

# *Magnolia PaperWeight*

V2.0 - IOS 14

An iPhone and iPad app for  
hand papermakers and paper conservators



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

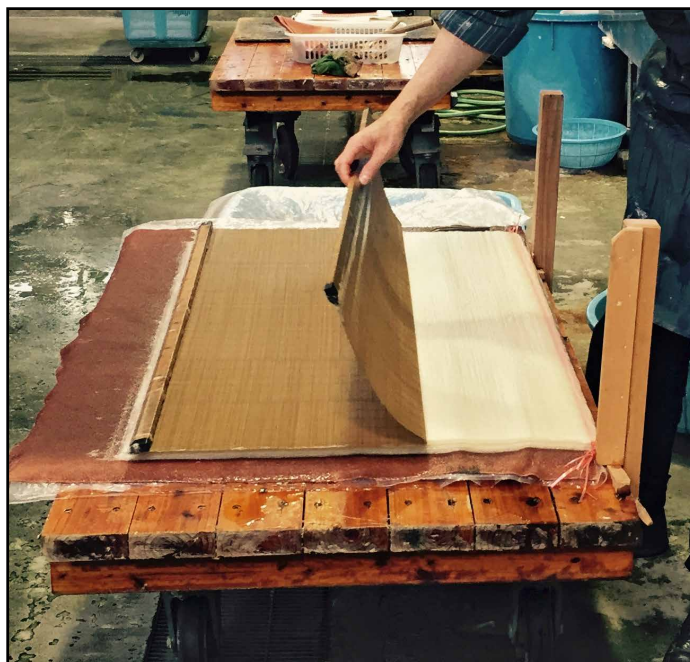




*Retted and shredded linen rag in an alkali cook, (soda ash)*



*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*

## *Introduction*

Where making paper by hand is concerned, sensation and perception 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.





### *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 density (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.

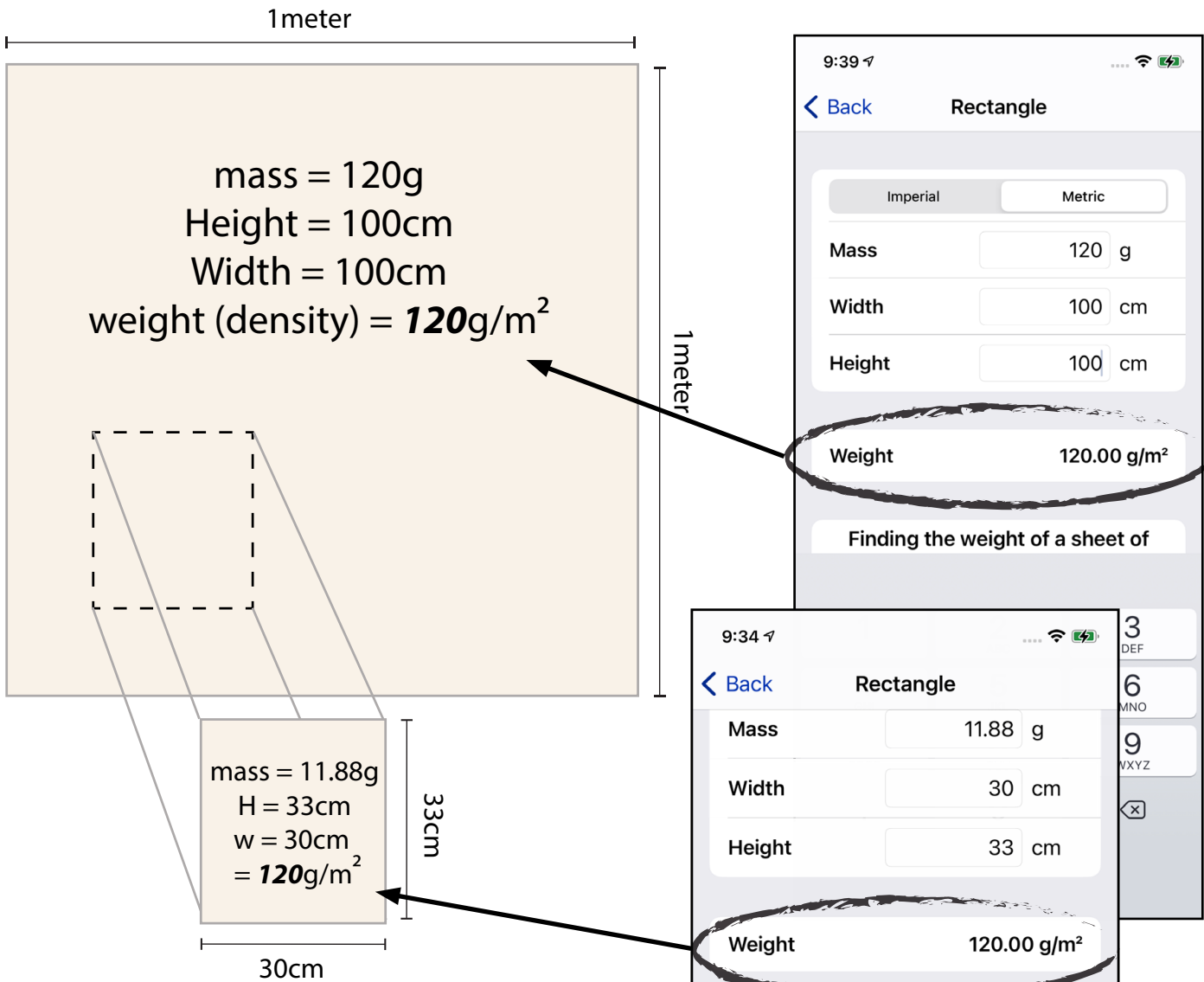
When describing a sheet of paper as lightweight, medium weight, or heavyweight, these general terms specifically refer to the sheet's density. With a gram scale and a ruler, density can be conveniently and accurately measured and expressed as "grammage," or "weight" – more accurately called "grams per square meter," GSM, or  $\text{g/m}^2$ ; 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  $104.80 \text{ g/m}^2$ .

**The Formula:** (used in the *PaperWeight* app)

To find the grammage ( $\text{g/m}^2$ ) of a rectangular sheet (long-hand), we can use this formula:

