# Magnolia PaperWeight V2.0 - IOS 14

## An iPhone and iPad app for hand papermakers and paper conservators

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	PaperWeight	
	PAPER CALCULATIONS	
	Rectangle	5
P	Circle	
	Area	>
2	Pixels	>
	Density	\$
	PULP CALCULATIONS	
	Rectangle	
	Circle	> ( \\
	Area	
	Deckle Depth	
	Concentration	
	PAPER PRODUCTION	
	Adjusted Deckle Calculator	
$\land$	Paper Production Calculator	> Q
	Beater to Vat Concentration	

Magnolia Paperweight is available for iPad and iPhone at the Apple App Store Apple computers using the M1 chip can also use this app



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A test production run of 40 sheets Verifying furnish concentration & Tools for Testing and Documentin Documenting a sheet of handmade



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Retted and shredded linen rag in an alkali cook, (soda ash)



Pulp on a knife edge



The hiss and snap of the su being lifted as a washi is couched



Lifting the deckle - an even sheet edge to edge, corner to corner

Where making paper by hand is concerned, sensation and percep-tion play the lead roles. Given time, these feelings and judgments soon become second nature. We smell the earthy fragrance of retting linen before selecting and ripping the cloth to assess the right moment to cook and wash the decomposing rag. The scent of an alkali cook (linen, hemp, kozo, gampi) lets us know the game is afoot.

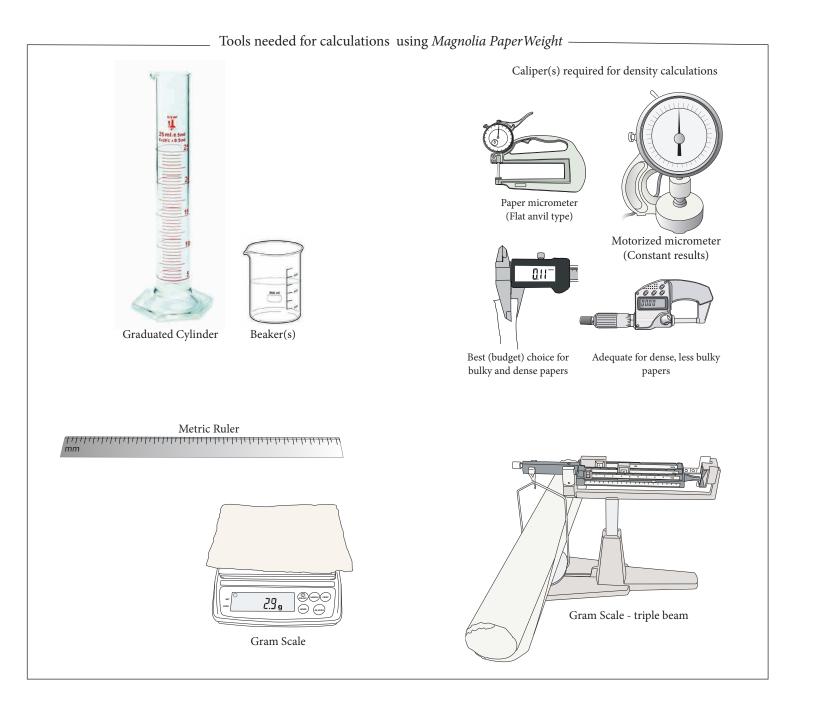
At the Hollander, we find meaning as the beater sings —we assess the fly-bars' percussion on rags and make subtle adjustments, feeling the pulp slipping between our fingers, determining its freeness. We catch fibers on a knife-edge and to ascertain their length. A visual clue might alter our shake in the last half-second of forming a Western sheet. Our senses find all four corners of the flowing furnish within the mould's deckle, assigning muscle memory responsibility for the fibrous mat's uniformity, catching a wave repeatedly, and throwing off the remainder at the last second in the way of nagashizuki. We throw a felt, and like those below, it lands squarely on the post, the stack of felt and paper that will soon be weeping under the tremendous pressure of the paper press.

From assessing the gentle tug on kozo still steaming hot in alkali liquor to the sheen on a well-formed sheet on the mould, the melodic hiss of the su, when lifted from a washi couch, all become instinctive, and all sensations heightened. It's an intricate ballet, the papermaker's dance and it's the reason we fall in love with this age-old process.

Our visceral, Dionysian feelings regarding this process do survive when we apply some Apollonian control to the process of charting a path for a specific paper we have in mind.

#### Introduction

### Magnolia PaperWeight



It may seem incongruous, reaching for a modern electronic device when making paper by hand, unless you are like me and see all technology as current (considering humans only just arrived on the scene). Handmade paper is, to me, a high point of man's ingenuity. Its invention was timely, significant, ecological, and allows for iterations, making all subsequent technology and stored knowledge possible. In this circumstance, an electronic device, no more or less innovative than papermaking, allows for computations that can dramatically influence a handmade process and its outcome. And this app aims to do just that; add insight into arriving at the elements necessary to create a particular sheet or set of sheets. It doesn't change how the materials behave, nor how thoroughly we revel in the process.

With the *PaperWeight* app, you can find the weight of any paper; combine that piece of information with a few other parameters, and much can be understood and accomplished, whether making a beaker of paper pulp or a beater load.

When describing a sheet of paper as lightweight, medium weight, or heavyweight, these general terms specifically refer to the sheet's grammage. With a gram scale and a ruler, grammage can be conveniently and accurately measured and expressed as "grams per square meter," GSM, or g/m<sup>2</sup>; this measurement represents the weight of one square meter of a given paper.

In this example, we make the calculations using the *PaperWeight* app: A sheet of rag paper weighs in at 40.75g. The sheets' height and width are 75.5cm x 51.5cm. I entered this data into the *Rectangle* menu within the *Paper Calculations* menu group to find the sheet has a weight (grammage) of 104.80 g/m<sup>2</sup>.

The Formula: (used in the *PaperWeight* app) To find the grammage  $(g/m^2)$  of a rectangular sheet (longhand), we can use this formula: (mass (g) x 10,000) ÷ sq cm = g/m<sup>2</sup>

Back Red	ctangle	
Imperial	Metric	
Mass	40.75	g
Width	75.5	cm
Height	51.5	cm
Weight	104.8	0 g/m²
1. Enter the 2. Enter the	eight of a shea aper: mass in gram e dimensions ir timeters	s
g		Ì



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PaperWeight	
PAPER CALCULATIONS	
Rectangle	>
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Area	>
Pixels	>
Density	>
PULP CALCULATIONS	
Rectangle	>
Circle	>
Area	>
Deckle Depth	>
Concentration	>
PAPER PRODUCTION	
Adjusted Deckle Calculato	r ≻
Paper Production Calculate	or >
Beater to Vat Concentratio	n >
Beater to Vat per Sheet	>
Stuff Chest Furnish to Add	>
INFO	
Paper's Weight	>
ISO Paper Proportions	>
Basis Weight	>
Basis Weight to GSM	>
About Magnolia PaperWeig	aht >

