DESIGN A JET-POWERED BLIMP (JPB)

Every year, engineers build an ice-runway to provide supplies to researchers at the McMurdo Research Station in Antarctica. A sudden shift in ice floes has blocked runway access and there is a race to identify an alternate runway location. Your team has been invited to present your design for a **jet-powered blimp (JPB)** that can survey the icy landscape quickly and efficiently.

Project Overview: You have 45 minutes to design a JPB prototype that can fly in a straight line, maintain altitude and cover long distances. You will also present the design concept and explain the propulsion system to the judges. Teams will earn points for performance (how far the JPB flies), design (the propulsion & flotation systems used), creativity, team-work and presentation skills.

Awards: Five teams will win awards for performance and three teams will be recognized for team work, design and creativity. One team will receive the 'Collier Inspired Innovation Award' for outstanding performance and creativity.

Definitions: A blimp is a non-rigid airship that relies on buoyant gases for lift and has a means of propulsion. In other words, a blimp

- floats using buoyant gases (like helium-filled balloons)
- has a way to move forward (using a motor or other propulsion system)
- is flexible (more like the top of a convertible car and less like the body of the car)

Jet propulsion is thrust produced by passing a jet of matter (typically air or water) in the opposite direction to the direction of motion. In other words, jet propulsion

- is explained by Newton's third law of motion: For every action, there is an equal and opposite reaction. So if you inflate a balloon and then let it go, it whizzes around until it loses all the air. Air flowing out of the balloon is the action, the balloon whizzing around is the reaction. The movement is called jet propulsion.

SUPPLY LIST – CHECK IMMEDIATELY!

You have five minutes to replace any missing items

RAW MATERIALS, MAY BE ALTERED			
2 sheets of paper (4 grams each)	1 piece of cardstock (8 grams)	2 paper plates (10 grams each)	4 Dixie cups (3 grams each)
4 rubber bands, 4 straws and 4 paperclips (0.16 grams each)		Masking tape	2 uninflated balloons (2 grams each)
OTHER RESOURCES, MAY NOT BE ALTERED			
1 pair of scissors, 1 pencil, team number sticker		2 tickets to redeem at the glue gun station	
Ziploc bag with supplies		1 ticket that can be redeemed for 2 helium-filled latex balloons (Each balloon can lift 10 grams)	
An additional helium-filled latex balloon may be purchased by taking your scoring sheet to the balloon station. You will pay for this balloon with a 30 point deduction on your final score.			

DESIGN BRIEF

- Introduce yourself to your team. Decide who will take on the different roles. Each team member must have an assigned role and all roles must be assigned. If your team has less than five members, some team members will serve in more than one role. (Engineering Team Members, page 5)
- Design the structure of the JPB so that it floats in place before it is launched. Consider the lift provided by the helium-filled balloons and the weight of the materials used in construction. Draw the design in the team documentation form. (Design Drawing, page 6)
- Design your propulsion system and identify how you will attach it to the JPB. Document this. (Propulsion, Page 7)
- No part of the JPB can go above the altitude markers (streamers) in each lane. The point at which the JPB floats above the streamers will be the distance traveled by the JPB.
- Review the scoring rubric and determine how you can meet the requirements and maximize points. (Scoring, page 3)
- Test as you build to make sure the JPB works as planned. (Answer all questions, page 7).
- Be creative and have fun with this project!

Good luck!

REQUIREMENTS, REGULATIONS AND CONSTRAINTS

REQUIREMENTS:
- The team number sticker must be visible when looking at the JPB from above.
- The JPB must have an **air-based propulsion system that uses a balloon**, **a release mechanism** (some way to get the vehicle moving), and **a chassis** (vehicle body connecting the two helium balloons).
- The JPB must be self-propelled at launch and cannot be pushed forward by a team member.

MATERIALS/RESOURCE CONSTRAINTS:
- Only the materials provided (and listed in this document) may be used in building the JPB.

TIME CONSTRAINTS:
- Teams will have 45 minutes to design, build and test the JPB. After 45 minutes, time will be called and construction will be halted. Teams will move their JPB to the judging area.
- Prior to each trial, the team will have a 5 minute adjustment period during which the team may prep the JPB for flight.
- There will be 2 rounds of judging with minimal time between rounds to repair any damages to the JPB.
- If the JPB has not touched the ground or floated above the maximum height markers after 30 seconds, the position at 30 seconds will be marked as the final position.
- Each team will have 90 seconds to deliver their presentation to the judges.

PRODUCTION CONSTRAINTS:
- Only one team member may take the JPB (or its parts) to the glue gun station. He/she must redeem a ticket to use the glue gun. Glue guns cannot be checked out for team use at the work table.
- Only one team member may visit the balloon station. He/she must redeem a ticket to receive 2 helium-filled latex balloons.
- One team member may visit the balloon station one additional time to purchase one extra balloon. This will cost the team 30 points. The team member must take the scoring sheet to the balloon station when purchasing this extra balloon.
- Teams are responsible for taking any leftover supplies to the judging area. They may fix their JPB between judging runs using these supplies. A glue gun will not be available in the judging area.

REGULATIONS:

- Only qualified runs will be scored at judging. To qualify the following must happen:
    - The Test Engineer must release the JPB from behind a starting line in the judging area. All parts of the JPB must be behind this start line when the JPB is released.
    - An extra balloon may be purchased only in the build zone. Cost of the balloon is a deduction of 30 points from the team's final score.
    - The JPB must maintain the allowed altitude throughout its flight.
    - Distance is measured from the point at which the JPB touched the ground or floated above the maximum altitude markers. If the JPB veered from the testing lane, the perpendicular distance to the lane is used to calculate the distance traveled.
- Once the JPB is released it cannot be touched until the judges score the run.
- Team members may watch the judging runs from a distance, as specified by the judges.

