# Balloon Car Lab

**Arizona Science Standard: Strand 5: Physical Science**

**Concept 2: Motion and Forces**
Understand the relationship between force and motion.

**Performance Objective 4:**
Describe forces as interactions between bodies (Newton's 3rd Law of Motion)

**Time:**

This lab will take 2-5 days, depending on how much time you want to spend on it.

**Learning Goal:**

Students will build a car that is propelled by a balloon. Students investigate the car's motion and explain why the car moves forward while air rushes out of the balloon in the opposite direction.

The balloon car is propelled along the floor according to the principle stated in Newton's Third Law of Motion. The escaping air is the action and the movement of the car in the opposite direction is the reaction. The car's wheels reduce friction and provide some stability to the car's motion. Newton's Third Law of Motion states: For every action, there is an equal and opposite reaction.

**Instructional Objectives:**

1. Students will be able to build and test a balloon car.
2. Students will identify and describe the associated laws of motion.
3. Students will identify action and reaction forces.

**Language Objectives:**

1. Students will read instructions and listen to directions.
2. Students will express their thinking by writing in lab journals.
3. Students will discuss their own ideas in small groups.

**Key Question:**

How does a balloon cause a car to move? In which direction will the car move?

**Materials to build the Balloon Car:**

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|---|---|
| Lab Handout | 2 Axles |
| JetToy Chassis Pattern | 2 Wheels |
| Ballpoint Pen | Hole punch |
| Ruler | Balloon 9" or 12" (Depends on space for testing) |
| Scissors | Rubber band |
| Masking Tape | 4" piece of ¼" ID Latex Tubing—use any flexible tubing students can **<u>easily</u>** remove from the balloon pump. (Check for allergic reaction to latex) |
| Scotch Tape | |

**Building the Balloon Car:**

The student is expected to:

(A) work with a partner;
(B) use only the parts in the baggie and the materials in the lab tray to build their Balloon Car;
(C) carefully follow the directions on the handouts to build the balloon car--no modifications at this time; and
(D) run practice tests with cars in the back of the room.

**Test Day: (Day Two)**

Students will perform three tests for distance and record all three in their lab journal. The three can be averaged or the best of the three can be recorded. (Teacher decides)

**Rubric:**

Teacher will establish the rubric for grading. Example: Give so many points per meter. This will also depend on the size of the balloon used. I have a nice 10 meter space, so I use a 9" balloon.

I have a meter tape laid out across the floor and I tell each student their distance and points for that trial. I make it worth 50 points—5 points per meter. With the meter tape laid out I can tell exactly where the car stopped. Example: A student's car stopped at 8.6 meters which would equal 43 points.

**Explain:**

Students will use lab journals to explain the answers to the following questions:

1. What makes the car move forward? **The air rushing out of the balloon makes the car move forward. This air is the force that sets the car in motion.**

2. In which direction is the car moving? **The car moves forward.**

3. In which direction is the air that rushes out the balloon moving? **The air is rushing out of the balloon opposite to the car's direction of motion.**

4. What are some variables that we discussed in class that can be manipulated to improve the car's speed? **We can manipulate the mass of the car and the force by adding more than one balloon.**

5. The teacher writes Newton's Third Law of Motion on the board and explains that the balloon car demonstrates this law. The teacher also labels the two forces as either the action or the reaction force.

   Balloon cars use the principle of Newton's third law in the same way that rocket and jet-propelled vehicles do. Before it is inflated, a balloon exerts no force on the relatively few molecules of air it contains. As it is inflated, however, more and more air molecules crowd into it, increasing the balloon's internal pressure and causing it to expand. As the rubber of the balloon stretches, it applies an increasing amount of force on the air inside. When the balloon is released, the air escaping from the balloon pushes against the air just outside the balloon. As the third law predicts, the outside air pushes back on the escaping air, propelling the balloon car forward.

   Just as all vehicles rely on Newton's third law to propel them forward, the forward motion they create (or harness, in the case of wind-propelled vehicles) must counteract the forces that resist forward motion, namely friction and drag. Although these forces cannot be eliminated, at least not on Earth, intelligent vehicle designs can reduce them considerably. Wheels, for example, are probably the simplest way to reduce friction on land. The more easily and smoothly they roll, the more of a vehicle's force will be applied to forward motion and the faster and farther it will travel.

**Elaborate: (Day Three)**

In lab groups, students brainstorm five everyday situations where Newton's Third Law of Motion applies. Each group will draw these situations on poster paper and present these situations to the class. For each situation, students need to explain the action and reaction forces and how Newton's Third Law applies. Students may choose to present through demonstrations, pictures, PowerPoint presentations, etc.…

**Evaluate:**

Students are evaluated on the accuracy of their explanations. Their explanations must be accurate and demonstrate an understanding of Newton's Third Law of Motion.