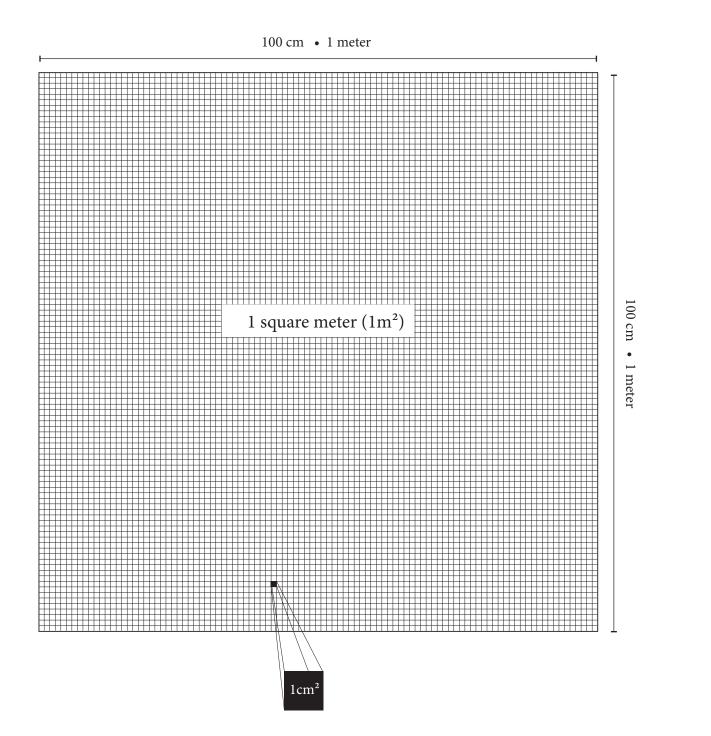
I. Paper Calculations: Calculate a paper's weight expressed as grams per square meter  $(g/m^2)$  for:

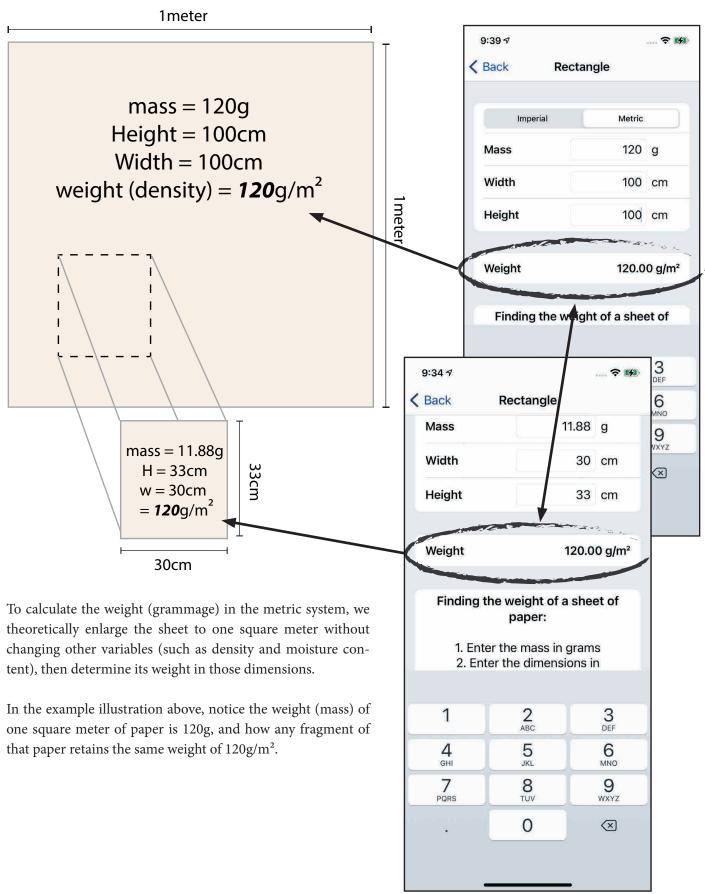
- *Rectangular* paper
- Circular paper
- *Area* cm<sup>2</sup>
- Pixel count in Photoshop for irregular and torn sheets.
- Density expressed in g/cm<sup>3</sup>

II. Pulp Calculation: Determine the amount of dry fiber needed to make a sheet of specific weight  $(g/m^2)$  and dimensions:

- Rectangular sheet
- Circular sheet
- Surface area
- Deckle Depth: Here, you can find the pulp (g/L) concentration required to make a paper of a specified weight (g/ m<sup>2</sup>) by entering the height of a paper mould's deckle. This data is ideal for a deckle box papermaking.
- Concentration: (g/L): Enter the mass of dry fiber in any amount of water to find the concentration in grams per liter.
- **III.** Paper Production:
- Adjusted Deckle Calculator: computes the Volume of furnish used per sheet formed at a vat and provides a conceptual (adjusted) deckle height corresponding to the volume of liquid passing through the mould when a sheet is formed.
- Paper Production Calculator: computes various aspects of producing a specified number of sheets of a specific weight and dimensions.
- Beater to Vat Concentration: Calculate the optimum amount of additional water (±) needed to arrive at a concentration perfect for a specific paper grammage.
- Beater to Vat per Sheet: This menu item calculates the volume of beaten pulp to be added to the vat after each sheet is formed.
- IV. Info:
- *Paper's Weight:* Description of paper weight (g/m<sup>2</sup>)
- ISO (216) is an international standard for paper sizes. All ISO paper sizes have the same aspect ratio,  $\sqrt{2:1}$ .
- Basis Weight Description
- Basis Weight to Grams per Square Meter (g/m<sup>2</sup>)
- About Magnolia PaperWeight

### Grams per Square Meter



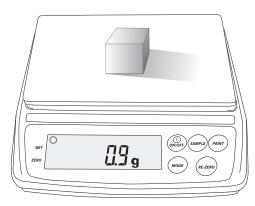


tent), then determine its weight in those dimensions.

that paper retains the same weight of  $120g/m^2$ .

### **Paper Density**

### I. Paper Calculations Menu group



Grams per centimeter cubed (g/cm<sup>3</sup>, or g/cc)

Paper density is a paper's mass per unit volume. A paper's density can be calculated by dividing a paper's grammage  $(g/m^2)$  by its caliper (in microns).

Imagine your paper as a cube measuring 1cm x 1cm x1cm; what would it weigh? That weight, expressed as g/cm3, is the paper's density.

A paper's density is determined by many factors, including duration of processing (beating time). Longer processing creates a paper of more density. Also, density can be increased with a gelatin or starch size and calendaring or decreased by air-drying paper. Additionally, density tends to be higher if the pulp containing hemicellulose (like bast fibers: kozo, mitsumata, gampi, abaca, or flax).

Tissue paper	0.25-0.50
Book Paper	0.72
Bond Paper	0.75
Cover Stock	0.92
Coated & Super Calendared	1.11 - 1.16
Glassine	1.16-1.52

Using hand-operated micrometers will give varied results, density numbers not consistent with industry standards. However, within your own studio, using such a caliper will inform the relationship between processing, sizing, pressing and drying within your own papermaking environment.

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<	Back	De	ensity	
	Weight		176.8	g/m²
	Thickness		.394	mm
	Thickness 2 Reading	nd	.382	mm
	Thickness 3 Reading	rd	.357	mm
	Density		0.471	g/cm³
	paper in 9 1. Enter the 2. Enter th	gram ci e gra ne thi ured	sity of a sheet of as per centimet ubed mmage of a she paper ickness of the sl with calipers (in limeters)	er et of neet
	g/m	2		F

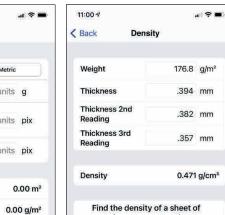
PaperWeight converts your measurement in millimeters into microns, (a micron is a unit of measure that is often used for describing paper thickness). One thousand microns equals one millimeter.