Grams per Square Meter

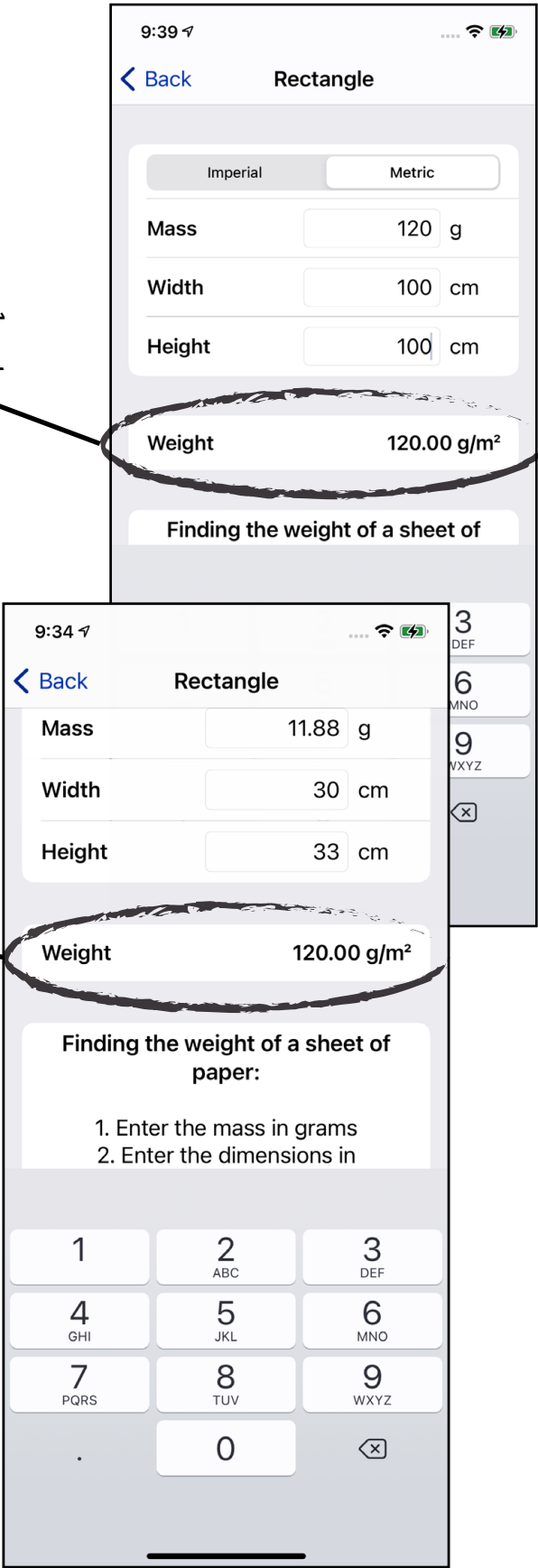


$(\text{mass (g)} \times 10,000) \div \text{sq cm} = \text{g/m}^2$

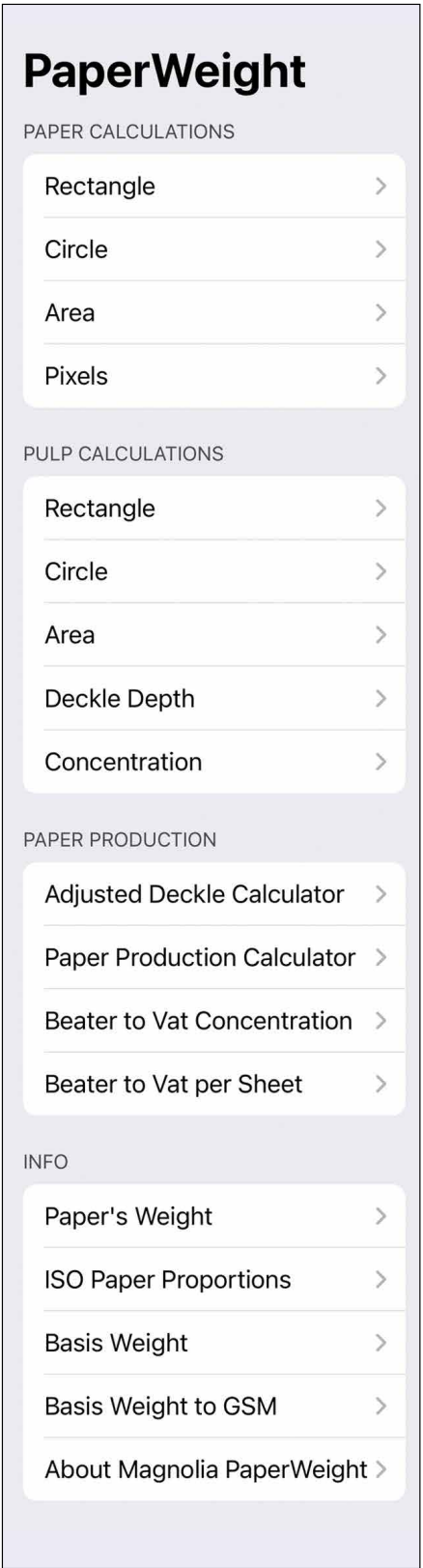
To calculate the weight (grammage, density) in the metric system, we theoretically enlarge the sheet to one square meter without changing other variables (such as density and moisture content), then determine its weight in those dimensions.

In the example illustration above, notice the weight (mass) of one square meter of paper is 120g, and how any fragment of that paper retains the same density of 120g/m².

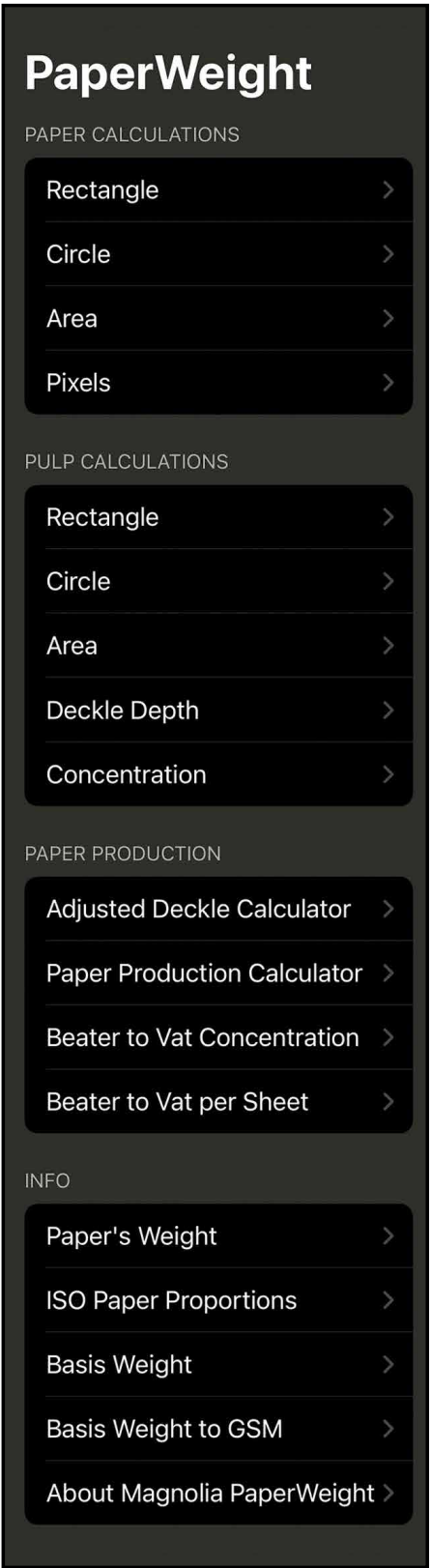
**1. Paper Calculations:** Calculate a paper’s density expressed as grams per square meter (g/m²) for:



PapertWeight Menus



Light Mode



Dark Mode



1

PAPER CALCULATIONS

Rectangle

>

Circle

>

Area

>

Pixels

>

2

PULP CALCULATIONS

Rectangle

>

Circle

>

Area

>

Deckle Depth

>

Concentration

>

3

PAPER PRODUCTION

Adjusted Deckle Calculator

>

Paper Production Calculator

>

Beater to Vat Concentration

>

Beater to Vat per Sheet

>

4

INFO

Paper's Weight

>

ISO Paper Proportions

>

Basis Weight

>

Basis Weight to GSM

>

About Magnolia PaperWeight

>

- *Rectangular* paper
- *Circular* paper
- *Pixel* count in Photoshop for irregular and torn sheets.

