

Energy Car

Assembly Instructions

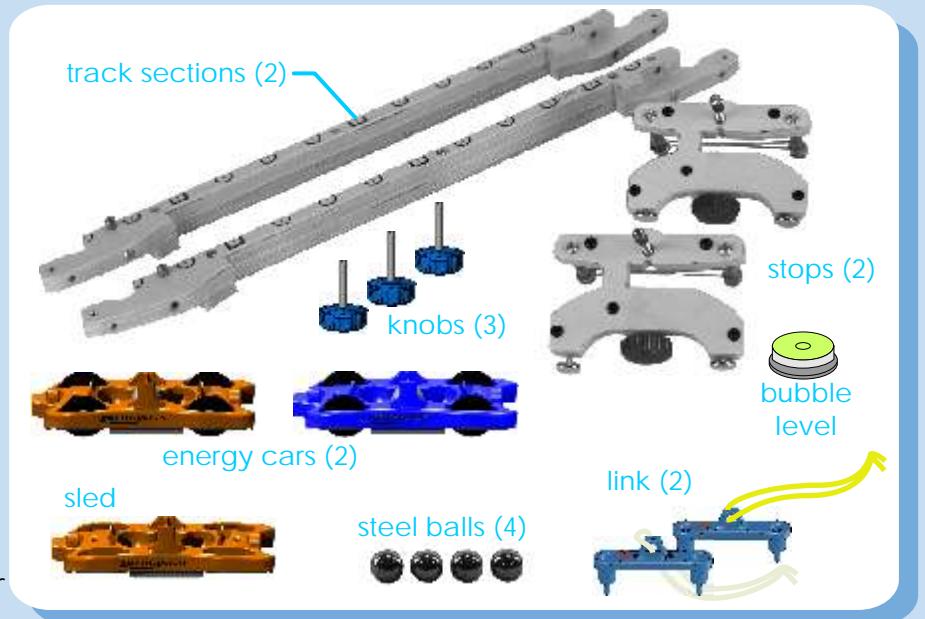
Parts Checklist

The following items are provided with the Energy Car:

- track sections (2)
- stops (2)
- energy cars* (1 blue, 1 orange)
- sled
- blue knobs with threaded rods (3)
- steel balls (4)
- link (2)
- bubble level
- clay (not pictured)
- string (not pictured)
- #32 rubber-bands (not pictured)

In addition, you will need these items:

- Physics Stand, assembled
- Timer console with power adapter
- photogates with wires (2)



*NOTE: The blue and orange energy cars are identical, with the exception of color. The cars are colored differently so that it is easier to distinguish cars when performing experiments using both cars (i.e. collision experiments).

1. Setting up the long straight track

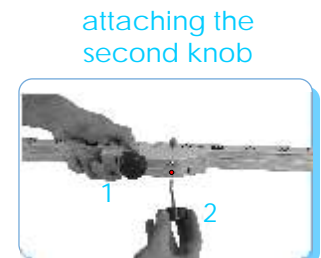
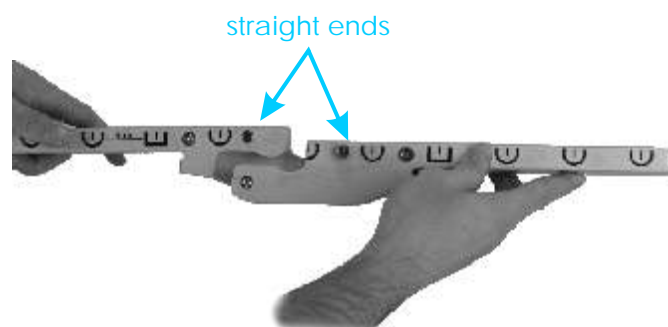


The long straight track is used for many experiments.

2. Joining the track sections

Notice that the ends of the track sections are different. One end is straight and the other has a slight curve. Join the two straight ends together to make the long straight track. The curved ends are for making a hill.