:47 -1	,ul <b>† ■</b>	3:15 🕫	Rectangle	ı  <b>?</b>
aperWeight		Imperial	Metric	
PERCALCULATIONS		Mass	Enter units	a.
Rectangle		Width	Enter units	
Circle	>	Height	Enter units	
rea	>		2002 2003	700.5
ixels		Weight	0.00	) g/m <sup>:</sup>
Density		Finding th	e weight of a shee	t of
P CALCO ATIONS	2	2. Ente	paper: r the mass in grams r the dimensions in centimeters	
Circle	>	-	$\overset{\longleftarrow}{\frown}$ 1	
Area	>	g		
Deckle Depth	>			
Concentration	ð.	-		
PER PRODUCTION				
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ater to Vat per Sheet	>	Mass	Enter units	g
uff Chest Furnish to Add	>	Photographe Document pixels	Enter units	pix
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O Paper Proportions	5	Area	-	00 m
Basis Weight	>	Weight	0.00	) g/m <sup>:</sup>
asis Weight to GSM	>		e weight (gsm) of	an
bout Magnolia PaperWeight	3		leaf (e.g., an old, document):	
		2. Photogra on a black l x1cm white alongside ( background 3. Open the Photoshop 4. Select th	mass in grams uph the leaf (docum packground with a ' paper square laying on the black d) image in Adobe e entire black d, using the Magic	1cm



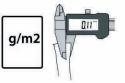


Imperial	Metric	
Mass	Enter units	g
Area	Enter units	Cm²
Weight	0.0	0 g/m <sup>:</sup>
Finding the v paper:	weight of a shee	2.745



Find the density of a sheet of paper in grams per centimeter cubed

- 1. Enter the grammage of a sheet of paper 2. Enter the thickness of the sheet
- measured with calipers (in millimeters)



PaperWeight converts your measurement in millimeters into microns, (a micron is a unit of measure that is often used for describing paper thickness). One thousand microns equals one millimeter.

- sm) of an ı old,
- ms (document) with a 1cm re laving
- lobe
- Magic ne selection ite square 6. Enter the document pixel count: With the document now selected, open the Histogram palette, click the refresh icon in the upper right to update the pixel count. (Pixel count is found in the lower left of
- 7. Enter the 1cm x1cm pixel count: Select the white 1cm x 1cm square with the Magic Wand or Marquee and find the pixel count in the

the Histogram window)

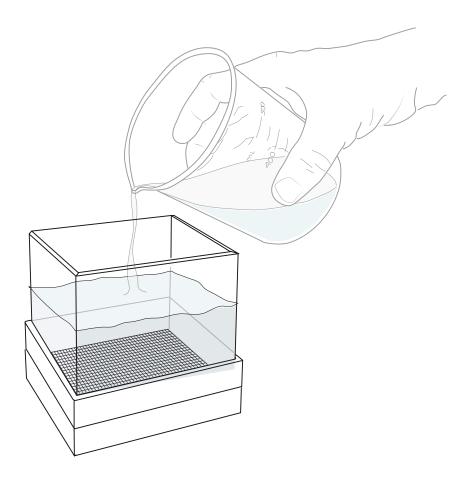
Histogram Palette

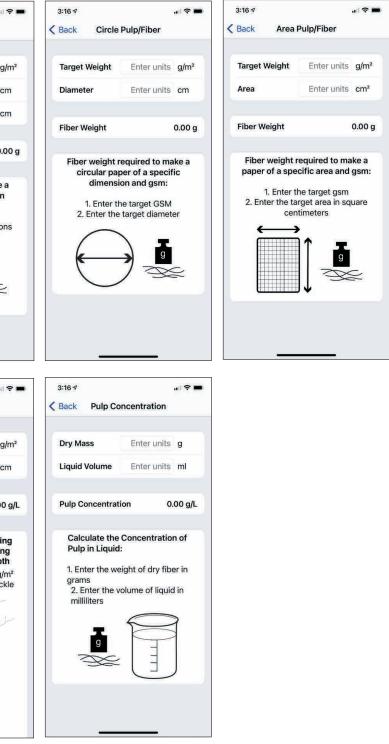
### II. Pulp Calculations Menu group

This group of menus focuses on the weight of dry fiber necessary to make a sheet of a specified height, width (or diameter in the case of circular paper), and weight (aka grammage,  $g/m^2$ , GSM)

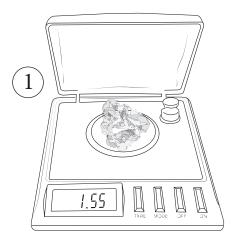
1:47 7	<b>■</b> \$ h.	3:16 1	ail
		K Back Rectan	gle Pulp/Fiber
PaperWeight		Target Weight	Enter units g/
PAPER CALCULATIONS		Height	Enter units cr
Rectangle	>	Width	Enter units cr
Circle	>		
Area	>	Fiber Weight	0.0
Pixels	>	Fiber weight	required to make a
Density	× ×	paper of a s	pecific dimension
ULP CALCULATIONS			er Target GSM et sheet dimension
Rectangle	2	<u> </u>	<b>}</b> ¬∧ _
Circle	×		g
Area	>		
Deckle Depth	>/		
Concentration	<u></u>		
PAPER PRODUCTION			
Adjusted Deckle Calculator	2	3:16 √ <b>〈</b> Back Deck	۰۱۰ . le Pulp/Fiber
Paper Production Calculator	>	C Dack Deck	
Beater to Vat Concentration	>	Target Weight	Enter units g/
Beater to Vat per Sheet	×	Deckle Depth	Enter units cr
Stuff Chest Furnish to Add	>		
INFO		Pulp Concentra	ation 0.00
Paper's Weight	>		ntration for makin
ISO Paper Proportions	>	a deckle o	veight paper using f a specified depth
Basis Weight	>	2. Enter the	target weight in g/n depth of your deck centimeters
Basis Weight to GSM	>		
About Magnolia PaperWeight	>		9-7800
			Deckle depth

Knowing the dry weight of fiber per sheet, (round, circular or odd shaped), for a specific grammage is perfect for leaf casting, deckle box and pouring a sheet. For paper made at the vat, see the *Paper Production Calculator* menu.



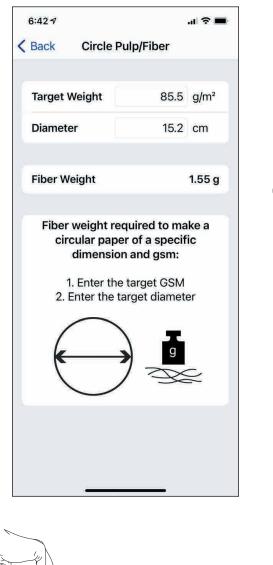


### Using the Circle Pulp/Fiber menu Step-by-step



Select & weigh fiber: Use the Paper-*Weight* app to calculate the weight of fiber needed for a specific  $g/m^2$  paper.

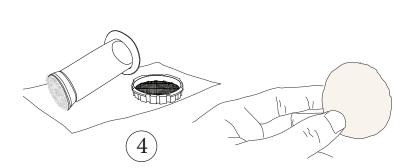
3



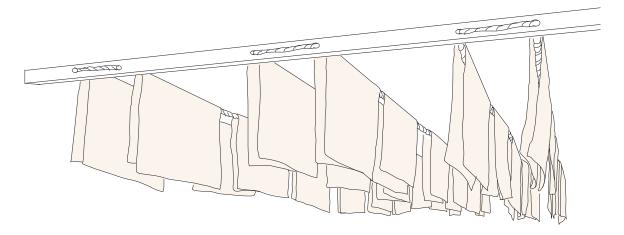


Soak the fibers for an hour (or more) before blending to increase the tear and tensile strength.