2. **Pulp Calculation:** Determine the amount of dry fiber needed to make a sheet of specific density (g/m<sup>2</sup>) and dimensions:

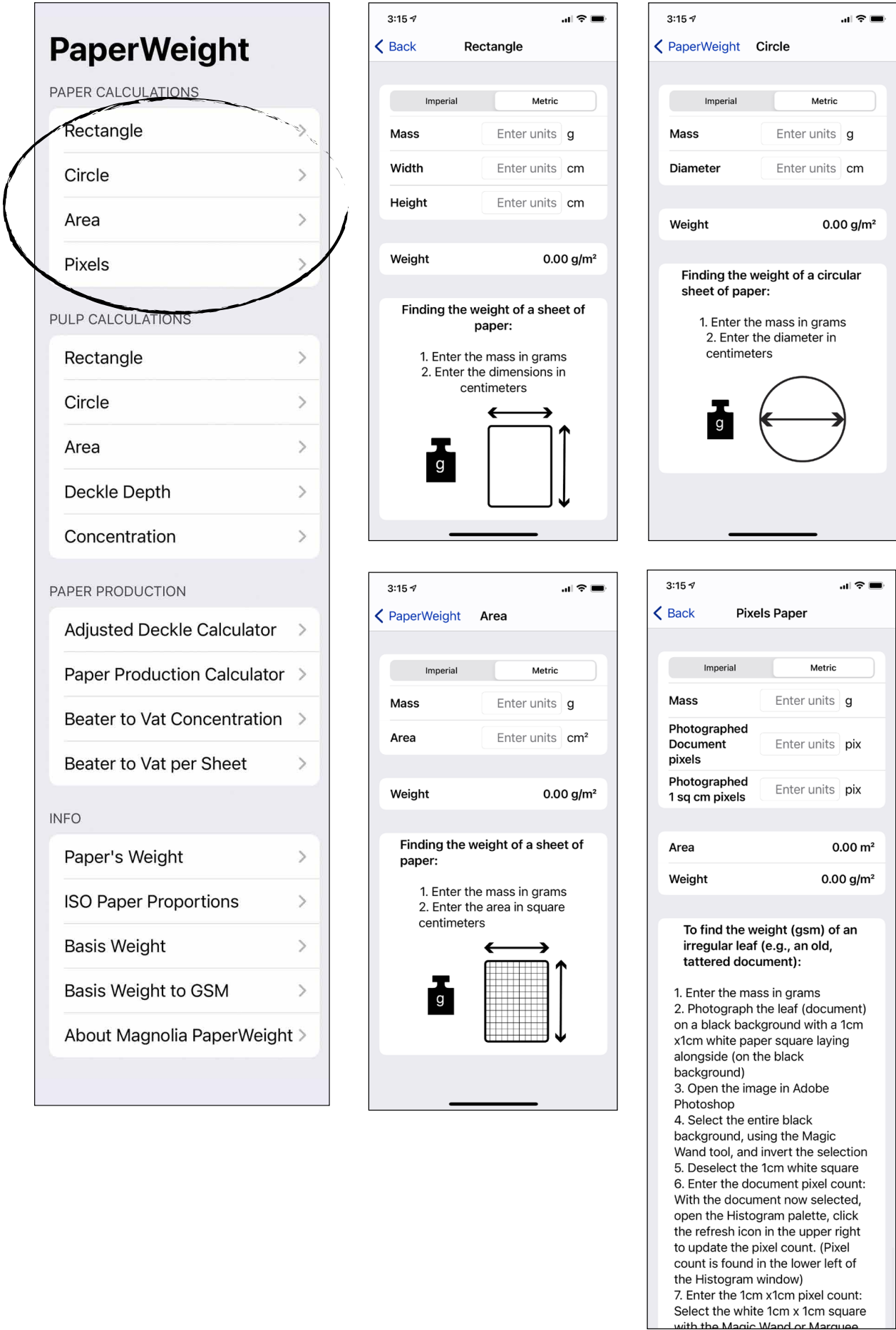
- *Rectangular* sheet
- *Circular* sheet
- *Surface area*
- **Deckle Depth:** Here, you can find the pulp (g/L) concentration required to make a paper of a specified density (g/m<sup>2</sup>) by entering the height of a paper mould's deckle. This data is ideal for a deckle box papermaking.
- **Concentration:** (g/L): Enter the mass of dry fiber in any amount of water to find the concentration in grams per liter.

3. **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 density and dimensions,.
- **Beater to Vat Concentration:** Calculate the optimum amount of additional water (±) needed to arrive at a concentration perfect for a specific paper density.
- **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.

