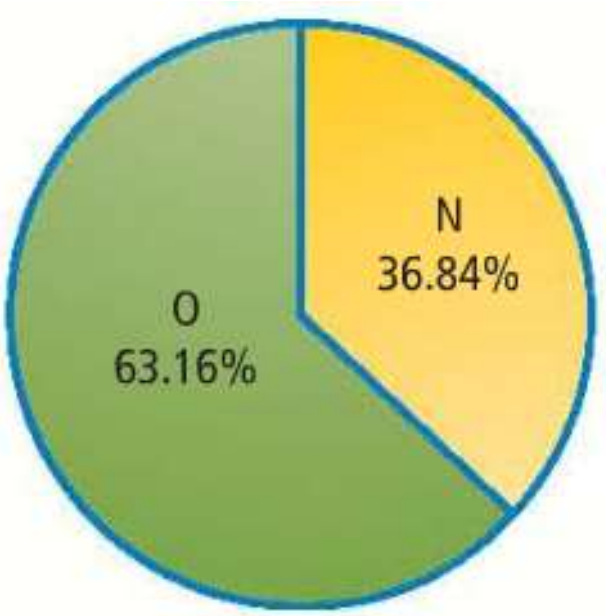
0421 – HW, #1

The circle graph at the right gives the percent composition for a blue solid. What is the empirical formula for this solid?



element	% comp by element	mass in 100 g sample	molar mass (g/mol)	mol in 100 g sample	normalize (divide by smallest number)	convert to whole numbers
O	63.16%	63.16	15.999	3.948	1.50	3.00
N	36.84%	36.84	14.007	2.630	1.00	2.00

Empirical Formula is N_2O_3

0421 – HW, #2

Determine the empirical formula for a compound that contains 35.98% aluminum and 64.02% sulfur.

element	% comp by element	mass in 100 g sample	molar mass (g/mol)	mol in 100 g sample	normalize (divide by smallest number)	convert to whole numbers
Al	35.98%	35.98	26.982	1.333	1.00	2.00
S	64.02%	64.02	32.065	1.997	1.50	3.00

Empirical Formula is Al_2S_3

0421 – HW, #3

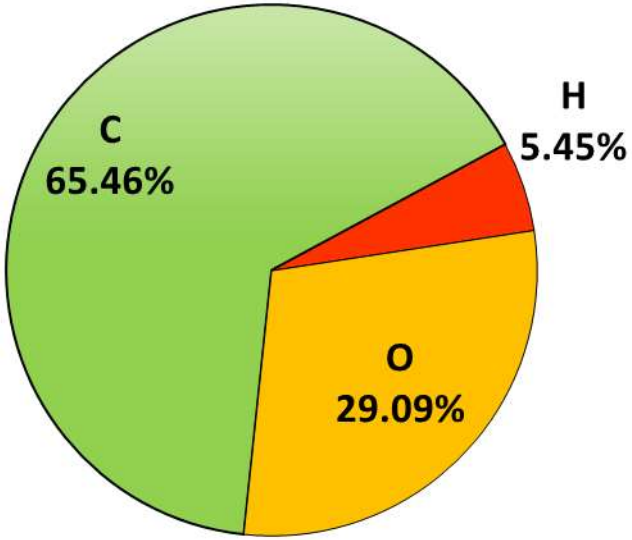
When an oxide of potassium is decomposed, 19.55 g of K and 4.00 g of O are obtained. What is the empirical formula of the compound?

element	mass (g)	molar mass (g/mol)	mol in 100 g sample	normalize (divide by smallest number)
K	19.55	39.098	0.5000	2.000
O	4.00	15.999	0.250	1.00