The two sections of the track join together with two blue knobs. Screw one blue knob into each of the two holes on the bottom of the joint where the two track sections meet.



Assembly instructions continue on next page.

Energy Car

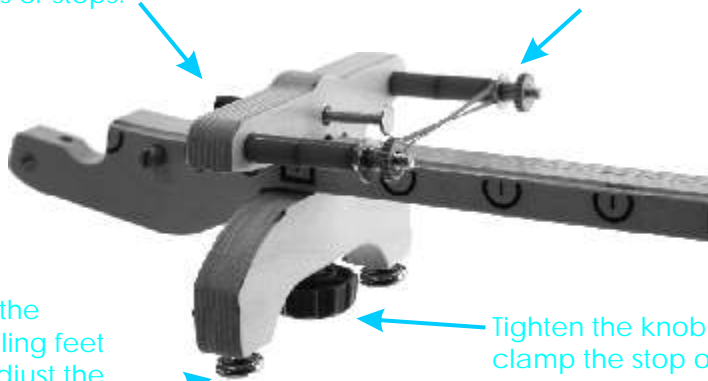
3. Attaching the stop and making a car launcher

Use this screw to adjust where the car starts or stops.

Put the rubber band between the washer and nut and gently tighten the thumbscrew (both sides).

Use the leveling feet to adjust the slope of the track.

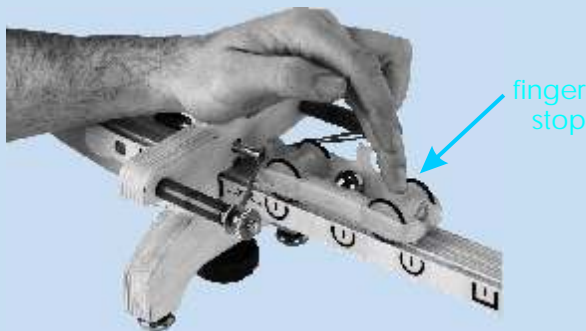
Tighten the knob to clamp the stop on the track.



The stop is used to both start and stop the car on the track. There are two stops, one for each end. They are identical.

To make the stop into a launcher, loosen the two thumbscrews by a few turns. Stretch a rubber band between the two screws. The rubber band should fit behind the washer. Give the rubber band one twist so it makes an "X" between the posts. The X helps provide even force when launching the car.

4. Launching the car

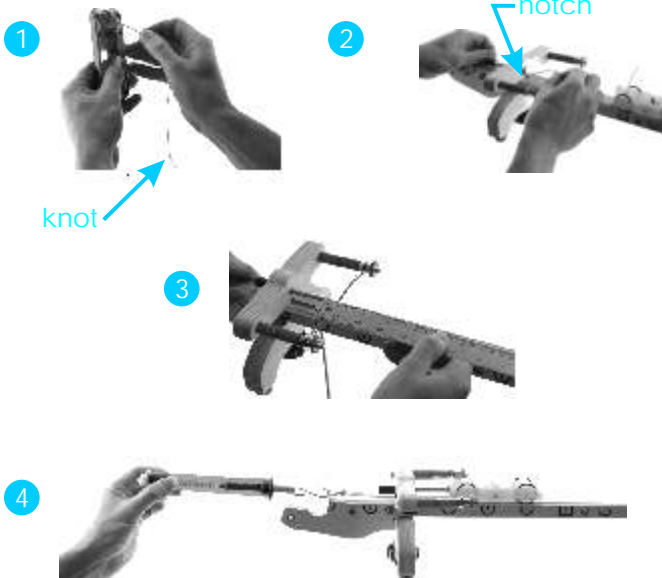


To launch the car, rest your hand on the top of the launcher and catch the finger stop (or thumb stop) on the car with your finger (diagram).

Pull the car back until it hits the screw. Change the adjustment of the screw to get different speeds.

Flick your finger back and off the finger stop with a quick motion to launch the car. With practice you can get speeds that are repeatable to within 1%.

