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| Rubber Band Car |  | Intermediate-Advanced |
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| Project GoalStudents build a car that can either travel at least 15ft. Optionally, they can modify the car to travel as far as possible, or go 15ft as fast as possible.Design VariablesAmount of weight on the car, the idle wheel size, and how much the rubber band is wound upKey ConceptsEnergy transformation is when one kind of energy turns into a different formMomentum is the force that causes a moving object to continue to move in the direction it is already going towardInertia is the tendency for objects to resist a change in motion**Prep*** For grades 5 and under: attach the rubber bands to the wheels
* Mark a starting line on the floor, and a finish line 15ft away
 |  | **Materials**Basic Example* 14 craft stick
* 6 craft cube
* 4 small r.band
* 1 long r.band
* Cable tie
* straw
* ¼" dowel
* large wheels
* tape
* hot glue

Optional:* small wheels
* metal washers
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| **Troubleshooting** |
| *If the car is…*  | *Then…* |
| Moving less than 15ft | * There’s not enough energy stored; wind it up more
* There’s excessive friction; look for unwanted hot glue, wheels rubbing against the frame or straws, etc.
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| Not rolling straight | * The wheels aren’t aligned. Remove and reattach the wheels to make the axels parallel with each other
* Try releasing the car with the drive wheels in front
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| “Spinning out” upon release | * The drive wheels don’t have rubber bands on them
* The rubber band was wound up too much, causing the drive wheels to spin in place for a moment; try winding it less
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# Introduce project name and demonstrate how it works (1 min)

# Explain how it works (2 min)

* Show how the wheels turn when the rubber band is wound up and released.
* Energy is stored in the rubber bands by stretching them. When released, the stored energy transforms into moving energy (kinetic energy) by turning the drive wheels.
* After the rubber band unwinds completely, the momentum of the car continues to move it forward. Define momentum.
	+ *Think of it like this:* Using a rubber band to push a balloon won’t work well; the balloon is light and easily stopped by air resistance. However, if a baseball is pushed with the same amount of force, it will roll much farther. This is because momentum = mass x velocity (speed). The more mass, the more momentum an object will have. The more momentum, the more easily it can overcome things like air resistance or friction, and thus the farther it will go.

# Show students how to build the Basic Example (3 min)

* Show students the Project Sheet and walk them through the steps of construction.
	+ For grades 4 and under, build a car step-by-step in real time (10 mins)
* Emphasize the gaps at the end of the frame where the drive wheels attach.
* Emphasize making sure the wheels are aligned.

# Explain how to launch the car (2 min)

1. Hook the rubber band onto the drive wheel axel.
2. Quickly turn the drive wheel by making circular motions with your index finger.
3. Put the car and release! No need to give it a push.

# Optional: Support designing for speed or distance (2 min)

* Speed: The car takes time to reach maximum speed because of inertia.
	+ Define inertia. i.e. it’s how much energy is required to move an object.
	+ Heavier objects have more inertia and require more energy to start moving.
	+ Therefore, to make a speedy car, it must be as light as possible.
	+ More than 1 rubber band can help, but too many extra bands won’t work.
* Distance: The car ceases moving because friction – like the wheels touching the ground – uses up energy.
	+ To go farther it needs to use the stored energy more effectively.
	+ Adding more mass (e.g. weight) will help the car go farther.
		- Why? Review momentum. More mass will increase momentum. i.e. the energy gets transformed into moving the extra mass. That extra mass “wants” to keep going straight, so it carries the car farther than before.
	+ Explain: Washers can be glued to the wheels to add mass, but they must be attached symmetrically.
	+ If more weight is added, then more rubber bands will also be required because momentum = mass x velocity (speed). i.e. To generate the additional momentum, the car must be able to speed up as much as possible.