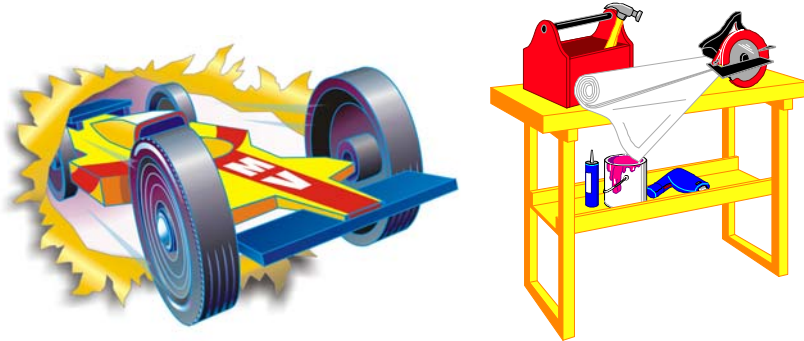


# Maximum Velocity!®



## **Free** Pine Derby Car Plan

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## **Free** Pine Derby Car Plan

*Published and Distributed by:*

**Maximum Velocity, Inc**

**info@maximum-velocity.com**  
**www.maximum-velocity.com**

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### **Important Printing Information**

While the booklet is open, use the File > Print command of Adobe Acrobat Reader (not the shortcut on the toolbar) and make sure the 'Fit to page' 'Shrink' or 'Expand' options are NOT selected. This ensures that the templates are printed to scale.

This booklet has some complex drawings that can overwhelm some laser printers equipped with small amounts of printer memory. If the printer does not successfully print the booklet, try the following:

- Using the printer's print properties, reduce the number of dots per inch (dpi) from 600 to 300 and try to print the booklet again. This usually resolves the problem.
- If a problem still occurs, leave the printer setting at 300 dpi and print one page at a time.
- Try printing on another printer, especially an inkjet printer.

### **Axle Slot Measurement**

The standard wheelbase templates in this booklet use the official measurements from the Cub Scout Derby - Grand Prix Pinewood Derby® Kit. However, the position of the axle slots in these kits (and kits from other manufacturers) are not always consistent with the official measurement.

If the slots on your block do not exactly match the slots on the template, line up the front axle slots and trace the front portion of the template, then line up the rear axle slots and trace the remainder of the template.

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# Maximum Velocity!

## Free Pine Derby Car Plan

### Introduction

Welcome to the world of Pine Derby racing! This booklet provides you with a plan for building a basic Pine Derby car.

The plan in this booklet provides for best weighting and weight location. However, to build a car that reaches *Maximum Velocity!* you must also prepare the wheels and axles, and lubricate and align the wheels. If you don't know how to do these steps, detailed information is provided in the companion booklet, "*Maximum Velocity - Speed to the Finish!*"

To reach *Maximum Velocity!*, you must fully understand the car building process, and allow enough time to build the car. Please read this entire booklet, and understand the plans *before* starting to build the car. Also, *follow the steps in order*. The sequence of construction was chosen based on actual experience from building the car.

The plan in this booklet is organized very similar to the car plans in our other booklets. The differences are as follows:

- This booklet contains the plan for 1 car. Our other booklets have plans for 3 cars.
- The plan in this booklet can be used to build a car with the standard (scouting) wheelbase. The plans in our other booklets (with a few exceptions) support the standard wheelbase and the extended wheelbase.
- A few informational sections contained in our other booklets have not been included in this free booklet. However, they do not affect the ability to build the car.

*Maximum Velocity!*

Visit us at: [www.maximum-velocity.com](http://www.maximum-velocity.com)

- |                            |                          |
|----------------------------|--------------------------|
| • Car Plan Booklets        | • Speed Supplies         |
| • Lead and Tungsten Weight | • Speed Wheels and Axles |
| • Decals                   | • Wood blocks and kits   |
| • Specialty Tools          | • Display and Cases      |

