http://usago1.ksc.nasa.gov/usasrb/

Exploring the Solid Rocket Boosters and Properties of Matter

By Amy Moffett
SIFT 2007

Designed for 8th grade science

Overview of SIFT Experience:

I worked for the United Space Alliance, LLC (USA) with the Solid Rocket Booster (SRB) Materials and Process engineers (M&P). I was assigned a project in which I needed to research and collect chemical and physical properties information, material safety data sheets (MSDS), and other product information from the vendor's websites and existing "in-house" files for a select group of materials used in building and refurbishing the SRBs. This information was then compiled in a report that summarized the information collected. My work site was at the Kennedy Space Center (KSC). This allowed for many opportunities to visit and tour sites operated by NASA, by USA, and by the Air Force. This included the vehicle assembly building (VAB), orbital processing facilities (OPF), the crawler with the mobile launch pad (MLP), and the SRB assembly and refurbishment facility (ARF), to name a few. In addition, the launch of STS-117 took place within the first week of employment allowing a day by day following of that mission including post flight operations for the SRBs. Two Delta II rockets were also launched during these 7 weeks. The sights were incredible and the operations witnessed were amazing. I learned so many things I never knew about the entire program and the shuttle itself. The entire experience, especially my work with the SRB materials, inspired my plan for implementation into the classroom.

Project Overview:

Properties of Matter and Solid Rocket Booster Design

Students will apply what they have learned about physical and chemical properties in solving a problem about the original design of paper rockets made from a class template. First, they will measure and collect discussed property data for selected items. The data will be compiled in a database for easy access. Secondly, the students will run tests of the template design rockets, assess their condition after impact, and propose a change in material (using database information) for a portion of the rocket sustaining the greatest damage. Further tests will be carried out to assess the quality of the change made. Meanwhile, a presenter from the Materials and Process Engineers Laboratory will discuss which properties need to be present in order to be a material used on the SRB. In addition, students will get to handle some of the actual materials used on the Solid Rocket Boosters. Science journals will be used for all data collection and design process notes.

Measurement Skills Learned	Tools Used
Density (by displacement and calculated volume)	Graduated Cylinder, Metric Ruler, and density formula
Tensile Strength	Spring Scale
Conductivity	Conductivity Tester
pH (liquid only)	Litmus paper
Mass	Triple Beam Balance
Magnetism	Magnet
Viscosity at Room Temperature	Stop watch and Tubing
Solubility at Room Temperature	Test tube
Apogee Altitude	Protractor and simple trigonometry formula

Items Tested:

- Aluminum Foil
- Styrofoam
- Felt
- Gel (hand sanitizer)
- Wire
- Plastic (soda bottle)
- Double Sided Tape
- Elmers Glue (liquid)
- Elmers Glue (solid, stick)
- Play Doe
- Salt Water

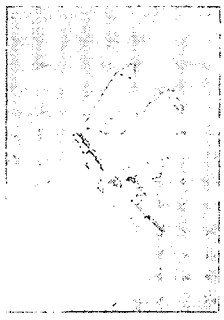
Properties of Matter and Solid Rocket Booster Design

Phase I: Material Properties Inquiry Lab

Objective: Students will....	**Assessment**	**SIFT Experience Connection**
A. accurately measure selected properties of several provided items using the appropriate tools and methods	Compare to pre-measurements providing a ±2 flex point.	Collected property data from vendor websites. Toured labs responsible to validating materials based on property statistics.
B. enter collected property data into a database using Microsoft access	Monitor process through visual observations	Used databases to search for property information, MSDS information, and vendor information.
C. use collected property data in the database to choose two items that will best maintain the integrity of the fins and nose cone of a paper rocket upon impact.	Monitor using visual observations and verbal questioning.	Read and researched material information through source control drawings of SRB materials.
D. apply the chosen items to rocket and prepare a brief rational for the items selected (written in hypothesis format; "if...then...because...").	Scoring rubric and by individual questioning.	Read and researched material information through source control drawings of SRB materials.