**Race Day: (Day Four)**

Students test their cars for speed, using new balloons. Again, they have three trials and record the information in their lab journals. I usually do the timing and have students record their time and distance for each trial. After all students have calculated their speed, then students race against each other. I usually give a prize, a large candy bar, for the top three and blow pops for everyone else.

**Modifications: (Day Four & Day Five)**

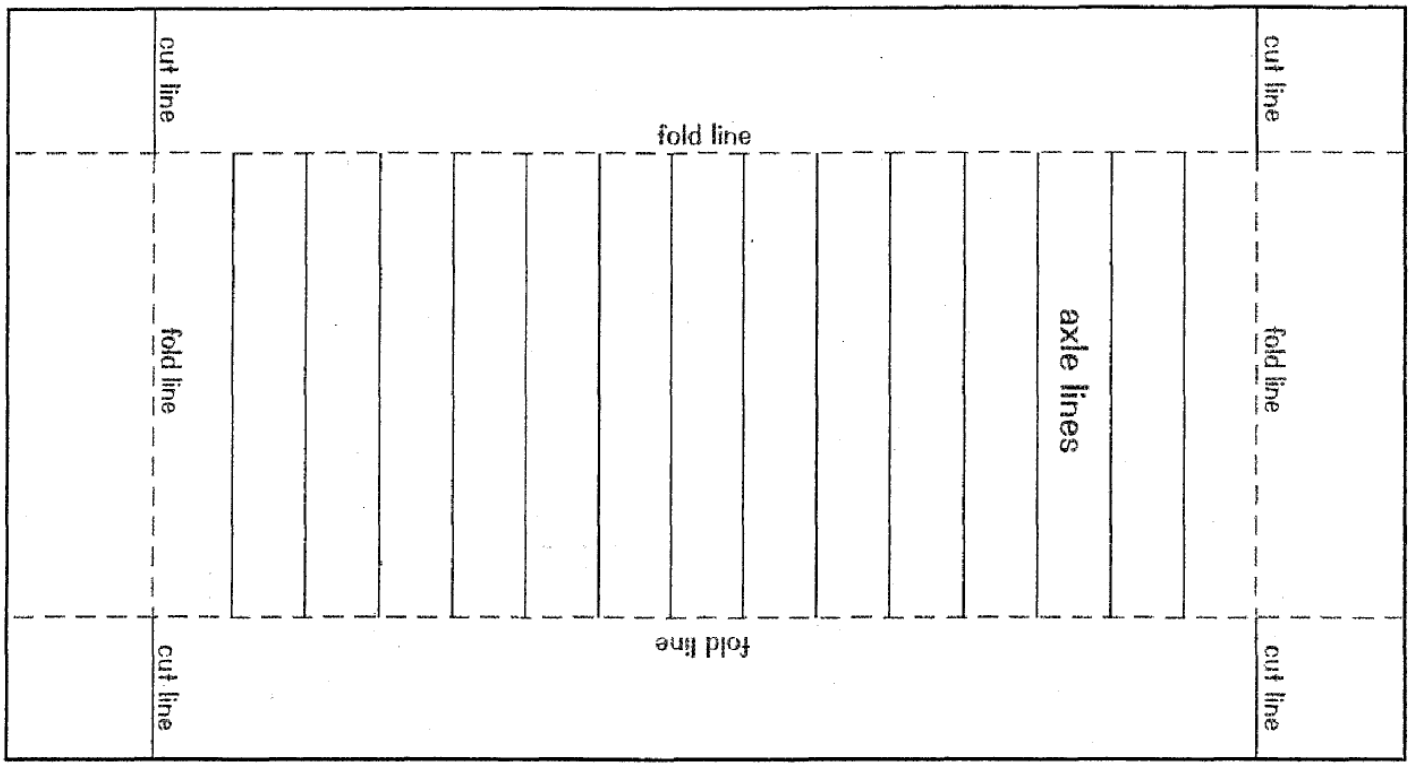
Students always want to make modifications so their cars go faster or farther. I let students do this on the last day. Some will add mass, others will make the car have dual exhaust—two tubes and balloons, and I have had students attach straws to the base and come up over the balloon like an arch—adding a little mass and supporting the balloon so it does not flop around.