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### Tools and Supplies

**I**n order to build the car in this booklet, you must have access to the tools and supplies listed below.

- 3/8 inch lead wire or Tungsten Composite Lead Replacement Weight (*available from [www.maximum-velocity.com](http://www.maximum-velocity.com)*)
- Pencil
- Ruler
- Saw - A Back saw, Hack Saw, or Coping saw all work well for making the major cut. A Hack Saw is best for creating the triangular detail.
- Cutting tool capable of cutting lead - Diagonal Cutters work well
- Drill - An electric hand drill is fine. A drill press is like heaven on earth!
- 25/64 inch (for lead wire) or 7/16 inch (for Tungsten Composite) drill bit (*Brad Point, Forstner, or equivalent*)
- Clamp or vise - To hold the wood block when drilling and cutting
- Particle mask and eye protection
- Sanding block
- Sandpaper - 60, 150, 240, 400, and 600 grit
- Masking tape
- Paint Supplies
  - ⇒ One 2-1/2" or longer dry-wall screw (to insert into the body as a handle for painting) (*Hardware store item*)
  - ⇒ Clothes pin or binder clip - To hang up the car while drying
  - ⇒ Sanding sealer or wood primer (*Optional*)
- If spray painting (*suggested for older builders*):
  - ⇒ Spray paint - Lacquer works best - avoid enamel paint
  - ⇒ Plastic bag - Large enough to cover your hand and wrist
  - ⇒ Rubber band - To hold the plastic bag to your wrist
- If brush painting (*suggested for younger builders*):
  - ⇒ Paint - Acrylic paint is suggested as it cleans up with water
  - ⇒ Paint brush (*1 to 2" wide*)
- Hot glue or Epoxy - 5 minute variety
- Toothpicks - To mix and apply the epoxy
- Wood Filler (*hardware store item*)

## Important Safety Information

To minimize the risk of injury, follow these rules:

1. **Protect your eyes** - Always wear eye protection.
2. **Protect your lungs** - Wear a mask when drilling, sawing, sanding, and spray painting.
3. **Protect your hands** - Be careful with sharp cutting edges. Treat them with respect.
4. **Be safe when using a drill** - To avoid serious injury, tie up long hair and avoid loose clothing when drilling.
5. **Be careful with lead<sup>1</sup>** - With long exposure and when ingested, lead is toxic. Therefore:
  - Wash your hands after handling lead.
  - Keep lead away from food, water, and food preparation areas.
  - Collect and properly dispose of any lead pieces.
  - Avoid melting or sanding lead.

## Wheel Bases

The car plan in this booklet supports wheel bases (distance between the front and rear axles - see Figure 1) as follows:

- **Standard Wheel Base: Supported** - Scouting kits have this wheel base. One pre-cut axle slot is closer to the end of the car than the other. *The slot closer to the end is used for the rear axle.*
- **Extended Wheel Base: Not Supported** in this free booklet.
- **Centered Wheel Base: Not Supported** - Awana kits have this wheel base. To use these plans you must purchase a block with a standard wheel base.

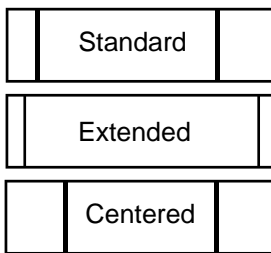


FIGURE 1  
Wheel Bases

## THE WEDGE TURBO

THE WEDGE TURBO (Figure 2) is a relatively easy car to build, as it requires a minimal number of tools and woodworking skills. Three ounces of weight are required for THE WEDGE TURBO. Most of the weight is inserted into holes drilled into the back of the car, while a small portion of weight is placed under the car. This underbody weight will be adjusted at the weigh-in, bringing the car to exactly 5 ounces.

### Step by Step Plans for THE WEDGE TURBO

#### Marking the Block

1. Locate and remove the templates from the booklet. *Make a copy of the templates onto cardstock and use the copy not the original.*
2. Write “Back” on the end of the block closest to an axle slot. Then write “Right” on the right side of the block.
3. Perform the steps under “Preparing Axle Slots” on page 8.
4. Cut out template W2 on the *solid lines*. Place W2 on the right side of the block, making sure that the bottom and back of the drawing are aligned with the bottom and back of the block. Trace the outline on the block.
5. Turn template W2 over to the blank side and place it on the left side of the block. Make sure that the bottom and back of the drawing are aligned with the bottom and back of the block. Trace the outline and remove the template.
6. Cut out template W3. Place W3 on the bottom of the block, making sure that the rear of the template is at the rear of the block. Mark the center of the lead holes by pushing a pencil tip through the template into the wood. Remove the template.
7. Cut out template W4. Place W4 on the back of the block, making sure that the bottom of the template is aligned with the bottom of the block. Mark the center of the two lead holes by pushing a pencil tip through the template into the wood. Trace the top line and remove the template.



