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 in./in./°F.

Compressive Strength – A material's ability to withstand being crushed or squeezed under load. Often expressed in lb./in.^{2}, the compressive strength is the maximum amount of compressive stress a material can handle before permanently deforming.

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 material will deform under a given load.

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.
Density = Mass / Volume

Elasticity – A material's ability to return to its original shape after deformed by applied force or stress.

Endothermic – A chemical reaction which absorbs heat.

Exothermic – A chemical reaction which generates heat.

Flexural Modulus – A representation of the stiffness of a given material. Expressed as a ratio of stress to strain in bending, the flexural modulus measures how much a material is capable of bending prior to breaking.

Flexural Strength – Also known as "bend strength", this is a measure of a material's ability to resist bending under stress.

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 the mixing of a two-component system and when the material ceases to flow. The system will exhibit a semi-solid/gel-like quality at this point.

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

Plasticity – A material's ability to undergo permanent and irreversible deformation under stress without breaking. The opposite of elasticity.

Post-curing – A secondary curing process in which a material is subjected to elevated heat after initial cure in mold at room temperature in order to further enhance its properties.

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. Softer materials/more flexible materials are measured using the Shore A scale, and harder/more rigid materials are measured using the Shore D scale.

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 – A representation of the stiffness of a given material. Expressed as a ratio of stress to strain under tensile/compressive stress, the tensile modulus measures how much a material is capable of being pulled prior to breaking.

Tensile Strength – A material's ability to resist being stretched or pulled before breaking.

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 – The property of becoming less viscous when subjected to applied stress, such as stirring or shaking.

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

METRIC & ENGLISH CONVERSIONS

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

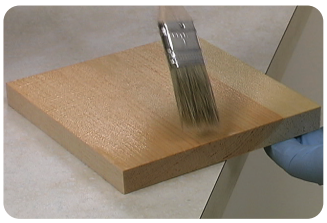
FRACTIONS, DECIMALS, MILLIMETERS

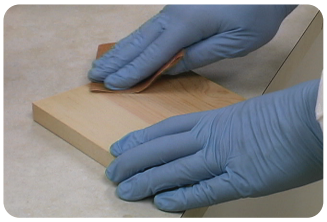
1/64	0.0156"	0.3969 mm
1/32	0.0313"	0.7938 mm
3/64	0.0469"	1.1906 mm
1/16	0.0625"	1.5875 mm
5/64	0.0781"	1.9844 mm
3/32	0.0938"	2.3813 mm
7/64	0.1094"	2.7781 mm
1/8	0.1250"	3.1750 mm
9/64	0.1406"	3.5719 mm
5/32	0.1563"	3.9688 mm
11/64	0.1719"	4.3656 mm
3/16	0.1875"	4.7625 mm
13/64	0.2031"	5.1594 mm
7/32	0.2188"	5.5563 mm
15/64	0.2344"	5.9531 mm
1/4	0.2500"	6.3500 mm
17/64	0.2656"	6.7469 mm
9/32	0.2813"	7.1438 mm
19/64	0.2969"	7.5406 mm
5/16	0.3125"	7.9375 mm
21/64	0.3281"	8.3344 mm
11/32	0.3438"	8.7313 mm
23/64	0.3594"	9.1281 mm
3/8	0.3750"	9.5250 mm
25/64	0.3906"	9.9219 mm
13/32	0.4063"	10.3188 mm
27/64	0.4219"	10.7156 mm
7/16	0.4375"	11.1125 mm
29/64	0.4531"	11.5094 mm
15/32	0.4688"	11.9063 mm
31/64	0.4844"	12.3031 mm
1/2	0.5000"	12.7000 mm

13.0969 mm	0.5156"	33/64
13.4938 mm	0.5313"	17/32
13.8906 mm	0.5469"	35/64
14.2875 mm	0.5625"	9/16
14.6844 mm	0.5781"	37/64
15.0813 mm	0.5938"	19/32
15.4781 mm	0.6094"	39/64
15.8750 mm	0.6250"	5/8
16.2719 mm	0.6406"	41/64
16.6688 mm	0.6563"	21/32
17.0656 mm	0.6719"	43/64
17.4625 mm	0.6875"	11/16
17.8594 mm	0.7031"	45/64
18.2563 mm	0.7188"	23/32
18.6531 mm	0.7344"	47/64
19.0500 mm	0.7500"	3/4
19.4469 mm	0.7656"	48/64
19.8436 mm	0.7813"	25/32
20.2406 mm	0.7969"	51/64
20.6375 mm	0.8125"	13/16
21.0344 mm	0.8281"	53/64
21.4313 mm	0.8438"	27/32
21.8281 mm	0.8594"	55/64
22.2250 mm	0.8750"	7/8
22.6219 mm	0.8906"	57/64
23.0188 mm	0.9063"	29/32
23.4156 mm	0.9219"	59/64
23.8125 mm	0.9375"	15/16
24.2094 mm	0.9531"	61/64
24.6063 mm	0.9688"	31/32
25.0031 mm	0.9844"	63/64
25.4000 mm	1.0000"	1

