

# **Basics of Building a Pinewood Derby Car**

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## About This Guide

This guide is meant for Cub Scouts that are building their first pinewood derby car, but even Cub Scouts that have had years of experience may learn something from this guide. It lists the basic steps in order to get a car ready to race. There are entire books on building pinewood derby cars that one can find in the library or online that will go into greater details like the optimal gap between the wheel hub and the block. This tutorial will not go into all of the details, physics or tricks on racing pinewood derby cars because this guide is for the beginner that just wants to put a car together for a race. Many references were read by this author, YouTube videos watched and several years of building cars went into this guide.

Many of the steps are optional. Even shaping and painting the car are optional, but the order of the steps should still be followed: i.e. if you are not going to polish the axles or wheels, then skip those steps. Then you would start with installing and removing the axles before designing and cutting the block.

This guide does not cover safety while using tools to shape your car. There are as many ways to shape the cars as there are cars. An adult should always supervise a scout when wood working tools are being used. Safety should always come first.

The rules mentioned in this guide are specific to the 2014 pinewood derby race run by the Pathfinder District of the Northwest Suburban Council. There are many ways to make your car go faster that are not legal. This guide will not cover any build techniques that give an unfair advantage to a car. Please remember the Cub Scout motto of "Do your best" and good sportsmanship.

### 1. Prepare axles

This step is optional, but it is crucial if you want to build a fast car. The burrs and crimp marks are one of the most critical friction points that will slow down the car.



#### a. File off bumps and burrs.

You can use a jewelry file to remove the burrs and crimp marks. You can put the axle into a drill or a rotary tool to speed up the filing process.

#### b. Polish axles.

Again, the drill or rotary tool will make the polishing process go much quicker. You will want to use a polishing agent or special sand paper with very fine grit to polish the head and the shaft of the axle. In the picture to the right, the axle on top is similar to what you have in your car kit. The axle on the bottom has been filed and polished and is ready to use.



### 2. Prepare wheels.

Again, this step is optional, and it isn't as critical as preparing the axles, but it will improve the speed of the car.

#### a. Lathe wheels.

The wheels are not perfectly round. Lathing the wheels is the way to make the wheels round to ensure a smoother ride. This requires a special tool or two. So don't worry too much about this step.

#### b. Polish wheels.

To reduce the friction on the outside of the wheel, the tread of the wheels can be polished to a shiny finish using a plastic polish.

#### c. Polish bore (hole where the axle is inserted).

This is probably the most important of the three wheel prep steps. A pipe cleaner with plastic polish to smooth out the inside of the wheel will help to reduce friction between the wheel and the axle.



#### d. Apply dry graphite lubricant.

No liquid lubricant is allowed. Only dry graphite lubricant is allowed. You can find sources of graphite lubricant online or at hobby stores. Put a small amount of graphite into the bore of a wheel, insert an axle and spin the wheel to work in the graphite. Only put the graphite into the wheel bore. Do not put the graphite on the wheel tread.

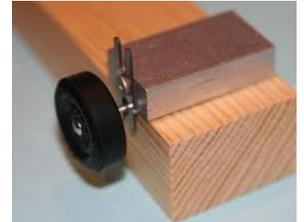
### 3. Insert the axles into block.

It is important to insert the axles before you begin cutting the design out. It is easier

to insert the axles squarely while the block is in its original shape. The block is also the most structurally sound at this point. The axle slots will not crack at this time. If you wait until the design is cut out, the chances of the axle slot cracking are greatly increased. Be careful during the installation and removal of the axles. You don't want to bend them during either step.

- a. Use axle alignment tool.

The axle alignment tool insures that the axle goes in straight. Clamp the tool to the block and gently tap in the axle with a hammer. You can install the axle with or without the wheel. Installing with the wheel will tell you how far you need to hammer in the axle, but it may be harder to remove the axle.



- b. Remove the axles from the block.

The objective of the previous step is to pilot the nails. You still need to cut out the design, and you will not want the axles to get in the way off shaping the car. You can use regular pliers, but you risk damaging the polish that you just got on your axles. Special axel pliers can gently extract the axles with no damage to the head.



4. Come up with a design.

- a. Keep the 2014 Pathfinder District rules in mind when coming up with the design:

- i. **Material:** All cars must be made from the official Pinewood Derby car kit from this year. If you buy it on the Internet, it is almost certainly NOT official BSA, even if they've put the logo on it.
- ii. **Width:** The overall width of the car shall not exceed 2 ¾ inches. Minimum width between wheels (on the same axle) shall not be less than 1-3/4 inches. The car body can be narrower than 1-3/4 inches, but the wheels must be a minimum of 1-3/4 inches wide so the car will straddle the track guide strip.
- iii. **Length:** The overall length of the car shall not exceed 7 inches. The center of the front bumper must be the furthest point forward on the car with the front bumper center being no more than ¼" higher than the undercarriage clearance of the car.
- iv. **Height:** The overall height of the car shall not exceed 4 ½ inches.
- v. **Axle Location:** All cars must maintain axle spacing of 4 3/8 inches. The slot depth may not be altered as it may interfere with the car's clearance of the track guide strip. The 4 3/8 inch spacing is measured from center of axle to center of axle.
- vi. **Undercarriage Clearance:** A clearance of 3/8" should be maintained

including any weights mounted underneath the car.

