DISCLAIMER: This document describes one method for calculating the weight of grave markers. The values produced by these calculations are not exact. *Always use common sense and err on the side of safety when working with heavy objects*. Know your limits and work within them. *YOU* are responsible for your own safety!

CALCULATING THE WEIGHT OF A MONUMENT:

As conservators, we are sometimes called upon to move grave markers. Care must be taken in such tasks, not only to prevent damage to the gravestone, but to prevent serious injury *or death* to ourselves and others. *Solid rock is astonishingly heavy!* The goal of this document is to give you the ability to *estimate* the weight of a marker before you try to move it. This is an essential conservation skill.

Why Calculate Weight?

There are those people who say "oh, I can move that," grab an object, and start wrestling. Heck, you might even *be* one of those people. But it's not a smart or safe approach with gravestones. Older markers can break under their own weight, especially when mishandled, *and* almost all of the time, stone is 'way heavier than it looks. What appears to be a simple dead-lift can easily become a step on uneven ground, a stumble on soft earth, a dropped and broken monument plus a ruined back. Honestly, all of you weight-lifters out there, it's smart to know how much a marker weighs *before you move it*—even if it's only for bragging rights, afterward.

How about an example?

Let's say you have an tilted marble slab that's wobbling in a slotted, sandstone base: a very common problem. As a conservator, you need to remove the slab from the base, move and level the base, and then put everything back together. Estimating 4 inches of stone in the slot, the slab is 24 inches high, 16 inches across, and 2 inches thick (61 x 41 x 5 cm).

Question: Can you do this job on your own, or do you need help? A quick calculation, as described below, tells us that the slab weighs right around 70 pounds (32 kg). Can you lift and move that amount of weight in a manner that is controlled and safe for both you and the stone?

Now… How about the slotted sandstone base that's tilted and out of position? It measures 10 inches high, 24 inches wide, and 8 inches across (25 x 61 x 20 cm)—can you manage that? Another calculation and you find the base weighs about 160 pounds (73 kg). Can you shift that by hand? Or will you need some sort of machinery, even if it's just a lever?

Calculating the weight of markers makes your work safer for both you and the stones!

Yes… Arithmetic is Involved:

Some people tend to freeze up as soon as they see numbers. Don't let this happen to you! There are a few simple steps to figuring the weight of a monument. We'll take each in turn and then run through a few sample calculations so you can see how it works. It's little complicated, but it's not difficult once you get the hang of it.

Step 1: Choose Your Units:

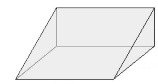
Most people in the U.S. prefer the English system of measures: that is, inches and feet for distance, and pounds for weight. The rest of the world uses metric: centimeters and meters, and grams and kilograms.

Before measuring the monument YOU have to decide what units you're going to use, and then stick with them. Not only that, but ALL of your measures for any particular monument HAVE to use the same unit. That means no mixing inches with feet or centimeters with meters. Again: ALL of your measurements have to be ALL the same thing: inches *or* feet *or* centimeters *or* meters. *Your calculations will fail if you mix the units – you have been warned!*

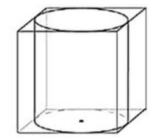
Step 2: Know What to Measure:

You can't just go out into a graveyard and start waving your tape-measure around—it's a waste of time unless you know what you're doing. We're going to concern ourselves with only a few, basic shapes that are used to build just about any monument that you might see. They are:

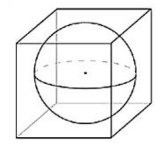
SOLID BOX: This is any block with square sides; short, tall, fat, or skinny. If it's a *shape* you normally ship through the mail, this one's for you! A fat block is a base. Two wide sides and a thin one make a slab. A tall, skinny block on its end is a square column. If it looks like it narrows, be sure it's not an optical illusion.
3 Measurements needed: **The length of all three sides. *The order does not matter!***



