Opener: Molar Mass

1. What is the molar mass of magnesium? …and unit label?
2. What is the molar mass of diatomic chlorine gas? …and unit label?
3. What is the value of Avogadro's number? …unit label?
4. What is the molar mass of ammonia, NH_3? …unit label?
5. What is the molar mass of sulfuric acid, H_2SO_4? …unit label?
6. Remember we calculated the molar mass of iron(III) sulfate, $Fe_2(SO_4)_3$ has a value of 400. 400 what? …unit label?
7. How many sulfur atoms per iron(III) sulfate ionicule?

Opener: Molar Mass

1. What is the molar mass of magnesium? …and unit label? $\frac{24.31 g}{1 mol}$
2. What is the molar mass of diatomic chlorine gas? …and unit label? $\frac{70.9 g}{1 mol}$
3. What is the value of Avogadro's number? …unit label? $\frac{6.02 \times 10^{23} \, items}{1 mol}$
4. What is the molar mass of ammonia, NH_3? …unit label? $\frac{17.04 g}{1 mol}$
5. What is the molar mass of sulfuric acid, H_2SO_4? …unit label? $\frac{98.09 g}{1 mol}$
6. Remember we calculated the molar mass of iron(III) sulfate, $Fe_2(SO_4)_3$ has a value of 400. 400 what? …unit label? $\frac{400. g}{1 mol}$
7. How many sulfur atoms per iron(III) sulfate ionicule? $\frac{3 S atoms}{1 Fe_2(SO_4)_3 \, ionicules}$

Opener Review: Part of Compounds

If you were given 2.85 g of magnesium chloride, $MgCl_2$ what mass of chlorine would be in this sample?

With your clicker send in: 1 if you could get an answer without any assistance,
2 if you needed a tiny bit of help from your mates to get an answer,
3 if you needed lots of help from your mates to get an answer,
4 if you don't even know where to begin, and can not get an answer.

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$$MgCl_2 \qquad 24.31 + (2 \times 35.45) = 95.21 g / mol$$

$$\frac{70.9 gCl}{95.21 gMgCl_2} = \frac{x gCl}{2.85 gMgCl_2}$$

Opener: Mole Calculations

Given 0.0459 g of ammonium sulfide, $(NH_4)_2S$ calculate the number of hydrogen atoms.

Please write out your dimensional analysis WITH UNITS before picking up a calculator.

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$$\left(NH_4\right)_2 S \qquad (2\times 14.01)+(8\times 1.01)+32.07 = 76.25 g/mol$$

$$0.0453 g\left(NH_4\right)_2 S \times \frac{1 mol\left(NH_4\right)_2 S}{76.25 g\left(NH_4\right)_2 S} \times \frac{6.02\times 10^{23} ionicules}{1 mol} \times \frac{8 H's}{1\left(NH_4\right)_2 S\ ionicule} = 2.86\times 10^{21} Hatoms$$

Opener: Mole Calculations

1. A sample of 0.0870 moles of a metal, M reacts completely with excess bromine to form 25.38 grams of MBr_3. How many moles of Br are in the sample of MBr_3?
2. What is the mass of Br in this sample?
3. How many grams of M are in this sample?
4. If you knew the molar mass of metal M you could make a prediction as to what metal M might be. From the info above calculate the molar mass of M. (In other words, make a ratio of mass to moles for M)

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If the compound is MBr_3, and there are 0.087 mol of M, then Br must be 3 times that amount:

$$0.087molM \times \frac{3Br}{1M} = 0.261molBr \quad 0.261molBr \times \frac{79.9g}{1mol} = 20.9gBr$$

If there is 25.38 g of the compound, 25.38g − 20.9g = 4.526g for M

Thus the molar mass of M is $\frac{4.526g}{0.087mol} = 52g/mol$ which must be chromium

Opener: Chemical Formulas

1. 3.73×10^{21} ionicules(formula units) of a copper halogen compound has a mass of 0.8340 g, what is the molar mass of this ionic compound? (Use the units of molar mass to guide your calculation.)
2. For this same substance, there are 7.46×10^{21} atoms of X (halogen) combine with 3.73×10^{21} atoms of Cu, determine the empirical formula of this compound.
3. Determine the identity of the halogen, X, then name this compound

Opener: Chemical Formulas

1. 3.73×10^{21} formula units (ionicules) of a copper halogen (F, Cl, Br, I , At) compound has a mass of 0.834 g, what is the molar mass of this substance ? (Use the units of molar mass to guide your calculation.)
2. For this same substance, there are 7.46×10^{21} atoms of X (halogen) combine with 3.73×10^{21} atoms of Cu, determine the empirical formula of this compound.
3. Determine the identity of the halogen, X, then name this compound

