Menstruum & Math for Herbalists
by Sharlene Peterson
Common Measurements

**Volume/Liquid**
- 1 oz. is ~ 30 mL
- 2 oz. is ~ 60 mL
- 1000 mL = 1 liter
- 1 liter is ~ 1 quart
- ~35 drops = 1 mL

**Weight/Mass**
- 1 oz. is ~ 28 grams
- 16 oz. = 1 pound
- 1 pound is ~ 454 grams
- 1000 mg = 1 gram
Extraction Ratio $= \text{Concentration of Tincture}$

A commonly used maceration extraction ratio is $1:5 \text{ w/v}$. The first number refers to the weight of herb; the second number refers to the volume of menstruum. A 1:5 ratio means one gram of herb was extracted with 5 mL of menstruum.

An extraction ratio of 1:5 if twice as concentrated as a 1:10 extract.

The label example is from Herb Pharm: Dry herb / menstruum ratio: 1:4.5 which means one gram of herb was extracted with 4.5 mL of menstruum.

Herb Pharm also includes “Extraction rate 158 mg herb per 0.7 mL” but most herbalists just use grams:mL. The extraction rate tells us how much of the dried herb is represented in about a dropperful of tincture (0.7 mL). (158 mg = 0.158 grams)(0.158 : 0.7) (divide both sides by 0.158 and you get about 1:4.5).

If you are preparing a 1:5 tincture and you have 28 grams of dried dandelion root, how many mL of solvent/menstruum will you need?

$$1:5 \ (w/v) (g/mL)$$
$$28:V \ \text{(what is V?)}$$
$$28 \times 5 = 140 \text{ mL}$$

Checking your work: (28:140 reduced = 1:5) (28 goes into 28 once and 28 goes into 140 five times or you may say 28 divided by 28 is one and 140 divided by 28 is five so 1:5)

How many grams of dried herb will you need if you want to use 240 mL (about 8 oz) of solvent/menstruum for a 1:5 tincture?

$$1:5 \ (w/v) (g/mL)$$
$$W:240 \ \text{(what is W?)}$$
$$240 \div \text{by } 5 = 48 \text{ grams}$$

Checking your work: (48:240 reduced is 1:5) (48 divided by 48 is one, 240 divided by 48 is five so 1:5)
What If I Need…?

What if you need to end up with 8 oz/240 mL of finished product?
When making herbs we often lose 20% to 30% menstruum. The herbs, even when carefully strained and pressed will retain menstruum and we also lose a little in spills and evaporation. 48 grams of herb in 240 ml solvent = 1:5 (240/48 = 5)

1:5 (w/v)(g/mL)  
48:240 + 30% (240 times 0.30 (30%) = 72 mL)  
(240 + 72 = 312 mL menstruum)  
Final Ratio = 1:6.5

Adding more menstruum reduces the concentration from 1:5 to 1:6.5  
48:312 = 1:6.5 (48 divided by 48 is one and 312 divided by 48 is 6.5)

If you want or need a 1:5 tincture you will need to adjust the amount of herbs also:

1:5 (w/v)(g/mL)  
W:312 mL (what is W?) 312 divided by 5 = 62.4 grams  
62.4 : 312 reduced = 1:5

It is usually not possible to make a 1:3, 1:2, or 1:1 maceration of dried plant material at home because there won’t be enough menstruum to cover the marc (depending on the degree of absorption of menstruum by the plant material and its expansion).
Choosing Your % Alcohol

**What ethanol percentage should we use?**
What percentage we choose depends on which constituents/plant chemicals we want to extract and plant matrix (delicate, woody, hard root, etc.). In order to preserve a tincture it is best to use a minimum of 25% EtOH.

There are thousands of chemicals in each plant. Through chemistry we can identify and assign actions and properties: berberine is very astringent; artemisinin is antimalarial; absinthins are anti-parasitic, etc. The problem is that the effective historical use of the whole plant is usually dependent upon several constituents acting together - synergy. It may be two, three, or even dozens of plant chemicals working together to get the desired results.

The herbalists of past, including the pharmacists that contributed to the pharmacopeias when herbs were held in high esteem, worked out the best solvents for many medicinal plants based on results. Most results still hold true today.

