# Glossary of Plastic Tooling Terms

**Adhesion** – The state in which two surfaces are held together by interfacial force.

**Coefficient of Thermal Expansion** – The fractional change in length of a material for a unit of change in temperature. Normally expressed in "inch-per-inch, per degree Fahrenheit".

**Compressive Strength** – ½" x ½" x 1" specimen is mounted in a compression-type tester between two heads that exert pressure at a constant rate of movement until the specimen fails by rupturing or deforming to a % of its' height. Normally expressed in "pounds per square inch", this test provides the maximum load sustained, divided by the original area of the specimen.

**Cure** – To change the physical properties of a plastic or resin by chemical reaction, which may be condensation, polymerization, or addition: usually accomplished by the action of either heat or catalyst or both, and with or without pressure.

**Deflection Temperature** – The temperature at which a 5" x ½" x ½" specimen deflects .010 inches under a stated load of 66 or 264 pounds per square inch.

**Density** – Mass per unit volume of a substance, expressed in units such as grams per cubic centimeter, pounds per cubic foot or pounds per gallon.

**Endothermic** – Pertaining to a reaction which is accompanied by the absorption of heat.

**Exothermic** – Pertaining to a reaction which is accompanied by the evolution (giving off) of heat.

**Flexural Modulus** – The ratio, within the elastic limit, of the applied stress on a test specimen in flexure to the corresponding strain in the outermost fibers of the specimen.

**Flexural Strength** – 5" x ½" x ⅛" specimen is placed on supports 4" apart and a standard load is applied to the center of the specimen at a specified rate. The maximum stress in the outer fiber at the moment of crack or break is expressed in "pounds-per-square-inch".

**Glass Transition Temperature (Tg)** – A reversible change that occurs when plastic is heated to a certain temperature range, characterized by a rather sudden transition from a hard, glassy, or brittle condition to a flexible or elastomeric condition.

**Gel Time** – With reference to thermosetting resins, the interval of time between introduction of the catalyst and the formation of a semi-solid system consisting of a network of aggregates in which a liquid is held. The initial jelly-like solid phase that develops during the formation of a resin from a liquid, usually a 4-fluid ounce mass.

**Percentage of Elongation** – Increase in length of a specimen at the instant before rupture occurs. Normally expressed as a percentage.

**Plasticity** – The ability of a material to withstand continuous and permanent deformations by stress exceeding the yield value of the material without rupture. The opposite of elasticity.

**Post-curing** – The process of forming an uncured thermosetting resin article, then completing the curing after the article has been removed from its forming mold or mandrel.

**Pot-life (working life)** – The period during which a compound, after mixing with a catalyst, solvent or other compounding ingredients, remains suitable for its intended use.

**Shore Hardness (Indention Hardness)** – The hardness of a material as determined by either the size of an indention made by an indenting tool under a fixed load, or the load necessary to produce penetration of the indenter to a pre-determined depth. To measure the Shore hardness of a material a Shore testing instrument is used which is comprised of spring-loaded indenter point projecting through a hole in a presser foot and a device to indicate the distance the point projects beyond the face of the foot. The scale readings range from 0 (for 0.100 penetration) to 100 (for zero penetration). A Shore "A" instrument employs a "sharp" indentor point with a load of 822 grams. The Shore "D" instrument employs a "blunt" point and the load is 10 pounds.

**Taber Wear Index** – The ability of a material to withstand mechanical action such as rubbing, scraping or erosion, that tends to progressively remove material from its surface. Usually expressed in milligrams loss per number of cycles per a given load.

**Tensile Modulus** – The ratio of stress to corresponding strain below the proportional limit of the material. Expressed normally in pounds-per-square-inch.

**Tensile Strength** – ⅛" thick x ¾" to ½" wide x 8½" long specimen is inserted in an Instron Tester and is pulled apart at specified rates until the specimen fails by separating. Usually expressed in pounds-per-square-inch.

**Thermoforming** – The process of forming a thermoplastic sheet into a three-dimensional shape by clamping the sheet in a frame, heating it to render it soft and flowable, then applying differential pressure to make the sheet conform to the shape of a mold or die positioned below the frame.

**Thermoplastics** – Resins or plastic compounds which in their final state as finished articles are capable of being repeatedly softened by increased temperature and hardened by decrease of temperature by means of physical change.

**Thermosetting Plastics (thermosets)** – Resins or plastic compounds which in their final state as finished articles are substantially infusible or insoluble. Thermosetting resins are often liquids at some stage in their manufacture or processing, which are cured by heat, catalyst or other chemical means. After being fully cured, thermosets cannot be reliquified by heat.