1. First determine the molar mass of the compound.
2. Determine the number of X's per Cu
3. Use the molar mass of the compound, and the mass of copper for determine the molar mass of X_2

$$\frac{0.834\,g}{3.73\times10^{21}\,ionicules}\times\frac{6.02\times10^{23}\,ionicules}{1\,mol}=134.6\,g/mol$$

$$\frac{7.46\times10^{21}\,Xatoms}{3.73\times10^{21}\,Cuatoms}=2\,Xatoms\ per\ ionicule,\ CuX_2$$

$$134.6-63.55=71.05\,g/mol\ for\ X_2$$

$$ThusX\ is\ 35.5\,g/mol\ which\ could\ be\ Cl$$

Opener: Mole Calculations Review

1. How many mole of sodium ions are there in 2.5 mol of sodium carbonate, Na_2CO_3?

2. If you had 9.39×10^{24} chloride ions, how many mole of aluminum chloride, $AlCl_3$ would you be able to make? *(If you had 21 wheels, how many dozen bicycles can you make?)*

Opener: Mole Calculations Review

1. How many mole of sodium ions are there in 2.5 mol of sodium carbonate, Na_2CO_3?
(How many dozen wheels are there in 2.5 dozen bicycles?)

$$2.5 mol Na_2CO_3 \times \frac{2 Na's}{Na_2CO_3} = 5.0 mol Na$$

2. If you had 9.39×10^{24} chloride ions, how many mole of aluminum chloride, $AlCl_3$ would you be able to make? *(If you had 21 wheels, how many dozen bicycles can you make?)*

$$9.39 \times 10^{24} chlorides \times \frac{1 mol}{6.02 \times 10^{23} chlorides} \times \frac{1 AlCl_3}{3 chloride} = 5.20 mole\ of\ AlCl_3$$

Opener: Empirical Formula

- An elemental analysis of 3.872 g of a compound made of tin, bromine and oxygen was determined to be 1.232 g of tin, 1.644 g of bromine, and 0.996 g of oxygen.
- Determine the empirical formula of this ionic compound.

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- Determine the empirical formula of this ionic compound.

$$1.227g \times \frac{1mol}{118.71} = 0.0103mol \qquad \frac{0.0103}{0.0103} = 1$$

$$1.652g \times \frac{1mol}{79.9g} = 0.0207mol \qquad \frac{0.0207}{0.0103} = 2 \qquad SnBr_2O_6$$

$$0.992g \times \frac{1mol}{16} = 0.062mol \qquad \frac{0.062}{0.0103} = 6$$

Opener: Hydrate Problem

- An iron, oxygen and hydrogen hydrate is analyzed and found to be 44.5 % water.
- On further analysis, the anhydrate was found to be 62.2% iron, 35.6 % oxygen, and 2.20 % hydrogen.
- Determine the formula (What is the prefix for the # of water in this hydrate?)
  - ✓ First you must notice that this problem is a little bit different than some of the others that you may have tried.
  - ✓ You are not told the chemical formula of the anhydrate.
  - ✓ Instead you are given information that will allow you to determine this, which must be done before moving on to the moles of water in the hydrate.

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$62.2g(\%)\times\frac{1mol}{55.85}=1.114mol \qquad \frac{1.114}{1.114}=1$

$35.6g(\%)\times\frac{1mol}{16g}=2.225mol \qquad \frac{2.22}{1.114}=2 \qquad FeO_2H_2 \Rightarrow Fe(OH)_2$

$2.20g(\%)\times\frac{1mol}{1.01g}=2.18mol \qquad \frac{2.18}{1.114}=2$

$55.5g(\%)\times\frac{1mol}{89.87g}=0.618mol \qquad \frac{0.618}{0.618}=1$

$44.5g(\%)\times\frac{1mol}{18.02g}=2.47mol \qquad \frac{2.47}{0.619}=4 \qquad Fe(OH)_2\bullet 4H_2O$

Opener: Hydrate Lab

1. Why did the student heat the dish more than once?
2. How can the student tell that they don't need to heat the dish a fourth time?
3. A student analyzed a nickel(III) nitrite hydrate, $Ni(NO_2)_3$ (anhydrate molar mass = 196.72 g/mol) and acquired the following data. Use the data to determine the formula of the hydrate and appropriately name the hydrate.

item	mass (g)
mass of empty evaporating dish (g)	36.783
mass of hydrate (g)	4.650
mass of anhydrate in dish after first heating (g)	39.879
mass of anhydrate in dish after second heating (g)	39.621
mass of anhydrate in dish after third heating (g)	39.617
mass of anhydrate (g)	
mass of the water removed (g)	

When the mass is no longer changing, the anhydrate must finally be dry.
This is called **heating to a constant mass**.
Do NOT average these values, use the last value.

