Designing a Mars Lander

Your team at NASA is charged with designing lander capable of safely landing a manned capsule on the surface of Mars. You will use a two faceted approach in your design to ensure a safe landing. First, you will design a protective structure that will absorb some of the energy at impact to reduce the risk of damage to the capsule. Second, you will design a structure that will use atmospheric resistance (like air resistance) to slow down the capsule to a safe terminal velocity before it impacts the surface. Finally, you will combine the two structures and test them together.

You will be modeling the Mars landing in the lab on earth. Earth has more gravity than Mars, but it also has more air resistance. To simplify, we will assume that the reduced gravity and atmospheric resistance of Mars will cancel each other out such that the terminal velocity of our model will be similar on either planet. During the final, combined test, you will use an egg to model the capsule. In the initial trials, you will not be able to use an egg.

I. What combination of design and materials will absorb the energy of impact to protect the capsule while still being relatively light weight?

II. What combination of design and materials will produce the slowest terminal velocity for the falling capsule?

III. How will your designs from questions I and II above be synthesized to create the most effective lander?

I. What combination of design and materials will absorb the energy of impact to protect the capsule while still being relatively light weight?

- **What criteria will you use to evaluate the success of the model? (how will you know how well it worked?)**

- **Design constraint: The protective structure may only cover 50% of the capsule so that the windows are exposed.**

Create a labeled sketch that shows your design and material choices for each model. Produce and test each model. Observe and evaluate each model in the spaces below.

<u>Design 1</u>

Sketch:

Observations:

Evaluate:

<u>Design 2</u>

Sketch:

Observations:

Evaluate:

<u>Design 3</u>

Sketch:

Observations:

Evaluate:

II. What combination of design and materials will produce the slowest terminal velocity for the falling capsule?

- **What criteria will you use to evaluate the success of the model? (how will you know how well it worked?)**

- **Material constraint: You are limited to $1m^2$ of each available sheet material for experimentation.**

Create a labeled sketch that shows your design and material choices for each model. Produce and test each model. Observe and evaluate each model in the spaces below.

<u>Design 1</u>

Sketch:

Observations:

Evaluate:

Design 2

Sketch:

Observations:

Evaluate:

Design 3

Sketch:

Observations:

Evaluate:

III. How will your designs from questions I and II above be synthesized to create the most effective lander?

- **What criteria will you use to evaluate the success of the model? (how will you know how well it worked?)**

- **Dimensional constraint: Has to fit out the window!**

Create a labeled sketch that shows your design and material choices the final model. Produce and test your model. Observe and evaluate the model in the space below.

<u>Synthesized Design</u>

Sketch:

Observations:

Evaluate:

Refinements: Based on your evaluation above, what changes, if any, will you make before dropping the lander out the window.)

Grading

Unbroken	>50% egg shows
Form correct	A+
Form mostly correct	A
Form incorrect	A-
No form	B+
Broken	
Form correct	B+
Form mostly correct	B
Form incorrect	B-
No form	C+
Protective structure covers more than 50% of capsule so windows are not exposed	Minus 1 letter grade
Late Project (other than absence)	Highest Grade is a B
No Project	F

If your project cannot withstand the fall, you need to be prepared to pick up after the drop.

Have fun designing the lander and try to keep the capsule safe!