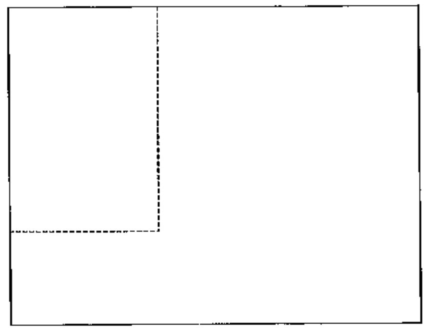
Procedure

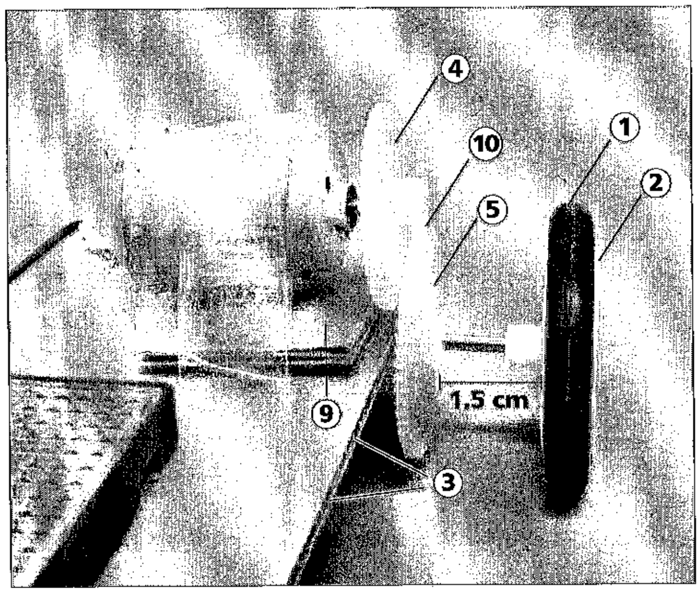
1. Prepare a proposal for your design that includes the information listed in the Design Guide.
2. Get your teacher's approval for your proposal before beginning construction.

Day 1: Design Activity—Building a Prototype Chassis

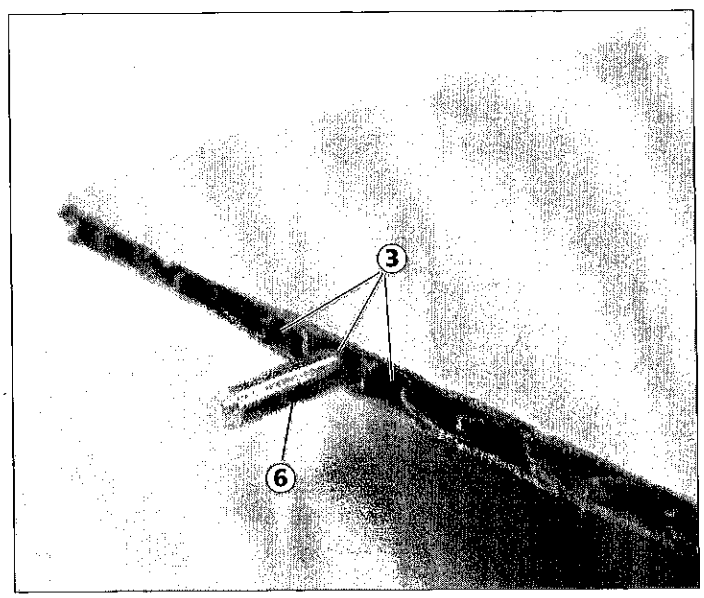
Initial Construction



1. Attach rubber O-rings ❶ to each of the four white wheel rims ❷. Make sure they are centered around the rims for straight rolling.
2. Each lab group will build the same prototype chassis, 4 inches wide and 6 inches long. Four inches is the maximum width that will accommodate the axles.
3. Cut the chassis from one end of the cardboard pad such that the corrugation holes ❸ are on the left and right sides of the chassis' 6-inch length. The axles will be inserted through two of these holes.