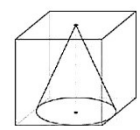
WEDGE: Any object that has a flat bottom and an upright side connected by a slope between them. You see these as part of markers, either on their large or narrow sides.
3 Measurements needed: **The length of the three un-sloped sides. *The order does not matter!***



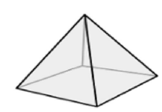
SOLID TUBE: Any straight tubular shape, short, tall, fat, or skinny. On its side, it might be a marker that looks like a round "bolster." Standing on end, it's a column. If it looks like it narrows, be sure it's not an optical illusion.
2 Measurements needed: **The width of the column, across, and the length of its long direction.**



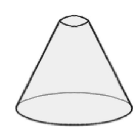
SOLID BALL: Any object that looks like a globe or sphere. You usually don't see these on their own, but they are used to "top" elaborate bases. Getting a size can be difficult because they are often up, off the ground and hard to reach. You may be able to compare them to other, easier to measure parts of the monument.
1 Measurement needed: **The width of the ball, across.**



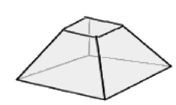
FULL CONE: Probably not a standalone feature but often seen as a carved part of a monument, like portions of urns. It's a mistake to think of these only on a small scale. Obelisks can be nothing more than tall, thin cones!
2 Measurements needed: **The cone's width across its base, and its height.**



SQUARE-BASE PYRAMID: There are all kinds of pyramidal shapes so look at the number of sides the base has to see if this applies. Like cones, smaller pyramids are most likely to be a carved part of a monument, but tall, thin pyramids could be square obelisks!
2 Measurements needed: **The length across one side of the pyramid's base, and its height.**



TRUNCATED CONE: This is a cone with its top cut off, that is, there is no point at the top of the cone. These are often seen as a carved part of a monument. Round columns that taper are tall, truncated cones!
3 Measurements needed: **The cone's width across its base, the width across it's top, and the cone's height.**



TRUNCATED SQUARE PYRAMID: This is a square-based pyramid with its top cut off, that is, there is no point at the top. These are often seen as a carved part of a monument but tall truncated square pyramids are tapered, square columns!
3 Measurements needed: **The length across one the side of the base, the length across one side of the top, and the pyramid's height.**

Step 3: Measure the Monument and Record the Numbers:

Hold on here a second! What if you can't get a good measurement? It happens all the time; The top of the monument is beyond your reach. How can you know how high it is?

Well… Besides using a tape measure, you should know your own measurements. How long is your foot? What is the span of your hand? How far is it from your elbow to your fingertips? When you hold your arms wide, how far is that? How tall are you at your knees? Your hips? Your shoulders? How tall are you in total? What height off the ground is your "eye level?" When you reach up, as high as you can, how far is that?

You can carry a walking stick that can help you measure. If, when you reach up, your hand is 7 feet (2.1 m) high, adding a reasonably long object can add another yard (meter) or so to your height. If you're willing to carry a longer stick, you can easily reach 12 feet (3.6 meters) and that'll measure the majority of the monuments you're likely to see. Put colored tape around your stick at even intervals and you make it even more useful.

Maybe there's a carved urn on the tippy-top—how big is it? Or the column narrows—won't that change the calculation? Or the shape is really odd. Or it's a carved statue. Or…

Relax! You're not trying to measure down to the very last molecule of monument. You're trying to get a reasonable estimate of the weight of the rock to see how best to handle it. That's a completely different thing.

Where you can reach, you want to be accurate, at least to the closest inch. You'll likely find that most monuments can be measured in whole inches because it was easier for the stone cutters and carvers to work that way. If you can't reach a section of the monument, well, you're going to have to estimate the size.

Comparing what you *can't* measure to what you *can* helps a great deal. That urn at the tippy-top has a base that's the same width of a column you can measure. It's height is about a quarter of the total of the column that you can reach with your stick. Unless you're climbing a ladder, those types of estimates will have to do!

Record your measurements as you take them! Do <u>not</u> think "I'll remember these when I get back to the car (or room, or home, or wherever else)," because you won't. *Always* take a few pictures of the monument. It'll help you remember what you measured and let you double-check your numbers against reality.