Empirical Formula is K_2O

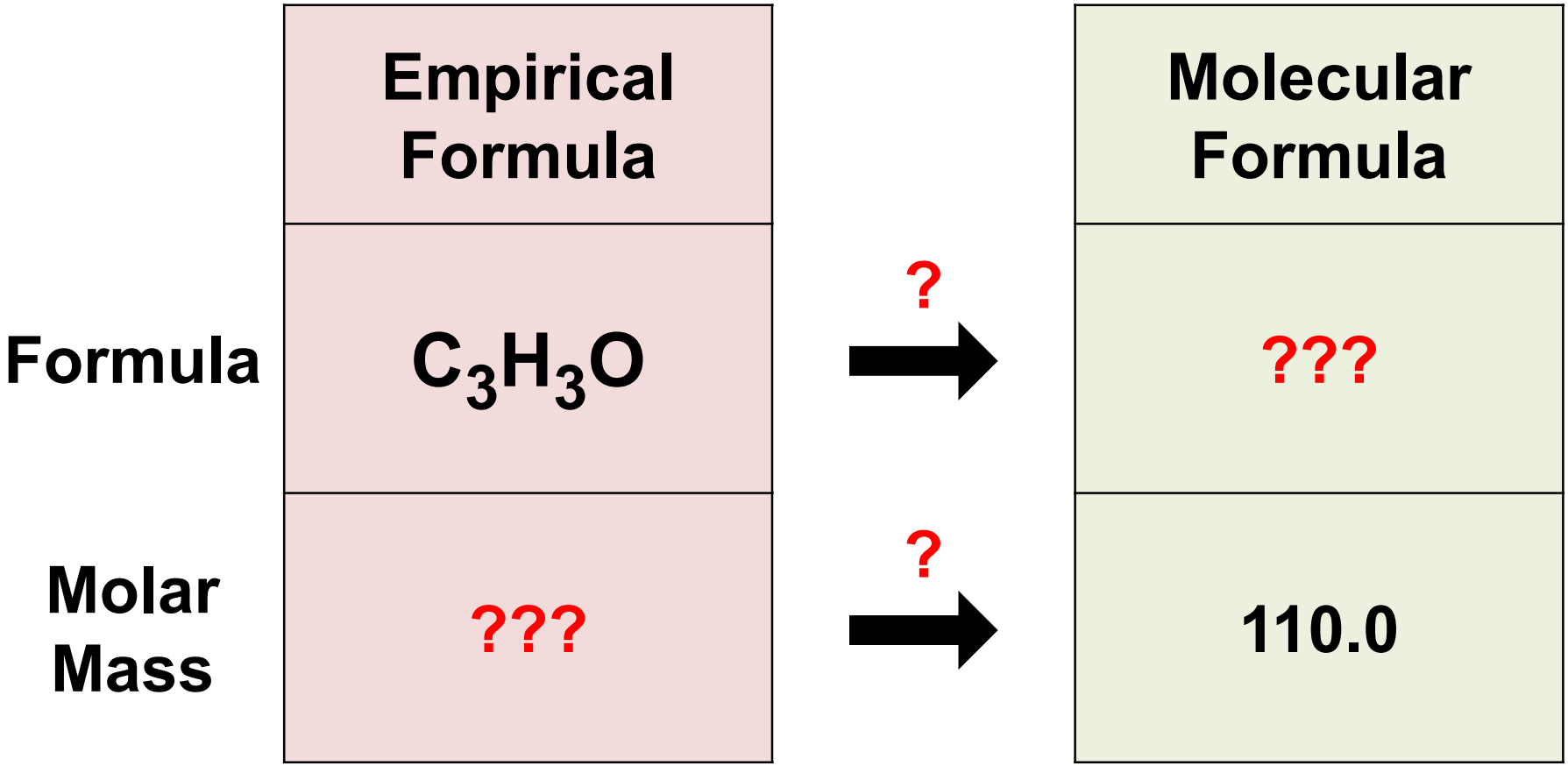
0421 – HW, #4

Analysis of a chemical used in photographic developing fluid yielded the percent composition data in the circle graph to the right. If the chemical's molar mass is 110.0 g/mol, what is the molecular formula?



element	% comp by element	mass in 100 g sample	molar mass (g/mol)	mol in 100 g sample	normalize (divide by smallest number)	round to whole numbers
C	65.45%	65.45	12.011	5.449	3.00	3
H	5.45%	5.45	1.008	5.407	2.97	3
O	29.09%	29.09	15.999	1.818	1.00	1