FIGURE 2

THE WEDGE TURBO

#### Cutting the Weight

1. Using the cutters, cut the lead wire or Tungsten Composite as follows:
  - ⇒ Two: 1-5/8” pieces
  - ⇒ Two: 1/4” pieces
2. If you are using lead, and lead pieces are bent, reshape them as needed by tapping the lead segments with a hammer on a hard surface (concrete

<sup>1</sup>As an alternate to lead, use Tungsten Composite Lead Replacement weight. Do not use steel or zinc weight, as these products are not dense enough to allow the car to reach the maximum weight.

floor).

### Drilling the Block

1. Clamp the wood block with the back facing upwards. Mark a depth of 1-7/8 inch on the 25/64 inch drill bit (7/16 inch bit if using Tungsten Composite) with masking tape (see Figure 3). *Measure the distance from the outside tips of the bit, not from the center tip.*
2. Drill the two rear lead holes. Make sure that both of the holes are parallel with the wood block, and are drilled no deeper than the tape on the drill bit.
3. Clamp the wood block with the bottom facing upward. Mark a depth of 3/8" on the drill bit with masking tape.
4. Drill the bottom lead holes. Make sure that the holes are drilled no deeper than the tape on the drill bit

### Inserting Weight in the Rear Holes

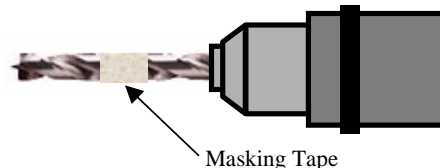
1. Insert glue into one of the rear weight holes
2. Insert a 1-5/8" piece of weight into one of the rear lead holes. Push the weight in as far as possible.
3. Repeat steps 1 and 2 for the other rear lead hole.
4. Allow the glue to dry.
5. Fill the remainder of the two rear holes with wood filler.

### Cutting the Block

1. Clamp the wood block in place.
2. Using the drawing on the right and left sides, cut along the diagonal line, leaving no more than 1/16" of material outside of the line. ***Make sure the cut is outside the line.*** Save the scrap piece of wood for later use.
3. Use the 60 grit sandpaper to sand the newly cut surface down to the line, and to remove the remainder of the dowel rod on the back of the car.
4. Shape the curve on the front of the car with the sandpaper.

### Creating the Triangular Detail

1. Cut template W2 on the *dashed line*.



**FIGURE 3**  
Marking the Drill Bit for Depth

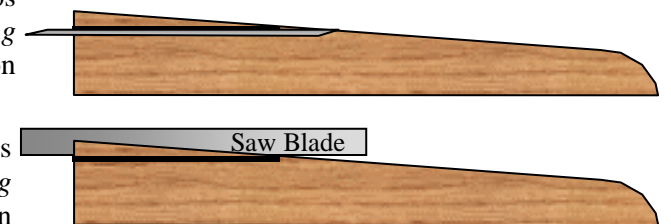
2. Place W2 on the right side of the block, making sure that the bottom and back of the drawing are aligned with the bottom and back of the block. Trace the newly cut line on the block.
3. Turn template W2 over to the blank side and place it on the left side of the block. Make sure that the bottom and back of the drawing are aligned with the bottom and back of the block. Trace the newly cut line.
4. Cut out template W1 on the *solid lines*.
5. Place template W1 on the top of the block, making sure that the back of the template aligns with the back of the block (see Figure 4). Trace the outline and remove the template.
6. Clamp the wood block in place with the top facing upwards.
7. Place the Hack Saw blade on the line on the right side of the car. Holding the blade parallel with the line on the top of the car, cut until the saw blade is even with the line on the top of the car (see Figure 5).
8. Place the saw blade on the right-side line on the top of the car. Holding the blade parallel with the line on the side of the car, cut down until the blade reaches the previous cut.
9. Repeat the previous steps for the left-side triangular detail.
10. Finishing shaping the triangular area using 120 grit sandpaper. Wrap the sandpaper around a piece of wood with a square edge (the wedge-shaped scrap piece of wood is fine) to help shape the area.
11. It is not necessary to remove all gouges as they will be filled with wood putty.