One final note about measuring. We keep mentioning that we're *estimating* the weight of the stone. But, always keep in mind that the weight of an object rapidly changes with small variations in size. ***If you are going to try to move the stone by hand you must measure it as accurately as possible!***

Step 4: Calculate the Volume of the Monument:

What's "volume?" That's how much space a thing takes up. We're probably more used to interior volume, so think of a small elevator. There's only so much space inside, right? As people get in the elevator, they take up more and more room. The room that a person takes up is *their* volume. Volume is always measured in "cubic" units. Some folks get confused by this, but it's easy to remember if you think of a cube of sugar: it needs to have length, width, *and* depth to be a cube. Three measure make a cube. Volume is measured in cubic units.

We are taught in school that each different shape (box, wedge, tube, etc.) has its own formula for calculating its volume. Some of that arithmetic is a little complex, so that's not what we're going to do. We're going to take an easy (lazy?) way out that enables us do a couple simple calculations to get almost the same, exact number as the more complicated way of doing things. We wouldn't use these techniques to build a rocket going to Mars, but for the weight of a grave marker, they are more than good enough. More on that later.

Step 5: Decide What Kind of Rock the Monument is:

Why does this matter? Because one kind of rock might be heavier than another.

Wait! Wait! What if I really have no idea what kind of rock I'm dealing with? Does it make that much of a difference? Yep, it sure does. The difference in rock can add or subtract nearly 20% to the total weight. On anything bigger than very small markers it can be the difference between handling a stone with people as opposed to using a tripod or crane. For example… That slotted sandstone base we were talking about at the start of this document, the one that weighed 160 pounds (73 kg)? If it was made out of granite, that same stone would be 190 pounds (86 kg).

It's possible to skip this step and calculate a maximum weight, but an important part of being a good conservator is the ability to identify the rock types used in grave markers, so give it a try. The CCUS website holds a series of documents on rock identification. You can start there.

Step 6: Find the Density of the Rock Type:

What's "density?" You know density by instinct. Sure, you do! Whenever you pick something up and you say "wow, this sure is heavy for its size," you are judging that thing's density because that's what density is: how much something weighs for its size. A box of feathers has low density. That same box full of bricks has high density. How do you know the density for your rock type? Simple! Look it up in the following handy-dandy "Type and Density" table. *Copies of all tables are placed at the bottom of this document.*

The different rock types are listed in the left-most column. The other 4 columns hold their densities. Look for and match the rock type with the underlined UNIT you used in your measurements. So, say your grave marker is a sandstone, and you measured in inches. The density number we need is ***0.084*** *pounds per cubic INCH*.

Type and Density				
MATERIAL	**Pounds per cubic INCH**	**Pound per cubic FOOT**	**Grams per cubic CENTIMETER**	**Kilograms per cubic METERS**
Granite/Igneous	0.099	172	2.75	2750
Marble	0.093	160	2.56	2563
Limestone	0.092	159	2.54	2540
Sandstone	0.084	145	2.32	2323
Slate	0.097	168	2.69	2690
Average	**0.093**	**161**	**2.570**	**2573**

For safety's sake: If you don't know your rock type, choose the maximum number in your UNIT column to calculate the *highest weight* for the monument! For example, if you're measuring in feet, but you don't know the rock type, use the density value ***172*** *pounds per cubic FOOT*.

Step 7: Multiply the Volume (step 4) by the Density (step 6) to Calculate the Weight of the Monument:

And… that's it!

That's It? Really?

Well… No. Not really. To get the total weight of an *entire* monument, you'd need follow the steps, above, for each one of the separate sections and then *add* them together. But it's all just repetition, mostly.

A Simple Example:

Here, we have the Swanson monument *(section X, Westwood Cemetery, Oberlin, Ohio, photo by Don Hilton, 2018*).

Step 1: I'm going to measure in inches.