Herb Pharm was used as an example because they primarily extract based on what was learned from the past and the results they achieve today. Looking at the range of alcohol and other solvents used by Herb Pharm and other reputable companies will help you determine what percentages of alcohol are needed for many different herbs, roots, flowers, and seeds.
<table>
<thead>
<tr>
<th><strong>Low Ethanol (20-40%)</strong></th>
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<tbody>
<tr>
<td>Cleavers ~ 30-35%</td>
<td>Licorice ~ 20-25%</td>
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<tr>
<td>Eleuthero ~ 30-35%</td>
<td>Marshmallow ~ 25-30%</td>
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<tr>
<td>Eyebright ~ 30%</td>
<td>Pau D’arco ~ 25-30%</td>
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<tr>
<td>Ginseng (Panax spp) ~ 20-30%</td>
<td>Red Root ~ 30-40%</td>
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<tr>
<td>Gotu Kola ~ 25-30%</td>
<td>Reishi ~ 20-25%</td>
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<tr>
<td>Green Tea ~ 25-30%</td>
<td>Willow bark ~ 15-20%</td>
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<td>Horsetail ~ 30-35%</td>
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<table>
<thead>
<tr>
<th><strong>Medium Ethanol (40-60%)</strong></th>
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<tbody>
<tr>
<td>Artemisia annua (Sweet Annie) ~ 50-55%</td>
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<tr>
<td>Astragalus ~ 40-45%</td>
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<tr>
<td>Black Walnut ~ 40-45%</td>
</tr>
<tr>
<td>Bladderwrack ~ 40-45%</td>
</tr>
<tr>
<td>Bugleweed ~ 50-60%</td>
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<tr>
<td>Burdock ~ 50-60%</td>
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<tr>
<td>Cat’s Claw ~ 60-65%</td>
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<tr>
<td>Chamomile ~ 50-60%</td>
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<tr>
<td>Cilantro ~ 50-60%</td>
</tr>
<tr>
<td>Cramp Bark ~ 50-55%</td>
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<td>Damiana ~ 55-60%</td>
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Preparing To Make Your Tincture

1. Determine the EtOH percentage needed for the herb(s) you will be using.
2. What volume of tincture will you need? Does it need to be exact? Remember that you will lose 20-30% of volume during processing.
3. Determine if you have enough herbal material for the desired ratio and enough menstruum to make the tincture you want.
Ethanol Percentage

Ethanol = Ethyl alcohol/EtOH

A hydroethanolic solution is water (hydro) and alcohol (ethanol)

The concentration of alcohol in your hydroethanolic solution has nothing to do with the concentration of herbs in your tincture. The ratio (1:5) is about the concentration of herbs within the menstruum. Our menstruum will be a combination of ethanol and water to make a tincture from dry herbs.

Herb Pharm (label example) used organic cane alcohol (54-64%) to make the burdock seed & root tincture. This tells us that the type of ethanol used was made from organic sugar cane, and the menstruum contains 54-64% EtOH and 46-36% water. This company gives a range for proprietary and/or manufacturing purposes.

80 Proof Vodka = 40% alcohol + 60% water
100 Proof Vodka = 50% alcohol + 50% water
190 Proof Everclear = 95% alcohol (use as 100%)

Vodka and Everclear are distilled grain alcohol. Distilled alcohol is gluten-free because if an alcohol is distilled, proteins from the starting materials that provided the starch or sugar are removed in the distillation process.
Alcohol Dilution

You have 50 g of dried horsetail for extraction. For a 1:5, you’ll need total 250 mL of menstruum (50 x 5 = 250). After some research, you decide to use 30% EtOH (0.30 EtOH)

250 mL (total) x 0.30 (30% EtOH) = 75 mL EtOH needed
250 mL - 75 mL EtOH = 175 mL of water is needed (250 – 75 = 175)

Pour the EtOH into your graduated cylinder or beaker up to the 75 mL mark, then add water up to the 250 mL mark

175 water + 75 EtOH = 250 mL menstruum with 30% of the hydroethanolic menstruum as alcohol.

DO NOT USE TAP WATER!
USE REVERSE OSMOSIS, DISTILLED, OR HEAVILY FILTERED
Alcohol Dilution

If you want 250 mL of finished product with a 1:5 concentration and you need a menstruum of 40% alcohol for the extraction where would you start?

1. You will lose 20-30% of menstruum so first add 30% to 250 mL (250 mL x 0.30 = 75 mL)

250 mL + 75 mL = 325 mL of menstruum is needed for at least 250 mL of finished product

2. How many grams of dried herb will you need if you are using 325 mL of menstruum and want a 1:5 concentration?

   1:5 w/v  (grams of herb/mL of menstruum)

   \[ G:325 \]  (325 divided by 5 = 65 grams of dried herb) (65:325 reduced equals 1:5)

3. If you have 80 proof vodka you already have a 40% EtOH and 60% water menstruum.

4. What do you do if you have 190 proof everclear? You will need to dilute the 95% alcohol with water to get 40% alcohol. This is when the Dilution Equation \((C_1)(V_1) = (C_2)(V_2)\) comes in handy!
Dilution Equation

The dilution equation is an easy equation when mixing a hydroethanolic menstrua (alcohol & water). You can only use it to make a menstruum more dilute, not more concentrated.

\[
(C_1)(V_1) = (C_2)(V_2)
\]

C stands for concentration (%) and V stands for volume (mL)

\[
(C_1)(V_1) = (C_2)(V_2)
\]

(Starting) = (Ending)

The “1” refers to what you start with, and the “2” to what you end up with.
Remember to use the same units for C and V (e.g., % and mL)

