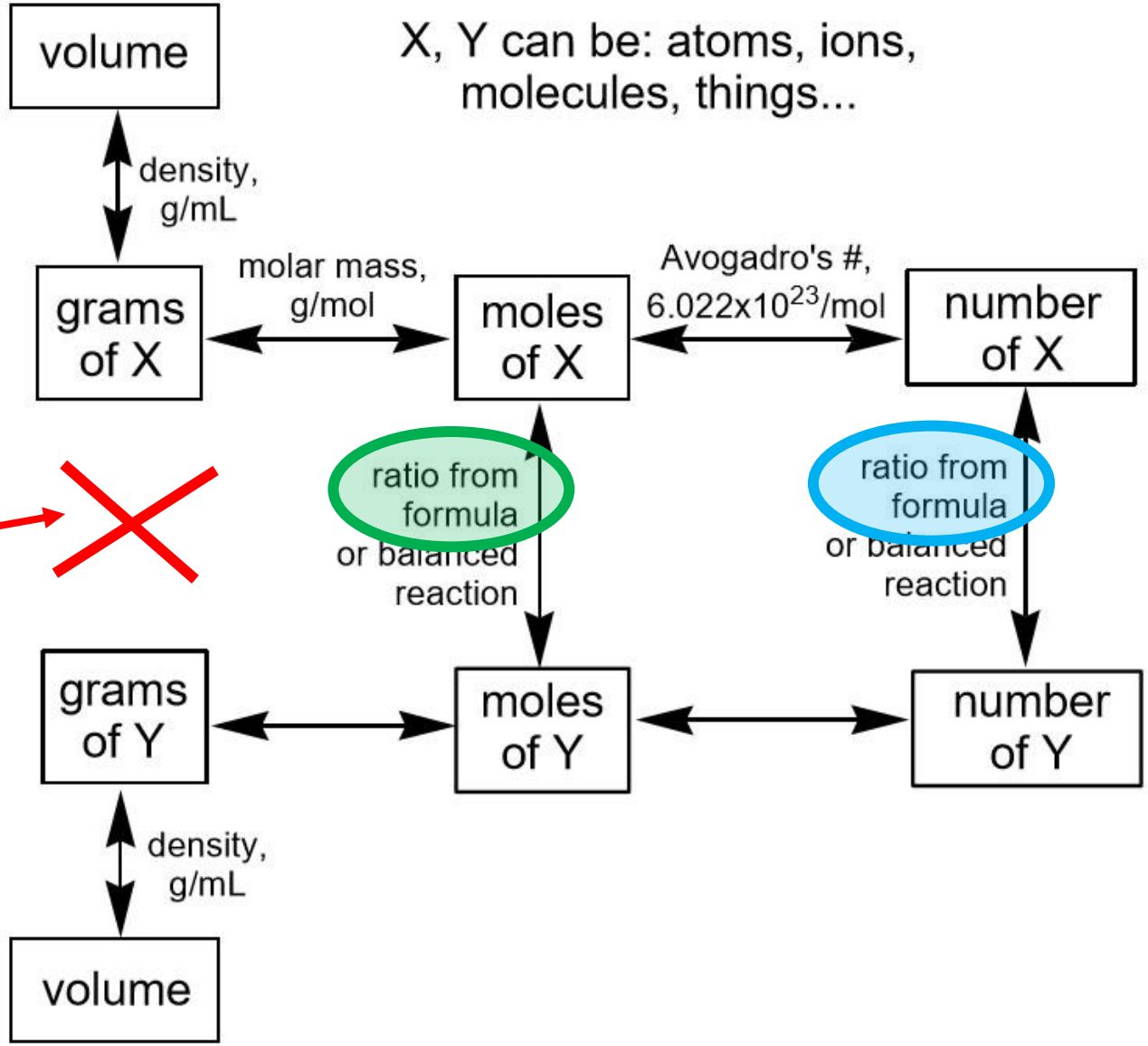
A) $(3.0 \text{ moles of } H_2O)\left(\frac{1 \text{ mol O}}{1 \text{ mol } H_2O}\right) = 3.0 \text{ mol O}$

B) $(2.0 \text{ moles of CO})\left(\frac{1 \text{ mol O}}{1 \text{ mol CO}}\right) = 2.0 \text{ mol O}$

C) $(2.0 \text{ moles of } CO_2)\left(\frac{2 \text{ mol O}}{1 \text{ mol } CO_2}\right) = 4.0 \text{ mol O}$

D) $(1.0 \text{ moles of } HNO_3)\left(\frac{3 \text{ mol O}}{1 \text{ mol } HNO_3}\right) = 3.0 \text{ mol O}$

Section 6.5: Relating “moles of X” to “moles of Y” using a chemical formula



X, Y can be: atoms, ions, molecules, things...