**Thixotropy** – A flow characteristic evidenced by a decrease in viscosity of a fluid when it is stirred at a constant or increasing rate of shear. When the stirring or shearing is discontinued, the apparent viscosity of the fluid gradually increases back to the original value. Changes in both directions are dependent on time as well as shear.

**Viscosity** – The thickness of a substance and its resistance to flow. The higher the viscosity number, the thicker the substance.

# Metric & English Conversions Table

## Liquid Volume

| When you know | You can find | If you multiply by |
|---|---|---|
| ounces | milliliters | 30 |
| pints | liters | 0.47 |
| quarts | liters | 0.946 |
| gallons | liters | 3.785 |
| milliliters | ounces | 0.034 |
| liters | pints | 2.1 |
| liters | quarts | 1.0567 |
| liters | gallons | 0.2642 |

## Mass

| When you know | You can find | If you multiply by |
|---|---|---|
| ounces | grams | 28.35 |
| pounds | kilograms | 0.4536 |
| short tons (2000 lbs) | metric tons | 0.9 |
| grams | ounces | 0.03527 |
| kilograms | pounds | 2.2046 |
| metric tons (1000 kg) | short tons | 1.1 |

## Length

| When you know | You can find | If you multiply by |
|---|---|---|
| inches | millimeters | 25.4 |
| feet | centimeters | 30.48 |
| yards | meters | 0.9144 |
| miles | kilometers | 1.6093 |
| millimeters | inches | 0.03937 |
| centimeters | inches | 0.39370 |
| meters | yards | 1.0936 |
| kilometers | miles | 0.6214 |

## Area

| When you know | You can find | If you multiply by |
|---|---|---|
| square inches | square centimeters | 6.452 |
| square feet | square meters | 0.0929 |
| square yards | square meters | 0.836 |
| square miles | square kilometers | 2.5899 |
| acres | square hectometers | 0.4 |
| square centimeters | square inches | 0.155 |
| square meters | square yards | 1.196 |
| square kilometers | square miles | 0.3861 |
| square hectometers | acres | 2.5 |

# Reference Tables

## Shore Hardness Guidelines

| Material | Approx. Shore A | Approx. Shore D |
|---|---|---|
| Rubber band, white eraser | 25-30 | – |
| Pink eraser | 35-45 | – |
| Rubber stamp | 40-55 | – |
| Hard eraser, inner tube | 45-65 | – |
| Leather belt, tire tread | 65-75 | – |
| Rubber shoe sole | 75-85 | 25-30 |
| Tap washer, skateboard wheel | 85-95 | 30-40 |
| Garden hose | 95-100 | 40-50 |
| Hard book cover | – | 50-55 |
| Golf ball | – | 55-65 |
| Wood yard stick | – | 70-75 |
| White board | – | 75-80 |
| Bowling ball, bone | – | 85-90 |

## Temperature

| When you know | You can find | If you |
|---|---|---|
| Fahrenheit | Celsius | subtract 32 and then multiply by .55 |
| Celsius | Fahrenheit | multiply by 1.8 and then add 32 |

## Properties of Metal Casting

| | Weight lb./in.$^3$ | Weight vs. Mahogany | Shrink in./ft. | Melt Pt. °F |
|---|---|---|---|---|
| Aluminum | .0975 | 3.1 x | 5/32 | 1,220 |
| Brass | .2961 | 9.5 x | 3/16 | 1,616 |
| Copper | .3210 | 10.1 x | 3/16 | 1,981 |
| Cast Iron | .2670 | 8.5 x | 1/8 | 2,105 |
| Steel | .2835 | 9.5 x | 1/4 | 2,500 |
| Zinc | .2565 | 8.2 x | 5/16 | 788 |

## Viscosity Guidelines

| Viscosity in Centipoise (@ 75°F) | | Similar in consistency to: |
|---|---|---|
| 1 | = | Water |
| 500 | = | #10 Motor Oil |
| 2,500 | = | Pancake Syrup |
| 10,000 | = | Honey |
| 25,000 | = | Chocolate Syrup |
| 50,000 | = | Ketchup |
| 250,000 | = | Peanut Butter |
| >1,000,000 | = | Paste Caulking |