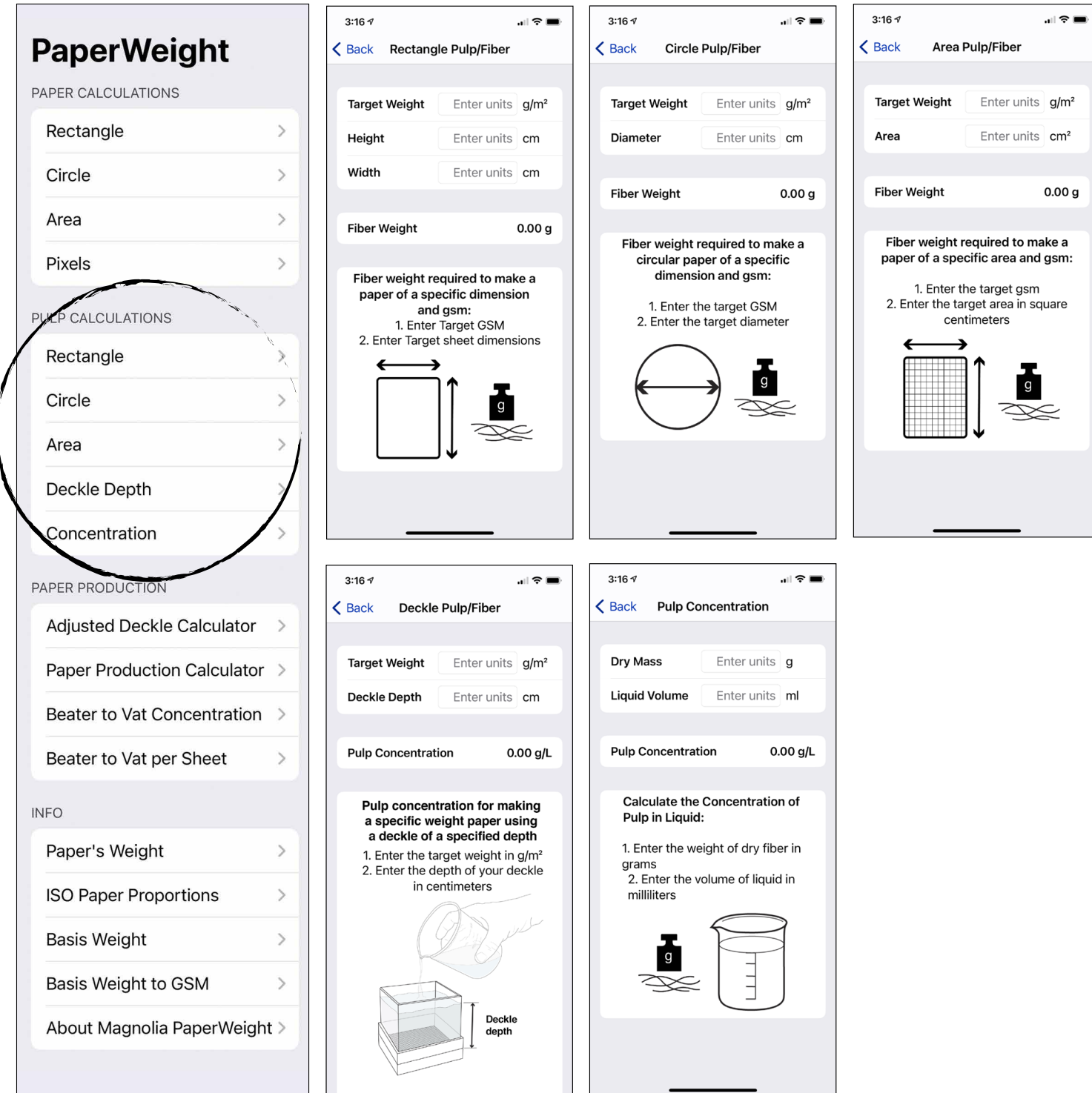
4. **Info:**

- **Paper's Weight:** Description of paper density (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**



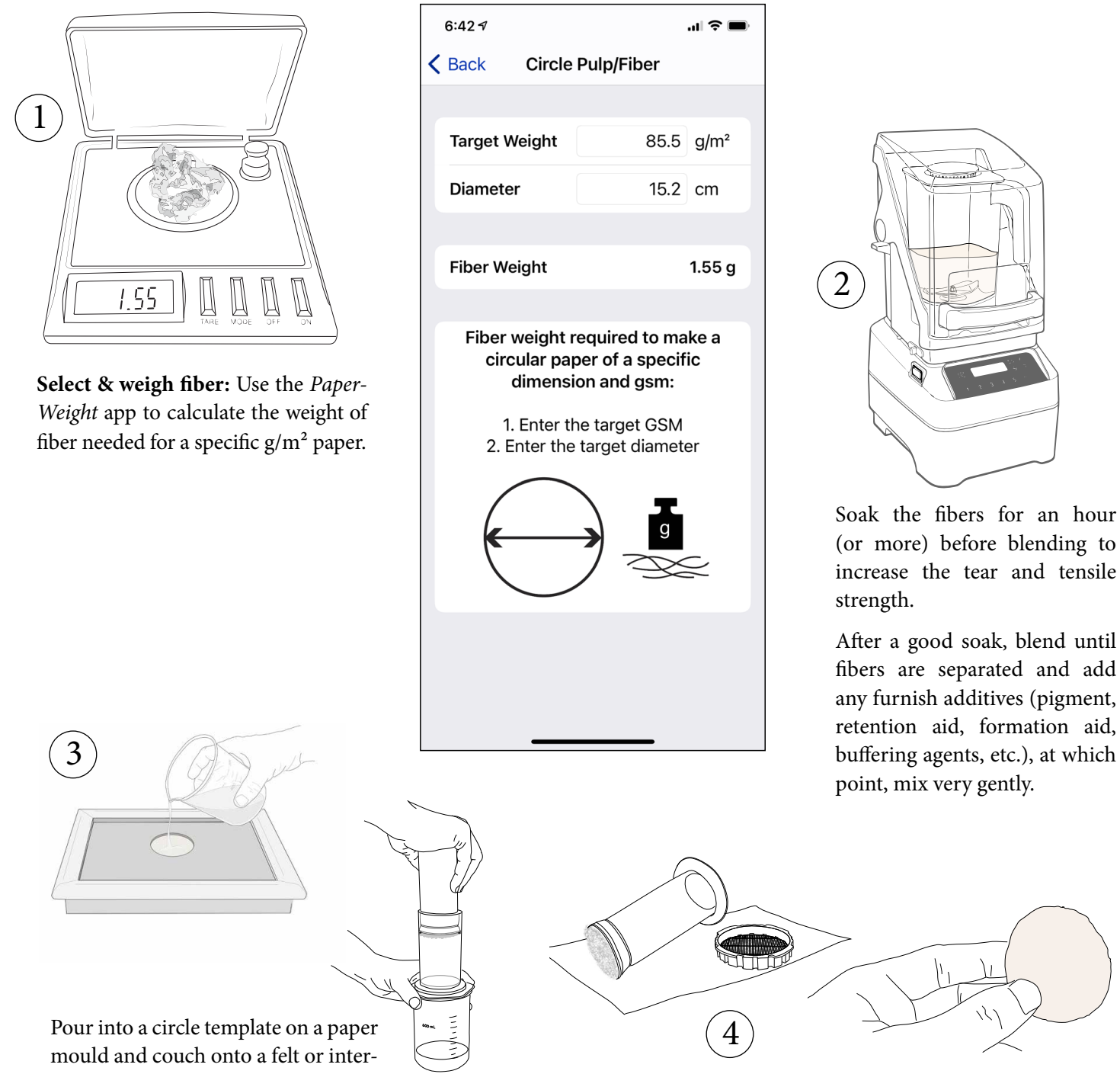
***Pulp Calculations Menu group:***

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 density (aka weight, grammage,  $\text{g/m}^2$ , GSM)



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 in the **Pulp Calculations** menu group  
Step-by-step



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.

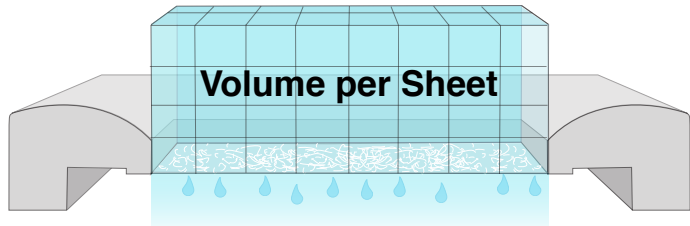
Blot and/or hot-press dry. The circular sheet will most likely be very close to your target g/m<sup>2</sup>, in this example weighing 1.5g. Slightly more g/m<sup>2</sup> in high humidity and less in a dry climate. It's important to use all the furnish in the pour, using the complete weight of dry fiber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



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.

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 would need to be that of the volume.

PaperWeight

PAPER CALCULATIONS

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Circle >

Area >

Pixels >

PULP CALCULATIONS

Rectangle >

Circle >

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Adjusted Deckle Depth Calculator

Dried Sheet Mass 7.4 g

Height 27.2 cm

Width 21.2 cm

Vat Concentration 5.4 g/L

Adjusted Deckle Depth 2.38 cm

Weight 128.33 g/m²

Volume per Sheet 1.37 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 (furnish) concentration

2. Form, press and dry a sheet of paper

3. Weigh the sheet (g)

4. Measure the dimensions of the dry sheet

Volume per Sheet

Enter the mass (weight in grams) of a dry sheet made using a vat with a known concentration.

