1. Determine the molecular weight of borax: $Na_2O \bullet 2B_2O_3 \bullet 10H_2O$

Amts. Of Elements	Totals	x Atomic Weights	Equals
2 Na 1 O 4 B 6 O 20 H 10 O	2 Na 17 O 4 B 20 H	22.9 wt. Na 16 wt. O 10.8 wt. B 1 wt. H	45.8 272.0 43.2 <u>20</u>.0 Total **381.0 mol wt.**

2.Determine the molecular weight of bone ash: $Ca_3(PO_4)_2$

Amts. Of Elements	**Totals**	**x Atomic Weights**	**Equals**
3 Ca 2 P 8 O	3 Ca 2 P 8 O	40 wt Ca 31 wt. P 16 wt. O	120 62 <u>128</u> Total **310 mol. Wt.**

3.Calculate the 100% recipe for this unity formula

RO, R_2O	**R_2O_3**	**RO_2**
.40 CaO .35 SrO <u>.25 BaO</u> 1.0 total	.25 Al_2O_3	2.5 SiO_2

Consider what the smaller, more critical oxides are. Begin by solving for one of the oxides.
Determine the materials that would provide the desired oxide.

It may be simpler to choose materials that provide only the oxide you are solving for. It requires some insight and planning to determine which multiple-oxide materials may work. CaO can come from whiting, which provides only CaO. Other options would be wollastonite, which provides CaO and $SiO_{2,}$ or a frit. If the wollastonite provides all the silica, that might mean using alumina hydrate to provide the Al_2O_3. Some clay in a glaze is helpful because it helps the raw glaze stick to the bisque ware better. In this example I've chosen whiting as the source of CaO.

Determine how many molecules of the material you will need to get the desired number of oxide molecules:
The amount of molecules of the desired oxide needed divided by the amount of molecules provided by a molecule of the chosen material.
The fired formula for whiting is CaO. If you need .40 CaO, how much whiting will provide this?: .40 ÷ 1 = .40 .40 molecules whiting will provide .40 CaO which satisfies the entire amount of CaO molecules needed.

How much whiting should you weigh out to get .40 molecules?

To determine the weight of the material needed:
Molecules of the oxide needed x weight per one molecule of your chosen material.
.40 molecules needed x 100 wt. whiting per molecule or: $^{.40}$ x $^{100}/_{1}$ = **40 whiting**

Repeat these steps for .35 SrO molecules needed:
.35 Strontium carbonate (fired formula SrO) will provide the .35 molecules SrO needed.
.35 molecules strontium carbonate x 148 wt. $SrCO_3$ /molecule = **51.8 wt. $SrCO_3$**.

Whiting	40.0
Strontium Carb	51.8
Barium Carb	49.2
Kaolin	64.5
Flint	12.0

Repeat for .25 BaO molecules needed:
.25 molecules barium carbonate (fired formula) will provide the .25 BaO needed. .25 mol. $BaCO_3$ x 197 wt $BaCO_3$/1 mol. = **49.25 wt. barium carb**

Alumina and silica are still needed. Kaolin provides both. .25 molecules of Al_2O_3 are needed. Kaolin's fired formula is Al_2O_3•$2SiO_2$. .25 molecules of kaolin will provide the .25 molecules of Al_2O_3 needed. .25 molecules of Al_2O_3•$2SiO_2$ x 258 wt./ 1 molecule = **64.5 kaolin.**

Because kaolin contributes both alumina oxide and silica dioxide, you must account for the entire kaolin molecule, not only the alumina. If you use .25 molecules of kaolin, you will have .25 x (Al_2O_3•$2SiO_2$), which means you get the .25 Al_2O_3 you wanted plus .25 ($2SiO_2$)= .5 SiO_2.

The total molecules of SiO_2 needed is 2.5. Subtract the silica molecules contributed by the kaolin:
2.5 - .5 = 2.0 molecules of silicon dioxide still needed.

Flint will supply this. Fired formula of flint is SiO_2. 2.0 flint supplies 2.0 SiO_2 molecules in the fired glaze. 2.0 flint molecules x 60 wt. flint/1 molecule = **120 flint**

To put this batch recipe into 100% format, total the base glaze:

Whiting	40.0x 100 ÷ 325.5 =		12.3
Strontium Carb	51.8	"	15.9
Barium Carb	49.2		15.1
Kaolin	64.5		19.8
Flint	120.0		36.9
Total	325.5		100

Whiting	12.12 Check this example using alumina hydrate instead of kaolin...
Strontium carb	15.69
Barium carb	14.92
Alumina hydrate	11.82
Flint	45.45
	100.0

4. Calculate the unity formula of the following glaze recipe: #32 Rhodes.

feldspar	48.9
China clay	25.1
dolomite	22.4
whiting	3.5
	99.9

To solve for the unity formula from the 100% recipe:

Multiply the weight of the material by 1 molecule per material molecular weight. This is the same as dividing the weight of the material by the molecular weight. The result is the number of molecules.
48.9 wt. Spar x 1 molecule/ 556 wt. Spar = .088 molecules spar

Now that you know the number of molecules of spar present, determine what this means in terms of oxides.
.088 (K_2O • Al_2O_3 • $6SiO_2$) = .088 K_2O • .088 Al_2O_3 • .528 SiO_2

Tally these oxides in the appropriate columns in the RO/R_2O • R_2O_3 • RO_2 chart.

RO, R_2O	R_2O_3	RO_2
.088 K_2O	.088 Al_2O_3	.528 SiO_2

Repeat this procedure for each material.
China clay (kaolin) 25.1 x 1/258 = .097 molecules china clay = .097 (Al_2O_3•$2SiO_2$) =
.097 Al_2O_3 and .097($2SiO_2$) or .194 SiO_2.

RO, R_2O	R_2O_3	RO_2
.088 K_2O	.088 Al_2O_3 .097 Al_2O_3	.528 SiO_2 .194 SiO_2

Dolomite 22.4 x 1/184 = .122 molecules dolomite = .122 (CaO • MgO) = .122 CaO + .122 MgO

RO, R_2O	R_2O_3	RO_2
.088 K_2O .122 CaO .122 MgO	.088 Al_2O_3 .097 Al_2O_3	.528 SiO_2 .194 SiO_2

Whiting 3.5 wt. x 1 mol./100wt. = .035 mol. whiting = .035 CaO

RO, R_2O	R_2O_3	RO_2
.088 K_2O .122 CaO + .035 CaO .122 MgO	.088 Al_2O_3 .097 Al_2O_3	.528 SiO_2 .194 SiO_2

Total like oxides:

RO, R_2O	R_2O_3	RO_2
.088 K_2O .157 CaO .122 MgO	.185 Al_2O_3	.722 SiO_2

Put in unity format: total the flux column. Divide each oxide in all columns by this total. Check: the flux column should equal one.

RO, R_2O	R_2O_3	RO_2
.088 K_2O ÷ .367 = .240 .157 CaO " .428 <u>.122 MgO</u> " .<u>332</u> .367 total 1.0	.185 Al_2O_3 ÷ .367 = .504	.722 SiO_2 ÷ .367 =1.97

Unity molecular formula. These are proportions of molecules.

RO, R_2O	R_2O_3	RO_2
.240 K_2O .428 CaO .332 MgO	.504 Al_2O_3	1.97 SiO_2