- vii. **Weight:** The weight of the car shall not exceed 5.0 ounces, as weighed on the scale(s) that will be used at the District Pinewood Derby. No loose/sliding weights or liquid materials of any kind are permitted in or on the car. The car may be hollowed out and built up to the maximum weight by the addition of wood, metal, plastic, glue, etc., provided it is securely built into the body.

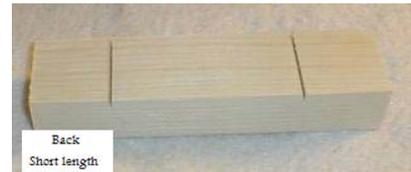
- b. Plan out where the extra weight is going to be placed.

The finished car (wheels, axles, paint, decorations and weights) should weigh as close to 5 oz as possible. The more the car weighs the more momentum it will gather as the car travels down the track. Additional weight will have to be added to the car to bring up the weight.

- i. Keep in mind that you want as much of the weight in the back of the car as possible. The further back the center of gravity is, the more potential energy the car will have, and the longer it will accelerate down the track.
- ii. The center of gravity should be 1" to 0.5" in front of the rear axle slot. If the weight is too far back, the front of the car could pop up if the car hits a seam.
- iii. Lead is common, inexpensive and readily available to use as weights. Keep in mind that lead is toxic and hands should be washed after handling lead. Other weights are available that are not toxic.
- iv. Once the car is finished you can determine exactly how much extra weight is necessary to bring the car as close to 5 oz as possible.

- c. You want the back of the car to be the side closest to axle slot

From a design perspective, it doesn't really matter which side is the front and which is the back. It does matter from a weight perspective.



Having the axle slot closest to the back of the car will allow the center of gravity to be further back on the car.

- d. Draw out design.

This is the time to get creative. Use your imagination, and you can make your "car" into anything. It can be a car, but it can be a candy bar, boat, sword, guitar, space ship, etc. You can go online and search for "pinewood derby cars" to get some inspiration.

- i. A template is included at the end of this pamphlet
- ii. Draw the design on the template
- iii. Cut out rectangular template (not the design) and glue it onto the car block
- iv. Cut out and shape the car

- v. Aerodynamics do not play a very important role in speed unless your design has some sort of sail or parachute, which is not recommended if you are going for speed

5. Paint the car.

- a. You can use any paint or decals, or you can leave the car unpainted if you want
  - i. Spray paint is commonly used to paint pinewood derby cars
  - ii. Latex paint can be applied with a brush if that is easier
- b. Put painters tape or masking tape over the axle slots to prevent the paint from getting into the axle slots
- c. Use a primer to help the paint adhere properly and to cover over any construction flaws
- d. It is better to apply several thin coats of paint than one thick coat
- e. Wait for the current coat of paint to dry completely before applying the next coat or before moving on to the next step
- f. Remove the tape over the axles once all the painting is done

6. Assemble the car.

- a. Check the weight of the car using a postage type scale
  - i. Make sure to include all decorations, the wheels and axles on the scale when checking the weight.
  - ii. Add enough weight to bring the car as close to 5.0 oz as possible.
  - iii. If you are right at 5.0 oz, be prepared to remove some weight because the “official” scale used at check-in may not measure the same weight as the scale that you are using.
- b. Install the wheels.
  - i. Put the axle in a wheel hub, and line it up with the pre-installed axle slot hole.
  - ii. Because the axles were pre-installed, you should be able to push the axles in with thumb pressure.
  - iii. Repeat with the three remaining wheels.
- c. Check the weight of the car again once all of the components are installed.
- d. Check the wheel installation.
  - i. All four wheels should touch on a flat surface.
  - ii. Check to see if the car rolls straight.  
Aligning the axles can be a bit of an art form, but a car that drifts to one side will lose speed to friction against the guide strip. There are several ways to accomplish this. This guide will not go over all of those techniques.
    - 1. Roll the car on a flat surface. It should roll fairly straight.
    - 2. Check to make sure the axles are not bent. This may require

removing the axles for inspections.

3. Check to make sure that the axles were installed straight.
  4. Try removing one axle and then see how straight the car rolls. If the car rolls straight, then the alignment issue is with that axle/wheel. If the car does not roll straight, re-install the wheel and axle, and try removing a different axle.
  5. Assuming that there is one axle causing the alignment problem and it has been identified:
    - a. Re-install the wheel and axle.
    - b. Mark a dot with a permanent marker at 12 o'clock.
    - c. Roll the car to check the alignment again.
    - d. If it is still drifting, rotate the axle a 1/8 turn clockwise. This is where the axle pliers will come in handy over regular pliers.
    - e. Check the alignment again.
      - i. If the drift is better, but not completely corrected, turn the axle another 1/8 turn.
      - ii. If the drift is worse, turn the axle 1/4 a turn counter clockwise, and check the drift. If the drift is better but not corrected, continue with another 1/8 turn counter clockwise.
      - iii. Continue turning the axle 1/8 of a turn until the car rolls as straight as possible.
- iii. You may want to glue down the axles at this point with glue.
    1. Make sure the glue does not touch the wheel or the axle near the wheel.
    2. A small dab of super glue at the tip will lock the wheel alignment in place with minimal risk of gluing the wheel to the axle.

7. Your car is ready to race.
  - a. Keep the car in a safe place until race day.
  - b. Bring the car in for inspection.
  - c. Bring some tools in case the car needs some adjustment due to inspection violations.