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, Tap**

- Push, wiggle or tap dowels into holes.
- 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).
- A reamer removes teeth from a hole. This allows a dowel to spin in the hole.
- Only ream holes where dowels should spin.
- Never ream pulleys, gears, wheels, or any hole a dowel stays stuck into.

**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.
- Do not ream holes you will put screws into.

**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**

- **4 - Connector Strips**
- **5 - Dowels 300mm (12")**
- **2 - Hole Plates**
- **4 - Wheels**
- **2 - Stretch Tires**
- **4 - Screws #10 1"**
- **4 - Nuts #10**
- **1 - Slide Stop 100mm (3")**
- **1 - Stop Clip**
- **10 - Rubber Bands**

**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**
- **Phillips 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
**Wheels On**

4. **Cut** two 13cm (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**.

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

Documents at [teachergeek.com/learn](http://teachergeek.com/learn)
Wind-Up

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.
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**.
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.

**Sprint**

Redesign your racer to break a speed record or win a race.

**Target**

Redesign your racer to stop on a target.

**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](http://teachergeek.com/learn)
How does your racer turn potential (stored) energy from the rubber bands into kinetic (moving) energy? Create a mechanism to release the energy over more rotations (turns) of the wheels. Adjust it for the different challenges.

Parallel or Series

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

Use Pulleys

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

Change the Frame

Use more parts to change the 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**.

**More Materials**

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

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