Remove a liter of furnish from your vat, strain, dry, and weigh the sample to find the vat (furnish) concentration.

This is the weight (grammage) of the sheet described above.

Enter the dimensions of the dried paper - height and width

This is the conceptual depth of your mould's deckle as if it were deep enough to hold the volume of furnish that flows through the mould in a single dip as you form a sheet.

This is the volume of furnish that flows through your mould for every sheet made.

The Paper Production Calculator

The *Paper Production Calculator* computes various aspects of producing a specified number of sheets of a specific density 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:**

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<sup>2</sup> 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.

7. How many sheets in the production run.

8. Your vat and beater volumes.

9. 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.**

PaperWeight

PAPER CALCULATIONS

Rectangle >

Circle >

Area >

Pixels >

PULP CALCULATIONS

Rectangle >

Circle >

Area >

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Paper Production Calculator

Target Weight 133.5 g/m²

Height 71.5 cm

Width 51.5 cm

Deckle Depth 2.15 cm

Production 10 shts

Seconds (Waste) 10 %

Vat Volume 108 L

Total Sheets 11 shts

Fiber per Sheet 49.16 g

Volume per Sheet 7.92 L

Target Vat Concentration 6.21 g/L

Fiber to Charge Vat 0.67 kg

Fiber Needed for Sheets 0.54 kg

Total Fiber Needed 1.21 kg

Beater Volume 60 L

Fiber Dry Mass Added to Beater .924 kg

Pulp Concentration in Beater 15.33 g/L

Water Adjustment per Liter of Beaten Pulp +2.47 L

Number of Sheets in Liter of Beaten Pulp 0.31 Shts

Pulp from Beater to Add to Vat per Sheet 3.21 L

Enter the height of your deckle x 2 ± or use the "Adjusted Deckle Calculator" for a more accurate estimation of deckle flow-through volume per sheet

Enter the number of perfect sheets you plan on making

Enter the amount of furnish required to fill your vat

This lets you know the grams of dry fiber required to make a sheet

The target concentration to maintain in your vat

After charging your vat, this is the weight of dry fiber (processed into furnish) that you will need to make your production goal

Enter number of liters it takes to fill your beater

The beater's concentration, expressed in grams per liter

This result lets you know the number of sheets in a liter of beaten pulp

...which leads to the next result; the amount of beaten pulp (ml) you need to add to the vat per sheet formed

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 percentage of flawed sheets you typically make.

This is the number of sheets you will need to make in order to meet your production goal

The amount of furnish used every time you form a sheet

This is the dry weight of fiber (processed into furnish) needed to charge your vat

This is the total dry weight of fiber you will need to process in order to both charge your vat and make your production

Enter mass (kg) of fiber you will be processing in your beater

This result lets you know the amount of water to add or subtract per liter of beaten pulp to make the correct furnish for your specified g/m²



The Beater to Vat Concentration Calculator

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 density. Determining the optimum Target vat concentration can be calculated in the Paper Production Calculator, included in *Magnolia PaperWeight*. This data is also available in the *Paper Production Calculator*, but here it is as a stand-alone

PaperWeight

PAPER CALCULATIONS

Rectangle >

Circle >

Area >

Pixels >

PULP CALCULATIONS

Rectangle >

Circle >

Area >

Deckle Depth >

Concentration >

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< Back Beater to Vat Concentration

Beater Volume 23 L

Fiber Dry Mass 3.6 kg

Pulp Concentration 156.52 g/L

Target vat concentration 12.01 g/L

Water adjustment +13.03 L

Enter number of liters (water) required to fill your beater

Enter mass (kg) of fiber you will be adding and processing in your beater.

Next, enter the target (grams per liter). You can arrive at a concentration for a desired density (GSM) by using the Paper Production Calculator in this app.

This result lets you know the beater's concentration, expressed in grams per liter

This result lets you know the amount of water to add or subtract per liter of beaten pulp for a perfect furnish for making a specific density paper.

PaperWeight main menu

Beater to Vat per Sheet

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

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 inputting 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*.

PaperWeight

PAPER CALCULATIONS

Rectangle >

Circle >

Area >

Pixels >

PULP CALCULATIONS

Rectangle >

Circle >

Area >

Deckle Depth >

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< Back Beater to Vat per sheet

Beater Volume 23 L

Fiber Dry Mass 3.6 kg

Pulp Concentration 156.52 g/L

Fiber per sheet 33.67 g

Number of sheets in liter of beaten pulp 4.65 sheets

Pulp from beater to add to vat per sheet 215.11 ml

Enter number of liters it takes to fill your beater

Enter mass (kg) of fiber you will be adding and processing in your beater

Next, enter the mass of one sheet you will be making; either by weighting an existing sheet from a previous run or by calculating the mass using the Pulp Calculations menu group – Rectangle menu in this app

This result lets you know the beater's concentration, expressed in grams per liter

This result lets you know the number of sheets in a liter of beaten pulp

...which leads to the next result; the amount of beaten pulp (ml) you need to add to the vat per sheet formed

PaperWeight main menu

PaperWeight

PAPER CALCULATIONS

Rectangle

Circle

Area

Pixels

PULP CALCULATIONS

Rectangle

Circle

Area

Deckle Depth

Concentration

PAPER PRODUCTION

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Beater to Vat Concentration

Beater to Vat per Sheet

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ISO Paper Proportions

Basis Weight

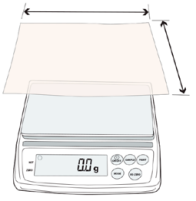
Basis Weight to GSM

About Magnolia PaperWeight

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Paper's Weight



When a sheet of paper is described as lightweight, medium weight, or heavyweight, these general terms really refer to the sheet's density. Using a scale and a ruler, density can be conveniently and accurately measured in "grammage," also called grams per square meter, GSM, or g/m<sup>2</sup>; this measurement represents the weight of one square meter of a given paper.

Describing the weight of any paper in Grams Per Square Meter requires some data and a calculation. This app makes the calculation easy, but does require the use of a scale and a ruler.

For papermakers and conservators, determining the weight (g/m<sup>2</sup>) of a leaf of paper provides the data necessary to calculate the ~~ratio needed to create a~~

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Basis Weight

PaperWeight app is for determining the density of paper or grammage, expressed as Grams per Square Meter. There is another, more cumbersome method used to determine paper density: "Basis Weight," expressed as weight per number of sheets of a specific size.

The "basis weight" of a paper is determined by weighing a sample cut to the basic size for that grade on a "basis weight scale" designed to determine the weight of 500 sheets of the paper being measured. Therefore, basis weight means the weight of a ream (500 sheets) of a particular grade of paper cut to the basic sheet size. If 500 sheets weigh 70 lbs, then the basis weight is 70 lbs. Paper is commonly identified using basis weight: 20-pound bond paper, 80-pound coated paper, and so on (though it is important to remember that the sheet's actual weight is most accurately represented by g/m<sup>2</sup>).

The basic size is not the same for all paper grades: for example, 25 x 38

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Paper Sizes

ISO (216) is an international standard for paper sizes. All ISO paper sizes have the same aspect ratio,  $\sqrt{2}$ :1.