PREPARING PATTERNS AND MOLDS

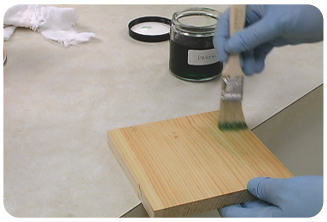
Sealing A Wood Pattern/Model
(also applies to plaster and sheet wax)





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, 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



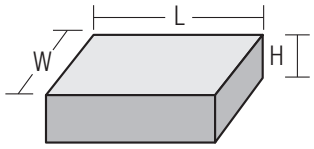
1. Cover the entire surface with Freeman Wax Release (a semi-paste, typically applied with a brush).
2. Immediately buff coat lightly to remove excess.
3. We suggest at least two coats of Wax Release following the above process to make sure your entire part is covered evenly.
4. Next, you'll need to 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

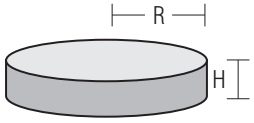
- Epoxy, urethane, or metal patterns require only the use of wax release agents. Apply three coats and lightly buff after each.
- Plaster patterns should be dried in an air-circulating oven at 120°-125° F for 16 hours, or in dry air for 48 hours before applying sealer.
- Plaster patterns can also be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

CALCULATING MATERIAL REQUIREMENTS

Step 1: Calculate Volume
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
3.14 x R^2 x H

Step 2: Find Volumetric Yield
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).

How to Calculate Volumetric Yield if needed
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.).

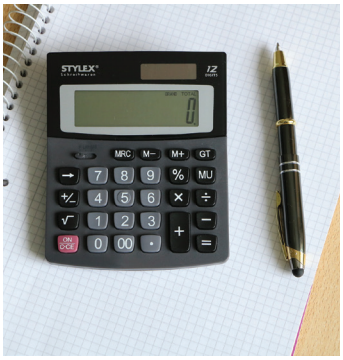
Step 3: Determine Material Required
Divide the volume of the part in cubic inches (step 2) by the volumetric yield (step 1) to determine the amount of material required in pounds

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

Step 4: Select Product
Select package size and quantity based on calculated weight.

CALCULATING MATERIAL FOR MIX RATIO

Once you know how much material you need in grams (lbs. x 453.6) and the product's mix ratio (found on the TDS or product packaging), you can calculate the material needed for each A & B (resin/hardener) components. Let's use an example.



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

Calculate total parts of resin and hardener combined.
Calculate total parts: 100 parts Resin to 60 parts Hardener = 160 parts total.

Calculate total grams need per part.
Divide total grams by total parts; 1,438 grams / 160 parts = 8.9875 grams/parts

Calculate grams need for each component of resin & hardener.
100 Parts Resin
100 x 8.9875 = 898.75 Grams
60 Parts Hardener
60 x 8.9875 = 539.25 Grams

You will need 898.75 Grams of Resin and 539.25 Grams of Hardener.

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

G

H

I

J

K

L

M

N

O

P

Resources

Terms & Conditions

Returned Goods
To save transportation charges, and facilitate handling of merchandise upon our receipt, we request that no merchandise be returned without prior written authorization.

Damaged Goods
Merchandise given to a transportation firm is their responsibility to deliver in satisfactory condition. If merchandise is delivered damaged, the customer should note as such on freight bill and file a claim with the delivering carrier. Regulations require that hidden damage, identified upon unpacking, must be reported within ten (10) days of delivery in order to file a proper claim.

Liability/Warranty Statement
Our products are intended for sale to industrial and commercial customers. We request that customers inspect and test our products before use and satisfy themselves as to contents and suitability. Nothing herein shall constitute a warranty, expressed or implied, including any warranty or merchantability or fitness, nor is protection from any law of patent to be inferred. All patent rights are reserved. The exclusive remedy for all proven claims is replacement of our materials and in no event shall we be liable for special, incidental, or consequential damages.