**FIGURE 4**  
Placement of Template W1

### Sanding, Detailing, and Painting

1. Follow the steps under "Sanding the Car Body" on page 9.
2. Follow the steps under "Painting the Car Body" on page 9.



**FIGURE 5**  
Cutting the Triangular Detail

3. To create a two-tone paint job, do the following:
  - Paint the entire car with the base color.
  - Use masking tape and paper to mask off the areas you do not wish to paint with the accent color.
  - Paint the exposed area with the accent color.
  - When dry, remove the masking tape. Any tape residue can be removed with a clean piece of masking tape.
4. The stripes and stars on the example car were created with 1/4 inch pinstriping. A set of 1/4 inch stars is included on the template.

### **Finishing the Car Body**

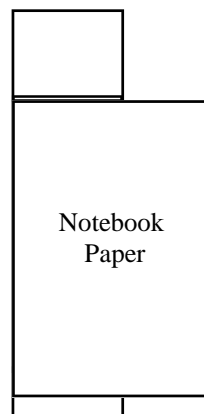
1. Remove the screw and lay the car on its back on a clean rag.
2. Apply any desired decals, pinstriping, personalized painting, etc.
3. Attach car numbers (if required for your race).
4. Weigh the car body, the wheels and the axles. Determine the amount of weight needed to make the car weigh 5 ounces. Re-cut the weight as needed to fit in the bottom holes.
5. Glue the weights into the bottom holes using epoxy or hot glue.
6. Complete the car as described under “*Completing The Car*” on page 10.
7. Store the car until the weigh-in. See page 11 for weigh-in instructions.

***Congratulations! You have built THE WEDGE TURBO.***

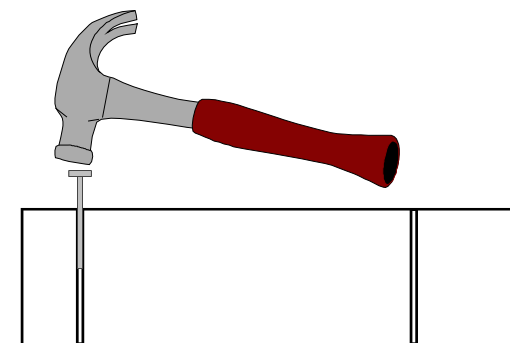
### **Preparing Axle Slots**

**B**efore beginning construction, perform the following steps to prepare your axle slots.

1. Use a piece of notebook paper (or a square if you have one) to check if the slots are square with the car body (see Figure 6). If a slot is not perfectly square with the body, either re-cut the axle slots on the opposite side of the car (use “*Cutting New Axle Slots*” on page 19 as a guide), exchange the car kit for a new car kit, or purchase a new block at a hobby store.
2. Sometimes the wood block will split when the axles are inserted into the axle slots. To prevent this from occurring after you have built the car, place the block on its side, insert an axle, and use a hammer to *gently* tap the axle into one slot (see Figure 7). Pull the axle back out of the slot by hand (or with a pair of pliers), and repeat the process for the other three slot positions. If the wood block splits, exchange the car kit, or purchase a new block at a hobby store. ***If you have nail-type axles, do not insert the axles into the wheels until after the axles are prepared. The burrs on the axles can permanently damage the wheel hubs.***
3. A more accurate way to prepare the axles slots is to drill pilot holes into the slots. This can be done with a drill press, or with a hand drill using the Pro-Body Tool offered at Maximum Velocity.



**FIGURE 6**  
Checking for Square Axle Slots



**FIGURE 7**  
Pre-inserting Axles to Check for Splitting

## Sanding the Car Body

**P**erform the following steps to sand the car body:

1. Fill any gouges, holes, etc. with wood putty.
2. Allow the wood putty to dry before continuing.
3. Sand the entire car with 150 grit sandpaper. To smooth in the triangular cut-outs, wrap the sandpaper around the edge of the scrap piece of wood.
4. Re-sand all sides with the 240 and 400 grit sandpaper.
5. Lightly sand all edges of the car to remove the sharp corners.
6. Use a rag to wipe off all excess wood dust, and remove any wood dust in the axle slots/holes.