5. Measuring the force on the car



(1) Tie a knot on the end of a length of string. Thread the string through the small hole in the end of the car so the knot is on top the car.

(2) Thread the string through the notch just below the screw on the wooden stop. Tie a small loop on the free end of the string about 20 cm away from the wooden stop.

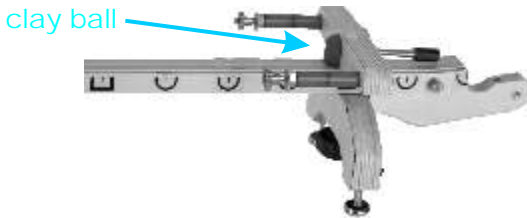
(3) Use a ruler to set the distance from the front of the screw to the front of the rubber band. Distances from 1 cm to 5 cm can be obtained.

(4) Attach a force scale to the loop on the string and pull the car back until it just touches the screw. The scale reads the force on the car at the measured deflection of the rubber band.

Assembly instructions continue on next page.

Energy Car

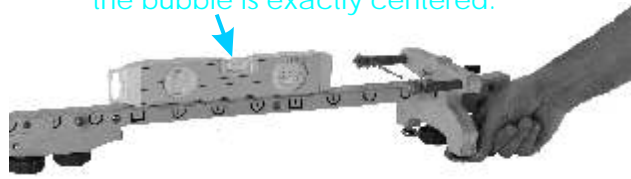
6. Stopping the car



Squish a small ball of modeling clay on the end of the screw to make a stop for the car. The clay prevents the car from bouncing.

7. Leveling the track

Adjust the leveling feet on one or both ends until the bubble is exactly centered.



Some experiments require that the track be level. A small bubble level works very well for this purpose. Adjust the leveling feet until the bubble is exactly in the center between the marking lines on the level.

If you do not have a horizontal level, you can use the bubble level that came with your Energy Car.

8. Attaching the photogates

The marks are 5cm apart. Use them to position the photogate.



flag
(1 cm wide)

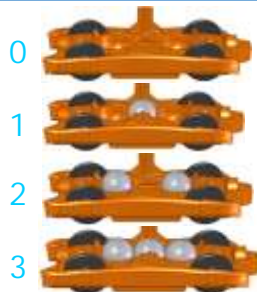


The car has a small flag on top that breaks the light beam in the photogates. The flag is one centimeter wide.

Attach photogates as shown in the diagram. The flag breaks the light beam when the photogate is snug against the bottom of the track.

9. Adding mass to the car

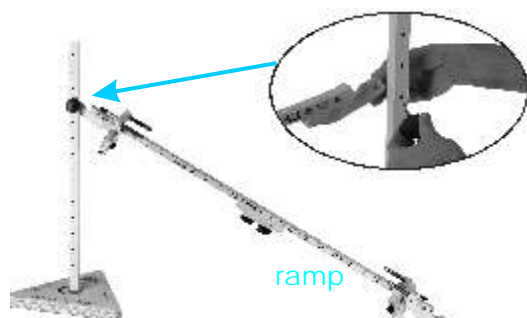
Add mass to the car so the steel balls are evenly spaced around the center of the car.



The steel balls add mass to the car. Each ball is 50% of the mass of the empty car. That means adding one ball increases the mass by 50%. Adding two balls doubles the mass.

The car is designed so the center of mass stays in the same place if the balls are added symmetrically around the center.

10. Making a straight ramp

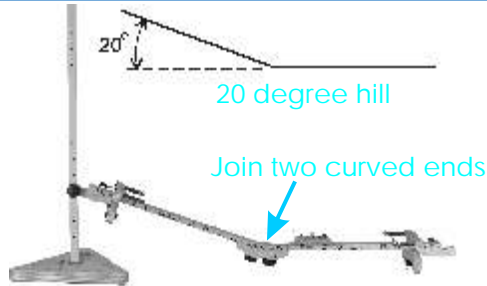


The long straight track can be attached to the Physics Stand to make a ramp. Insert a blue knob through a hole in the stand and screw the threaded end into the end of the ramp.