# Fractions, Decimals, Millimeters

| Fractions | Decimals | Millimeters |
|---|---|---|
| 1/64 | .0156 | 0.3969 |
| 1/32 | .0313 | 0.7938 |
| 3/64 | .0469 | 1.1906 |
| 1/16 | .0625 | 1.5875 |
| 5/64 | .0781 | 1.9844 |
| 3/32 | .0938 | 2.3813 |
| 7/64 | .1094 | 2.7781 |
| 1/8 | .125 | 3.1750 |
| 9/64 | 1406 | 3.5719 |
| 5/32 | .1563 | 3.9688 |
| 11/64 | .1719 | 4.3656 |
| 3/16 | .1875 | 4.7625 |
| 13/64 | .2031 | 5.1594 |
| 7/32 | .2188 | 5.5563 |
| 15/64 | .2344 | 5.9531 |
| 1/4 | .250 | 6.3500 |
| 17/64 | .2656 | 6.7469 |
| 9/32 | .2813 | 7.1438 |
| 19/64 | .2969 | 7.5406 |
| 5/16 | .3125 | 7.9375 |
| 21/64 | .3281 | 8.3344 |
| 11/32 | .3438 | 8.7313 |
| 23/64 | .3594 | 9.1281 |
| 3/8 | .375 | 9.5250 |
| 25/64 | .3906 | 9.9219 |
| 13/32 | .4063 | 10.3188 |
| 27/64 | .4219 | 10.7156 |
| 7/16 | .4375 | 11.1125 |
| 29/64 | .4531 | 11.5094 |
| 15/32 | .4688 | 11.9063 |
| 31/64 | .4844 | 12.3031 |
| 1/2 | .500 | 12.7000 |

| Millimeters | Decimals | Fractions |
|---|---|---|
| 13.0969 | .5156 | 33/64 |
| 13.4938 | .5313 | 17/32 |
| 13.8906 | .5469 | 35/64 |
| 14.2875 | .5625 | 9/16 |
| 14.6844 | .5781 | 37/64 |
| 15.0813 | .5938 | 19/32 |
| 15.4781 | .6094 | 39/64 |
| 15.8750 | .625 | 5/8 |
| 16.2719 | .6406 | 41/64 |
| 16.6688 | .6563 | 21/32 |
| 17.0656 | .6719 | 43/64 |
| 17.4625 | .6875 | 11/16 |
| 17.8594 | .7031 | 45/64 |
| 18.2563 | .7188 | 23/32 |
| 18.6531 | .7344 | 47/64 |
| 19.0500 | .750 | 3/4 |
| 19.4469 | .7656 | 49/64 |
| 19.8438 | .7813 | 25/32 |
| 20.2406 | .7969 | 51/64 |
| 20.6375 | .8125 | 13/16 |
| 21.0344 | .8281 | 53/64 |
| 21.4313 | .8438 | 27/32 |
| 21.8281 | .8594 | 55/64 |
| 22.2250 | .875 | 7/8 |
| 22.6219 | .8906 | 57/64 |
| 23.0188 | .9063 | 29/32 |
| 23.4156 | .9219 | 59/64 |
| 23.8125 | .9375 | 15/16 |
| 24.2094 | .9531 | 61/64 |
| 24.6063 | .9688 | 31/32 |
| 25.0031 | .9844 | 63/64 |
| 25.4000 | 1.000 | 1 |

# Preparing Patterns and Molds

## Sealing A Wood Pattern/Model

(also applies to plaster and sheet wax)

1. Apply one coat of Freeman Wood and Plaster Sealer (a fairly thin viscosity, lacquer-based paint) to the bare wood surface using a pure bristle brush and allow the material to absorb into the wood.
2. After the first coat has dried (about half an hour), you'll notice that the sealer has swelled the grain and made it rough. Using sand paper or Scotch-Brite®, lightly sand the surface to make it smooth again. Sanding is not necessary when working with plaster or sheet wax.
3. Wipe off the pattern with a cloth and then apply a second coat of sealer.
4. After allowing the second coat to dry overnight, lightly sand the wood again and wipe it off with a cloth.
5. You are now ready to apply the release agents.

## Applying Release Agents


1. Cover the entire surface with Freeman Wax Release (a semi-paste, typically applied with a brush).
2. Allow this coat to dry or immediately wipe the off excess with a cloth.
3. We suggest at least two coats of Wax Release to make sure your entire part is covered evenly.
4. Next, you'll need to apply two layers of Partall PVA mold release (a polyvinyl alcohol) with brush or a spray.
5. Each coat will require a half hour of drying time unless you use a fan or air hose.
6. After the second coat of PVA has dried thoroughly, apply a final coat of Freeman Wax Release.
7. Buff this last coat very gently so as not to break through the layers of the PVA.

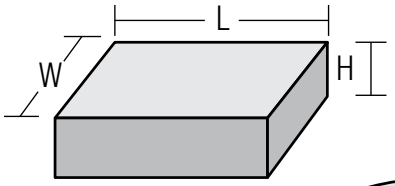
### Additional Notes

- Epoxy, urethane, or metal patterns require only the use of wax release agents. Apply three coats and lightly buff after each.
- Plaster patterns should be dried in an air-circulating oven at 120°-125° F for 16 hours, or in dry air for 48 hours before applying sealer.
- Plaster patterns can also be sealed.
- Sheet Wax should be seated with aerosol version.