## Painting the Car Body

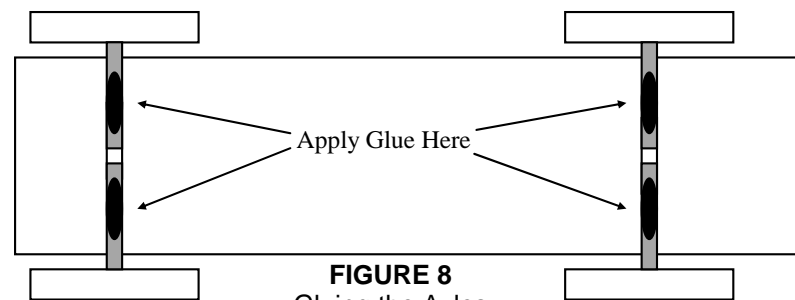
**P**erform the following steps to paint the car body:

1. Insert the 2-1/2" screw at an angle into the side of the bottom lead well hole about 1/4" (Be careful, don't go all the way through the car!). This screw is used to hold the car while painting, and while drying.
2. If desired, apply one or more coats of sealer/primer per the recommendation on the container. Lightly sand with 600 grit sandpaper between coats.
3. Apply a coat of paint. If spray painting, put the plastic bag over one hand and secure it with a rubber band around the wrist. In an area free of wind and dust, attach the clothes pin or binder clip to the screw and hang the car up to dry (We use a short piece of wire between two shelves in the garage as a 'Car Line'). Allow the car to dry.
4. Using the 600 grit sandpaper, *gently* sand all surfaces of the car.
5. Repeat steps 3 to 4 until you are satisfied with the paint job. Don't sand the car the last time!

## Completing The Car

**N**ow that the car body is finished, it is time to complete the car. Note that steps 1 and 2 below can be performed while the glue and/or paint is drying on the car. If you are not sure how to perform any of the steps below, please refer to the companion booklet "*Maximum Velocity - Speed to the Finish!*"

1. Prepare the wheels and axles
2. Apply Lubrication
3. **Axle Slots Only** - Press the axles into the axle slots with your hand, or use pliers to twist them into the slots.
4. **Axle Holes Only** - Insert the axles into the axle holes. If the axles do not fit tightly, then a tiny amount of glue can be placed into the hole with a toothpick before inserting the axle. ***Before inserting the axle, wipe off any glue that got on the body!***
5. Align Wheels
6. **Axle Slots Only** - To keep the axles from becoming misaligned during the race, place glue in the axle slots on top of the axles (see Figure 8). Use epoxy, hot glue, white glue, or a similar product. ***Keep the glue away from the wheels!*** Remove excess glue, making sure that the glue does not hang down below the car, reducing the clearance to less than 3/8". Set the car on its back to dry for 24 hours.



**FIGURE 8**  
Gluing the Axles

### ***Important!***

Apply glue to the axles at least 24 hours before the weigh-in. If the glue is not dry, the wheels could become misaligned during the weigh-in and staging/storage process. Do not use a thin glue such as super glue. The glue may run down the axle and into the wheels, causing the wheels to become glued to the axles.

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## The Weigh-In

At the weigh-in, the weight of the car must be adjusted to equal 5 ounces. Along with your car, bring the following materials to the weigh-in:

- Drill and 3/16" drill bit
- 2 clean rags
- Additional weight
- Hot glue or epoxy.

Use the scale at the weigh-in to determine the weight of your car.

### ***If the Car is Overweight***

1. Lay the car on its back on a clean rag.
2. Hold on to the car very tightly with your hand, and slowly drill out a small portion of the lead weights on the bottom of the car. Try to remove an equal amount of lead from each weight.
3. Re-weigh the car.
4. Repeat the previous steps until the car weighs 5 ounces.

### ***If the Car is Underweight***

1. Glue additional weight into one or more of the bottom holes.
2. Re-weigh the car.
3. Repeat the previous steps until the car weighs 5 ounces.

***When the car is properly weighted, remove any debris, and turn it in.***

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## Specialty Tools and Supplies

Specialty tools and supplies can help your car reach *Maximum Velocity!* Here are our favorite products, all of which are available at:

[www.maximum-velocity.com](http://www.maximum-velocity.com)

**Axle Polishing Kit** - Take the guess work out of axle polishing! This set of industrial grade cushioned abrasive papers is designed for polishing metal to a high shine, and is thus ideal for polishing pine derby axles. The kit consists of five papers ranging from 30 micron to 3 micron (finer than pumice). One set of axle polishing papers will polish 8 axles.

**Max-V-Lube Graphite** - A top quality graphite containing molybdenum. This is the lube of choice of most pine derby champions.

**Pro-Axle Guide** - Simplify accurate axle insertion with this easy-to-use axle installation tool.

**Pro-Axle Press** - A precision machined device that produces straight and round nail axles, and accurately squares the axle head to the axle shaft.