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$Ni(NO_2)_3 \bullet ?H_2O$

$58.69 + 3(14.01) + 6(16) = 196.72$

$39.617\,gAnhydrateInDish - 36.783\,gDish = 2.834\,gAnhydrate$

$4.650\,gHydrate - 2.834\,gAnhydrate = 1.816\,gWater$

$2.834\,g \times \frac{1\,mol}{196.72\,g} = 0.0144\,mol \qquad \frac{0.0144}{0.0144} = 1$

$1.816\,g \times \frac{1\,mol}{18.02\,g} = 0.1008\,mol \qquad \frac{0.1008}{0.0144} = 7 \qquad Ni(NO_2)_3 \bullet 7H_2O$

Opener: Challenging Hydrate Calculation

- A student analyzed a hydrate that contained 23.04 % nickel, 11.00% nitrogen, 62.80% oxgen, and 3.17% hydrogen. Use the data to determine the formula of the hydrate.
  Hint: calculate the empirical formula, then extract out water to build the anhydrate formula. Assum H's are only a part of water, not part of the anhydrate.

Opener: Challenging Hydrate Calculation

- A student analyzed a hydrate that contained 23.04 % nickel, 11.00% nitrogen, 62.80% oxgen, and 3.17% hydrogen. Use the data to determine the formula of the hydrate and the prefix for the number of waters.
  Hint: calculate the empirical formula, then extract out water to build the anhydrate formula.

$$Ni\ 23.04g \times \frac{1mol}{58.69g} = 0.393mol \qquad \frac{0.393mol}{0.393mol} = 1$$

$$N\ 11g \times \frac{1mol}{14.01g} = 0.785mol \qquad \frac{0.785mol}{0.393mol} = 2$$

$$O\ 62.8g \times \frac{1mol}{16g} = 3.925mol \qquad \frac{3.925mol}{0.393mol} = 10$$

$$H\ 3.17g \times \frac{1mol}{1.01g} = 3.14mol \qquad \frac{3.14mol}{0.393mol} = 8$$

take out 8 H's for water, thus 4 O's and leave rest of O's for the Nickel anhydrate

$NiN_2O_6 \bullet 4H_2O$

Opener: moles, millimoles, what the difference? …. and concentration.

- Write down the molar mass of water in the space below. Be sure and put units on your molar mass. NOW convert those units to milligrams per millimole.

- Which solution of red dye #3 is more concentrated? Explain how you know.

- What does it mean for a solution to be more concentrated?

Opener: moles, millimoles, what the difference? …. and concentration.

- Write down the molar mass of water in the space below. Be sure and put units on your molar mass. NOW convert those units to milligrams per millimole.

H_2O MM: 18 g/mol

$$\frac{18g}{1mol} \times \frac{1000mg}{1g} \times \frac{1mol}{1000mmol} = 18mg/mmol$$

- Which solution of red dye #3 is more concentrated? Explain how you know.

- What does it mean for a solution to be more concentrated?

Opener: Molarity

- What mass of calcium nitrate dihydrate would you need to weigh out in order to produce 200. ml of an aqueous calcium nitrate solution with 0.0430 M?

Hint: Write the chemical formula. Write down the molarity equation. Using the info in the problem, solve for moles of calcium nitrate, then convert those moles into grams.

Opener: Molarity

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Hint: Write the chemical formula. Write down the molarity equation. Using the info in the problem, solve for moles of calcium nitrate, then convert those moles into grams.

$Ca(NO_3)_2 \cdot 2H_2O$ MM: 200.13 g/mol

40.08 + 2(14.01) + 6(16) + 4(1.01) + 2(16)

$$Molarity(M) \times \frac{mol}{Liter} \qquad M \times V = moles$$

$$0.043M \times 0.2L = 0.0086molCa(NO_3)_2 \cdot 2H_2O$$

$$0.0086mol \times \frac{200.13g}{1mol} = 1.72g\ of\ Ca(NO_3)_2 \cdot 2H_2O$$

Opener: Moles of Ions in a Solution

- If you mixed 35 ml of 0.20 M calcium nitrate solution and 25 ml of 0.60 M sodium nitrate solution, how many millimoles of nitrate ions would be in the solution?

Remember that molarity is $\frac{mol}{L}$ *OR* $\frac{millimol}{milliLiter}$

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$$M \times V = mol$$

$$0.2M \times 35ml = 7mmolCa(NO_3)_2 \times \frac{2NO_3^-}{Ca(NO_3)_2} = 14mmolNO_3^-$$

$$0.6M \times 25ml = 15mmolNaNO_3 \times \frac{1NO_3^-}{NaNO_3} = 15mmolNO_3^-$$

$$= 29mmol\ NO_3^-\ ions$$