After a good soak, blend until fibers are separated and add any furnish additives (pigment, retention aid, formation aid, buffering agents, etc.), at which point, mix very gently.



Blot and/or hot-press dry. The circular sheet will most likely be very close to your target  $g/m^2$ , in this example weighing 1.5g. Slightly more g/m<sup>2</sup> in high humidity and less in a dry climate. It's important to use all the furnish in the pour, using the complete weight of dry fiber required in order to achieve your target  $g/m^2$ .





Pour into a circle template on a paper mould and couch onto a felt or interfacing. Alternatively, use a modified Arrow coffee press (with a screen instead of a coffee filter), pour in your furnish, insert (a felt tipped) Plunger into Cylinder, and press slowly.

### **III.** Paper Production

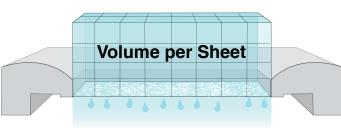
#### Adjusted Deckle Depth Calculator

The furnish volume required to form a given sheet can be thought of as a cube the fits nicely in the deckle. That cube's height is the conceptual "adjusted" deckle depth, describing the white water volume that passes through the mould when a sheet is formed at a vat. (It also includes the moisture in the sheet filtered out on the mould's screen surface.) Furnish characteristics, especially freeness and concentration, can dramatically affect the volume that will pass through a mould with each sheet formed. Therefore, it is advisable to recalculate Volume per Sheet and Adjusted Deckle Height for furnishes of different densities and those with longer or shorter processing time.

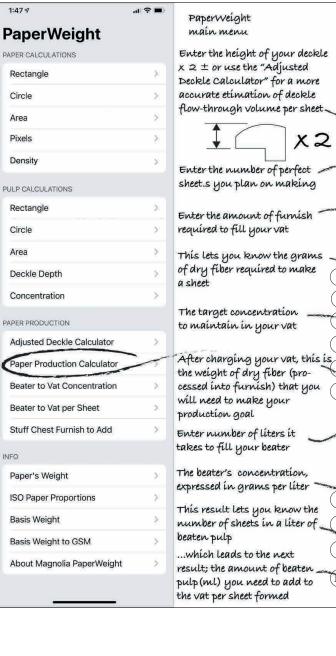
18

1:47 🔊 would need to be that of the volume. PaperWeight main menu **PaperWeight** PAPER CALCULATIONS Rectangle 10:45 1 Circle Adjusted Deckle Depth Calculator Area Enter the mass (weight in Pixels grams) of a dry sheet made **Dried Sheet** 7.4 g using a vat with a known Mass Density concentration. Enter the dimensions of the Height 27.2 cm dried paper - height PULP CALCULATION and width Width 21.2 cm Rectangle Remove a liter of furnish from your vat, strain, dry, and Vat Circle 5.4 g/L This is the conceptual depth of weigh the sample to find the Concentration your mould's deckle as if it vat (furnish) concentration. Area were deep enough to hold the This is the weight (grammage) Adjusted Deckle Depth 2.38 cm Deckle Depth volume of furnish that flows of the sheet described above. through the mould in a single Concentration Weight 128.33 g/m<sup>2</sup> dip as you form a sheet. 1.371 Volume per Sheet PAPER PRODUCTION This is the volume of furnish Adjusted Deckle Calculator that flows through your mould Finding the volume of furnish used Paper Production Calculator for every sheet made. per sheet and establish an adjusted (conceptual) deckle Beater to Vat Concentration depth for a given paper mould: Beater to Vat per Sheet 1. Measure the vat (furnish) concentration Stuff Chest Furnish to Add 2. Form, press and dry a sheet of pape 3. Weigh the sheet (g) 4. Measure the dimensions of the Paper's Weight dry sheet **ISO Paper Proportions Basis Weight** Basis Weight to GSM About Magnolia PaperWeight

Knowing the volume and concentration used when forming a sheet in production is key to achieving a target grammage and understanding the quantities of pulp required to replenish the furnish while creating sheets in a production setting. This volume to sheet relationship is also used in Freeness testers and deckle box hand sheets.



The above illustration displays the furnish volume required to make a sheet and depicts a deckle's conceptual depth. i.e., if this were a closed system (like a deckle box), the height of the deckle



#### The Paper Production Calculator

The Paper Production Calculator computes various aspects of producing a specified number of sheets of a specific weight and dimensions, for practitioners of traditional handmade paper making:

**Data entry:** (what you enter)

•Target weight (grammage)

•The dimension of your mould including deckle depth

#### **Results:**

Area

Area

INFO

1. The weight of dry fiber required for each sheet.

2. The amount of furnish necessary for each sheet.

3. The weight of fiber needed to charge your vat.

4. The concentration in the vat to maintain to form sheets of your specified  $g/m^2$  and dimensions.

5. The weight of dry fiber required to charge your vat. 6. The total weight of dry fiber necessary for this user-defined production run.

- •How many sheets in the production run.
- •Your vat and beater volumes.
- •The dry weight of fiber in each beater load

7. The pulp concentration in your beater.

8. The water adjustment to make per liter of beaten pulp to make your furnish the correct concentration to achieve a paper of your target weight.