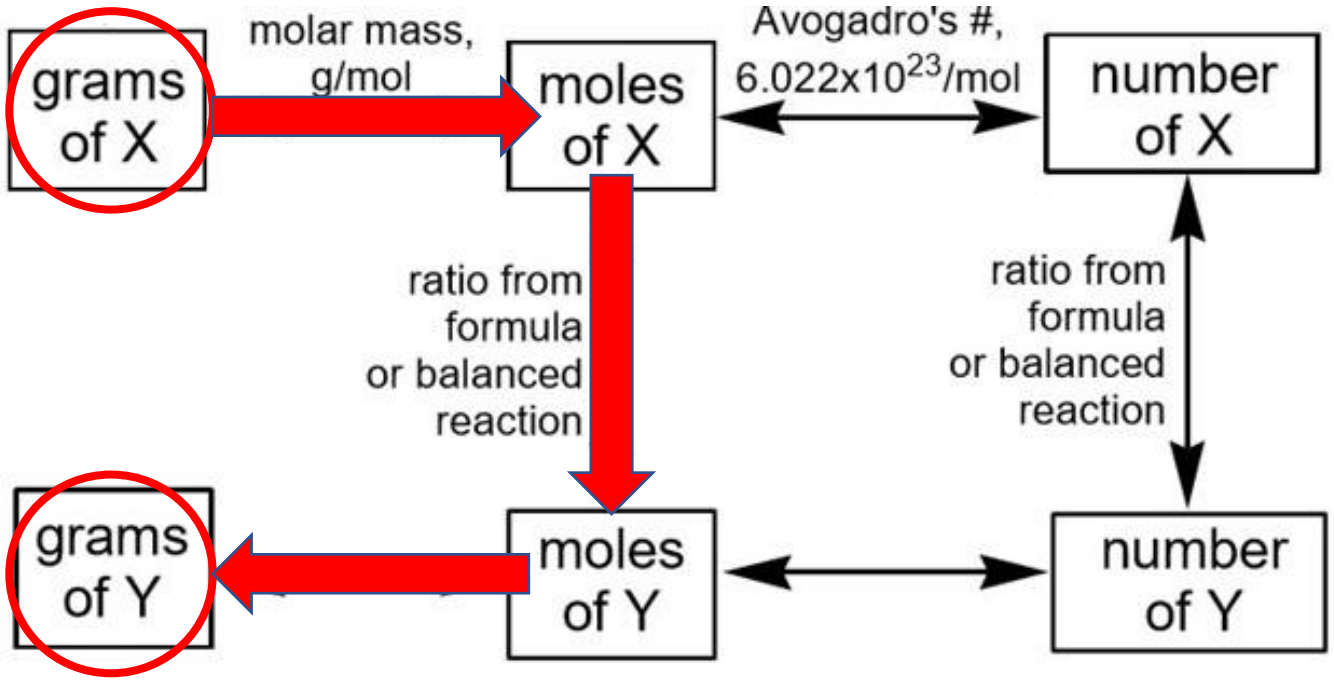
No direct bridge between grams of X and grams of Y

$$\frac{2\ \text{O}}{1\ \text{CO}_2}$$

$$\frac{2\ \text{mol O}}{1\ \text{mol CO}_2}$$

Sample calculation: Relating "moles of X" to "moles of Y"

Ex: A sample of calcium nitrate contains 0.15 g of O. What is the mass of the sample in grams?



Flowchart: g O → mol O → mol sample → g sample

Formula: sample = $Ca(NO_3)_2$

Sample calculation continued… Relating "moles of X" to "moles of Y"

Ex: A sample of calcium nitrate contains 0.15 g of O. What is the mass of the sample in grams?

Answer: **Flowchart:** g O → mol O → mol $Ca(NO_3)_2$ → g $Ca(NO_3)_2$

Molar mass: $\frac{164.10\ g\ Ca(NO_3)_2}{1\ mol\ Ca(NO_3)_2}$ and $\frac{16.00\ g\ O}{1\ mol\ O}$ *

Mole-to-mole ratio: $\frac{6\ mol\ O}{1\ mol\ Ca(NO_3)_2}$

* The molar mass of O doesn't depend on the compound's formula (it is **not** 6 x 16.00). The 6 in the compound's formula comes in during the mole-to-mole ratio (see * below), not the molar mass.