Empirical Formula is C_3H_3O

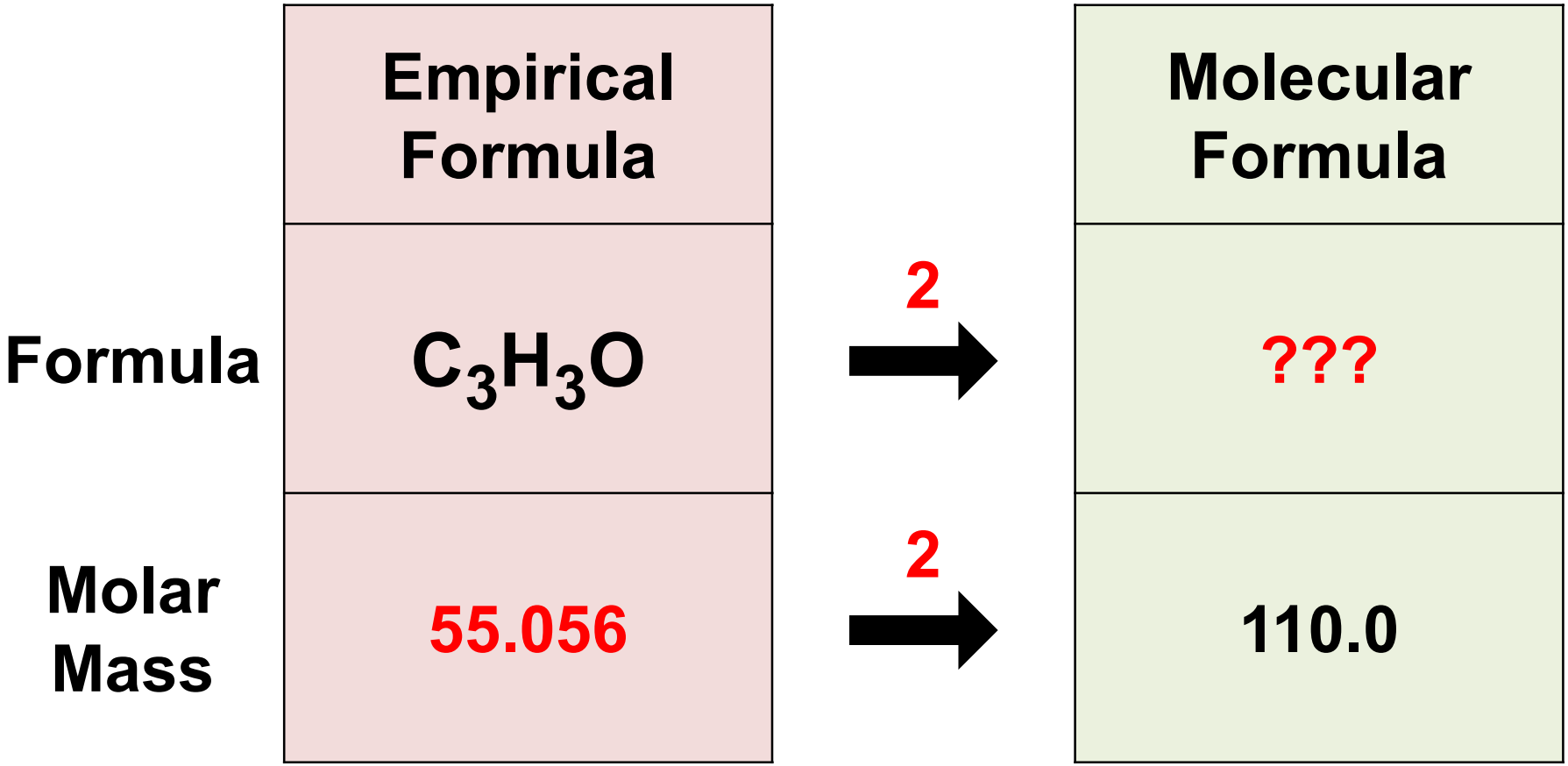

Empirical Formula
Molecular Formula
Formula
C_3H_3O
???
?
Molar Mass
???
110.0
?