9. The number of sheets in a liter of beaten pulp.

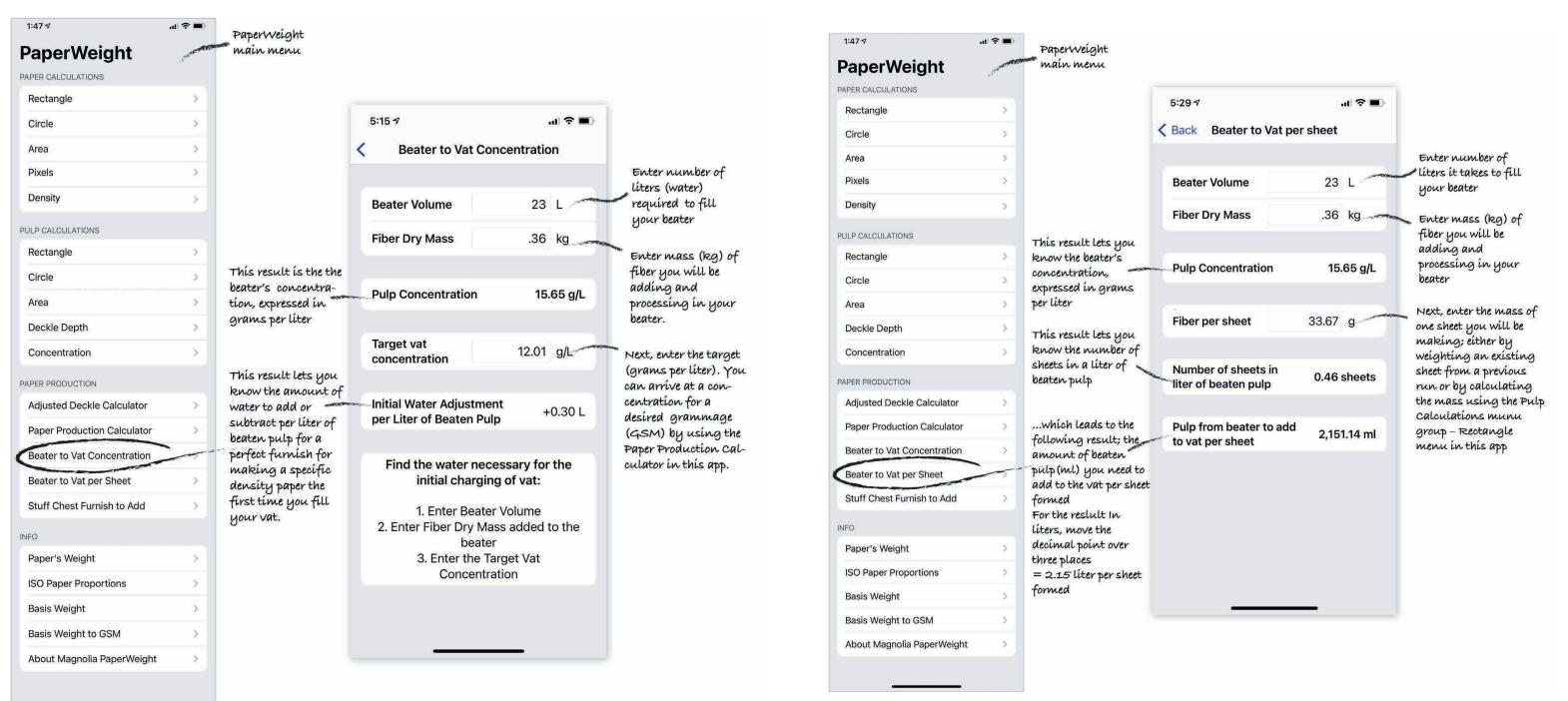
10. If you want to add pulp directly from beater to vat as you make each sheet this identifies the quantity you should add to maintain vat concentration.

		Enter the weight in Grams
Target Weight	133.5 g/m²	per Square Meter of the paper you intend to make
Height	71.5 cm	and the second s
Width	51.5 cm	Enter the height and width of Your paper based on the inner
Deckle Depth	2.15 cm	dimensions of your paper mould's deckle
Production	10 shts	Enter the percentage of flawed
Seconds (Waste)	10 %	sheets you typically make.
Vat Volume	108 L	This is the number of sheets
	/	you will need to make in order
Total Sheets	11 shts	to meet your production goal
Fiber per Sheet	49.16 g	The amount of furnish used
Volume per Sheet	7.92 L	every time you form a sheet
Target Vat Concentration	6.21 g/L	This is the dry weight
Fiber to Charge Vat	0.67 kg	of fiber (processed into furnish
Fiber Needed for Sheets	0.49 kg	needed to charge your vat
Total Fiber Needed	1.21 kg	This is the total dry weight of fiber you will need to process in
		order to both charge your vat
Beater Volume	60 L	and make your production
Fiber Dry Mass Added to Beater	.920 kg	Enter mass (kg) of fiber you will be processing in your bea
Pulp Concentration in Bea	ater 15.33 g/L	
Water Adjustment per Liter of Beaten Pulp	+ 2.47 L	This result lets you know the
Number of Sheets in Liter Beaten Pulp	of 0.31 Shts	amount of water to add or subtract per líter of beaten pu to make the correct furnísh fo
Pulp from Beater to Add t Vat per Sheet	<sup>0</sup> 3.21 L	your specificed g/m²

#### The Beater to Vat Concentration Calculator

Charging your vat to begin a new session of paper production: Use this calculator to calculate the dilution of beater pulp to achieve the fiber concentration. There are essential factors to consider when processing fiber in a Hollander beater; one key variable is pulp concentration (fiber to water ratios in the beater). A lower fiber ratio to water allows for more cutting action in the beater, while a higher fiber concentration produces more hydration and fibrillation. Therefore, concentrations vary depending on the desired characteristics of the finished paper.

Typically a beater load of beaten pulp is not considered "furnish" ready for papermaking; typically, water, fillers, and chemicals are most often added to achieve a viable furnish. Using Beater to Vat Concentration, you can find the optimum amount of additional water needed to arrive at a concentration perfect for a specific paper grammage. Determining the optimum Target vat concentration can be calculated in the Paper Production Calculator, included in Magnolia Paper-Weight. This data is also available in the Paper Production Calculator, but here, in this menu, as a stand-alone



### Beater to Vat per Sheet

The elements in the *Beater to Vat per Sheet* menu can also be found as part of *Paper Production Calculator*. The *Beater to* Vat per Sheet calculator helps determine the volume of beaten pulp to be added to the vat after each sheet is formed. Start by imputing your beater's water volume and the dry weight of fiber you will be processing (kg) to discover your beater's pulp concentration (g/L). You will need to enter the mass (g) of a target sheet in the Fiber per sheet field which can be calculated using the menu Pulp Calculations - Rectangle.

(Pulp from beater necessary to replenish vat after a sheet is made)



#### Stuff Chest to Vat per Sheet

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PaperWeight main menu

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### **PaperWeight**

#### PAPER CALCULATIONS

Rectangle	>
Circle	>
Area	>
Pixels	>
Density	>
PULP CALCULATIONS	
Rectangle	>
Circle	>
Area	>
Deckle Depth	>
Concentration	>
PAPER PRODUCTION	
Adjusted Deckle Calculator	>
Paper Production Calculator	Σ
Beater to Vat Concentration	>
Beater to Vat per Sheet	4
Stuff Chest Furnish to Add	>
INFO	
Paper's Weight	>
ISO Paper Proportions	2
Basis Weight	>
Basis Weight to GSM	>
About Magnolia PaperWeight	>

2:50 1		🕈 🔳			
Stuff Chest Furnish per Sheet					
Target Weight	120	g/m²			
Height	61	cm			
Width	45	cm			
Stuff Chest Concentration	46	g/L			
Fiber Weight per Shee	et 3	2.94 g			
Stuff Chest Furnish to Sheet	Add per	0.72 L			
Number of Sheets between Charges	5	shts			
Stuff Chest Furnish to	add for 5	3.58 L			
sheets					
How to Calculate	Furnish to	o Add			
<ol> <li>Enter Target g/m<sup>2</sup></li> <li>Enter Height</li> <li>Enter Width</li> <li>Enter Pulp Conce</li> </ol>		n Stuff			
Chest 5. Enter the Numbe	er of Sheet	S			
Formed between Vat Recharge					

Enter the weight in Grams per Square Meter of the paper you intend to make

Enter the height and width of your paper based on the inner dimensions of your paper mould's deckle

Enter the concentration of the furnish in your stuff chest

Enter the Number of sheets you would like to make between vat re-charges.

The app provides you with the quantity of furnish to add to the vat from your stuff. I generally don't charge my vat by dumping pulp directly from the beater into the vat. I like to blend batches of processed pulp in a *Stuff Chest*, thereby combining multiple beater loads to achieve a homogenized furnish and more consistent finished paper results.

Blending batches of slowly beaten pulp (a stock with increased bonding potential) with fibers pounded hard and fast create a sheet with more diverse characteristics; the dimensional stability, shorter fibers, and better look-through provided by the hard beating "free" pulp and the rattle and tensile strength of the slowly processed fibers.