It is no accident that the ratio of standard sheet dimensions hews to 1.4142 ( $\sqrt{2}$ :1). Given this ratio of length to width, a sheet will retain the same format (aspect ratio) as the full sheet no matter how many times it is folded in half.

594 x 841mm  
23.4 x 33.1"

A1

420 x 594mm  
16.5 x 23.4"

A2

297 x 420mm  
11.7 x 16.5"

A3

210 x 297mm  
8.3 x 11.7"

A4

148 x 210mm  
5.8 x 8.3"

A5

4:00

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Magnolia PaperWeight



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Magnolia PaperWeight built by  
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Queen and Nick Stone

For more information please visit  
magnoliapaper.com

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 di-  
mension (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 re-  
moving, 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 gram-  
mage. 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

Adjusted Deckle Calculation

Dried sheet mass

7.06

g

Height

28

cm

Width

21

cm

Vat Concentration

5.00

g/L

Adjusted Deckle Depth

2.4

cm

Weight

120

g/m<sup>2</sup>

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

Volume per sheet



For this first test of the beta software, I will use the app to guide me while making 40 sheets of 8½ x 11 inch, 16th-century style rag paper, with a target weight of 120 g/m². That is to say, laid sheets couched on coarse handmade felts, air dried, made from Spanish flax half stuff, and animal-sized.

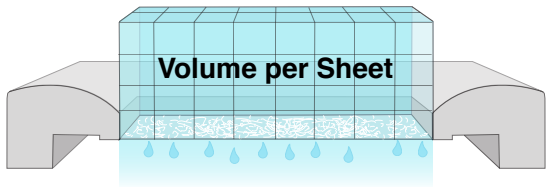
To key-in the data it is necessary for me to measure my deckle, find the Valley Iron Works beater volume and the volume at which I normally fill my small tub vat – easy enough.

- 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 g/m²) in one normal dip. The result was approximately 2 x the deckle height. And now I know the furnish volume per sheet.



5:58

Paper Production Calculator

Target Weight

120

g/m²

Height

28

cm

Width

21

cm

Adjusted Deckle Depth

2.4

cm

Production

40

shts

Seconds (Waste)

10

%

Vat Volume

25

L

Total Sheets

44 shts

Fiber per Sheet

7.06 g

Volume per Sheet

1.41 L

Target Vat Concentration

5.00 g/L

Fiber to Charge Vat

0.12 kg

Fiber Needed for Sheets

0.31 kg

Total Fiber Needed

0.44 kg

Beater Volume

18.9

L

Fiber Dry Mass Added to Beater

.44

kg

Pulp Concentration in Beater

23.28 g/L

Water Adjustment per Liter of Beaten Pulp

+ 4.66 L

Number of Sheets in Liter of Beaten Pulp

3.30 Shts

Pulp from Beater to Add to Vat per Sheet

0.30 L

Actual

116 g/sm²

6.5 g

4.5 g/L

22 g/L

0.30L  
= 6.5 g  
target 7.06g

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
<hr/>	
Water remaining in vat	= 1.11
Pulp added per sheet	+ 0.30
<hr/>	
= 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.



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

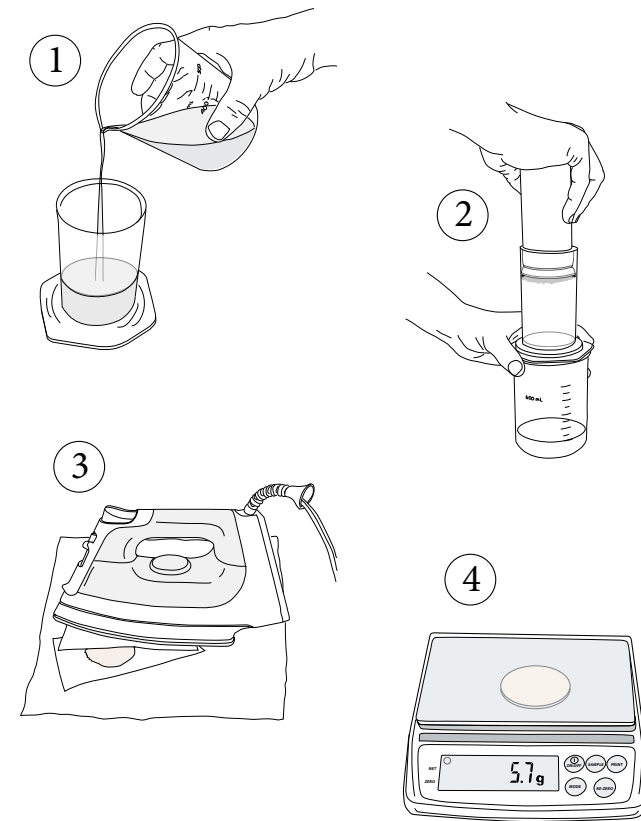
When making a sheet of a desired g/m², it is good to verify the concentration of furnish in the vat. After following the output provided by *PaperWeight / Paper Production Calculator* we can double check the predictions.

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-sheet-formed 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.

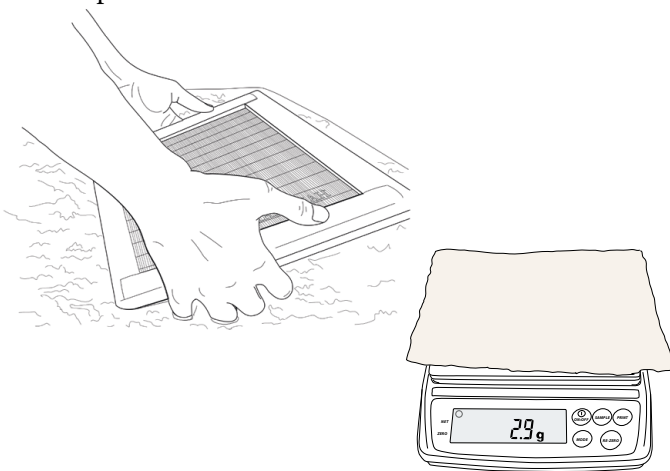
To find the volume per sheet:  
Divide the mass of the dry paper by the grams per liter from the above test.

- 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 volume of water used per sheet.



Projected parameters  
working premise

7:42	
< Back Paper Production Calculator	
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	10 shts
Fiber per sheet	42.00 g
Volume per sheet	3.50 L
Target Vat concentration	12.00 g/L
Fiber to charge vat	1.20 kg
Fiber needed for sheets	0.42 kg
Total Fiber Needed	1.62 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	+1.28 L
Number of sheets in liter of beaten pulp	0.37 sheets
Pulp from beater to add to vat per sheet	2,739.13 ml

Actual empirical result  
Note adjusted deckle depth

7:42	
< Back Paper Production Calculator	
Target Weight	133.5 g/m²
Height	71.5 cm
Width	51.5 cm
Deckle Depth	2.15 cm
Production	10 shts
Seconds (waste)	0 %
Vat Volume	100 L
Total Sheets	10 shts
Fiber per sheet	49.16 g
Volume per sheet	7.92 L
Target Vat concentration	6.21 g/L
Fiber to charge vat	0.62 kg
Fiber needed for sheets	0.49 kg
Total Fiber Needed	1.11 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	+2.47 L
Number of sheets in liter of beaten pulp	0.31 sheets
Pulp from beater to add to vat per sheet	3,206.09 ml