Step 2: I'm calculating the weight of the *upright section* of the monument. It looks to be a box (with a top that's a little uneven, but that's okay). For a box, I need the length of all three sides. *The order does not matter!*

Step 3: Side A is **48** inches, Side B is **36** inches and Side C is **8** inches.

Step 4: The volume is **13,824** cubic inches

(more on the calculation just below this example).

Step 5: The rock type is granite-igneous.

Step 6: The density value is **0.099** pounds per cubic inch.

Step 7: The volume times the density is **1,369** pounds (**621** kg).

So… The upright section of the monument weighs **1,369** pounds!

See how easy?

VOLUME CALCULATIONS:

Almost all monuments are made up of variations and combinations of simpler shapes. If you learn how to calculate the volumes of a few basic forms you can combine them to figure reasonable estimates of weights for almost everything you see. Again, the idea is to over-estimate so you're better safe, than sorry.

When you're in school, how you calculate a volume depends on its shape. But we're not going to do that. For us, we're going to build an imaginary box that holds the object. Next, we'll calculate the volume of the box—and that's really easy. Then, we'll multiply the volume of the box by a "conversion factor" to change it into the volume of the shape we want. *Then, you have to multiply the number from the volume calculation with the density number from the table above to get the weight of what you measured!*

It works like this:

Box Volume Calculation: Remember, this is any block with square sides; short, tall, fat, or skinny.

Measurements needed:

All three sides in identical units—their order does not matter!

Formula:

Side A * Side B * Side C = *multiply* them together. *Don't add them, that's a beginner's mistake!*

Example:

A slab of granite-igneous rock forms an upright monument.

Side A = **48** inches. Side B = **36** inches. Side C = **8** inches.

Calculation:

48 inches * **36** inches * **8** inches = **13,824** cubic inches = the volume of the slab.

Then, we take that volume and multiply it by the density to get the weight:

For a granite-igneous rock: **13,824** cubic inches * **0.099** pounds per cubic inch = **1,369** *pounds.*

Converting a Box Volume to Different Shapes:

What they usually don't tell you in school is that there are fixed relationships and easy ways to convert the volume of a box to any standard shape cut from it. Back in the day, these conversions were commonly used to perform quick-and-dirty mental calculations. Chances are good that anybody with a reasonable 19th-century education knew and used these little tricks. All it takes is some imagination.

We've seen that the volume of a box is dead-simple to calculate. All you need to do is measure the three sides and multiply them together. What the following technique does is let you calculate the volume of a box and then convert it into the shape you want.

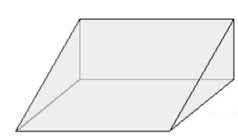
Each shape needs its own kind of box and has its own conversion factor that is listed in a table at the end of this section. Spending a little time understanding how this works can save you a lot of time and confusion with calculations in the field!

Conversion Factors from a BOX		
Shape	**Measure(s) needed**	**Conversion Factor**
Wedge	Length of all three un-sloped sides	0.5
Ball / Sphere	Diameter	0.523
Round Column	Diameter of column (not base) & Height	0.785
Full Cone	Diameter of the base & Height	0.262
Full Square-based Pyramid	Distance across the side of base & Height	0.333
Truncated Cone (also use for tapered *round* columns)	Diameter of the base *and* the top & Height of column	.8
Truncated Square Pyramid (also use for tapered *square* columns)	Distance across side of base *and* top & Height of column	1.037

Wedge:

Measures needed: Length of all three un-sloped sides – the order does not matter

Size of Imaginary Box: Side A, Side B, & Side C = Each one of the un-sloped sides.



Wedge Conversion Factor: 0.5

Example Calculation:

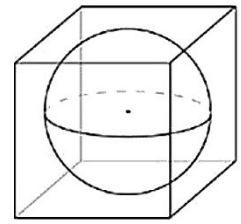
Our wedge is **4** inches high, **36** inches across, and **18** inches wide.

Our imaginary box: Side A = **4** inches. Side B = **36** inches. Side C = **18** inches.