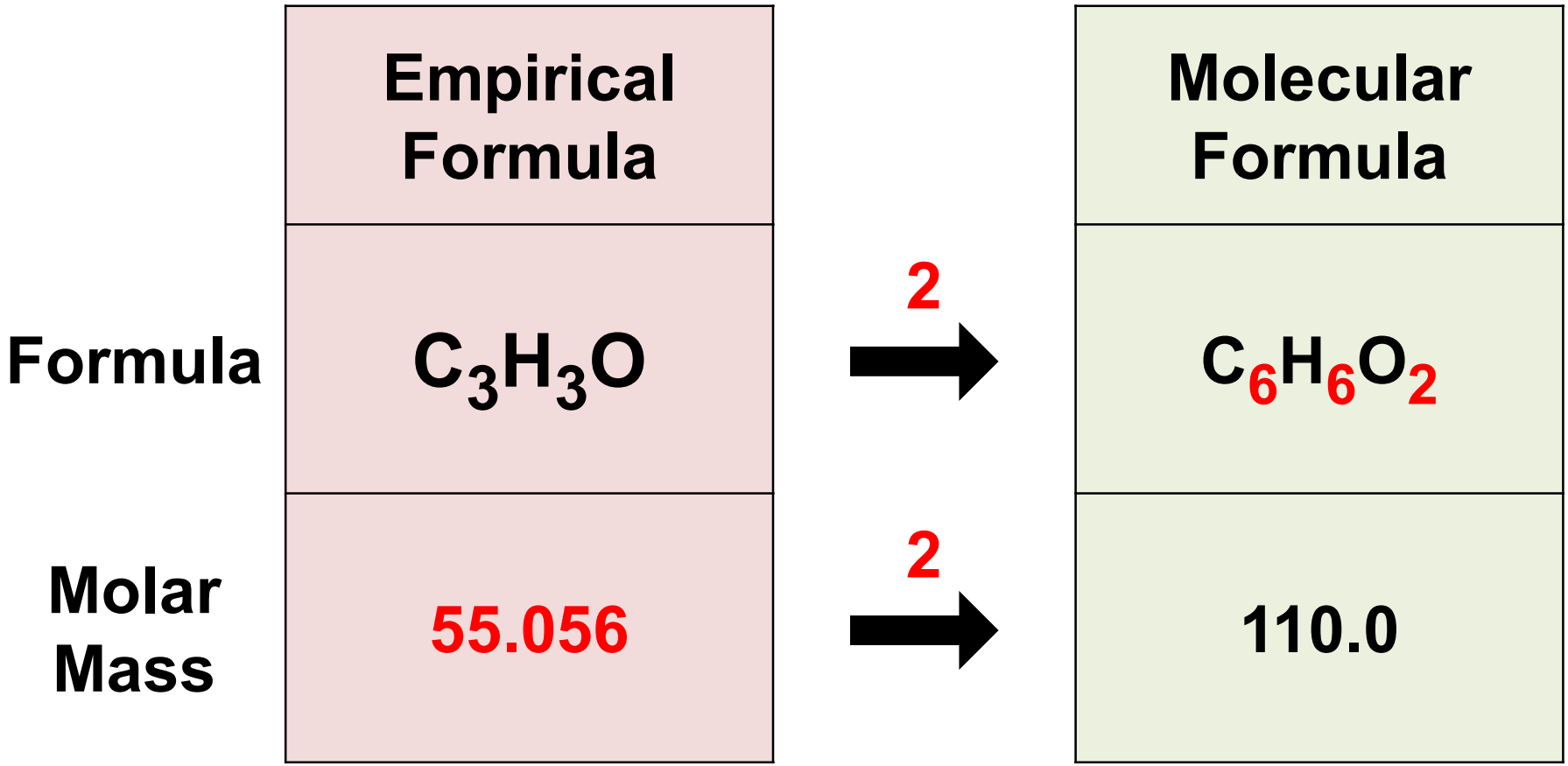
element	number of each element	molar mass	mass of each element
C	3	12.011	36.033
H	3	1.008	3.024
O	1	15.999	15.999

