Start by building the example racer, then turn into your own unique design.
What do you need to know, to build your racer?

**Cut**
- Multi-Cutters cut wood & plastic (like dowels and connector strips). They do not cut metal.

**Push, Wiggle,**
- Push, wiggle or tap dowels into holes.

**Tap**
- Use a hammer and slider block to tap dowels farther through holes.

**Quick Tip!**
- Use a crayon, or soap on the end of a Dowel to make building easier.

**Ream**
- Most parts have holes with teeth. The teeth hold dowels (keep dowels from falling out).

**Screws & Nuts**
- Screws (without nuts) can connect parts, and allow them to rotate.
- Screws (with a nut) can connect parts, and keep them from rotating.

**Stop Clip**
- Press a stop clip onto a dowel to keep it from sliding or use it as a hook for a string / rubber band. It takes little force to get it on.

**Slide Stop**
- Cut slide stop into sections. Use slide stop on dowels to stop dowels from sliding through reamed holes.
Gather components to build the example racer, and then turn it into your own amazing design.

**TeacherGeek Supplies**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Item</th>
<th>Description</th>
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<tbody>
<tr>
<td>6</td>
<td>Connector Strips</td>
<td>300mm (12”)</td>
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<tr>
<td>8</td>
<td>Dowels</td>
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<tr>
<td>2</td>
<td>Hole Plates</td>
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<tr>
<td>4</td>
<td>Wheels</td>
<td></td>
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<tr>
<td>2</td>
<td>Stretch Tires</td>
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<tr>
<td>4</td>
<td>Screws</td>
<td>#10 1”</td>
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<tr>
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<td>Slide Stop</td>
<td>75mm (3”)</td>
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<tr>
<td>1</td>
<td>Stop Clip</td>
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</tr>
<tr>
<td>10</td>
<td>Rubber Bands</td>
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</table>

**TeacherGeek Tools**

This isn’t a kit. You’re going to really build (cut, ream, screw) your Racer. Here are tools you’ll need to get started. They can be shared by up to 4 groups at a time.

- **TeacherGeek Reamer**
- **TeacherGeek Multi-Cutter**
- **Tapping Block** - Optional
- **Small Hammer**
- **Pliers** - Optional
- **Philips Screwdriver**

**Tip:** Save all your materials (even what you cut off). Keep them in a bag. They can be used later.
**FRAME BUILD**

1. **Cut** four **10cm (4”) dowels.**

2. **Tap or push** **dowels** into an upside-down **hole plate.**

3. **Tap or push** a **hole plate** on top of the **dowels.**

Congratulations! Your frame is done.

If you are going to do the optional Sled Race, it’s now time.

Documents at [teachergeek.com/learn](http://teachergeek.com/learn)
**WHEELS ON**

4. **Cut** two 13 cm (5.1”) ***dowels***. These will become ***axles*** for the ***wheels***.

5. Push or tap the two ***axles*** into ***wheels***.

6. Place the ***axles*** through the ***frame***, three holes up from the bottom.

7. Push or tap two ***wheels*** onto the other side of the ***axles***.

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If you are going to do the optional Ramp Roll Lab, it’s now time.

Documents at teachergeek.com/learn
8. **Snap** on the **stop clip** to one of the wheel **axles**.

It takes a lot of force to snap a stop clip on. An adult may need to help.

9. **Cut** one 13cm (5.1”) **dowel**.

10. **Place the 13cm **dowel** through the **frame**, with a **rubber band**, as shown.

11. **Cut** two 1cm sections of **slide stop**. Use them to keep this **dowel** from falling out.

12. **Hook** the **rubber band** around the **stop clip**. Wind up the **rubber band** by turning the **wheels**.

Set it down and let it go. **Play** and **experiment** with it.
TRACTION

Are your wheels spinning? Maybe you need to give them more traction.

13 Place stretch tires on the rear wheels, if you have not already.

Try adding more rubber bands to your racer. What happens? Do the rubber bands release their energy too fast? Can you redesign your racer so rubber bands release energy slower?

Traction is the friction between the wheels and the ground. It allows the vehicle to move forwards. Increase the traction (friction) between your wheels and the ground by adding tires.

Tips
Use a glue stick to keep tires from slipping off the wheels.
1. Coat the wheel with glue.
2. Wait a few minutes for the glue to partially dry.
3. Then put the stretch tire on.

Is your stop clip spinning on the dowel? A little glue will fix it.

Congratulations!
Your example racer is done. Now turn it into your own design.
ENGINEERING CHALLENGES

Make your racer go farther, faster, or stop on a target. The step-by-step instructions end here, but you’re just getting started. It’s time to redesign your racer for these engineering challenges.

1. **Sprint**
   - Redesign your racer to break a speed record or win a race.

2. **Target**
   - Redesign your racer to stop on a target.

3. **Long Shot**
   - Redesign your racer to go really far.

The next pages will give you tips to help you redesign your racer.

Download the Engineering Challenge documents at teachergeek.com/learn
How does your racer turn \textbf{potential} (stored) \textbf{energy} from the rubber bands into \textbf{kinetic} (moving) \textbf{energy}? Create a mechanism to release the energy over more \textbf{rotations} (turns) of the wheels. Adjust it for the different challenges.

\textbf{Parallel or Series}

Rubber bands can be connected in \textbf{series} (forming a thin, long band) or in \textbf{parallel} (forming a short, thick band).

\textbf{Use Pulleys}

\textbf{Pulleys} can be used to change the direction of a rubber band or string. Dowels, that can spin, can be used as pulleys.

\textbf{Change the Frame}

Use more parts to change the \textbf{frame}. 
Add a Lever

A lever can create a **mechanical advantage** (trading force for distance). Use it to trade force from rubber bands for more wheel revolutions (distance).

How does it work? The rubber bands pull the **lever arm**. The lever arm pulls the **string**. The string unwinds from the axle and **turns** the **wheels**.

Try Gears

Gears can be used to create a **mechanical advantage** (like a lever).

This gear turns five times for every time the large gear turns once.
MORE MATERIALS

To turn your racer into your own design, you are going to need more materials. Try using…

- Extra TeacherGeek parts
- Recycled materials (food packaging, containers, bottles, cardboard, etc.)

TROUBLESHOOTING

What often makes a racer turn?

- The frame is not straight or square
- The axles are loose, or not symmetrical with the frame

How can you make your racer go straight?

- The frame and axles are symmetrical
- Slide stop can be placed on the axles to help "steer" the racer. It can keep the axles symmetrical with the racer frame, or offset (making the racer turn, or correct for a turning problem)