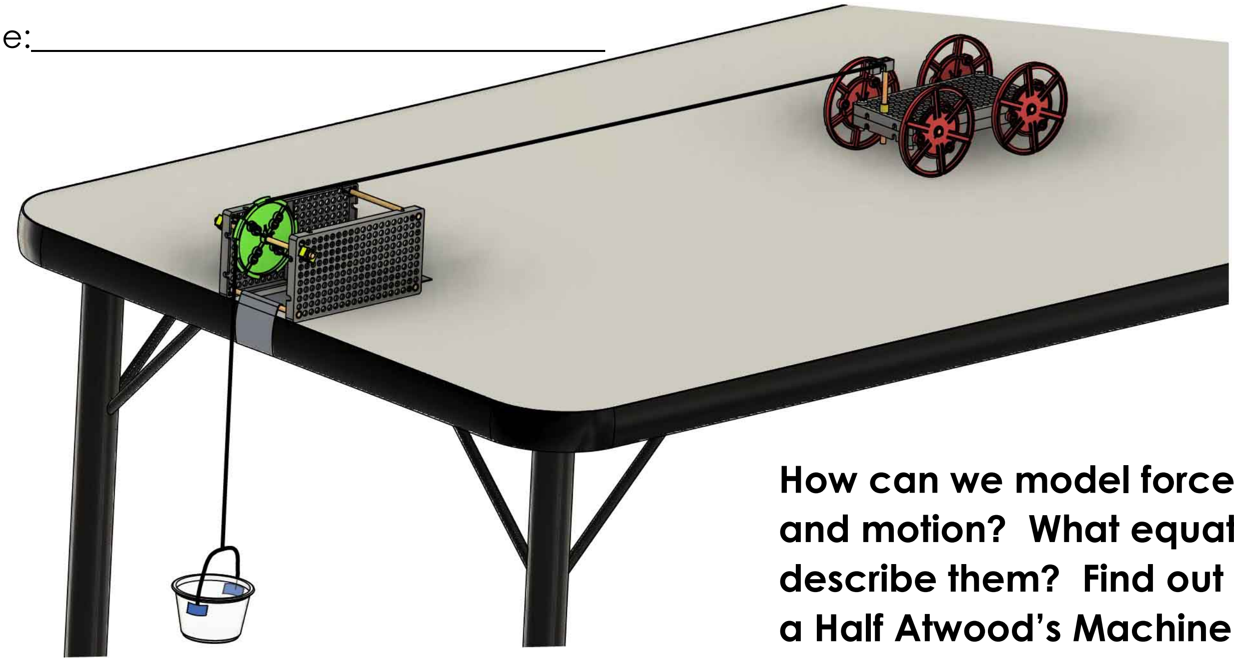
ATWOOD'S MACHINE LAB

Name:______________________________________

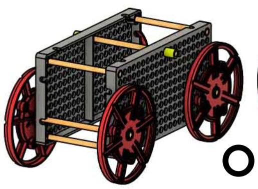


How can we model forces and motion? What equations describe them? Find out with a Half Atwood's Machine!

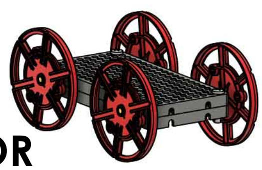
LAB SUPPLIES

For instructions on assembling your Car or Half Atwood's Machine, go to **teachergeek.com/learn**

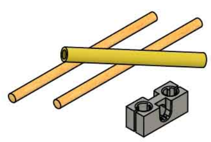
TeacherGeek Parts



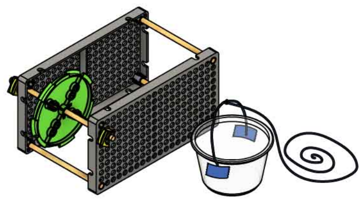
OR



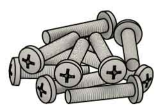
"Built" TeacherGeek Car
from Sail Car, Electric Race Car, or Rubber Band Racer.



Spare Parts
to make minor modifications to your car.



Half Atwood's Machine
TeacherGeek machine pictured; any will work.



10x Screws
or 3-5 gram weights.

