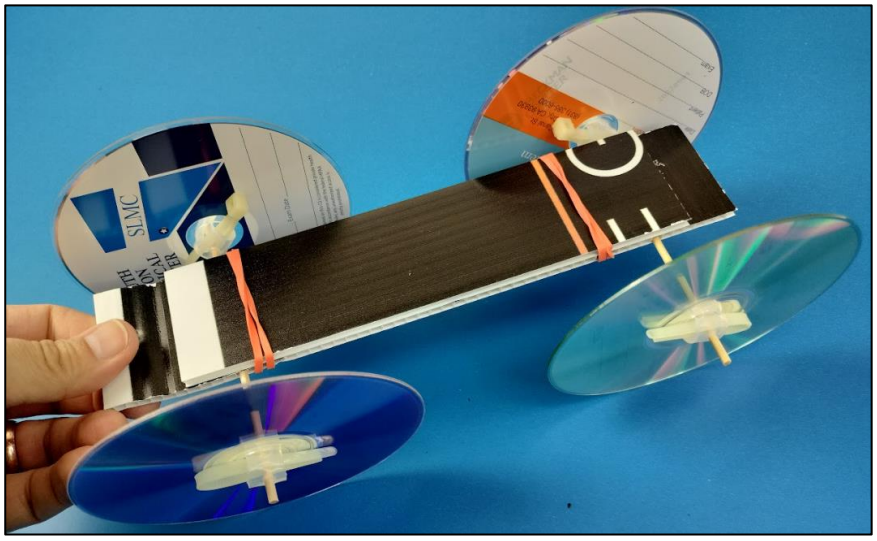
PLATFORM CAR

Investigate motion and energy with this cleverly designed car!

The Platform Car is a great example of RAFT's concept of "found engineering", using materials that were not meant to go together to do things they were not intended to do. This car moves easily due to its simple wheel and axle system and use of low friction wheels, leading to fun and intriguing motion experiments using gravity. With a few extra parts it can even be powered via a rubber band and propeller! How far and how fast can the platform car move down a ramp and/or across the floor? How much weight can it hold? Explore these questions and more with this unique design!



Curriculum topics

- Energy
- Forces & Motion
- Investigations
- Simple Machines
- Technology

Subjects

- Engineering
- Physical Science

Grade range: K – 8

Who we are: Resource Area for Teaching (RAFT) helps transform the learning experience by inspiring joy through hands-on learning.

The development of this kit was funded in part by Electrify America

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http://bit.ly/RAFTkitsurvey

Materials

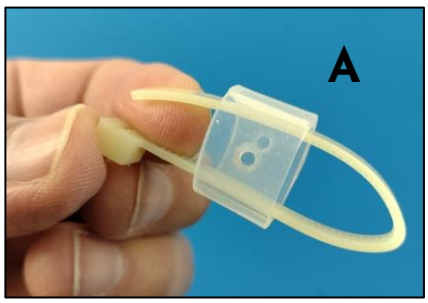
Materials in the kit may vary but generally, this kit contains the following:

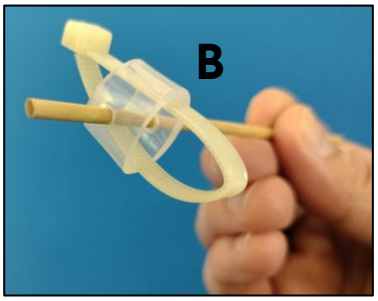
- CDs (4)
- Wood dowel, 1/8” diameter x 6” long (3)
- Corrugated plastic, 2” wide x 10” long with one punched hole, flutes parallel to **narrow** sides (1)
- Corrugated plastic, 2” wide x 8” long with flutes parallel to **long** sides (1)
- Zip tie sections (8)
- Tubing, 5/8” OD, ½” ID, 7/16” wide with punched holes (4)
- Elastic bands, 1/8” wide x 3.5”, non-latex
- **Not included:** Scissors, tape

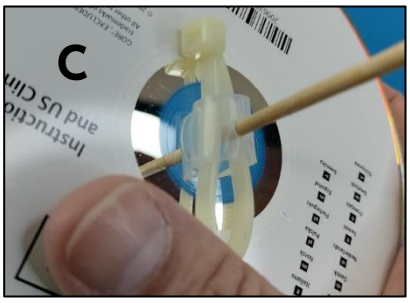
WARNING: CHOKING HAZARD – Small parts not suitable for children under 3 yrs.