How much 70% EtOH menstruum can I make if I have 500 mL of 95% EtOH to start with? C1 is 95(%), V1 is 500 (mL) = C2 is 70(%) and V2 is “how much can I make?”

\[
(95)(500) = (70)(V_2)
\]

47,500 = (70)(V_2) - divide both sides by 70 so V2 is alone - V2 = 678.6 (mL)
You can make ~ 679 mL of 70% menstruum from 500 mL of 95% EtOH.
Dilution Equation Example

\[(C_1)(V_1) = (C_2)(V_2)\]
\[(\text{Starting}) = (\text{Ending})\]
C stands for concentration (%) and V stands for volume (mL)

I need 250 mL of a 50% EtOH menstruum. How many mL of 95% EtOH will I need to use to make this?

\[(95)(V_1) = (50)(250)\]
\[(95)(V_1) = 12,500\]
Divide each side by 95 to get \(V_1\) alone = 131.5 mL

Put 131.5 mL of 95% EtOH in a beaker or graduated cylinder and bring it up to the 250 mL mark with water. You now have 250 mL of a 50% EtOH menstruum.

I have 300 mL of 80% EtOH left over from a previous project. How much 65% EtOH can I make from that?

\[(80)(300) = (65)(V_2)\]
\[24,000 = (65)(V_2)\] - divide each side by 65 to isolate \(V_2\) - and \(V_2 = 369\) mL.
I can make 369 mL of 65% EtOH from my leftover menstruum.
Dilution Equation Example

\[(C_1)(V_1) = (C_2)(V_2)\]
(Starting) = (Ending)

C stands for concentration (%) and V stands for volume (mL)

You have 400 mL of 95% EtOH. How many mL of 60% EtOH can you make by diluting that, and how much water will you need to add to do so?

\[(95)(400) = (60)(V_2)\]
\[3800 = (60)(V_2) - divide both sides by 60 to isolate V_2 and V_2 = 633 mL\]

So you can make 633 mL of 60% EtOH from 400 mL of 95% EtOH. Take the 633 mL total fluid minus (-) 400 mL EtOH = 233, so you’ll need to add 233 mL of water to your 400 mL of 95% EtOH to get 633 mL of 60% EtOH. Or, like the previous example, you may add the the 400 mL of EtOH to the beaker and then add enough water to reach 633 mL.

You want to make 500 mL of 35% EtOH menstruum. How much 95% EtOH will you need to start with and how much water will you need to add to it?

\[(95)(V_1) = (35)(500)\]
\[(95)(V_1) = 17,500 - divide both sides by 95 to isolate V_1 and V_1 = 184 mL\]

You will need 184 mL of 95% EtOH to make 500 mL of 35% menstruum. 500 – 184 = 316, so you’ll need to add 316 mL of water to your 184 mL of 95% EtOH to make 500 mL of 35% menstruum.
The ratio of the herb to menstruum determines the concentration of the tincture. A commonly used maceration extraction ratio is 1:5 w/v. The first number refers to the weight of herb; the second number refers to the volume of menstruum. A 1:5 ratio means one gram of herb was extracted with 5 mL of menstruum.

If you are preparing a 1:5 tincture and you have 28 grams of dried dandelion root, how many mL of solvent will you need? 1:5 (w/v) 28:V (what is V?) 28 x 5 = 140 mL

The concentration (%) of alcohol in your hydroethanolic solution (menstruum) has nothing to do with the extraction ratio (1:5 w/v), the concentration of the tincture.

The volume is the how many mL of liquid you are adding to the herbs to extract the desired constituents. In the above example we need 28 grams of herb and 140 mL of solvent/liquid to make an extract that has a 1:5 ratio. The solvent/liquid could be 20 mL of vinegar, 20 mL of water, and 100 mL of 95% alcohol or it could be 140 mL of 80 proof vodka.

Dilution Equation: You must use the same units (e.g. mL, L, %). We typically work with mL and % alcohol. Do not use 80 proof as a concentration and do not use mL on one side of the equation and Liter or quart or pint... on the other. 80 proof vodka is 40% alcohol.

\[(C_1)(V_1) = (C_2)(V_2)\]

C is concentration (%) and V is volume (mL)
Just for Fun

How many mL of a 2.50 M NaOH solution are required to make 525 mL of a 0.150 M NaOH solution?

\[ M_1 V_1 = M_2 V_2 \]

\[
\frac{(2.50 \text{ M})(V_1)}{2.50 \text{ M}} = \frac{(0.150 \text{ M})(525 \text{ mL})}{2.50 \text{ M}}
\]

How many mL of a 95% EtOH solution are required to make 250 mL of a 50% EtOH solution? (I need 250 mL of a 50% EtOH menstruum. How many mL of 95% EtOH will I need to use to make this?)

\[ (95)(V1) = (50)(250) \]
\[ (95)(V1) = 12,500 \]
\[ \text{Divide each side by 95 to get } V_1 \text{ alone = 131.5 mL} \]