55.056

	Empirical Formula		Molecular Formula
Formula	C_3H_3O	? →	???
Molar Mass	55.056	? →	110.0

$$\frac{110}{55.056} \cong 2$$

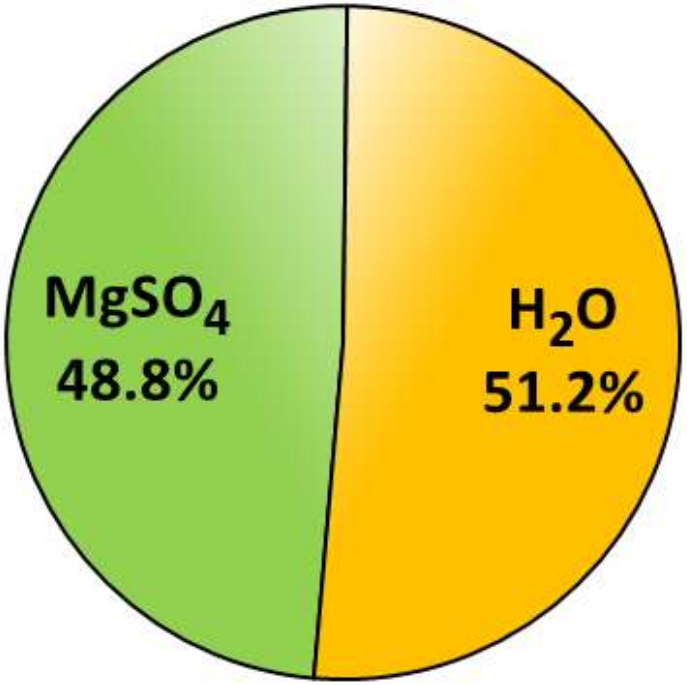

Empirical Formula
Molecular Formula
Formula
C_3H_3O
???
2
Molar Mass
55.056
110.0
2



The molecular formula is $C_6H_6O_2$

0421 – HW, #5

The composition of a hydrate is given in the circle graph shown below. What is the formula of this hydrate?



$MgSO_4 \bullet ?H_2O$

compound	% comp by cpd	mass in 100 g sample	molar mass	mol in 100 g sample	normalize (divide by smallest number)	round to whole numbers
$MgSO_4$	48.8%	48.8				
H_2O	51.2%	51.2				

element	number of each element	molar mass	mass of each element
Mg	1	24.305	24.305
S	1	32.065	32.065
O	4	15.999	63.996
			120.366

element	number of each element	molar mass	mass of each element
H	2	1.008	2.016
O	1	15.999	15.999
			18.015

$$\frac{48.8\ \text{g}}{\left|\begin{matrix}1\ \text{mol} \\ 120.366\ \text{g}\end{matrix}\right.} = 0.405\ \text{mol}$$

$$\frac{51.2\ \text{g}}{\left|\begin{matrix}1\ \text{mol} \\ 18.015\ \text{g}\end{matrix}\right.} = 2.84\ \text{mol}$$

compound	% comp by cpd	mass in 100 g sample	molar mass	mol in 100 g sample	normalize (divide by smallest number)	round to whole numbers
$MgSO_4$	48.8%	48.8	120.366			
H_2O	51.2%	51.2	18.015			

The hydrate formula is $MgSO_4 \bullet 7H_2O$

0421 – HW, #6

An 11.75 g sample of a common hydrate of cobalt (II) chloride is heated. After heating, 0.0712 mol of anhydrous cobalt (II) chloride remains. What is the formula of this hydrate?

cpd	mass	molar mass	moles
$CoCl_2 \bullet nH_2O$			
$CoCl_2$			
H_2O			

$$n = \frac{\text{mol } H_2O}{\text{mol } CoCl_2}$$

element	number of each element	molar mass	mass of each element
Co	1	58.933	58.933
Cl	2	35.453	70.906
			129.839

cpd	mass of cpd (g)	molar mass (g/mol)	amount of cpd (mol)
$CoCl_2 \bullet nH_2O$	11.75		
$CoCl_2$			0.0712
H_2O			

$$n = \frac{\text{mol } H_2O}{\text{mol } CoCl_2}$$

element	number of each element	molar mass	mass of each element
H	2	1.008	2.016
O	1	15.999	15.999
			18.015