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 g/m²  
Actual deckle dimensions: 73 x 52 x 1.1cm = 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

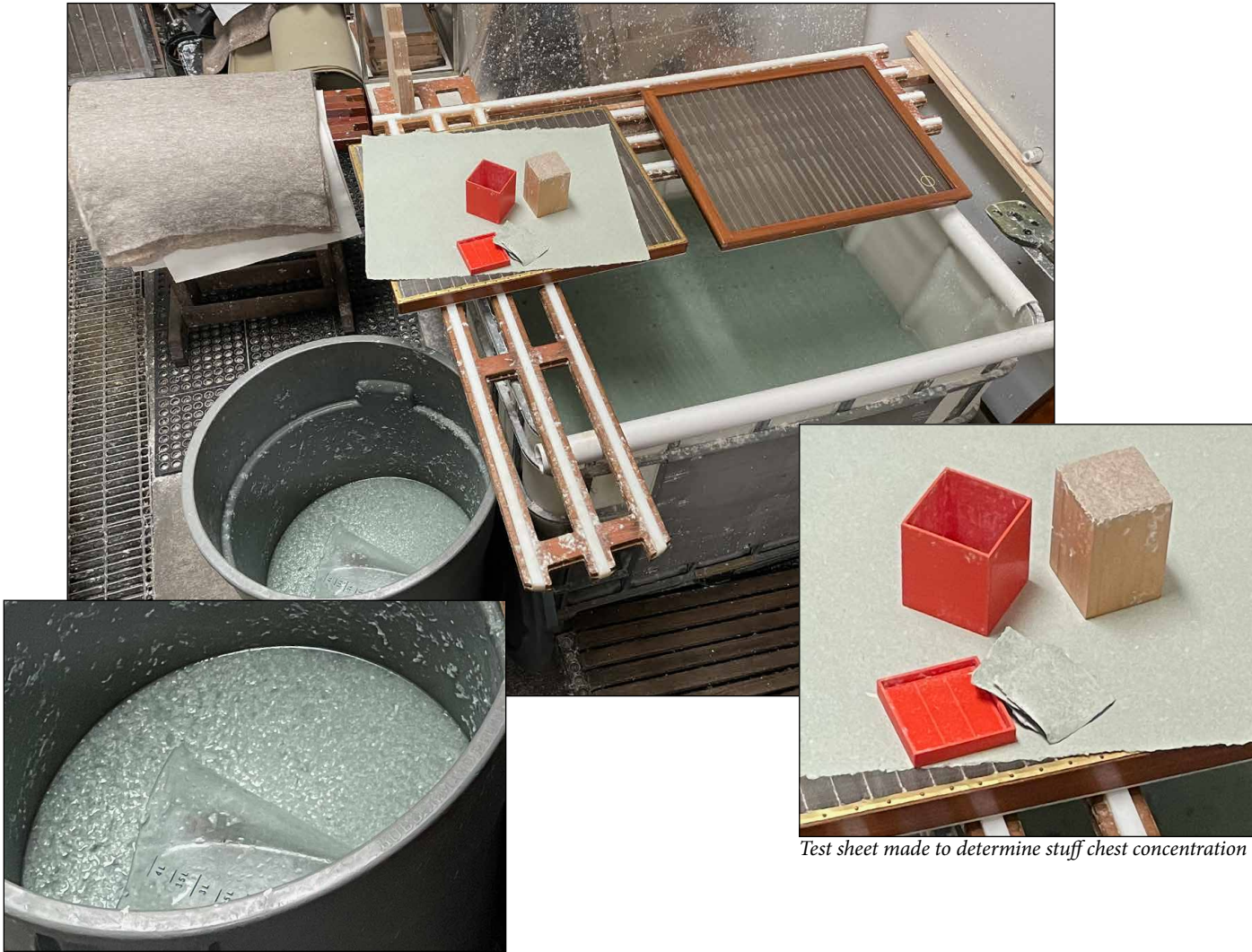


Vat concentration measurement = 6.2g/L  
Freeness of furnish measurement = 220CSF  
Couched paper volume measurement = 1 liter  
Approximate water draining back into vat: 6-7 liters

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.

Furnish per Sheet – From Stuff Chest to Vat



A 32 gallon "Brute" trash can – stuff chest

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.

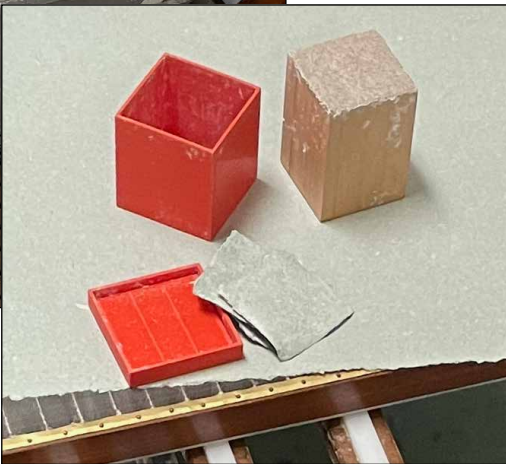
Blending batches of slowly beaten pulp (a stock with increased bonding potential) with fibers pounded hard and fast create a sheet with more diverse characteristics; the dimensional stability, shorter fibers, and better look-through provided by the hard beating "free" pulp and the rattle and tensile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



Test sheet made to determine stuff chest concentration

10:01



Back Stuff Chest Furnish per Sheet

Target Weight	120 g/m <sup>2</sup>
Height	61 cm
Width	45 cm
Stuff Chest Concentration	46 g/L

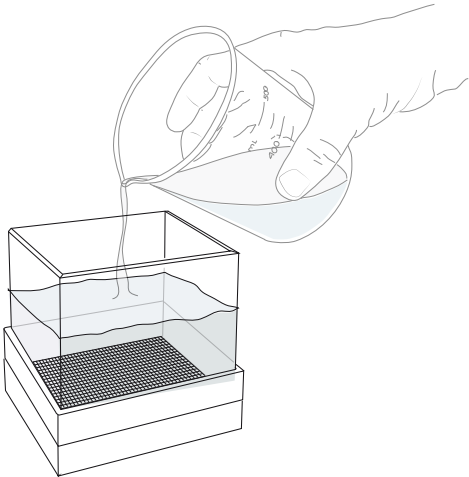
Fiber Weight Per Sheet	32.94 g
Stuff Chest Furnish to add per sheet	0.72 L

No. of sheet between charges	5 shts
Stuff Chest Furnish to add for every ____ sheets	3.6 L

Enter the target weight (g/m<sup>2</sup>), height, and width of your paper. Enter the concentration of stuff-chest-furnish (g/L). (To find the concentration, sample 500ml of stuff chest furnish, strain, dry, and weigh the sample, then multiply by two.)

The app then displays the amount of furnish needed to add to the vat for every sheet formed.