Other Supplies

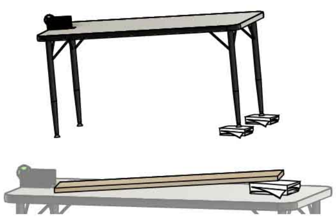
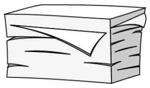
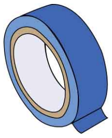


Table or Board
to create a slightly declined ramp.



Index Cards
to prop your table.

Scale
grams/ounces



Tape

Motion Sensor

OR

Measuring Tape

&

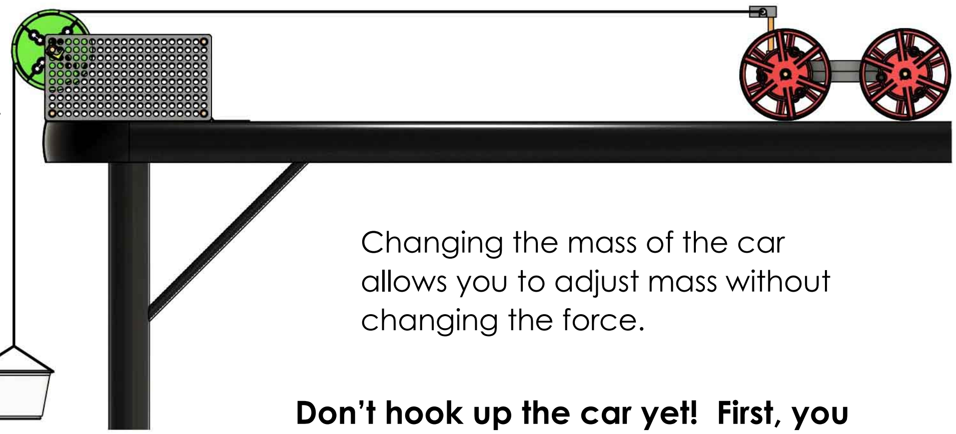
Stopwatch

HOW IT WORKS

Atwood's Machines let us study the motion of a car under a constant force.

Hanging weights over the pulley applies a constant horizontal force to the car.

Adding or subtracting mass from the hanger changes the force on the car.

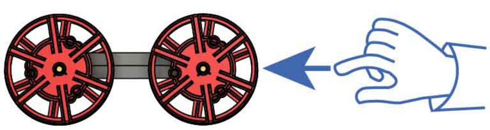


Changing the mass of the car allows you to adjust mass without changing the force.

Don't hook up the car yet! First, you need to calibrate the Atwood's Machine.

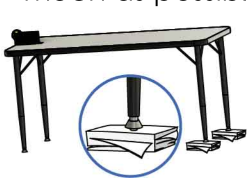
CALIBRATE THE TRACK

1. Make a prediction: If you **softly push** the **car**, will it move at **constant velocity?** Or will it **slow down?** Test it.



2. You should see **friction slowing your car**. To continue our investigation, we need to **eliminate the *effects* of friction**. We cannot get rid of friction, so we will gravity to balance it out.

3. Use a ream of paper or index cards to **incline one side of your track**. Incline as much as possible without your car moving.



If your pulley isn't already attached, you will attach it on the next page.

4. **Softly push your car** again. You want it to move across the track at **constant velocity**.

The slower your car moves, the easier it is to see if velocity is constant.

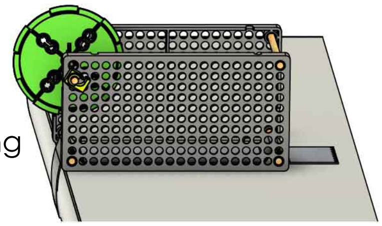
5. **Adjust the track up or down** until your car moves with constant velocity.

Tip

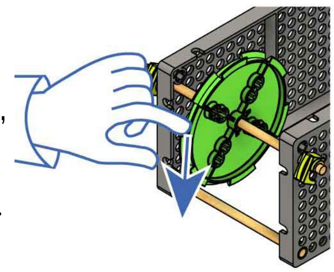
For the best results, use a sensor to graph velocity and make sure velocity is constant.