Phase II: Crash Proof Rocket Design Challenge:

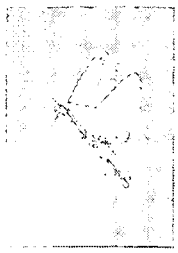
Objective: Students will....	**Materials needed**	**Assessment**	**SIFT Experience Connection**
A. make preflight and post flight measurements of the rocket's mass (using a triple beam balance), altitude, and of the physical condition of the nose and fins(using photos and written descriptions).	Paper rockets, rocket launcher, protractors, digital cameras, triple beam balance.	Observation of triple beam balance use. Read and provide feedback during description process. Final project rubric for data collection.	Observed part of the process for post flight assessment of the SRBs (videos, mapping observations, retrieval of SRBs. Toured labs that test materials.
B. determine rocket's maximum altitude by using a simple trigonometry equation provided.	Protractors, tangent table	Observation of protractor use. Review of student math work in science journals. Use team "math check" partner.	
C. graph flight vs. mass and altitude using Microsoft Excel.	Laptop computers with excel	Observation and monitor process. Final project rubric for data analysis.	Spreadsheets used to organize property and vendor research information.
D. analyze and discuss the data in lab journals.	Analysis and conclusions guiding questions.	Final project rubric for data analysis and discussions	



References:

NASA and USA Materials Used with Students:

- SRB Retrieval Process (overview)– Narrated presentation by Manuel DeLeon (© 2003), United Space Alliance, LCC (USA)
- "NASA FACTS: Space Shuttle Solid Rocket Booster Retrieval Ships", www.nasa.gov
- Design Specifications Sheet, NASA EnginVision Challenge- Rockets



Density and Retrieval of the Solid Rocket Boosters

Goal is to expose students to how density is used in the retrieval process of the SRBs. A presenter from the SRB retrieval dive team will give a presentation showing the retrieval process. As a follow-up, students will read a NASA Facts document explaining the steps involved in the retrieval process. A submarine demonstration, using a soda bottle, will show how manipulating the air to water ratio in the bottle moves the bottle toward or away from the surface of the water. Students will be asked to explain the change as it relates to density.

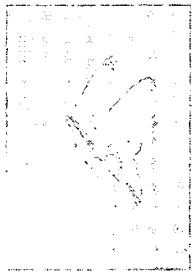
Materials Used:

- Presentation of Solid Rocket Booster Retrieval (presenter: Manuel De Leon)
- Soda bottle submarine
    - Rubber bands, 3 coins, rubber tubing (air hose), balloon, soda bottle with cap, Aquarium (10 gallon)
- NASA Facts document

Video link. (back-up)
http://mediaarchive.ksc.nasa.gov/dynavideo/?format=rm&mediaid=28467

Density and Retrieval of the Solid Rocket Boosters

Objective: Students will....	Assessment	SIFT Experience Connection
A. use the density concept to explain the behavior of different materials in water.	-Density assortment lab-rubric -Density calculations and predictions worksheet -Preliminary discussion about behavior of SRBs after splashdown.	Behavior of SRBs in saltwater after splashdown.
B. explain how filling an object with air affects the overall density of an object in water using observations and by manipulating the volume component of the density formula.	Use the density formula to show effect of volume changes to a given mass. Compare to expected observations of submarine and actual observations.	Met one of the divers for retrieval of the SRBs. Received tour of a retrieval ship.
C. test the effect of increasing the volume of an object using air and it's behavior in water by participating in a mock submarine demonstration.	Journal reflection exercise.	Met one of the divers for retrieval of the SRBs. Watched video and looked through photographs of SRB retrieval process.
D. explain why the SRB's are on their side when brought into port but vertical after splash down using knowledge gained from prior exercises and work on density property.	Journal reflection exercise with share-out.	



Project Goals as related to SIFT program:

Make Meaningful Connections

- Expose student to how properties of matter are important to the development, maintenance, and safety of the Solid Rocket Booster's operation.

Career Awareness

- Presenters from the SRB element of USA will meet and hold discussions with students about their work as material process engineers, specialty divers, and laboratory technicians.

Work Skills Development

- Students will employ a variety of technologies to collect, store, and analyze data.

- Students will work as a team to solve an engineering /design problem.

Scheduled Presenters:

- *Nathan Cox:* Materials and Process Laboratory Technician

  - Will talk about the type of skills and education needed to do his work.
  - Will talk about what he does and the types of properties tested.
  - Will show some samples of actual materials used on the SRBs.

- *Manual De Leon:* SRB Retrieval, Disassembly & Refurbishment Engineer

  - Will talk about the type of skills and education needed to do his work.
  - Will explain and show slides of the SRB retrieval process.

Crash Test Challenge

Design Number

Design Specifications Sheet

Team Members: _____

_____

_____

Date: _____

Class: _____

Sketch your model below after testing. Show failure points if any.

