# ROCKET ENGINEERING DESIGN COLLABORATIVE ACTIVITY

<table>
<thead>
<tr>
<th>Role</th>
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| **Physicist (Scientist)** | • Researches science of rockets (forces and motion)  
                              • Identifies pros/cons of design and development choices  
                              • Collects, analyzes, summarizes data in graphs and tables for experiments | • Answers Questions 1, 2 on Engineering Design Packet  
                              • POSTER: Provides data (for example, size of balloons, straws, and load) and scientific explanations for design features |
| **Mechanical Engineer**          | • Creates detailed illustrations of rocket and features (for design process and dissemination)  
                                          • Adjusts design as engineering process dictates                                                       | • Completes Skyscraper Challenge  
                              • Answers Questions 3, 4 on Engineering Design Packet  
                              • Assists with measurements and research  
                              • POSTER: Illustrates 2-3 drawings of design choices and structure blueprint |
| **Aerospace Engineer**                  | • Builds rocket as effective (in terms of size, cost, speed)  
                                          • Conducts experiments to determine quality; adjusts design as appropriate | • Answers Questions 5, 6, 7 on Engineering Design Packet  
                              • Builds rocket  
                              • Participates in class design test |
| **Publicist/Reporter**                   | • Gathers drawings from architect, explanation from scientist, and data from engineer  
                                          • Takes pictures/video of rockets and tests  
                                          • Creates poster/multimedia presentation to disseminate results | • Answers Question 8 on Engineering Design Packet  
                              • POSTER: Takes 3-5 pictures of rockets and tests and group members (if digital assignment)  
                              • POSTER: Leads development of poster/multimedia  
                              • Delivers oral presentation to class |

## PRESENTATION REQUIREMENTS

<table>
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<tr>
<th>POINTS</th>
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<tbody>
<tr>
<td>ON POSTER: Title and Names of group members (Publicist/Reporter)</td>
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<tr>
<td>ON POSTER: Illustrations/photos of rocket features (Mechanical Engineer)</td>
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<tr>
<td>ON POSTER: Data of experiments organized in tables/graphs (Scientist)</td>
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<td>DEMONSTRATION: Shows rocket size, speed, and quality (Aerospace Engineer)</td>
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<td>ORAL PRESENTATION: Reviews all information above (Publicist/Reporter)</td>
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<td><strong>TOTAL</strong></td>
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## Engineering Activity: Balloon Rockets

### Project
- Build a device, propelled only by a balloon, which travels along a string.

### Goal
- Make a balloon rocket that travels farthest.
- Make an egg balloon rocket that carries the most cargo

### Materials
- Various sizes/shapes of balloons
- Large and small paperclips
- Various sizes of straws
- Various types of tapes
- Plastic eggs, scissors, kite string

### Things to Consider
- The friction between the Balloon Rocket and the string
- The shape of your Balloon Rocket components
- The weight of your Balloon Rocket components
- The direction of the deflating balloon
- The shape and size of the balloon and how it changes as it deflates
- The weight of the cargo egg and placement above/below the balloon

### Questions
- What does friction have to do with balloon rocket speed? How can you reduce the amount of friction?
- Which match of straw, tape, and balloon results in the best rocket?
Background Information: Rocket Science

Rocket Design (our rocket navigation is the STRING and STRAW)

- The key elements in designing a rocket are the propulsion system, which includes the propellant and the exit nozzle, and determining the number of stages required to lift the intended payload.
- Rocket navigation is usually based on inertial guidance; internal gyroscopes are used to detect changes in the position and direction of the rocket.

Rocket Propellants (our propellant is AIR)

- The most vital component of any rocket is the propellant, which accounts for 90% to 95% of the rocket's total weight. A propellant consists of two elements, a fuel and an oxidant; engines that are based on the action-reaction principle and that use air instead of carrying their own oxidant are properly called jets.
- Propellants in use today include both liquefied gases, which are more powerful, and solid explosives, which are more reliable. The chemical energy of the propellants is released in the form of heat in the combustion chamber.
- A typical liquid engine uses hydrogen as fuel and oxygen as oxidant; a typical solid propellant is nitroglycerine.
- The efficiency of a rocket engine is defined as the percentage of the propellant's chemical energy that is converted into kinetic energy of the vehicle. During the first few seconds after liftoff, a rocket is extremely inefficient, for at least two unavoidable reasons: High power consumption is required to overcome the inertia of the nearly motionless mass of the fully fueled rocket; and in the lower atmosphere, power is wasted overcoming air resistance. Once the rocket gains altitude, however, it becomes more efficient.

Design of the Exit Nozzle (our exit nozzle is the OPENING OF THE BALLOON)

- A critical element in all rockets is the design of the exit nozzle, which must be shaped to obtain maximum energy from the exhaust gases moving through it.
- The nozzle usually converges to a narrow throat, then diverges to create a form which shapes the hypersonic flow of exhaust gas most efficiently.

Staging of Rockets (our rocket will be ONE STAGE)

- Although early rockets had only one stage, it was early recognized that no single-stage rocket can reach orbital velocity (5 mi/8 km per sec) or the earth's escape velocity (7 mi/11 km per sec).
- Hence multistage rockets, such as the two-stage Atlas-Centaur or the three-stage Saturn V, became necessary for space exploration. In these systems, two or more rockets are assembled in tandem and ignited in turn; once the lower stage's fuel is exhausted, it detaches and falls back to earth.