SCORING

Judges will score the design, performance and creativity of the JPB as follows:

TASK	SCORE
Design	MAX: 15
JPB has a name	5
Team number is clearly visible on JPB	5
JPB chassis is creatively built and/or decorated	1-5
Presentation	MAX: 20
Team can explain why their design is the best solution for surveying the Antarctic ice fields	1-5
Team can explain why the JPB moves (describe propulsion system)	1-5
Teamwork	1-5
Overall presentation skills	1-5
Performance (2 Runs)	
Distance Travelled – Measured as the perpendicular distance of the balloon's final position from the starting line	5 points per foot
Key Performance Parameters – Key Performance Parameters (KPP) are key system capabilities that must be met in order for a system to meet its operational goals	
KPP #01 – JPB does not deviate from assigned flight lane.	25
KPP #02 – JPB travels at minimum, 5 feet from start line.	25
KPP #03 – JPB maintains altitude (does not touch floor or streamer) for 15 feet.	25
KPP #04 – JPB beyond 20 feet from the start line.	25
Additional Balloon	
Team purchased extra balloon	-30
TOTAL SCORE	**Sum of above**

JPB DESIGN TIPS

- Test early and often!
- A JPB will consist of helium balloons connected in some way and a balloon jet to provide thrust. How can you use your materials to maximize thrust and reduce air resistance?
- Think of the shape of objects that move quickly through the air. What do footballs, javelins and the Goodyear Blimp have in common?
- Keep your JPB neutrally buoyant (floats in place) as you add weight and enhancements.
- Top-heavy blimps are hard to control—choose the location of your balloon jet carefully.
- Ensure that your balloon jet is secured in order to have a smooth flight.
- Make sure that your design will allow you to inflate (and re-inflate) your propulsion balloon between flights with minimal alterations as time and access to your JPB will be limited during the testing phase!
- Control your jet power! Release air too quickly and your JPB will lose thrust quickly while too little air may not take your blimp anywhere.
- Do not forget that while minimal, all objects including tape, balloons (inflated and non-inflated) and glue add weight to your JPB!

NOTE: The completeness of documentation will be used to break any ties.

PROJECT DOCUMENTATION

Team Number: _____

JPB Name: _____

ENGINEERING TEAM MEMBERS

- **CAPTURE LEAD** will verify that the team-designed JPB has a name, team members have specific roles, and documentation is complete, and will work with the rest of the team to develop the marketing slogan and deliver the sales pitch to the judges.
- **DESIGN ENGINEER** will lead the overall design and is responsible for including the design drawing(s) in the documentation. She/he will lead the team in developing a strategy to maximize points earned.
- **STRUCTURAL ENGINEER** will lead the team in designing a JPB with neutral buoyancy (float in place). She/he will visit the fabrication station and use the tools/glue efficiently.
- **PRODUCTION ENGINEER** will lead the building phase of the competition. She/he will ensure that all the materials and tools provided are considered by the team when building the JPB and will pick up balloons from the balloon station.
- **TEST ENGINEER** will serve as the team's representative during judging. She/he will set up the vehicle propulsion system during testing, release the vehicle behind the starting line and ensure that all testing rules are followed.

ROLE	FIRST NAME	LAST NAME
CAPTURE LEAD		
DESIGN ENGINEER		
STRUCTURAL ENGINEER		
PRODUCTION ENGINEER		
TEST ENGINEER		

DESIGN DRAWING(S) AND NOTES

PROPULSION SYSTEM

What makes your JPB move? How are you controlling the direction of movement (thrust)?

_____

_____

MARKETING

What are your design's main selling points? How would your JPB identify a good runway location on an ice field?

_____

_____

DESIGN

What was your team's plan for designing the JPB? Did it work or were there any revisions?

_____

_____

_____

IDEAL WORLD/REAL WORLD

What additional supplies/tools would have helped your team build a better JPB? What was your most challenging task as a team?

_____

_____

_____

Team number: _____   Vehicle Name: _____

ADDITIONAL BALLOON PURCHASE: A team may purchase an extra helium-filled balloon. This will cost the team 30 points, deducted from the final score.

_____   _____
Balloon Station Staff – please print   Team Member Name – please print

METRIC	Judges: Please Circle your selection				
DESIGN					
Team has a name.	Yes			No	
Team number sticker is visible when looking down at the JPB.	Yes			No	
The chassis is creatively built and decorated.	1	2	3	4	5
PRESENTATION					
Team has a name and marketing slogan and can explain why their design is the best solution for the customer's needs.	1	2	3	4	5
Team can explain why the JPB moves (identify its propulsion system).	1	2	3	4	5
Team works well together.	1	2	3	4	5
Team demonstrates creativity, is enthusiastic and has good overall presentation skills.	1	2	3	4	5

PERFORMANCE

RUN	Qualified Run (Launches succesfully)	Distance Travelled (in feet, rounded up)	KPP #01 (Maintains lane)	KPP#02 (Travels 5ft minimal distance)	KPP#03 (Maintains altitude for 15 feet)	KPP#04 (Distance Bonus: Travels 20 ft or beyond in lane, maintaining altitude)
1	☐		☐	☐	☐	☐
2	☐		☐	☐	☐	☐

VERIFICATION

_____   _____
Judge's name – please print   Judge's name – please print