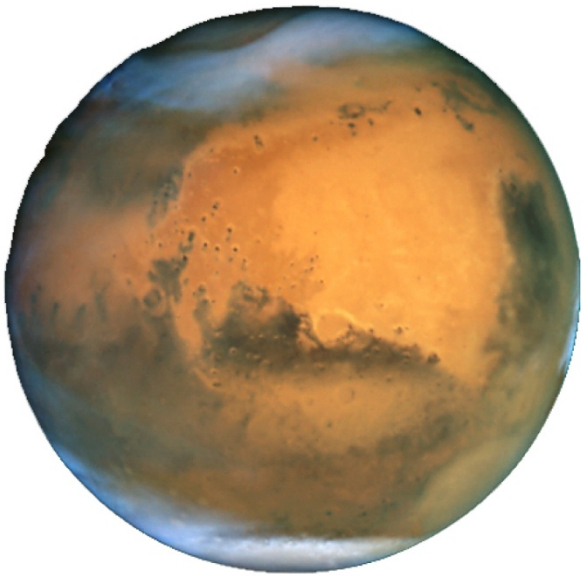


MISSION TO MARS

A Hands-on Application of Newtons' Second Law of Motion

by Thomas Sarradet

INTRODUCTION

The purpose of this lesson is to teach middle school students how to apply Newton's Second Law of Motion, **Force = Mass x Acceleration** to alter the flight path of their compressed air model rocket. The students will also gain teamwork experience.

TIMEFRAME

Day 1 - Introduction of the lesson, Classroom

1. Introduce the lesson to the class.
2. Allow students to pick teams of two. If there is an extra student, allow one team to have three students.
3. Give a demonstration of rocket construction.

Day 2 – Rocket construction, Classroom

1. Pass out building materials to each team: one student handout, 2 pairs of scissors, 1 ruler, 1 glue stick, one piece of typing paper, one Mars Rocket parts template on stock paper.
2. Have available to students if needed: Clear tape.
3. Guide the class in building the model rockets.

Day3 – Rocket launches, Athletic field.

1. Bring the class to the athletic field and set up launcher and target.
2. Conduct at least one launch per team, more if time permits.

Day 4 – Rocket launches, Athletic field.

1. Bring the class to the athletic field and set up launcher and target. Change the location of Mars and/or the launch angle to keep it competitive.
2. Continue to launch as time permits.
3. Collect completed student worksheets.

Day 5 – Discussion and assessment, Classroom

1. Announce winners, interview winners
2. Compile data from all launches and discuss trends and predictions.

TO: NASA Astronaut Team

FROM: Director of Mars Exploration

National Aeronautics and Space Exploration

Greetings Brave Space Pioneers!

The President of the United States has just authorized one bazillion dollars for the purpose of putting Americans on Mars by the end of the week. You and your partner have been selected as candidates to represent the Unites States on its first Mars mission.

Your first task is to build a rocket that will get two astronauts (that's you two) to the mysterious red planet. Due to the president's commitment to cleaner fuel, your rocket must only be propelled by compressed air.

Once all astronaut teams have completed the construction of their rockets, NASA will hold a competition to pick the team that will have the highest possibility for success. A working knowledge of Newton's Second Law of Motion will come in handy for your team. The closest to the Red Planet wins!

Good luck!

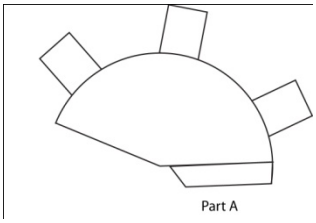
Werner von Goddard-Oberth

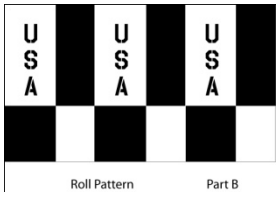
Director

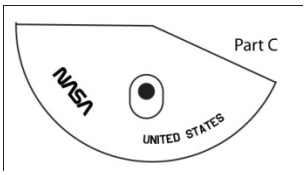
MARS ROCKET CONSTRUCTION

Materials: One sheet of typing paper for the airframe, one Mars Rocket Template Sheet on card stock paper, 12 inch section of ¾ inch PVC pipe, glue stick, ruler, two pairs of scissors, clear tape, scale