Volume of imaginary box: **4** inches * **36** inches * **18** inches = **2,592** cubic inches.

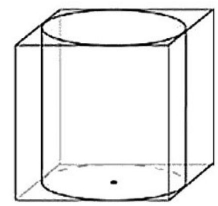
Volume of our wedge = Volume of imaginary box * Wedge Conversion Factor.
Volume of our wedge = **2,592** cubic inches * **0.5** = <u>**1,296** cubic inches</u>
Don't forget to multiply the volume by the density to get the weight!

Solid Ball / Sphere:



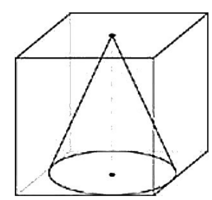
Measures needed: Diameter through the ball.
Size of Imaginary Box: Side A, Side B, & Side C = Each is the diameter of the ball.
Ball Conversion Factor: 0.523
Example Calculation:
Our ball is **2** feet in diameter.
Our imaginary box: Side A = **2** feet. Side B = **2** feet. Side C = **2** feet.
Volume of imaginary box: **2** feet * **2** feet * **2** feet = **8** cubic feet.
Volume of our ball = Volume of imaginary box * Ball Conversion Factor.
Volume of our ball = **8** cubic feet * **0.523** = <u>**4.2** cubic feet</u>
Don't forget to multiply the volume by the density to get the weight!

Round Tube / Column:



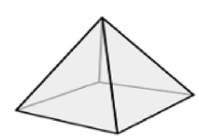
Measures needed: Diameter through the column (*not* the base) & Height.
Remember; If a column is on its side, height becomes length!
Size of Imaginary Box: Side A & Side B = Column's diameter. Side C = Column's height.
Column Conversion Factor: 0.785
Example Calculation:
Our column is **10** inches wide and **120** inches long.
Our imaginary box: Side A = **10** inches. Side B = **10** inches. Side C = **120** inches.
Volume of imaginary box: **10** inches * **10** inches * **120** inches = **12,000** cubic inches.
Volume of our column = Volume of imaginary box * Column Conversion Factor.
Volume of our column = **12,000** cubic inches * **0.785** = <u>**9,420** cubic inches</u>
Don't forget to multiply the volume by the density to get the weight!

Full Cone (not truncated):



Measures needed: Diameter through the base of the cone & Height of cone.
Size of Imaginary Box: Side A & Side B = Cone's diameter. Side C = Cone's height.
Cone Conversion Factor: 0.262
Example Calculation:
Our cone is **25** cm wide and **15** cm high.
Our imaginary box: Side A = **25** cm. Side B = **25** cm. Side C = **15** cm.
Volume of imaginary box: **25** cm * **25** cm * **15** cm = **9,375** cubic centimeters.
Volume of our cone = Volume of imaginary box * Cone Conversion Factor.
Volume of our cone = **9,375** cubic centimeters * **0.262** = <u>**2,456** cubic centimeters</u>
Don't forget to multiply the volume by the density to get the weight!

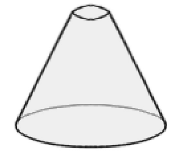
Full Square-Base Pyramid (not truncated):



Measures needed: Length of one side of the base & Height of pyramid.
Size of Imaginary Box: Side A & Side B = Length along Pyramid's base. Side C = Pyramid's height.
Pyramid Conversion Factor: 0.333
Example Calculation:
Our pyramid is **1** foot along its base and **15** feet high (so, it's a tall, skinny obelisk).
Our imaginary box: Side A = **1** foot. Side B = **1** foot. Side C = **15** feet.
Volume of imaginary box: **1** foot * **1** foot * **15** feet = **15** cubic feet.
Volume of our pyramid = Volume of imaginary box * Pyramid Conversion Factor.

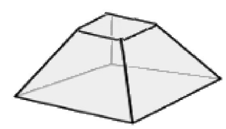
Volume of our cone = **15** cubic feet * **0.333** = **5** cubic feet
Don't forget to multiply the volume by the density to get the weight!