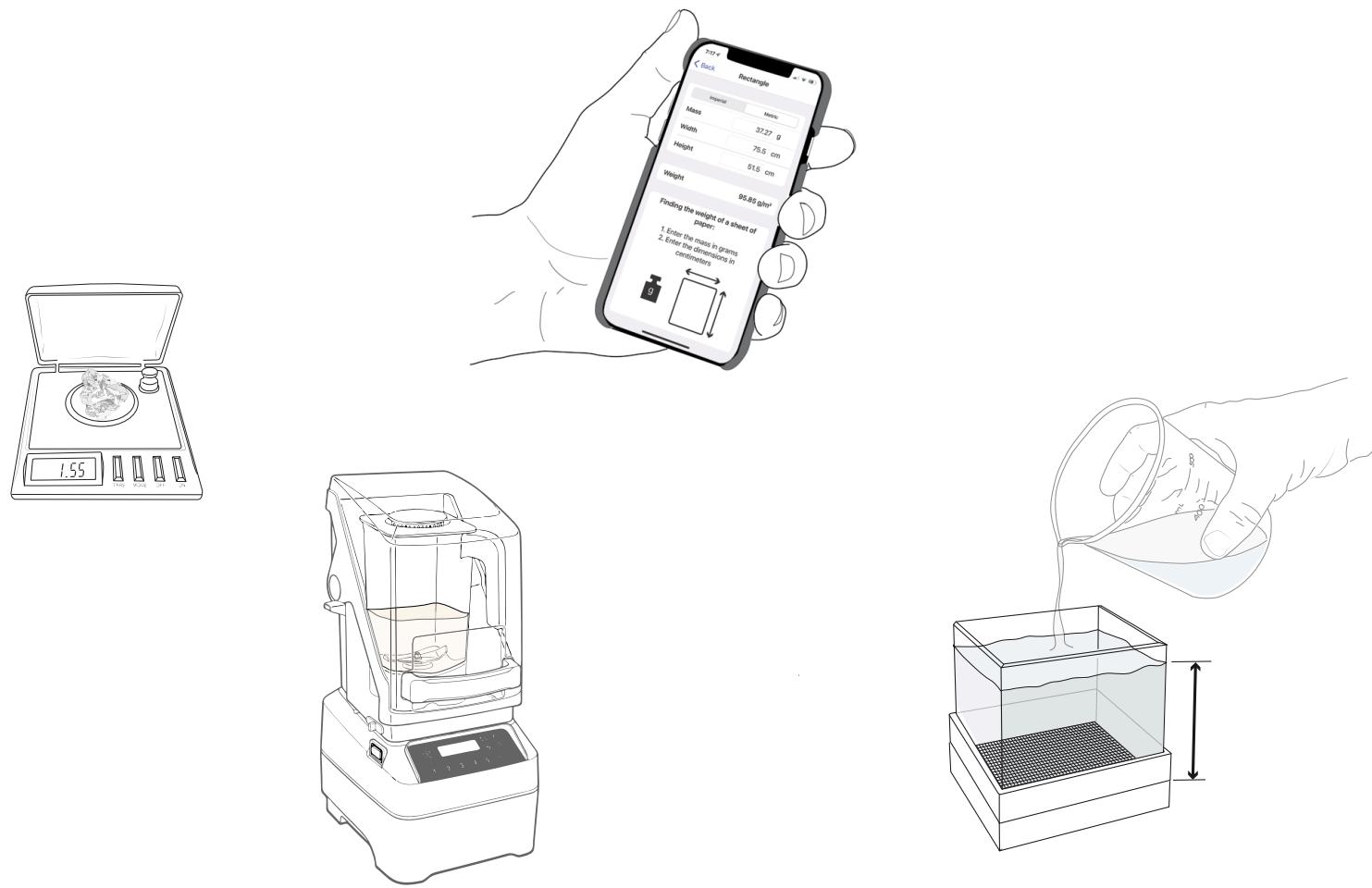
Finally, enter the number of sheets you prefer to make before adding additional furnish; the app displays the volume necessary to make up for the pulp depleted during sheet formation.



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

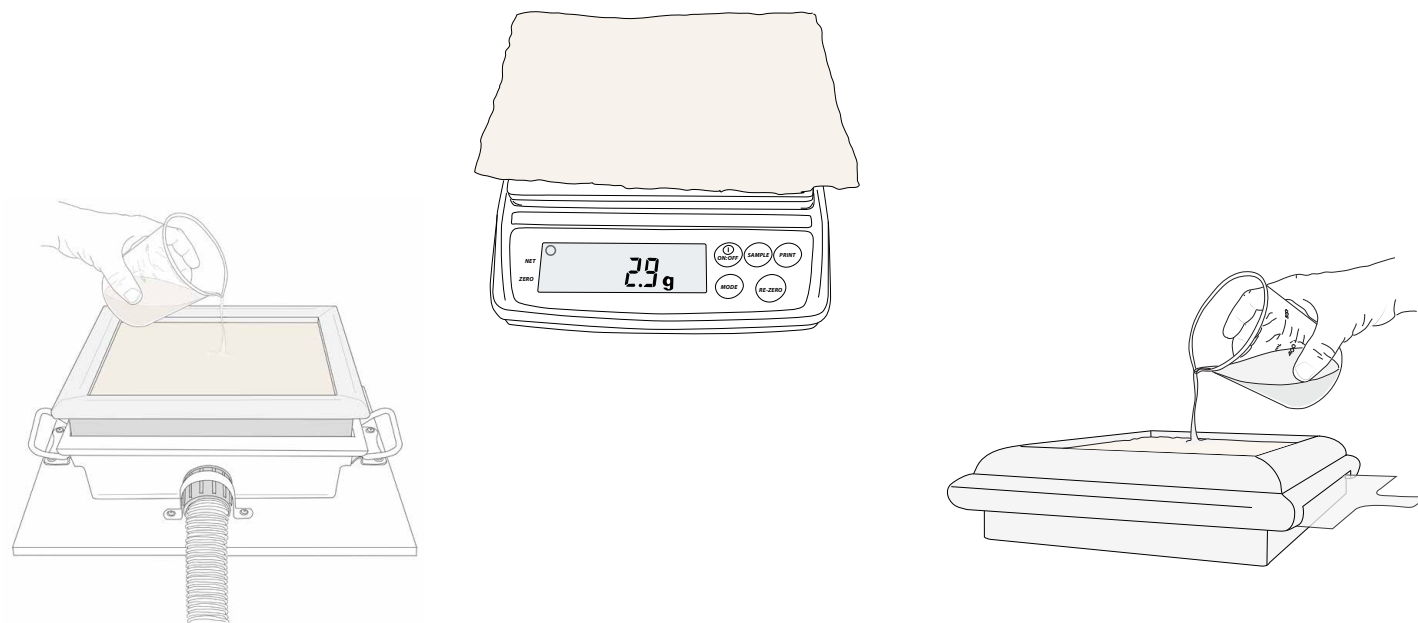
Once made and dry, weigh the sheet (grams) and multiply by two to find the **grams per liter** of the furnish in your stuff chest.





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

*Paper is truly versatile, with each paper run manufactured in a specific density designed to harmonize with a paper's intended purpose. Might the resulting leaves be the repository of important literature? Great art? Bound and later burned for heresy? Are they to be hoarded at the outbreak of a plague for later use in our water closets? Knowing a paper's intended purpose informs the maker who designs its characteristics –weight/density plays a key role, and PaperWeight can offer a helping hand.*



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