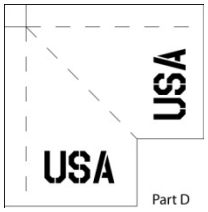
Step 1 Preparing the Parts: While one team member cuts out parts **A, B, and C**:

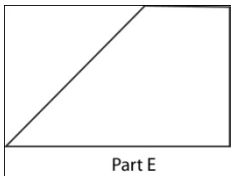


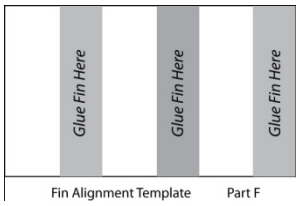




The second team member cuts out parts **D (x 3), E (x 3), and F**:



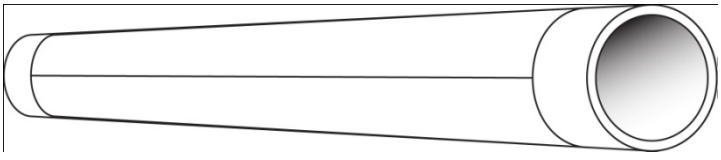




Step 2 Making the Airframe: Carefully roll the typing paper lengthwise around the ¾ inch PVC pipe without any glue. Do this several times until the paper starts to curl.

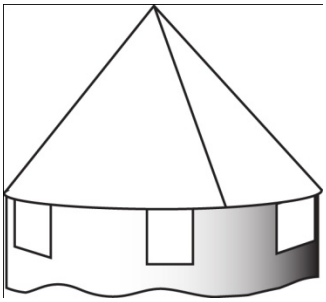
a) Curl the paper one more time but stop when the edge of the paper is on top of the pipe.
b) While one team member holds the paper in place, the other member applies glue from the glue stick along the entire edge of the paper.
c) Roll the paper evenly around until the glued edge makes contact with the paper. Continue to roll until about two inches of paper remain.
d) Apply glue to the edge of the paper and then continue rolling the paper until the applied glue makes contact.

The airframe should be snug but easily slides along the pipe. If it is too loose, the rest of the rocket parts will not fit properly. If it is too tight, the rocket will not be able to launch. If you are not satisfied with the airframe, make a new one.



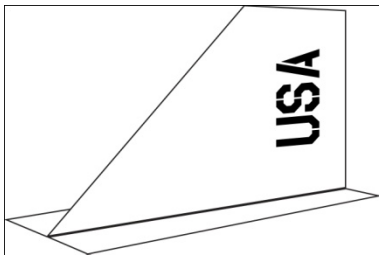
Step 3 Assembling and Attaching the Nose Cone and Roll Pattern:

While one team member works on Step 3, the second team member can work on Step 4, Assembling the Fins.



a) Curl **Part A**, the nosecone several times to shape it. Once it stays curled, apply glue to the **Tab a** and on the inside of the cone where the tab will attach. Attach **Tab a** and hold it in place for a minute until the glue sets. Make sure that the cone keeps its shape. If needed, place a small piece of tape to secure the tab in place.
b) Slide the typing paper until it is flush with the edge of the pipe. Apply glue to **Tabs b, c, and d** and attach the nose cone to the airframe. Make sure that the cone is straight. After waiting a minute to allow the glue to set, apply a piece of clear tape over the tabs.
c) Roll **Part B**, the roll pattern around itself until it retains a curved shape. Apply glue to the back of it and attach it to the upper edge of the airframe so that it covers **Tabs b, c, and d** of **Part A,** the nose cone. Hold the edges down for one minute until the glue sets. Apply a small piece of clear tape if needed.
d) Curl **Part C,** the capsule shroud, with your fingers until it retains its shape. Apply glue to the inside of the shroud and attach it over **Part A**. Hold it in place for a minute while the glue sets. If needed, place a small piece of clear tape on the seam to hold it in place.