Describe the key parts of your design

_____

_____

_____

_____

_____

_____

_____

_____

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_____

_____

_____

Crash Test Challenge

Design Number

Design Specifications Sheet

Team Members: _____

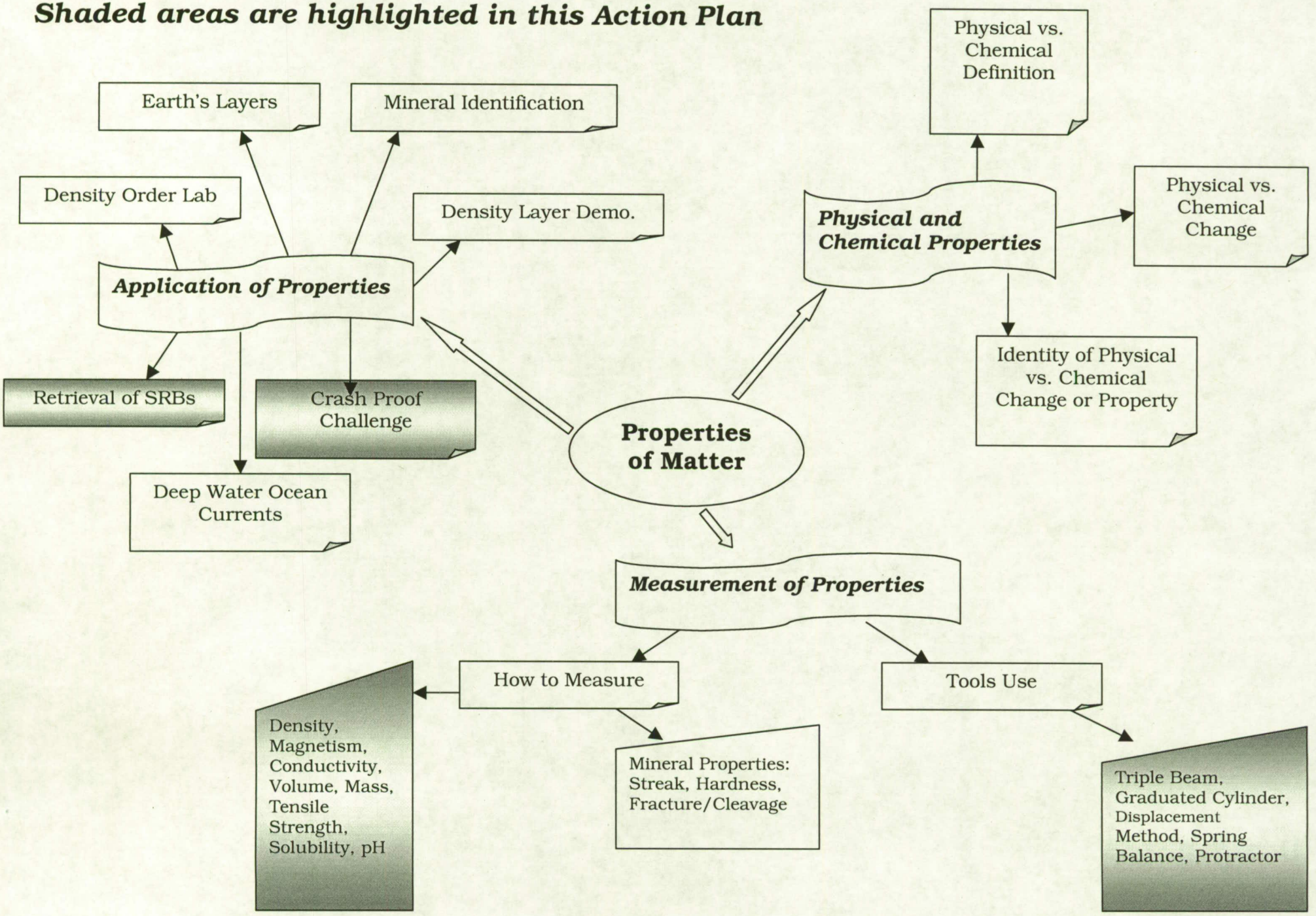
Date: _____

Class: _____

Sketch your design below. Identify materials used. Show glue points.

Describe the key parts of your design

Unit Overview:
Shaded areas are highlighted in this Action Plan



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14. ABSTRACT
I worked for the United Space Alliance, LLC (USA) with the Solid Rocket Booster Materials and Process engineers. I was assigned a project in which I need to research and collect chemical and physicals properties information, Material Safety data sheets, and other product info.

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