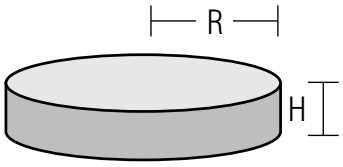
# Calculating Material Requirements

## Step 1

Calculate the volume of the part (or mold) in cubic inches. Follow whichever shape is closest to your model or mold:




**Volume of a Rectangle**
L x W x H




**Volume of a Cylinder**
R x R x H x 3.14

## Step 2

Find the volumetric yield for your material. This number, which can be found in most specification tables, represents how much coverage your material will achieve. If the Volumetric Yield is not available, you can calculate it based on the specific gravity (density).

1. Find the specific gravity (or density) on the specification table and/or SDS. This is measured in grams per cubic centimeter (grams/cm$^3$).
2. Divide 27.68 by the density (grams/cm$^3$) to calculate the Volumetric Yield (in.$^3$/lb.).

## Step 3

Divide the volume of the part in cubic inches (step 2) by the volumetric yield (step 1) to determine the amount of material required in pounds

$$\frac{\text{Volume of Model or Mold (in.}^3\text{)}}{\text{Volumetric Yield (in.}^3\text{/lb.)}} = \text{Weight of Product Required (lb.)}$$

## Step 4

Select package size and quantity based on calculated weight.

# Calculating Material for Mix Ratio

Once you know how much material you need and the product's mix ratio (found on the TDS or product packaging), you may need to calculate the mix ratio for a specific weight of A & B combined. Let's use an example.

Say a product's mix ratio is 100:60 by weight and you need 1,438 grams total.

### Calculate the above equation to determine the pounds needed

You will need 3.17 lb. for a pour. This equals 1,438 grams (ounces x 28.35 = grams).

### Determine ratio multiplier

The 1.6 factor is the multiplier to work out the resin based on the total amount of resin required. Calculated from the mix ratio 100:60 meaning if you have 100 parts resin you will need 60 parts hardener. 160 divided by 100 = 1.6.

### Determine how much of each resin and hardener to mix

Take the total weight (in grams) needed of mixed resin and divide by your ratio multiplier:
1,438 / 1.6 = 898.75 g resin, therefore the hardener is 539.25 g (1,438 - 898.75).
So you would now pour 898.75 g resin and 539.25 g hardener.

### Poured too much on one side? Calculate for the other side

If you accidentally over-pour by 30 grams on the resin side, multiply 30 x 1.6 (the mix ratio multiplier) and you get 48. You would add 18 grams of hardener (48-30=18).

### Still not sure?

Our Technical staff is available to answer any question, large or small, via phone at (800) 321-8511 opt. 5 or via email at tech@freemansupply.com.

# Alphabetical Product Listings

# F



# G



# H



# I



# J



# K



# L



# M



# N



# O



# P

# Q



# R



# S



# T



# U



# V



# W



# X

None

# Z



# Appendix

# My Favorite Products

| SKU | Name | Page # |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

# Did You Know...

## ...Freeman's website is constantly upgraded with new features?

Since we've unveiled our revamped website, we've added features such as a favorites list, quote builder, interactive closeout list, web discounts, quotes/order history, and more!

**Now, you can get all of that and more with a Freeman 360° Account!** Make sure to keep checking back – we're always adding new features to make your experience hassle-free.

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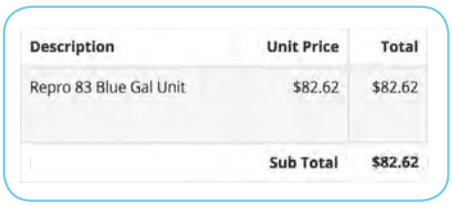
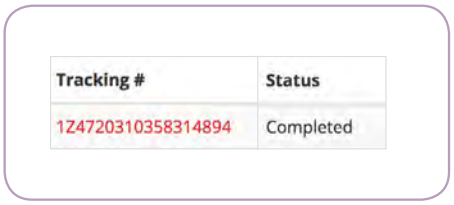


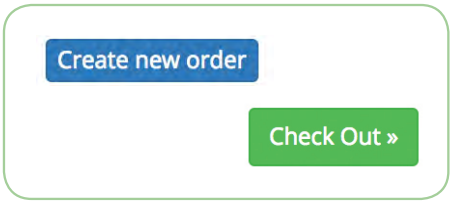
| Description | Unit Price | Total |
|---|---|---|
| Repro 83 Blue Gal Unit | $82.62 | $82.62 |
| | Sub Total | $82.62 |

*Complete access to product pricing*



| Tracking # | Status |
|---|---|
| 1Z4720310358314894 | Completed |

*Keep track of your order from start to finish*

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**Your Tech Team:** Available 8-5 M-F

**Phone:** (800) 321-8511 opt. 5

**Email:** tech@freemansupply.com

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