4 wheels good, 2 wheels bad

**Purpose:** To distinguish between pressure and force

**Materials:**
- Automobile
- 4 sheets graph paper (12” X 18”)
- Pencils
- Tire Pressure Gauge (psi)

**Discussion:**
It is very common for people to confuse the two words force and pressure. Tire manufacturers will add to this confusion by saying, “Inflate to 45 pounds” when they really mean “45 pounds per square inch.” It is the force of friction that wears out a tire, and it is the pressure that is low when the tire needs more air. The pressure on your feet is painfully more when you stand on your toes (or your high heels) than when you stand on your whole feet, even though the force of gravity (your weight) stays constant. The amount of pressure depends on how a force is distributed over a certain area. It decreases as the area increases.

\[
\text{pressure} = \frac{\text{force}}{\text{Area}}
\]

In this activity you will measure the pressure and the area of contact of the tire of an automobile on the ground. With this data you can estimate the weight of the vehicle by computing the amount of force the tire exerts against the road.

\[
\text{force} = \text{pressure} \times \text{area}
\]

**Procedure**

1. Position the 4 pieces of graph paper in front or below the tires. Roll or place the automobile onto the paper.

2. Trace the outline of the tires where they make contact with the graph paper. Roll or lift the car off the paper. Compute/Estimate the area inside the tracings (Each box is 0.25 in\(^2\)). Record your data using the data table below.

3. Use a tire gauge to measure the pressure in each tire in pounds per square inch (psi) Record your findings in the data table.

4. Compute the force each tire exerts against the road using force = pressure x area. Use the data table to organize your results.

5. Find the weight of the vehicle from another source. The driver’s side door will usually have a label with the Gross Vehicle Weight (GVW) listed in pounds. Many dealerships will also know the weight of the car.

<table>
<thead>
<tr>
<th>Tire</th>
<th>Pressure (psi)</th>
<th>Outline Traced on paper (in(^2))</th>
<th>Force (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Front</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Front</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Rear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left Rear</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Total Force = |

Notes: Don't worry about the gaps in the tire where the tread isn't. The air inside the tire presses down on the smooth interior wall of the tire, the uneven exterior tread is irrelevant.
1. How does your experimental value compare to the known weight of the auto? What is the % error you found?

2. How might the owner’s manual value for the weight differ from what you found as the actual weight of the car?

3. Why is it important, in terms of pressure to have good tread on your tires—particularly in rainy weather? (It may help to think of the Goodyear® Aquatread™ design)

4. A tire gauge measures the difference between the pressure in the tire and atmospheric pressure (14.7 psi) outside the tire. What is the total pressure inside a tire?

5. Draw and label two detailed free-body diagrams using numbers (units in pounds) to indicate relative magnitudes for each type of force. One of the car itself, and one of an individual tire.

6. Why do large trucks have so many tires (18-wheelers)? What would you speculate as to the pressure of the tires on these “big rigs”? You may assume the average weight of a truck is more than 15,000 lbs.