Step 4 Assembling the Fins



a) Using a ruler, fold each fin, **Parts D** along the center dotted line. Make sure that the two halves of the fin are aligned before creasing the edge with your fingers. Using the ruler, bend the two tabs of each fin outwards so that the fin can stand up on the table.
b) Apply glue to both sides of each fin's inside area (BUT NOT ON THE TABS), place **Part E,** the fin stiffener inside fin, and then press the fin sides closed around the stiffener. Shape the fin tabs by pressing the fins onto the table until the tabs lay flat. Repeat for each of the three fins. While the fins are drying and once the first team member is finished with Step 3, move on to step 5.

Step 5 Attaching the Fins

a) Curl **Part F**, the fin alignment template, until it retains its shape.
b) Apply glue to the inside of **Part F** and attach it to the bottom edge of the airframe. Hold it one minute or until the glue sets.
c) Apply glue to the underside of the fin tabs. Attach the fin onto Part F so that the tabs cover the shaded areas. Make sure that the fin is properly aligned. Repeat for each of the three fins.
d) Check the alignment of the fins.

e) Write the team member names and team number on the airframe.
f) Carefully remove the rocket from the pipe, making sure that the airframe is not bent during removal.
g) Weight rocket in grams on the scale and write the weight on one of the fins.

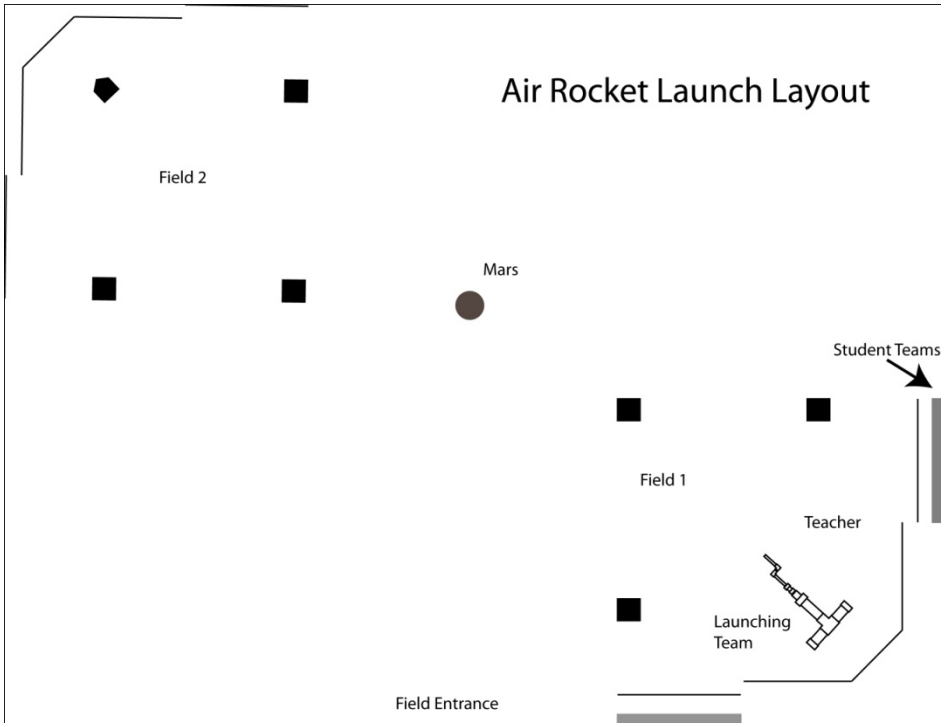
MARS ROCKET MISSION

Materials: Student rockets, a teacher built rocket, air rocket launcher, bicycle pump with pressure gauge, large wooden protractor, large red beach ball, measuring wheel, Mars Mission Data Sheet (teacher), Mars Mission Student Worksheet (one for each team), pencil or pen for each team.