Calculation:

$$(0.15\ g\ O)\left(\frac{1\ mol\ O}{16.00\ g\ O}\right)\left(\frac{1\ mol\ Ca(NO_3)_2}{6\ mol\ O}\right)\left(\frac{164.10\ g\ Ca(NO_3)_2}{1\ mol\ Ca(NO_3)_2}\right) = 0.256406\ g$$

Keep 2sf

2sf *4sf* * *∞ sf* *5sf*

= **0.26 g $Ca(NO_3)_2$**

Clicker question: Relating "moles of X" to "moles of Y"
Go to LearningCatalytics.com Session ID =

3) What mass of Ni, in grams, can be isolated from 15 g of nickel(III) carbonate? The molar mass of nickel(III) carbonate = 297.41 g/mol.

A) 1.5 g Ni
B) 76 g Ni
C) 38 g Ni
D) 3.0 g Ni
E) 1.5×10^2 g Ni
F) 5.9 g Ni

Answer: **Flowchart:** g $Ni_2(CO_3)_3$ → moles $Ni_2(CO_3)_3$ → moles Ni → g Ni

molar mass: $\frac{297.41\ g\ Ni_2(CO_3)_3}{1\ mol\ Ni_2(CO_3)_3}$ and $\frac{58.69\ g\ Ni}{1\ mole\ Ni}$

mole-to-mole ratio: $\frac{2\ moles\ Ni}{1\ mole\ Ni_2(CO_3)_3}$

Calculation:

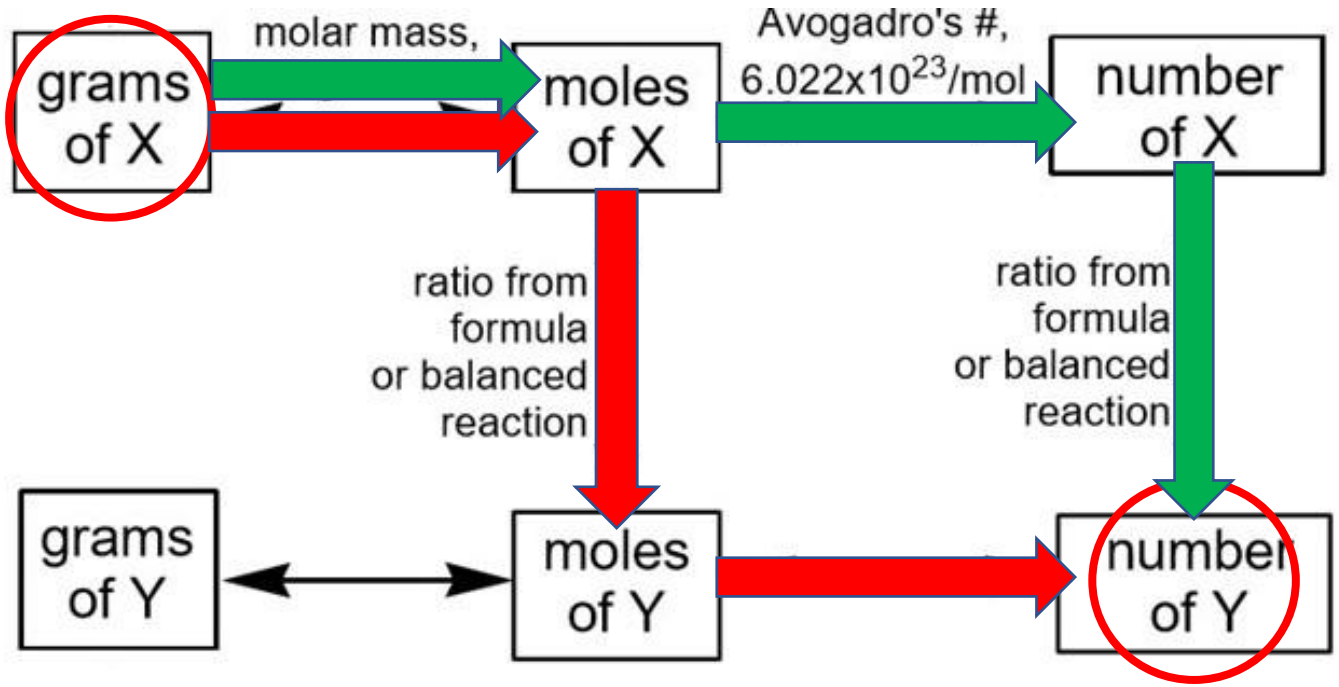
$$(15\ g\ Ni_2(CO_3)_3)\left(\frac{1\ mol\ Ni_2(CO_3)_3}{297.41\ g\ Ni_2(CO_3)_3}\right)\left(\frac{2\ moles\ Ni}{1\ mole\ Ni_2(CO_3)_3}\right)\left(\frac{58.69\ g\ Ni}{1\ mole\ Ni}\right) = 5.92011\ g\ Ni$$