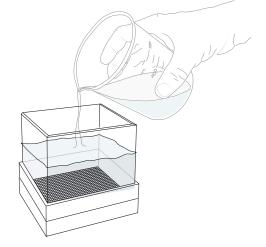
With my furnish blended in the stuff chest, the vat charged, and a specific weight paper in mind, how much furnish do I add per sheet to make the paper of my desired weight?

Because I don't have a "hog" (an automatic stirring device in my vat), I prefer not to replenish my vat between each sheet formed – it slows me down. I like to pull four or five sheets between vat replenishing.

With the *Furnish-per-Sheet menu*, you can calculate the replenishment volume for any number of pulled sheets.

First, find the furnish concentration in your stuff chest. Then, in the app, enter the target grammage, the sheet's height and width, the grams per liter in the stuff chest, and the number of pulls between charges. The app lets you know the volume of stuff-chest-furnish to add per specified number of sheets pulled.

#### Determine Stuff Chest Concentration

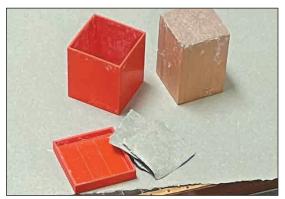


Form a small sheet from 500ml of stuff-chest-furnish.

Once made and dry, weigh the sheet (grams) and multiply by two to find the grams per liter of the furnish in your stuff chest.

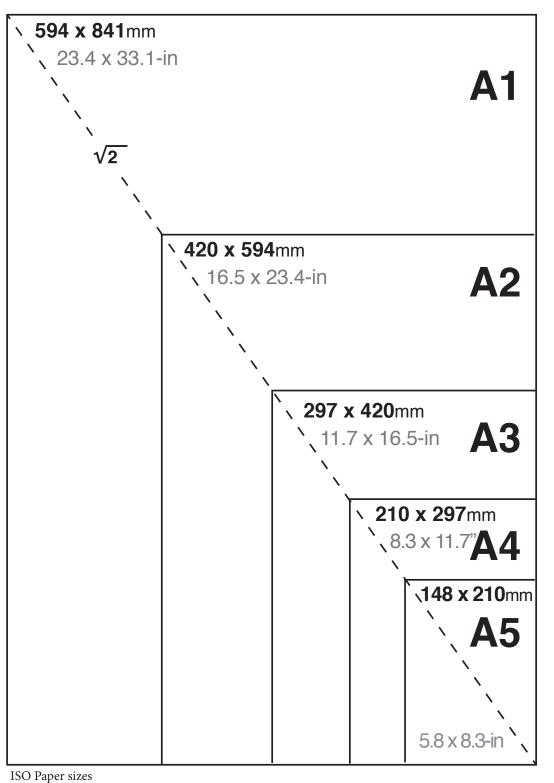


Weighing a sheet made from 500ml of stuff chest furnish. Multiply x 2 to find a concentration of 17.8 g/L

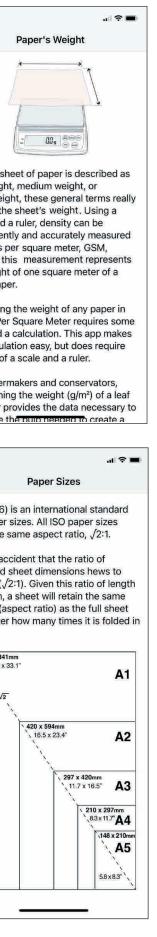


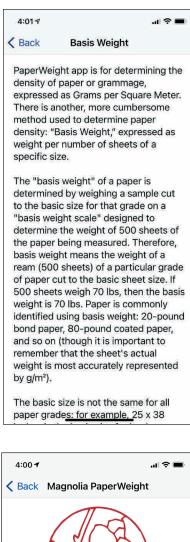
Test sheet made to determine stuff chest concentration

## IV. Info Menus



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_			K Back F
PaperWei			1
PAPER CALCULATIONS	5		1
Rectangle		>	l k
Circle		>	
Area		×	When a shee
Pixels		×	lightweight, r heavyweight
Density		>	refer to the s scale and a r
PULP CALCULATIONS			conveniently in grams per
Rectangle		>	or g/m²; this the weight of
Circle		>	given paper.
Area		>	Describing th Grams Per Se
Deckle Depth		>	data and a ca the calculatio
Concentration		>	the use of a s
			For paperma determining
PAPER PRODUCTION	100 C 100 C 100		of paper prov
Adjusted Deckle		>	Calculate me
Paper Production	n Calculator	>	<mark>4:00</mark> ₹
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Stuff Chest Furn	ish to Add	>	for paper siz
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ISO Paper Propo	rtions	>	to width, a s format (aspe
Basis Weight		×	no matter ho half.
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About Magnolia	PaperWeight	>	`, 23.4 x 33.1
			1







## A test production run of 40 sheets

If you pour a quantity furnish containing a know amount of dry fiber into a mould and deckle, the fiber trapped on the screen forms a sheet of know weight and dimension (and therefore grammage). Whereas, if you form a sheet at a vat of known concentration you can only know the grammage, the amount of dry fiber you are removing, if you have previously determined the volume passing through and trapped by your mould and deckle.

Thanks to Nicholas Price and Alex Sheppard, our ace programmers, I have a beta version of the *PaperWeight* App with the newly added *Adjusted Deckle Calculation* and *Paper Production Calculator*. These tools (calculators) can help us find these volumes. Let's put these two menu items to the test and make a production run of paper. Is it beneficial and easy to use? Is it accurate?

I am confident the app will help with consistency and simplify the analytical approach to a production paper run. Still, nothing worthwhile is easy. Now we must make test sheets, measure volumes, concentrations, and check the grammage. There are many variables to contend with when the goal is the making of consistent sheets.

Key variables that influence g/m2 repeatability:

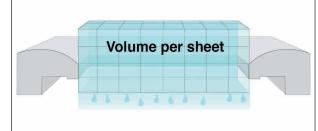
- Freeness
- Beater and vat (furnish) concentrations
- Vat furnish temperature
- Paper mould's screen porosity
- Deckle depth
- The vatman's skill

5:58 🕫	.ıl ≎ ⊯			
Adjusted Deckle Calculation				
Dried sheet mass	7.06 g			
Height	28 cm			
Width	21 cm			
Vat Concentration	5.00 g/L			
Adjusted Deckle Depth	n 2.4 cm			
Weight	120 g/m²			
Fiber per Sheet	7.06 g			
Volume per Sheet	1.41 L			

Finding the volume of furnish used per sheet and establish an adjusted (conceptual) deckle depth for a given paper mould:

- 1. Measure the vat (frunish) concentration 2. Form, press and dry a sheet of paper
  - 3. Weigh the sheet (g)

4. Mesure the dimensions of the dry sheet



For this first test of the beta software, I will use the app to guide me while making 40 sheets of  $8\frac{1}{2} \times 11$  inch, 16th-century style rag paper, with a target weight of 120 g/m<sup>2</sup>. That is to say, laid sheets couched on coarse handmade felts, air dried, made from Spanish flax half stuff, and animal-sized.

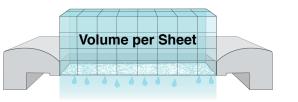
To key-in the data it is necessary for me to measure my deckle, find the Valley Iron Works beater volume and the volume at which I normally fill my small tub vat – easy enough.