Truncated Cone (it has its top cut off): ***If tall and thin, this is a tapered, round column!***



Measures needed: Diameters through the base **and** the top the cone & Height of cone.
Size of Imaginary Box: Side A = Cone's height. Side B & C = are a little complicated.
B & C = value halfway between the diameter of the base and the diameter of the top.
Truncated Cone Conversion Factor: 0.8
Example Calculation:
The cone is **15** inches high. The base is **12** inches in diameter. The top is **8** inches diameter.
>We use a value halfway between the base and top diameters for Sides B and C of our imaginary box!
>Halfway between **12** inches and **8** inches is **10** inches.
So…Our imaginary box: Side A = **15** inches. Side B = **10** inches. Side C = **10** inches.
Volume of imaginary box: **15** inches * **10** inches * **10** inches = **1,500** cubic inches.
Volume of our truncated cone = Volume of imaginary box * Truncated Cone Conversion Factor.
Volume of our truncated cone = **1,500** cubic inches * **0.8** = **1,200** cubic inches
Don't forget to multiply the volume by the density to get the weight!
>>Note! This technique tends to under-estimate "squatty" cones.

Truncated Pyramid (it has its top cut off): ***If tall and thin, this is a tapered, square column!***
Measures needed: Distance across the side of the base *and* the top of the pyramid & Height of pyramid.
Size of Imaginary Box: Side A = Cone's height. Side B & C = are a little complicated.
B & C = value halfway between the side of the base and the side of the top.



Pyramid Conversion Factor: 1.037
Example Calculation:
The pyramid is **15** inches high. Length along pyramid's base is **12** inches. Along the top is **8** inches.
>We use a value halfway between the length of the pyramid's base and top for Side B and C.
>Halfway between **12** inches and **8** inches is **10** inches.
So… Our imaginary box: Side A = **15** inches. Side B = **10** inches. Side C = **10** inches
Volume of imaginary box: **15** inches * **10** inches * **10** inches = **1,500** cubic inches.
Volume of our cone = Volume of imaginary box * Truncated Pyramid Conversion Factor.
Volume of our cone = **1,500** cubic inches * **1.037** = **1,556** cubic inches
Don't forget to multiply the volume by the density to get the weight!
>>Note! This technique tends to under-estimate extreme "squatty" pyramids.

What's the Downside of Taking the Easy Way Out?

While many monuments are made up of the shapes above, you are bound to see markers that contain features that are not covered by our shortcut conversions. Some can be handled with a little creative geometry, but there are oddly-shaped prisms, and frustums (frustums?) that are beyond what we can cover. The end of this document lists sources you can use to calculate the volume of all kinds of geometric shapes, including some that you don't even know exist! Freeform and flowing monuments will be always be wildcards.

A REAL WORLD EXAMPLE:

How does all of this work together? Let's take an actual monument and break it down into its various components. The one we're going to use is made up of three different rock types in various shapes (*Lee monument, around 1872, section N, Westwood Cemetery, Oberlin, Ohio, Don Hilton, 2018*).

Looking at the monument we see it's made up of five different pieces;

A: The bottom is a wide sandstone block serving as a base.

B: Next up is a support block of filthy marble.
C: Above that, we see a taller and skinnier block of slightly cleaner marble.
D: Then the standout component, a tall, straight granite column.
E: On the tippy-top, is an dirty marble urn.

The granite column *looks* like it's slightly tapered, but it's not. Any apparent change you might see in its width is an optical illusion.

Everything else is straightforward except the urn. How do we handle that? We have several choices. We could subdivide it into a cone on top, followed by an inverted truncated cone, a ball and, at the bottom, a small column sitting on top of another truncated cone. On the other hand, we can't measure any of those components, all we have is estimates. Some, like the transition between the granite column and the urn, we can't even see! If we want real measurements we're going to have to break out our ladder and get up there. If we're silly (dumb?) enough to try to lift the urn by hand, we're going to climb that ladder, no matter what.