TEST THE PULLEY

6 **Tape** the **pulley frame to** the **table**, with the edge of the pulley extending beyond the table.

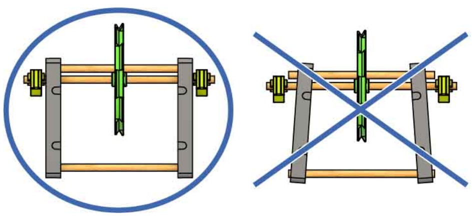


7 Spin your pulley to **make sure it spins freely**. A solid 'flick' should make it spin for 8 to 10 seconds.

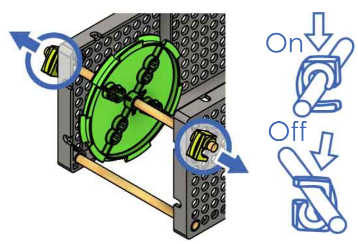


If your pulley does not spin freely, try these fixes:

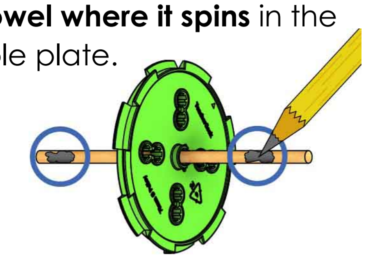
Make sure your **hole plates are parallel** and your **dowel is straight**.



Pull the **stop clips away** from the hole plates.

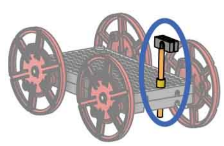


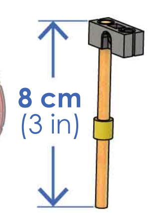
Use a **pencil to lubricate** the **dowel where it spins** in the hole plate.



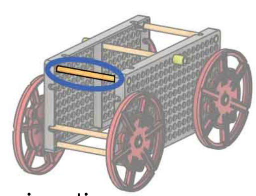
ATTACH THE CAR

8 **Tie** the **string to your car 10 cm** (4 in) **above** the **track**.

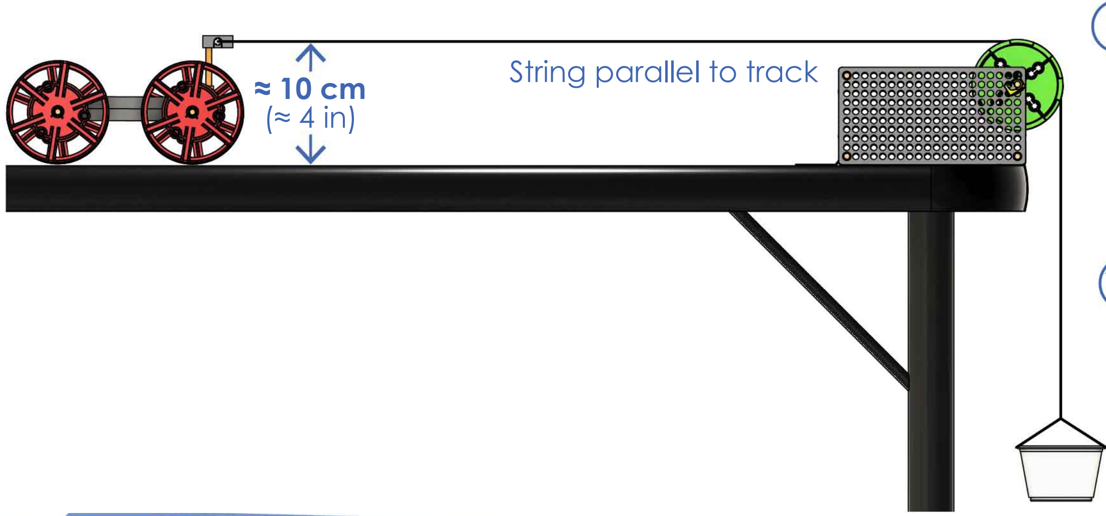




A If using a Sail Car, modify as shown.



B Otherwise, tie string to this dowel.