- Deckle: 8.5 x 11.25 x 0.4 inches (28 x 21 x 1.2cm)
- Valley Iron Works Beater: 5 gal (18.9 liters)
- Small vat volume: 6.6 gals (360 L)

I entered the numbers above into the *Paper Production Calculator*. The app's answers describe the task ahead. I must process 0.44kg (1 lb) of dry fiber, of which 0.12kg (¼ lbs) will be used to charge the vat.

There is a relationship between the *deckle depth* and the volume of water that passes through the mould when sheet forming at a vat. Since the water flows through the mould as we dip, the volume is a moving target. In my verification tests on the following pages, I am finding that dipping and pulling up through the furnish use about 2x the deckle's volume.

On this day, I happened to have another vat with a 5g/L concentration (220CSF linen and hemp), so I formed a sheet using the same small mould we will be using in this test. Perfect results: the dry sheet's weight and vat concentration only agreed if I doubled the deckle's physical depth.



Using the *Adjusted Deckle Depth Calculator* in the app, I entered the *vat concentration* (5g/L), and sheet dimensions to make a 7g sheet ( $120 \text{ g/m}^2$ ) in one normal dip. The result was approximately 2 x the deckle height. And now I know the furnish volume per sheet.



5:58 1	i		
Paper Produ	ction Calculate	or	
			Actual
Target Weight	120	g/m²	116 g/sm <sup>2</sup>
Height	28	cm	
Width	21	cm	
Adjusted Deckle Depth	2.4	cm	
Production	40	shts	
Seconds (Waste)	10	%	
Vat Volume	25	Ĺ.	
Total Sheets	4	4 shts	
Fiber per Sheet		7.06 g	6.5 g
Volume per Sheet		1.41 L	
Target Vat Concer	tration 5.	00 g/L	4.5 g/L
Fiber to Charge Va	it (	).12 kg	
Fiber Needed for S	Sheets (	).31 kg	
Total Fiber Neede	o k	.44 kg	
Beater Volume	18.9	1	
Fiber Dry Mass	.44		
Added to beater			
Pulp Concentratio Beater	n in 23.	28 g/L	22 g/L
Water Adjustment per Liter of Beate		4.66 L	
Number of Sheets Beaten Pulp	in Liter of 3.3	0 Shts	0.30L
Pulp from Beater t	o Add to	0.30 L	= 6.5  g

### Verifying furnish concentration and furnish-per-sheet-formed volume

#### Following the *Water Adjustment* recommendation:

For every liter of pulp I transfered from the beater to the vat I added 4.66 liters of water, it this way, filling my vat to the 25 liter mark (the *Vat Volume*).

At this point, before forming any sheets and because I am verifying the app, I take a concentration measurement of the vat.

Next, I would like to know the volume of pulp I am removing for every sheet formed; So, I couch into a tray and weight the result - 192g. (7g of which is fiber) So, looks like I am leaving about 1.2L of water in the vat with each sheet I form (minus the water the drips on the floor outside the vat). Since I will be adding 0.30L of pulp per sheet formed that works out pretty well to the specifications in the app.

Volume per sheet	= 1.41 Liters
Couched volume	- 0.19
Drained outside vat	- 0.11
Water remaining in va	at = 1.11
Pulp added per sheet	+ 0.30
	= 1.41 Liters

This works out very nicely, assuming I drain 110ml of water outside the vat as I make a sheet, and replenish with .30L of pulp from beater, (as per the instructions from the app) the vat concentration remains the same.

Time to make 44 sheets, adding 0.30L (300ml) of beaten pulp per sheet.















From left to right top to bottom: Beating, Testing Freeness, taking sample from vat, Pouring sample into Arrow Press, Paper Puck at tip of Arrow Press after pressing, The paper puck, Drying puck on inverted iron, weighing puck. When making a sheet of a desired g/m<sup>2</sup>, it is good to verify the concentration of furnish in the vat. After following the output provided by *PaperWeight /Paper Production Calculator* we can double check the predictions.

#### Find the grams of dry fiber per liter in your vat:

- Stir the vat well.
- Remove 1 liter of furnish, strain and blot.

• Dry, the strained and blotted furnish (Oven, hotplate, iron or air-dry.)

• Allow dried furnish to acclimatize then weigh.

The result is the mass of dry fiber in one liter of furnish residing in your vat (g/L).

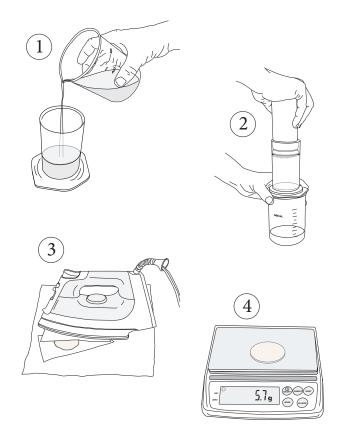
Removing a smaller amount is more convenient and less wasteful.

1. Scoop out 250ml of furnish.

2. Pour into an Arrow (coffee) Press (with substituted screen for a filter).

3. Allow the furnish drain, then insert plunger (with felt tip) and press firmly.

4. Dry and weigh the puck. Multiply the Arrow Press results by 4 to find the grams per liter (g/L).



Because Western-style papermaking dips a paper mould once per sheet, scooping out furnish onto the mould surface, it is not difficult to find the quantity of furnish used per sheet. Knowing the volume of furnish-per-sheetformed can prove to be valuable data:

#### Volume of furnish-per-sheet-formed

• From a vat of furnish with a known concentration (i.e., the above test), stir well and form a sheet using your standard style and technique.

- Couch and dry the sheet.
- •Weigh the paper sheet. Note the result.

To find the volume per sheet:

Divide the mass of the dry paper by the grams per liter from the above test.

• Compare the results to the predictions in *PaperWeight/ Paper Production Calculator*.

Another data point of interest is the volume of water used and water left behind in the vat after forming a sheet.

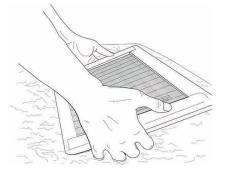
#### Volume of water used when forming per sheet formed

• Place a felt and plastic sheet (or a plastic tray) on a scale and press the tare button to zero out the scale.

• Form a sheet from a vat of known concentration. Couch the sheet on the felt and plastic (or into the plastic tray).

• Carefully place the plastic, felt (or tray), and wet paper onto the scale to find the weight of fiber and water volume used per sheet.

• Dry the paper and weigh it. Reference your vat concentration and the difference between your liquid weight and dry weight in the tray, and figuring the water left in the vat is simple math.