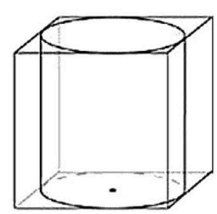
But, maybe we can simplify our work by figuring a ball-park weight. How about we treat it as if it's a short marble column with half of its bulk removed by carving? We'll need to set up and climb our ladder if we need anything better!

Calculations:
Component A: The sandstone base = Box:
Measurements needed: All three sides.
Formula: Side A * Side B* Side C
Measurements: Side A = **21** inches. Side B = **48** inches. Side C = **48** inches.
Volume Calculation: **48** inches * **48** inches * **21** inches = **48,384** cubic inches.
Weight Calculation: Sandstone = **0.084** pounds per cubic inch * **48,384** cubic inches = ***<u>4,064</u>*** *<u>pounds</u>*

Component B: Filthy marble support base = Box:
Measurements needed: All three sides.
Formula: Side A * Side B* Side C
Measurements: Side A = **18** inches. Side B = **30** inches. Side C = **30** inches.
Volume Calculation: **18** inches * **30** inches * **30** inches = **16,200** cubic inches.
Weight Calculation: Marble = **0.093** pounds per cubic inch * **16,200** cubic inches = ***<u>1,507</u>*** *<u>pounds</u>*

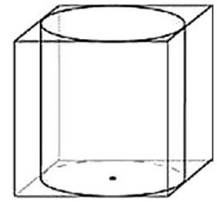
Component C: Slightly cleaner marble block = Box:
Measurements needed: All three sides.
Formula: Side A * Side B* Side C
Measurements: Side A = **30** inches. Side B = **20** inches. Side C = **20** inches.
Volume Calculation: **30** inches * **20** inches * **20** inches = **12,000** cubic inches.
Weight Calculation: Marble= **0.093** pounds per cubic inch * **12,000** cubic inches * = ***<u>1,116</u>*** *<u>pounds</u>*

Component D: Granite column = Box * *0.785 conversion factor*:
Measurements needed: The width and length of the column.
Formula: Side A * Side B * Side C *of an imaginary box big enough to hold the column*
Measurements COLUMN: **10** inches in diameter, **60** inches long.
Measurements of Imaginary BOX: Side A = **10** inches. Side B = **10** inches. Side C = **60** inches.
Volume Calculation: **10** inches * **10** inches * **60** inches = **6,000** cubic inches.
>Convert from Box to Column: **6,000** cubic inches * **0.785** conversion = **4,710** cubic inches.
Weight Calculation: Granite: **0.099** pounds per cubic inch * **4,710** cubic inches = ***<u>466</u>*** *<u>pounds</u>*



Component E: Marble Urn as Column = Box * *0.785 conversion factor* with <u>half of its volume</u> carved away:
Measurements needed: The width and length of the column.

Formula: Side A * Side B * Side C *of an imaginary box big enough to hold the column*
Measurements COLUMN: **10** inches in diameter, **20** inches long.
Measurements of Imaginary BOX: Side A = **10** inches. Side B = **10** inches. Side C = **20** inches.
Volume Calculation: **10** inches * **10** inches * **20** inches = **2,000** cubic inches.
>Convert from Box to Column: **2,000** cubic inches * **0.785** conversion = **1,570** cubic inches.
>Carve away half its volume: **1,570** cubic inches * **1/2** = **785** cubic inches
Weight Calculation: Marble: **0.093** pounds per cubic inch * **785** cubic inches = ***<u>73</u>*** *<u>pounds</u>*



ADDING UP!

4064 pounds = A:
1507 pounds = B:
1116 pounds = C:
466 pounds = D:
73 pounds = E:
7226 pounds = The Monument's total weight
And… that's it!