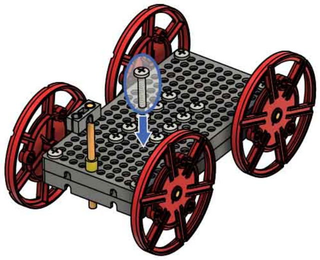


9 **Hang** the **weight hanger over** the **pulley**. Adjust so the **string** is **parallel** to the **track**.

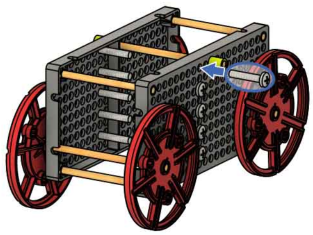
10 **Test it out!**
The empty weight hanger should pull the car down the track.

MAKE OBSERVATIONS

11. **Slide 10 screws into** the **hole plate** of your car. These will let you adjust the car's mass.

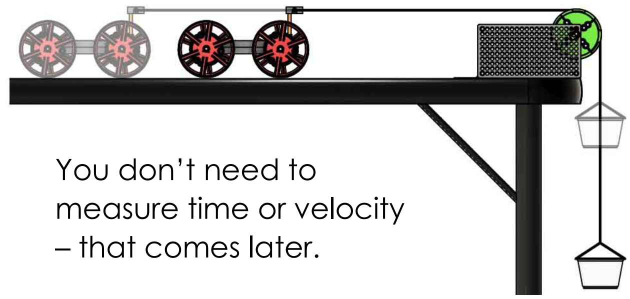


Sail Car



Electric Race Car or Rubber Band Racer

12. Use the Atwood's machine to **accelerate the car** down the track.

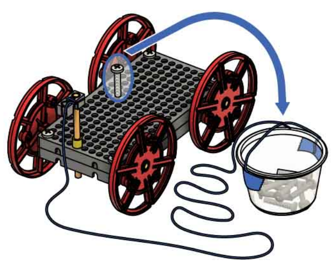


You don't need to measure time or velocity – that comes later.

13. **List all the objects that were accelerated** when you sent the car down the track.

14. Predict **what will happen if you move screws** from the car **to the weight hanger**.

15. Now **move all 10 of the screws from the car to the weight hanger** and send it down the track again.



16. Was your **prediction correct?** Explain.

17. When you moved the screws from the car to the hanger, **did you change the mass being accelerated?**

18. **What variables(s) *did change*** when you moved the screws?

PLAN YOUR EXPERIMENT

What relationship will you investigate? Circle one.

Acceleration vs Mass OR **Acceleration vs Force**

19 **What variables** do you need to **keep track of?**

Independent Variable(s)	Dependent Variable(s)	Control Variable(s)

20 **How will you measure** (or calculate) **these variables?**

Mass	**Acceleration** (circle one)	Force
	Use Sensors OR Calculate Using $d = v_i t + \frac{1}{2} a t^2$	

21 **Describe your procedure**:

____
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22 **Get instructor approval** before moving on to your experiment.

Instructor Approval: ______________________________

DATA & CALCULATIONS

23 **Complete your experiment**, recording data, calculations, tables, graphs, etc. in this section. Be sure to **show all work for your calculations**. If you run out of room, continue on a separate paper.

EVALUATE YOUR RESULTS

24 Newton's 2nd "Law" states that $\Sigma F = ma$ (when mass is constant). Using this "Law," **calculate the theoretical acceleration** for your car for each of your trials. **Show all work.**

25 Compare the theoretical acceleration (from Step 24) to your measured acceleration (from Step 23) by **computing the percent error. Show all work.**

$$(\%\,Error) = \frac{(Measured\ Value) - (Theoretical\ Value)}{(Theoretical\ Value)}$$

CONCLUSION

26 **Describe all the forces** that acted on your car.

27 What variables did you measure and **what was their mathematical relationship?** (Proportional, inversely proportional, quadratic, inverse square?) How can you tell?

28 **Does your data support Newton's 2nd "Law"** ($\Sigma F = ma$)**?** Reference your percent errors in your explanation.

29 What were some possible **sources of error?**

30 **How will** your experiences from **this lab help you create a better design** for your engineering challenge?