Assembly instructions continue on next page.

Energy Car

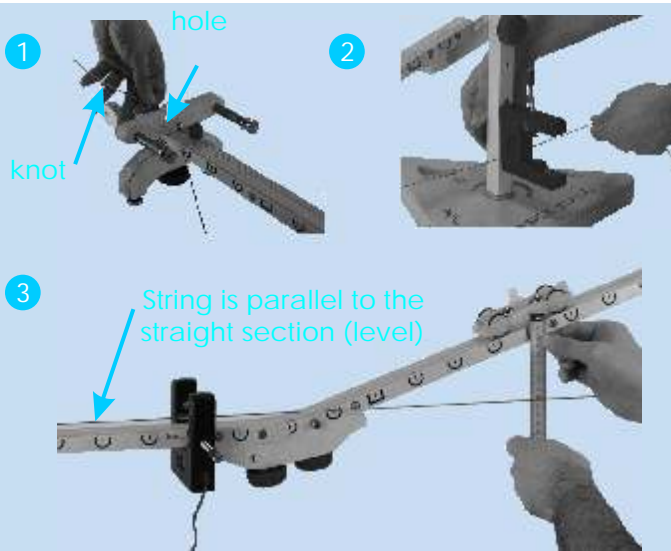
11. Making a flat section with a hill



You can join the two sections of the track to make a 10 degree hill or a 20 degree hill. To make the 10 degree hill, join one curved end to one straight end. To make a 20 degree hill, join both curved ends together.

Use the Physics Stand to support the track at the top of the hill.

12. Measuring height on the hill



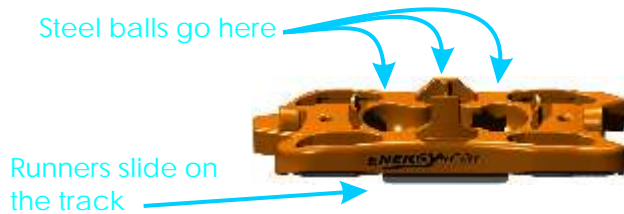
A level string can be used as a reference to measure the height of the car on the hill.

(1) Make the horizontal section of the track level. Tie a knot in one end of a string and thread the string through the small hole in the stop.

(2) Use a photogate and a knob to clamp the other end of the string against the Physics Stand. Adjust the position until the string is parallel to the horizontal section of the track.

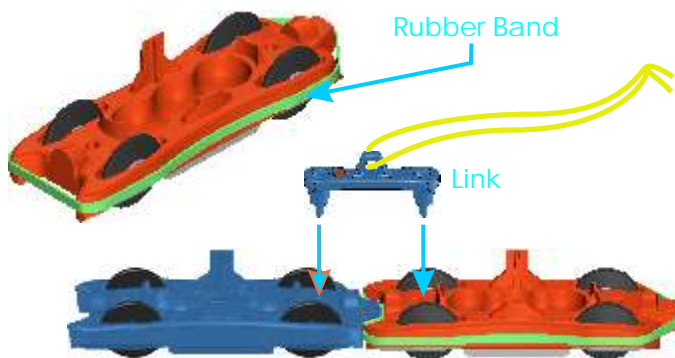
The string is now level and at the same height as the center of mass of the car! You can easily make height measurements on the hill by measuring the vertical distance between the center of the car and the string.

13. Using the sled



The sled is just like the car, but without wheels. The sled is used for friction experiments.

14. Using the link



Use the link to connect the two cars. Place a rubber band around the first car as shown. With both cars pointed in the same direction, put the second car (shown here in blue) in line so that it is as close as possible to the first car (deflecting the rubber band). Press the pins of the link into the holes of each car. The cars are now "loaded" and ready to be released to perform your investigation.

For activities, refer to the investigations manual, teacher's guide, or curriculum resource guide.