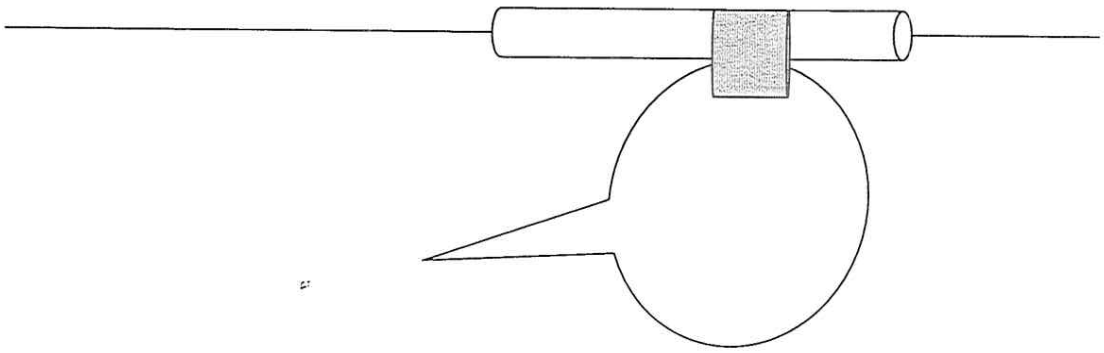
Activity 2.4: "Modeling the Motion of a Rocket"

We are going to ***model*** the motion of a rocket by using a balloon. A model is not the real object (a rocket in this case) but some of the model properties are similar to those of the real object. A model helps us study more easily certain properties of the real object. This is especially useful when the real object is inaccessible.

The principle behind any rocket is propulsion motion. This could be explained in simple terms as motion due to recoil. When gas streams out of a rocket it produces the thrust that moves the rocket in the opposite direction. A rubber balloon can be used as an illustration or model of such process. Similarly, when air gets out from an untied balloon it produces thrust and the balloon moves in the opposite direction. The only difference is that the stream of air coming out of a balloon keeps changing directions and the balloon bounces from side to side. To direct the motion of the balloon we will use a light string drawn through a soda straw which is attached to the balloon by a piece of tape.



It is obvious that gravity will affect the motion of a balloon (rocket). But how large will this effect be? The answer to that question is the goal of this experiment. The answer must be quantitative. This means that during the discussion you will compare the distances balloons of same weight travel in the horizontal and the vertical directions. Then analyze the differences to see if there is a pattern. At the end, in conclusion, estimate the ratio of the change in distance for each additional weight due to gravity.

Problem:

How large will be the effect of gravity on a balloon's (rocket) travel?

Hypothesis:

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To answer this question a balloon needs to be released horizontally first to see how far the balloon will go while excluding the effect of the gravity. In the second experiment we will release the balloons vertically to maximize the effect of gravity (no support from the string in this case). The conclusion will be made based on the comparison of the distance reached in these two cases. For both experiments we will keep the same amount of the air in the balloon but we will increase the mass of the balloon by attaching increasing weights (to increase the force of gravity).

Materials: Straw, tape, spool of string, balloon, scissors, measure tape.

Procedure:

1. Draw the string through the straw.
2. Blow 3 blows into the balloon but do not tie it, just keep it closed.
3. Attach the straw to the balloon by taping it over, closed end facing the spool.
4. The partner holding the balloon takes the spool and stretches the string 30ft.
5. While holding the string tight release the balloon.
6. Measure and record the distance traveled by the balloon.
7. Repeat steps 2 – 6 two more times and calculate the average.
8. Repeat steps 2 – 7 but each time tape increasing weights to the bottom of the balloon.
9. Repeat steps 2 – 8 using exactly the same weights but stretching the string vertically. (One of the partners needs to step on a chair)

Experimental Results:

A. Horizontally.

Number of blows *(const)*: 3

Mass attached to balloon, grams. *(manipulated.)*	Distance traveled by balloon, meters. *(responding)*			
	Trial #1	Trial #2	Trial #3	Average

B. Vertically.

Number of blows *(const)*: 3

Mass attached to balloon, grams. *(manipulated.)*	Distance traveled by balloon, meters. *(responding)*			
	Trial #1	Trial #2	Trial #3	Average

Discussion and Conclusion:

Discuss how the distance traveled by the balloon was affected by additional weights for the motions in both directions. Then compare the changes in vertical (max. gravity) and horizontal (min. gravity) distances traveled by the balloon as the same additional weights were added. Finally make a conclusion about the effect of gravity based on this comparison. Review your hypothesis. Make suggestions/comments as to how a real rocket must be designed.