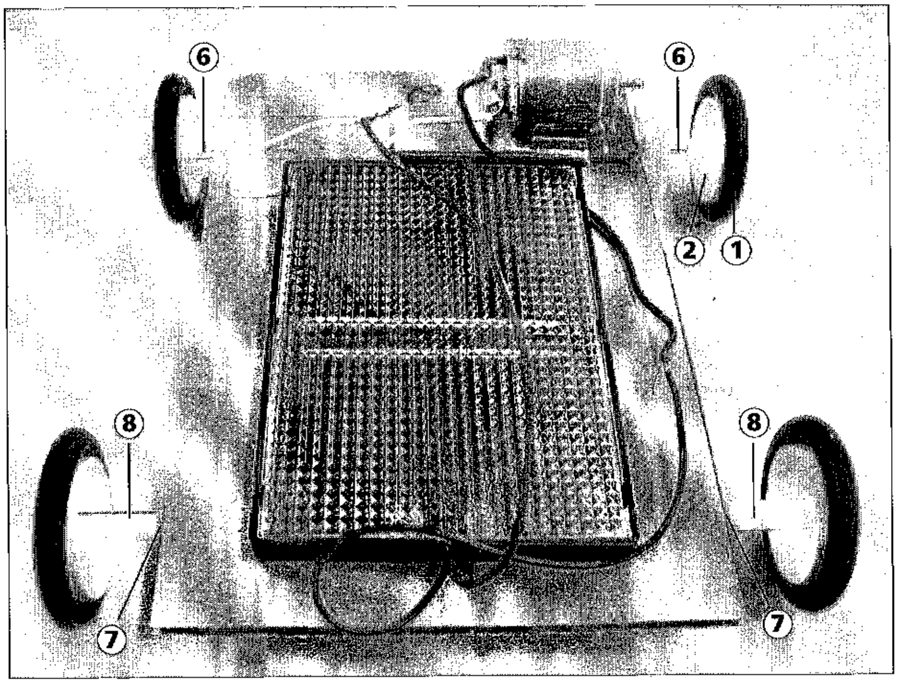


4. Get the gear wheel with two gears (an outer set of teeth and a small-diameter pinion gear) ❹. With the pinion gear to the outside, press this gear onto the motor shaft.
5. To get an axle into the smaller of the two flat gears ❺, lay the gear over a support such as the opening behind the closed jaws of a pair of pliers or the narrow space between the spines of two books lying back-to-back on the table. Stand one end of an axle in the gear's center hole and tap the top of the axle lightly with a hammer to drive it through the hole.
6. Brace the free end of the axle against a sturdy surface, such as the edge of the tabletop, and carefully push the gear away from you until it is 1.5 cm in from your end of the axle.



7. Place one of the wheels flat on the table and insert the gear-bearing end of the axle into the center hole of the wheel. Tap the other end of the axle lightly with a hammer to seat the axle.
8. Select a corrugation hole 5 or 6 holes from one end of the chassis and slide the free end of the axle into the hole until it emerges on the other side ❻.
9. Press a wheel onto the free end of the axle. This will be the drive axle.

10. Place a third wheel on one end of the other axle.
11. Select a corrugation hole, 5 or 6 holes from the other end of the cardboard and slide the free end of the axle through. This will be the non-drive axle ❼.
12. From a drinking straw, cut spacers ❽ to keep the non-drive axle from sliding to the left or right and causing the wheels to rub against the chassis during movement of the car.
13. Measure for the spacers from the inside of each wheel along the wheel shaft to the chassis. The spacer should fit loosely against the cardboard chassis.



14. Press the fourth wheel with its spacer on the other side of the non-drive axle and make sure the spacers fit close to the cardboard on both sides.
15. Test all four wheels to see if they roll freely.
16. You can lengthen or shorten the wheelbase (distance between the centers of the front and rear wheels) by choosing different corrugation holes for the axles. Roll the car to see how it performs for each axle setting.
17. After deciding on the best wheelbase, place the motor on the cardboard chassis. Add a spacer using another piece of cardboard ❾ to elevate the motor so that the teeth of the pinion gear engage with the teeth of the gear on the axle ❿. Attach the spacer to the chassis with strips of tape along the edge or a loop underneath.
18. With the gears engaged, attach the motor to the chassis with a couple of strips of transparent tape. Make sure the motor is anchored firmly to the chassis.

Testing Gear Drives

1. Temporarily attach a solar cell on the chassis next to the motor with a loop of transparent tape.
2. Attach the wires from the motor to the solar cell by twisting the bare leads together. If the bare leads are not at least 0.5 cm, remove more insulation with wire strippers.
3. Test in full sunlight. Cover the solar cell with a cloth or paper towel until ready to test. Uncover the solar cell and note the direction the car moves. Is it front-wheel or rear-wheel drive?
4. If you reverse the motor leads to the solar cell leads, the motor's shaft will turn in reverse, making the car move in the opposite direction.
5. You can time your chassis-only car on a sunlit 5-meter straight track to see whether front- or rear-wheel drive delivers the lower elapsed time (ET) (i.e., the higher speed).
6. You may also replace the gear on the drive axle with the larger-diameter flat gear and then test again. Note which drive gear yields a lower ET and be sure to use that one on race day.

Day 2: Design Activity—Alterations, Testing, and Competition

1. Each group will disassemble their chassis prototype and design a new car that includes a new chassis and a body. The new chassis may be as long as 8.5 inches (limited by the need for corrugation holes for axle placement) or it may be shorter than the 6-inch prototype. A group may custom fit the body over the chassis using thin cardboard, construction paper, or file folders. Consider aerodynamic body shapes that reduce drag. The solar cell must be located on the car's body so that the sun strikes the cell at the most efficient angle determined in the Energize Activity. (The sun's position in the sky at the time of the competition will govern placement of the solar cell for maximum voltage.) Hook-and-loop fasteners or loops of transparent tape may be used to attach the solar cell to the car body.
2. Each group must have teacher approval for the chassis and body design before building and testing.
3. Be creative and artistic with your body design. Your teacher will judge your design.
4. Your group will have three runs on the 5-meter track. The lowest ET of the three runs will be the official time for your car.
5. Using the lowest elapsed time, your group will calculate the speed in meters per second and miles per hour.

Day 3: Design Judging and Group Presentations

1. Submit cars for design judging.
2. Give group presentations.
3. Answer questions and reflect on your design.

Design Guide

1. What is your objective?
2. What additional materials will you need to design a body around the chassis?
3. What procedure will you follow? Describe the step-by-step process.
4. Draw pictures and write descriptions of the car you are designing.
5. How will you perform the tests and collect your data?
6. Will you have to perform any calculations or create any graphs?
7. How will you analyze and present your data?