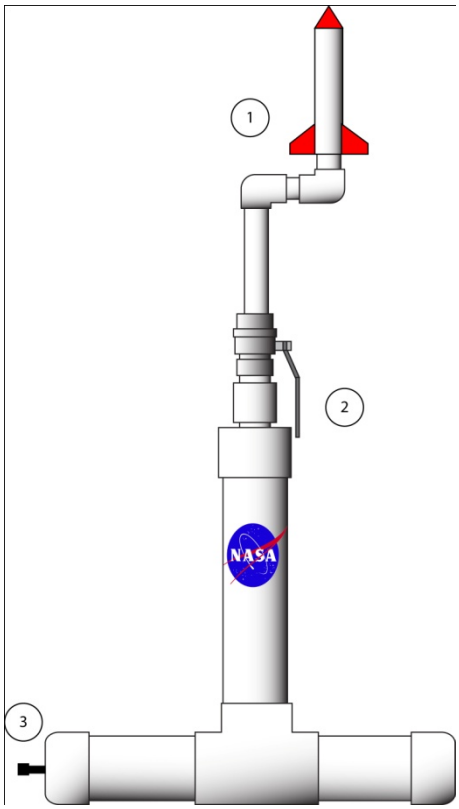
IMPORTANT NOTE TO TEACHER: Please carry the launcher to and from the field yourself. If it is dropped, it may be damaged and no longer safe to use.

Setup:

1. Place the launcher on the home plate on the softball field nearest the entrance to the field and pointing in the direction of center field.
2. Only one team is allowed at the launcher at a time. All other students should be seated in the dugouts.
3. Using the measuring wheel, place the ball representing Mars 50 meters (165 feet) from the launcher in the direction of the other baseball field. FOR SAFETY, DO NOT LAUNCH ROCKETS IF THERE ARE STUDENTS WITHIN 30 METERS OF THE TARGET.



Launching:



1. The teacher's rocket is launched first in order to give the students a starting point in their calculations. The psi is set low so that the rocket will not reach the target. To launch the teacher's rocket:
    a. Set up the teacher's rocket on the launcher and adjust the launch angle to 70 degrees (1).
    b. Set the launch handle to the upright position (2).
    c. Attach the pump to the launcher (3) and pump to 1 BAR. Announce to the students these settings so that they can write them on their launch sheets for reference.
    d. Give a five second audible countdown.
2. Launch rocket
3. Using the measuring wheel, measure the distance of the rocket from the launcher. Announce the distance to the students and help them to figure out the distance in percentage.
4. Have each team come up and launch attempt using these procedures:
    a. Based on the result of the teacher launch, each team will determine how much air pressure to use using the Formula F = MA. Using the instructions found on their student worksheets, they will make the calculation based on the additional distance to travel to Mars in a percentage and then figure out the additional percentage of pressure to add.
    b. The team may pump the launcher to no less than 1 bar and no more than 3.5 bar.
    c. This data must be entered in their launch sheet.
    d. The team may keep their settings secret from the other teams or they may share them if they wish.
    e. The next team must wait until the team before them has cleared the launch area.
4. Once all teams have made a launch, measure the distance from Mars to each rocket. Rank the teams in order of nearest to farthest.
5. If time permits, allow students a second launch.

Mars Mission Class Data Sheet															
Launch	Angle			bar			Distance Traveled			Distance from Mars			Rank		
Launch #	1	2	3	1	2	3	1	2	3	1	2	4	1	2	3
Teacher				1											
Team 1															
Team 2															
Team 3															
Team 4															
Team 5															
Team 6															
Team 7															
Team 8															
Team 9															
Team 10															
Team 11															
Team 12															
Team 13															
Team 14															
Team 15															
Team 16															
Team 17															
Team 19															
Team 20															

Mars Mission Teams			
Team	Student 1	Student 2	Student 3 Only one team may have 3
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			

Mars Mission Student Worksheet

Team # ____

Student Names:

_____

_____

_____

_____

F = MA

Launch #	bar	Angle	Rocket mass (g)	Distance Traveled	Distance from Mars	% to Target + or -
	F	**=**	**M**	**A**		
Teacher						
1						
2						
3						
4						

INSTRUCTIONS

Mark where your rocket lands on the line. Determine how much or less compressed air you will need for your next flight to land on Mars by percentage. Remember: **Force = Mass x Acceleration**!