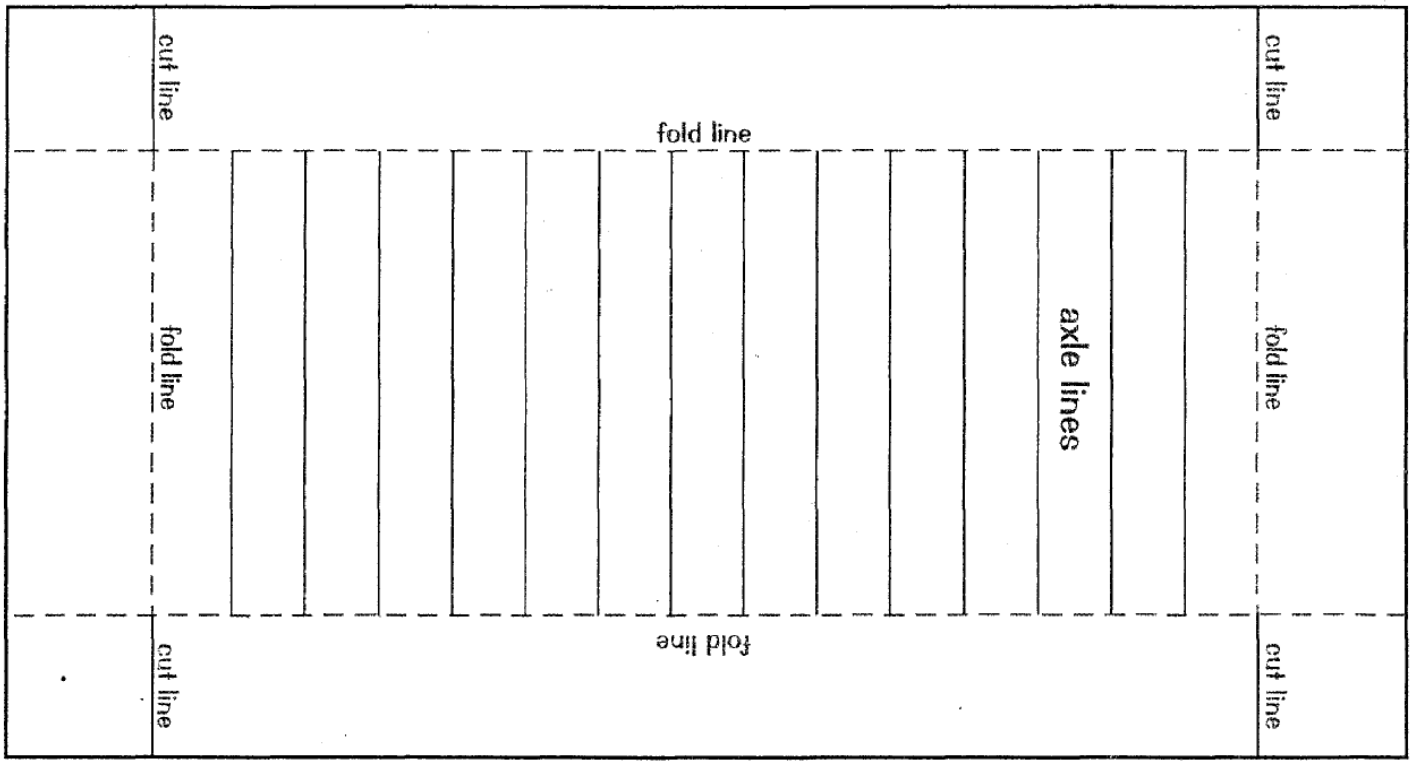
This year I will make a car with two tubes and balloons, one on each end. This would be a great way to demonstrate balanced, unbalanced, and net forces. I will have to experiment with balloon sizes and have someone help me demonstrate it.

**Resources:**

The JetToy Chassis Pattern, Building the JetToy Chassis, and Assembling the Axles and Wheels are all from the Society of Automotive Engineers, Inc. 2000.

# JetToy Chassis Pattern



# Building the JetToy Chassis

**Materials**

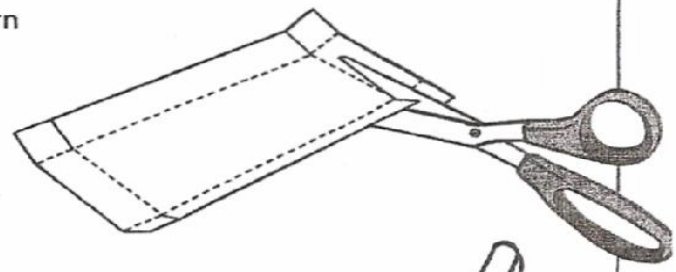
- JetToy Chassis Pattern
- scissors
- ballpoint pen
- masking tape

**Procedure**

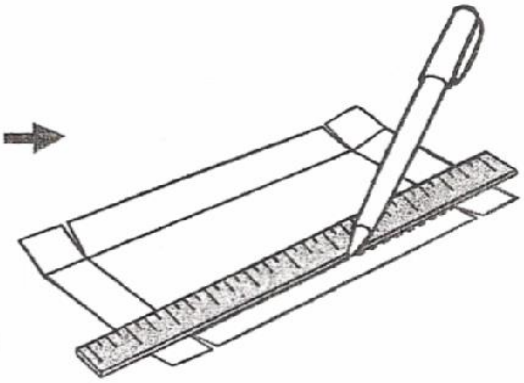
1. Every other team, get a JetToy Chassis Pattern. Cut the two chassis apart and give one to another team.