To Do and Notice

1. Hub Assembly: Bend the zip tie sections in half. Insert a bent zip tie section through one of the precut pieces of tubing included in the kit. Rotate the zip tie section so that the small, punched holes in the tubing are on the sides of the open loop as shown below (**A**). Repeat for 3 more pieces of tubing.



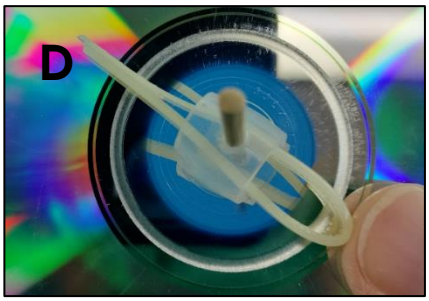




2. Insert a wood dowel through both holes in the tubing a few inches, making sure it also goes through the loop formed by the zip tie section as shown above (**B**).

3. Pinch and insert the tubing and dowel through the center hole of a CD so the zip tie loop is pressed firmly against the CD (**C**).

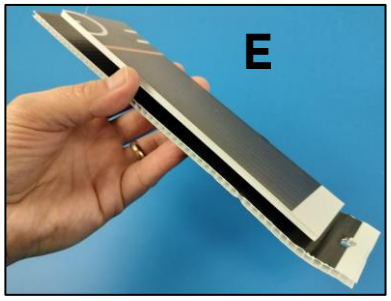
4. Insert a bent zip tie “tail” section through the tubing and around the dowel **on the opposite side** of the CD (**D**). Adjust as needed to get a secure fit and to ensure the wood dowel is perpendicular to the CD.

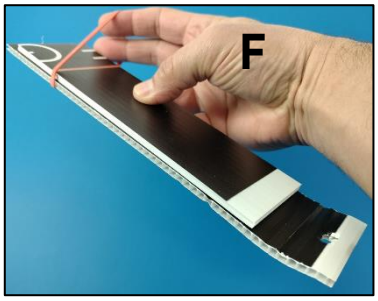


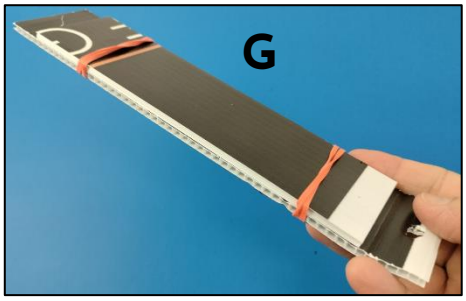
5. Repeat **B**, **C**, and **D** using another bent zip tie section, free dowel end and CD.

6. Pinch and insert one of the tubing hubs prepared in step 2 into the center hole of another CD, as in step 4, but **without** the wood dowel.

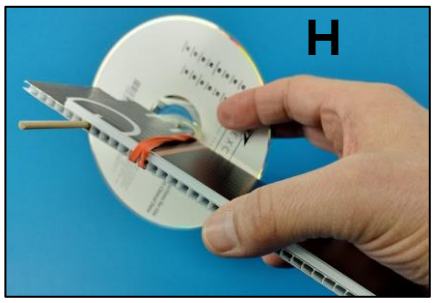
7. Preparing the Chassis: Notice the channels (flutes) running through the corrugated material. The flutes in the longer piece of material run parallel to its shortest (2”) side. The flutes on the shorter corrugated material run parallel to its longest (8”) side. Stack and center the shorter corrugated material atop the longer one (**E**). Double wrap a rubber band at each end of the stack to hold them together (**F, G**).

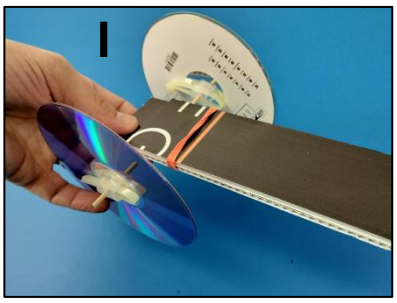


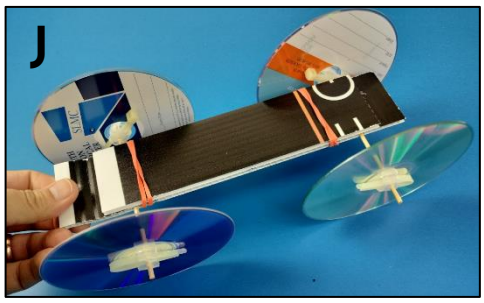




8. Installing Wheels & Axles: Count about 8 flutes starting from the 2” end of the 10” long corrugated material (chassis). Insert the end of the dowel without the CD through the identified flute (**H**). Attach a prepared CD with tubing hub by inserting the dowel through the holes in the hub (**I**). Repeat for the opposite end of the corrugated chassis, yielding a platform car with 4 wheels attached to two axles (**J**).