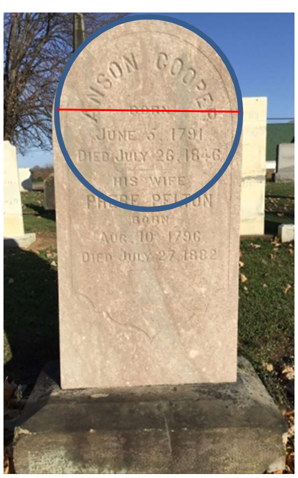
That's It? Really?
Well… No. Not really. There's a little bit more to it than that.

Lumpers and Splitters:

There are two kinds of people in this world: people who lump things into larger chunks, and people who split things into smaller pieces. Your author happens to be a lumper, but (unfortunately) not everyone is.

Take a closer look at the three, lowermost parts of the example monument. See how the top of the sandstone base is beveled? Look at the next piece up—it has a stepped top. And the less-filthy marble blends upward into a shape that's more like a column.

None of our calculations accounted for these details. Could we have done so? Yes, we could. Is it worth our time? That is, does that make a difference? Probably not. The reason why is because all of these blocks are so heavy that you'd never consider shifting them by hand. You would be using equipment to move them and if you're doing that you *still* want an overestimate of the weight to be sure your machinery can handle it. Playing around at the very edge of a machine's capability with such stones is an idiot's game!



Still, if you want super-accurate calculation, you can still use the shortcuts, it's just that you'll need to separate more complex components into the simple shapes you can handle.

Geometry is Your Friend:

Many times, a monument has a bamboozling shape. Often, a little bit of geometry and judicious use of a tape measure can get us out of a squeeze.

A great example is the marker of Anson and Phoebe Cooper (*Brownhelm Twp. Cemetery, Lorain County, OH, Don Hilton, 2018,*). Excluding the fine-grained, brown, quartz sandstone base, this mottled pink limestone marker is **39** inches high, **21** inches wide, and **4** inches thick (100 cm, 53 cm, 10 cm). These measures *exclude* the few inches that are down inside the slotted base.

Now, if this limestone marker were flat across the top it would be a piece of cake to figure the weight of what we see. We could multiply the three sides to get a volume and then multiply that by the limestone density factor to get a weight of **301** pounds (137 kg). The trouble is, the top **10.5** inches of the stone is rounded. Treating it as square adds weight that really isn't there. What can we do?

The correct way to do it is to 2-stage the calculation. Figuring the weight of the stone squared off where it begins to curve (**28.5** inches) and adding to that the weight of the semicircle at the top, it being calculated as *half* of a very short column that's **21**-inches in diameter. Doing that, the total weight of what we see is **283** pounds (129 kg). That's lighter. Does it really make a difference? Probably not, especially when you add the weight of the stone that's slotted in the base.

NEED A COUPLE MORE EXAMPLES HERE

It takes a little practice to see shapes within shapes and just a little more time to split them apart for calculation's sake, but it's not difficult and, once you get the knack, it's an enjoyable exercise.

The funny thing is; Once you get really good at calculating the weight of markers, you'll only need it on the occasions when a stone seems "on the edge" of a technique. That is, can I lift this by myself, or do I need another person? Or, do I need two more people? Do I need to clamp boards across it, or can we pick it up barehanded? Can people move this, or do I need a tripod? Will rope do, or should I use chains? Should I use my 1-ton tackle, or should I change it out for my 2-ton? Can I lift this with the equipment I have, or do I need something stronger?

AND THEN I WRAP IT UP, SOMEHOW

Concrete added to the bottom

Summary:

BLAH BLAH BLAH.

Table copies here:

MATERIAL	**pound/INCH3**	**pound/FOOT3**	**g/CC**	**kg/METERS3**
Granite/Igneous	0.10	172	2.75	2750
Marble	0.09	160	2.56	2563
Limestone	0.09	159	2.54	2540
Sandstone	0.08	145	2.32	2323
Slate	0.10	168	2.69	2690
Average	**0.09**	**161**	**2.570**	**2573**

Sources:

Rock density numbers from: https://www.artfibe999rglass.com/calc/stonecalc.html

Shapes in boxes from: https://schoolbag.info/mathematics/sat_3/6.html