2. Each team, cut out the JetToy Chassis Pattern outline along the solid outer lines.

3. Cut the "cut lines" at the corners. Be careful that you don't cut too far.

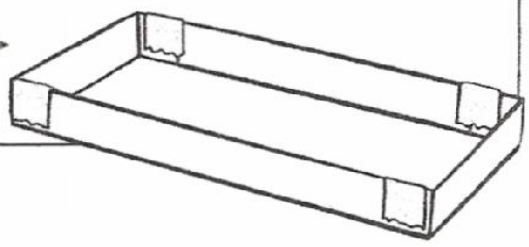


4. Use a ballpoint pen to draw a very heavy, deep line over each of the dotted fold lines. Press the pen hard back and forth to score the paper to make it easier to fold.



5. Fold down the four sidewalls on the scored lines. Make sure that the axle lines are showing on the outside of the chassis.

6. Use small pieces of masking tape to carefully attach all the flaps inside the chassis.

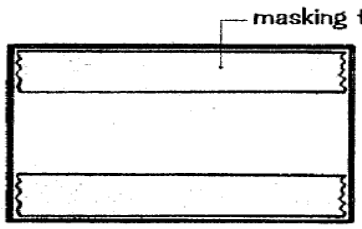


# Assembling the Axles and Wheels

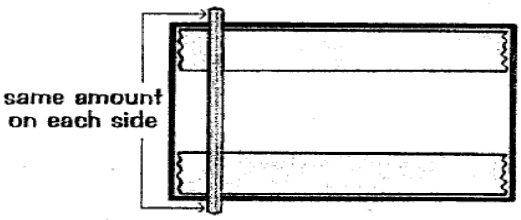
**Procedure**

1. Cut 2 axle bearings from a drinking straw. Each bearing should be exactly 7 centimeters long. Make sure that the cut edges are straight and not jagged.

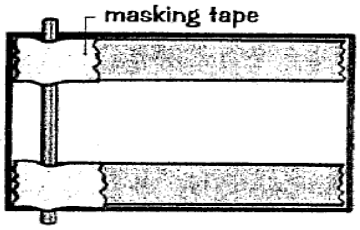
2. Put two strips of masking tape along the side of the chassis.




3. One team member can line up an axle-bearing with one of the axle lines. Center the bearing so the same amount extends on each side of the chassis.



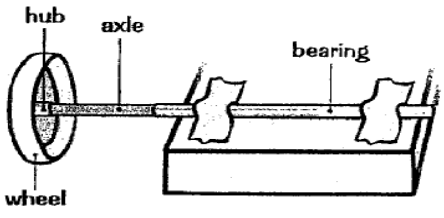

4. Another team member can tape the straw in place. Put the tape over the tape already on the chassis.



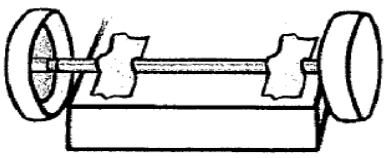

5. Repeat steps 3 and 4 to mount the other axle bearing.

6. Carefully push an axle stick into the hub of one wheel, then insert the stick into the axle bearing.

7. Carefully push a wheel onto the other end of the axle.




8. Repeat this procedure to make the other wheel assembly.



# Attaching the Tubing and the Balloon

1. Place a small piece of masking tape over one end of the chassis. Place the tape in center covering the inside and outside of the end piece.

2. Use a hole punch to punch a hole through the center of the tape. This is where the tubing will be inserted.

3. Place four or five pieces of masking tape on the inside bottom of the chassis towards the same end where the hole is punched. The tubing and balloon will be taped down across the masking tape.

4. Use the rubber band to attach the balloon to the tubing. Wrap the rubber band around the balloon and tube several times. The rubber band should be tight enough to hold the balloon on, but not too tight to keep the air from flowing.

5. Push the tubing through the punched hole from the inside of the chassis. If the hole is not big enough, punch out a little more, just enough for the tube to fit through.

6. Pull the tube so that one to one-and-a-half inches of tubing hangs outside of the chassis.

7. Tape the tubing down across the masking tape.

8. Use a balloon pump to blow up the balloon.

9. Pinch the tubing to hold the air in and pull the tubing off the end of the balloon pump.

10. Place the balloon car on the floor, center it, and release the tubing.

## Troubling Shooting

1. Make sure the axles are centered and taped down securely.

2. Make sure the same amount of axle sticks out on both sides of the chassis.

3. Make sure the wheels are securely attached.

4. Make sure the tubing and balloon are securely attached.

5. Experiment with the amount of air to put in the balloon.