9. Test & Optimize: Roll the car on a flat surface. Look for instances where the wheels rub the chassis, causing friction. Adjust the spacing between chassis and wheels by holding the axles and pushing or pulling on the hubs, sliding the CDs along the axles as needed to prevent friction due to rubbing. Also observe and adjust the angle of the wheels as needed. It may be necessary to remove the wheels/axles and reinstall through other flutes in the chassis, especially if the axles are not in alignment.

10. Invesigate: Roll the car on a flat surface from a starting line. Measure and record the distance travelled and the duration (e.g. 200 cm, 32 sec). Repeat for multiple trials and calculate average speed (distance/time). Roll the car down a ramp and repeat the measurements from where it leaves the ramp to its stopping point. Add weight incrementally to the car. Repeat these investigations and then compare and discuss the results. How do changes to the design and the surface affect the car’s motion? Why?

11. Troubleshooting: If the chassis bends along its length, it can be reinforced at the bent area by attaching a rectangular piece of cardboard to the chassis with 2 wide elastic bands (not included).

12. **Share** your learning with RAFT! Submit photos/video via email at education@raft.net or on social media (Facebook, Twitter, Instagram).

Core Content Skills:

Science & Engineering (NGSS)

Developing and Using Models, Planning and Conducting Investigations, Forces and Motion, Types of Interactions, Definitions of Energy, Collecting and Interpreting Data; Cause and Effect; Constructing Explanations and Designing Solutions, Optimizing Design Solutions

Social Emotional Learning

- Self-awareness
- Self-management
- Responsible decision-making

The Science Behind the Activity

The **wheel and axle** are one of the six **simple machines**. Machines make work easier by changing the size and/or the direction of an input force. For the platform car, the friction between the wheels and the surface below, plus the friction of the axle rubbing inside of the flutes, slows the car. For each rotation, the axle travels a shorter distance around than the wheel. The shorter turning distance and smaller diameter of the axle means less energy is lost as the platform car moves.

When the platform car is at rest on a flat surface and no horizontal force is applied, the car will remain at rest in accordance with Newton's 1st Law. Newton's 2nd Law of Motion, **F** = **ma**, states that the **net force** (sum of forces) acting on an object is the product of its **mass** and **acceleration** (change in speed and/or direction). If all the forces acting on an object are balanced, the object does not move. Newton's 3rd Law of motion says that for every force acting on an object there is an equal and opposite force also acting on the object. Gravity pulls downward on the car and in response, the surface applies an upward force on the car. This makes sense because the car neither plunges through the surface nor floats in the air! If a horizontal force is applied to the car, it will roll. **Friction** is a force acting opposite the direction of motion and slows the car to a stop.

Releasing the car from the top of a ramp (incline plane) adds an additional downward force besides the gravity already acting on the car. The strength (magnitude) of the additional downward force is a function of the height of the ramp, as is the potential (stored) energy the car possesses at the top of the ramp. The car accelerates down the ramp due to gravity and the potential energy it started with gets converted to kinetic energy (energy of motion). The higher the ramp, the more kinetic energy the car possesses while in motion, and the farther and faster it will roll forward from the ramp until friction eventually brings it to a stop.

Reuse

This kit uses 100% reusable materials designed for other uses. To continue making a positive impact in reducing waste, reuse these materials in other projects. Additionally, any unused materials can be collected and delivered back to RAFT.

Feedback

Please comment on this kit by taking this short survey: http://bit.ly/RAFTkitsurvey. Let us know of any material concerns (missing, broken, or poorly fitting parts) as well as any suggestions for improvement.

Visit https://raft.net to view related activities!

- Car on a Roll
- Retractor Car
- Rollback Can

Resources

- Newton's Laws of Motion - https://bit.ly/2RPnV6z
- Khan Academy, Balanced & Unbalanced Forces - https://bit.ly/3a7bElr