#### **Projected parameters** Working premise

7:42		· ? I
Back Paper Production Ca	alculato	or
Target Weight	120	g/m²
Height	70	cm
Width	50	cm
Deckle Depth	1	cm
Production	10	shts
Seconds (waste)	0	%
Vat Volume	100	L
Total Sheets	1	I0 shts
Fiber per sheet	4	2.00 g
Volume per sheet		3.50 L
Target Vat concentration	12.00 g/l	
Fiber to charge vat	t 1	
Fiber needed for sheets	eets 0.42	
Total Fiber Needed	1	l.62 kg
Beater Volume	60	L
Fiber Dry Mass added to Beater	.920	kg
Pulp Concentration in Beater	15.	33 g/L
Water Adjustment per liter of beaten pulp	э	-1.28 L
Number of sheets in liter of beaten pulp	0.37	sheets
Pulp from beater to add to vat per sheet	2,739	9.13 ml

Actual empirical result Note adjusted deckle depth

Sack Paper Production Calculator

- ÷ =

133.5 g/m<sup>2</sup>

71.5 cm

51.5 cm

2.15 cm

10 shts

0 %

100 L

10 shts

49.16 g

7.92 L

6.21 g/L

0.62 kg

0.49 kg

1.11 kg

60 L

.920 kg

15.33 g/L

+2.47 L

0.31 sheets

3,206.09 ml

7:42

**Target Weight** 

**Deckle Depth** 

Production

Seconds

(waste)

Vat Volume

**Total Sheets** 

Fiber per sheet

Target Vat

concentration

Volume per sheet

Fiber to charge vat

**Total Fiber Needed** 

Beater Volume

Fiber Dry Mass

added to Beater

in Beater

**Pulp Concentration** 

Water Adjustment per

liter of beaten pulp

Number of sheets in

liter of beaten pulp

Pulp from beater to

add to vat per sheet

Fiber needed for sheets

Height

Width

Using empirical	data:
-----------------	-------

Rather than taking my input numbers for granted (my working premise data entered), I followed the guidelines on the previous page and measured the volumes, dimensions and mass of the various elements of production papermaking. I started a new Paper Production Calculator and entered these very real numbers. Since Target Vat concentration is not user entered, I adjusted the Deckle Depth until my vat concentration and grammage numbers agreed with reality.

#### Actual Grammage = $133.5 \text{ g/m}^2$

Actual deckle dimensions:  $73 \times 52 \times 1.1$ cm = 4.18L Felt constrained dried paper: 71.5cm x 51.5cm Air dried paper dimensions: 70cm x 50cm Actual dried paper mass 49.2 grams Deckle depth adjusted = 2.15



#### 1cm deckle x 2 $\pm$

Vat concentration measurement = 6.2g/LFreeness of furnish measurement = 220CSFCouched paper volume measurement = 1 liter Approximate water draining back into vat: 6-7 liters

What this real-life example describes: The volume of water draining from the furnish flowing through the mould covering (laid screen) during sheet formation is double that of the deckle volume. Deckle volume being: length x width x (height x 2)

This production was done using a furnish with a freeness of 220CSF.

1:47-7	al 🕈 🔳
PaperWeight	
APER CALCULATIONS	
Rectangle	×
Circle	2
Area	š.
Pixels	ž
Density	\$
ULP CALCULATIONS	
Rectangle	5
Circle	×
Area	×
Deckle Depth	8
Concentration	ž
APER PRODUCTION	
Adjusted Deckle Calculator	ξ
Paper Production Calculator	ķ
Beater to Vat Concentration	Ś
Beater to Vat per Sheet	ž
Stuff Chest Furnish to Add	5
IFO	
Paper's Weight	Ş
ISO Paper Proportions	5
Basis Weight	2
Basis Weight to GSM	5
About Magnolia PaperWeight	2

4147.4

PaperWeight Rectangle Circle Area Pixels Rectangle Circle Area Deckle Depth Concentration Adjusted Deckle Calculator Paper Production Calculator Beater to Vat Concentration Beater to Vat per Sheet Stuff Chest Furnish to Add Paper's Weight ISO Paper Proportions

Light Mode

Dark Mode

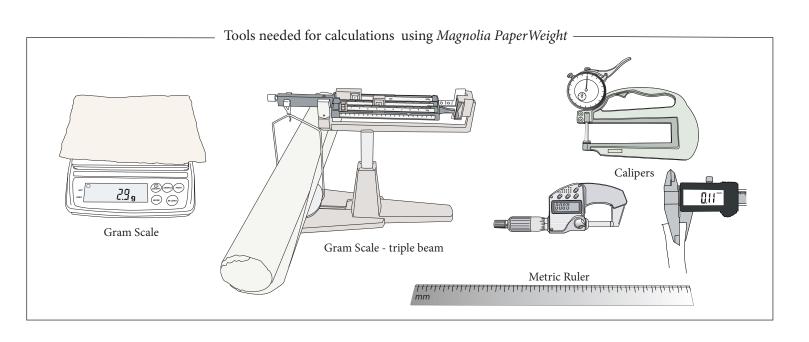
Basis Weight

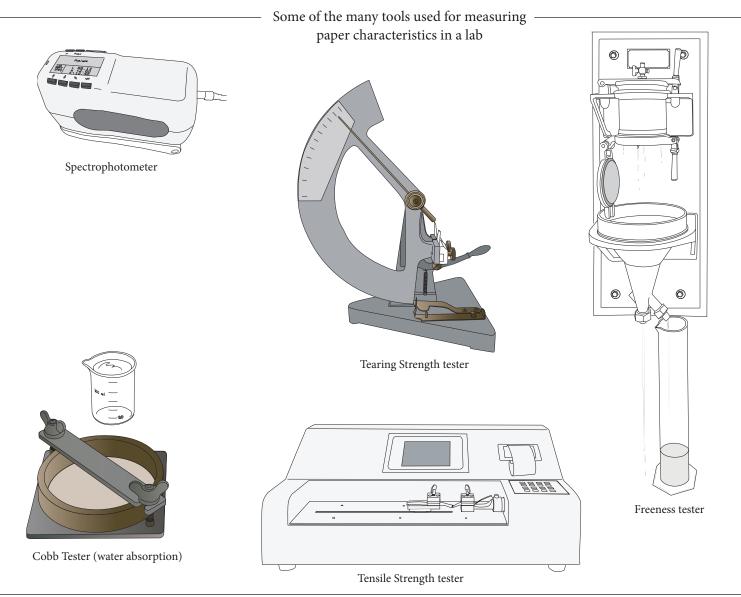
Basis Weight to GSM



### Tools for Testing and Documenting Paper

## **Documenting a Sheet of Handmade Paper** (example)





Paper Name: 120g/m <sup>2</sup> Renaissance texture drawing			<b>Date:</b> 2/12/2021				
Description: Heavy weight gelatin sized drawing paper with felt hair marks							
<b>Content:</b> 50% flax, 3	Content: 50% flax, 30% hemp, 20% abacaBuffer: MgCO3 & CaCO3					: MgCO3 & CaCO3	
Dimensions: 18 x 2	4-in 45.7 x 61cm			Drying:	Air dri	ed (6 sheet spurs)	
Sizing Tub: 3%	hide glue tub size	Siz	ing bea	ter: none	Co	olor: L88, a -1, b +13	
Mass: 41g	Grammage: 121.96 g/m		Caliper: 0.35mm			<b>Density:</b> 0.42g/cm <sup>2</sup>	
Cobb: 40g/m <sup>2</sup>	Tensile (Peak): 15.98kg		<b>Tear:</b> 0.205 (mN/g/n			g/m <sup>2</sup> ) Burst	
Notes:							
Paper mould: Laid	Paper mould: Laid, Britt Quilan Watermark:			nark:			
Beater: Nobel & We	ood Ratio: 20 g/Lt	Time: 30min Freeness: 310CSF			ss: 310CSF		
Beater operator:	Vatman:			]	Finishe	er:	

Collecting data on any given sheet of paper has its benefits. Minimum documentation requires only a ruler, scale, and calipers. More testing equipment allows for more collected data. In this example Freeness, Cobb, Tensile, Tear and Burst require specialized equipment.

#### Acknowledgments

*The Magnolia PaperWeight* app for iPhone, iPad and Apple computers using the M1 chip, is available for free from the Apple App Store, thanks to the programming efforts of **Nicholas Price** and **Alex Shepard** 

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