cpd	mass of cpd (g)	molar mass of cpd (g/mol)	amount of cpd (mol)
$CoCl_2 \bullet nH_2O$	11.75		
$CoCl_2$	9.24	129.839	0.0712
H_2O	2.51		

$$n = \frac{\text{mol } H_2O}{\text{mol } CoCl_2}$$

The hydrate formula is $CoCl_2 \bullet 2H_2O$

cpd	mass of cpd (g)	molar mass (g/mol)	amount of cpd (mol)
$CoCl_2 \bullet nH_2O$	11.75		
$CoCl_2$	9.24	129.839	0.0712
H_2O	2.51	18.015	0.139

$$n = \frac{0.139 \text{ mol}}{0.0712 \text{ mol}}$$

Do Now

To mimic the rejuvenating effect of natural mineral springs, people bathe in warm water containing Epsom salt, a hydrate of $MgSO_4$. A 33.767 g sample was dried to give 16.490 g of anhydrous $MgSO_4$. What is the formula for Epsom salt?

To mimic the rejuvenating effect of natural mineral springs, people bath in warm water containing Epsom salt, a hydrate of $MgSO_4$. A 33.767 g sample was dried to give 16.490 g of anhydrous $MgSO_4$. What is the formula for Epsom salt?

cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$			
$MgSO_4$			
H_2O			

$$n = \frac{\text{mol } H_2O}{\text{mol } MgSO_4}$$

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$MgSO_4$			
H_2O			

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cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$	33.767		
$MgSO_4$	16.490		
H_2O			

$$n = \frac{\text{mol } H_2O}{\text{mol } MgSO_4}$$

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cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$	33.767		
$MgSO_4$	16.490		
H_2O	17.277		

$$n = \frac{\text{mol } H_2O}{\text{mol } MgSO_4}$$

element	number of each element	molar mass	mass of each element
Mg	1.000	24.305	24.305
S	1.000	32.065	32.065
O	4.000	15.999	63.996
			120.366

cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$	33.767		
$MgSO_4$	16.490		
H_2O	17.276		

$$n = \frac{\text{mol } H_2O}{\text{mol } MgSO_4}$$

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$$n = \frac{\text{mol } H_2O}{\text{mol } MgSO_4}$$

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S	1.000	32.065	32.065
O	4.000	15.999	63.996
			120.366

cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$	33.767		
$MgSO_4$	16.490	120.366	0.13700
H_2O	17.276		

$$n = \frac{\text{mol } H_2O}{\text{mol } MgSO_4}$$

element	number of each element	molar mass	mass of each element
Mg	1.000	24.305	24.305
S	1.000	32.065	32.065
O	4.000	15.999	63.996
			120.366

cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$	33.767		
$MgSO_4$	16.490	120.366	0.13700
H_2O	17.276		

$$n = \frac{\text{mol } H_2O}{0.13700}$$

element	number of each element	molar mass	mass of each element
H	2	1.008	2.016
O	1	15.999	15.999
			18.015

cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$	33.767		
$MgSO_4$	16.490	120.366	0.13700
H_2O	17.276		

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$$n = \frac{\text{mol } H_2O}{0.13700}$$

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H	2	1.008	2.016
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cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$	33.767		
$MgSO_4$	16.490	120.366	0.13700
H_2O	17.276	18.015	0.95900

$$n = \frac{\text{mol } H_2O}{0.13700}$$

element	number of each element	molar mass	mass of each element
H	2	1.008	2.016
O	1	15.999	15.999
			18.015

cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$	33.767		
$MgSO_4$	16.490	120.366	0.13700
H_2O	17.276	18.015	0.95900

$$n = \frac{0.95900}{0.13700}$$

The hydrate formula is $MgSO_4 \bullet 7H_2O$

cpd	mass	molar mass	moles
$MgSO_4 \bullet nH_2O$	33.767		
$MgSO_4$	16.490	120.366	0.13700
H_2O	17.276	18.015	0.95900

$$n = \frac{0.95900}{0.13700} = 7$$