2sf *5sf* *∞ sf* *4sf* *Keep 2sf*

Sample calculation: Relating "moles of X" to "moles of Y"

Ex: How many atoms are in 15 g of $Ni_2(CO_3)_3$?

Note: There are
14 atoms
in every $Ni_2(CO_3)_3$



Flowchart #1: g $Ni_2(CO_3)_3$ → mol $Ni_2(CO_3)_3$ → mol atoms → # atoms

Flowchart #2: g $Ni_2(CO_3)_3$ → mol $Ni_2(CO_3)_3$ → # $Ni_2(CO_3)_3$ → # atoms

Sample calculation continued… Relating "moles of X" to "moles of Y"

Ex: How many atoms are in 15 g of $Ni_2(CO_3)_3$?

Answer: There are 14 atoms in each $Ni_2(CO_3)_3$

Flowchart #1: g $Ni_2(CO_3)_3$ → mol $Ni_2(CO_3)_3$ → mol atoms → # atoms

$$(15\text{ g } Ni_2(CO_3)_3)\left(\frac{1\text{ mol } Ni_2(CO_3)_3}{297.41\text{ g } Ni_2(CO_3)_3}\right)\left(\frac{14\text{ moles atoms}}{1\text{ mole } Ni_2(CO_3)_3}\right)\left(\frac{6.022 \times 10^{23}\text{ atoms}}{1\text{ mole atoms}}\right) = 4.3 \times 10^{23}\text{ atoms}$$

Flowchart #2: g $Ni_2(CO_3)_3$ → mol $Ni_2(CO_3)_3$ → # $Ni_2(CO_3)_3$ → # atoms

$$(15\text{ g } Ni_2(CO_3)_3)\left(\frac{1\text{ mol } Ni_2(CO_3)_3}{297.41\text{ g } Ni_2(CO_3)_3}\right)\left(\frac{6.022 \times 10^{23}\text{ } Ni_2(CO_3)_3}{1\text{ mole } Ni_2(CO_3)_3}\right)\left(\frac{14\text{ atoms}}{1\text{ } Ni_2(CO_3)_3}\right) = 4.3 \times 10^{23}\text{ atoms}$$

Clicker question: Relating "moles of X" to "moles of Y"

Go to LearningCatalytics.com Session ID =

4) How many atoms are in 8.50 g of dinitrogen tetroxide?

A) 5.56×10^{22} atoms

B) 9.27×10^{21} atoms

C) 4.71×10^{26} atoms

D) 3.34×10^{23} atoms

E) 2.83×10^{27} atoms

F) 7.79×10^{-21} atoms

Answer: formula = N_2O_4 (there are 6 atoms in each N_2O_4) molar mass = $\frac{92.02\ g\ N_2O_4}{1\ mol\ N_2O_4}$

Flowchart #1: g N_2O_4 → mole N_2O_4 → moles atoms → # atoms

$$(8.50\ g\ N_2O_4)\left(\frac{1\ mol\ N_2O_4}{92.02\ g\ N_2O_4}\right)\left(\frac{6\ mol\ atoms}{1\ mol\ N_2O_4}\right)\left(\frac{6.022 \times 10^{23}\ atoms}{1\ mole\ atoms}\right) = 3.34 \times 10^{23}\ atoms$$

Flowchart #2: g N_2O_4 → mole N_2O_4 → # N_2O_4 → # atoms

$$(8.50\ g\ N_2O_4)\left(\frac{1\ mol\ N_2O_4}{92.02\ g\ N_2O_4}\right)\left(\frac{6.022 \times 10^{23}\ N_2O_4}{1\ mol\ N_2O_4}\right)\left(\frac{6\ atoms}{1\ N_2O_4}\right) = 3.34 \times 10^{23}\ atoms$$