**Pro-Body Tool** - An drilling guide that allows you to drill precise guide holes into the existing axle slots, or drill new axle holes with a hand drill.

**Pro-Hub Tool** - A tool that squares the wheel hub to the wheel bore, easily cones the inside wheel hub, and reams undersized wheel bores (great for wheels that don't fit on the Wheel Mandrel!).

**Pro-Wheel Mandrel** - An accurate wheel mandrel equipped with a thumbscrew for easy wheel mounting. The step-down tool face allows reverse mounting of BSA wheels (easier access to inside tread surface).

**Pro-Wheel Shaver** - Create perfectly round wheels with this simple substitute for a lathe (for BSA, PineCar, and other hard plastic wheels).

**Solid Lead** - The traditional choice for car weighting, solid lead is much denser than the zinc product sold at hobby stores, and is readily cut and shaped. Available as a 3/8" diameter wire, or in segmented form.

**Tungsten** - An alternate weight, tungsten is non-toxic and much heavier than lead (weighs the same as pure gold). If you want to create a minimalist design, then tungsten is the best bet for weighting your car. Available in cylinders, cubes, beads, and disks.

**BSA Speed Wheels** - Precision-trued BSA wheels for top performance.

We also offer **Speed Axles**, a **digital caliper**, and a **digital scale**. Come visit us at:

[www.maximum-velocity.com](http://www.maximum-velocity.com)

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## **About the Author**

**M**y wife and I, and our four children live in the greater Phoenix area (it's a dry heat!). My entire family is involved in the Awana<sup>3</sup> program at our local church.

In 1995 we began participating in the Awana Pine Derby (known as the Awana Grand Prix). Then in 1997, I began leading the derby, and started studying Pine Derby techniques. In a desire to improve the competition by making the techniques known to all the entrants, I wrote the booklet "Maximum Velocity! - Speed to the Finish!" (formerly "Car Construction Guidelines"). That booklet focuses on the techniques needed to build a fast car, and only slightly covers the design of the car, and the actual wood-working techniques.

Since the basic design of the car is critical to the performance of the car, and since many people are unfamiliar with the proper construction of a Pine Derby car, I created a series of car plan booklets.

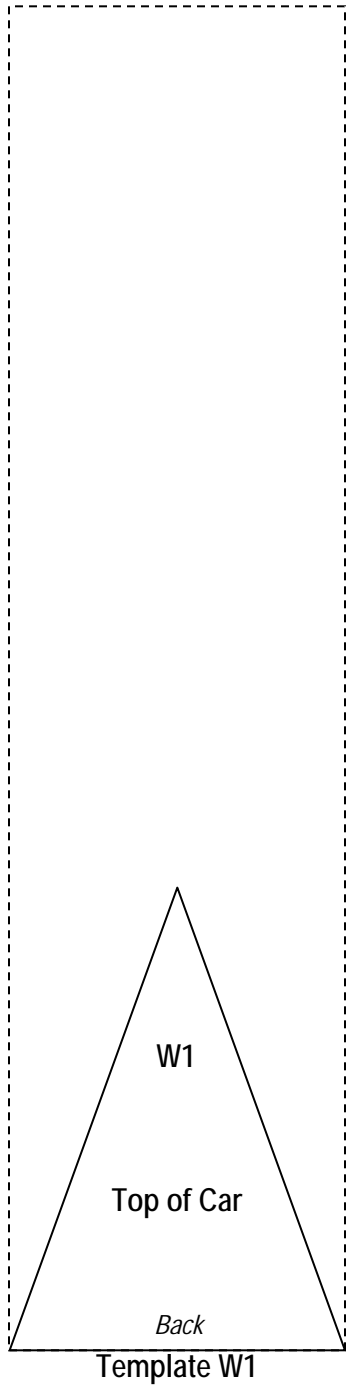
My desire is that by using this booklet, not only will you create a competitive car, but that you and your parent (or guardian) will more thoroughly enjoy the car building process. Winning the race can be the secondary goal, but the primary goal should be the enjoyment of building and racing a Pine Derby car with someone you care about.

I would greatly appreciate any feedback as to how to make this booklet more useful to you. I would also like to hear about the result of your races. You can reach me by e-mail at:

*info@maximum-velocity.com*

Good luck in your races, and may God bless you and your family!

Randy Davis



Verify that this measurement is exactly - 7"  
 If not, see "Important Printing Information" at the front of the booklet

**THE WEDGE TURBO**

