Name:_____ Date:_____ Hr.:____

Save the Penguins Design Challenge

Part 1: Define the Problem

Many scientists agree that the Earth is warming, and that human activities have exacerbated the problem (NRC 2001; 2002). Engineers, scientists, and environmental groups around the globe are hard at work finding solutions to mitigate or halt global warming.

The energy we use to heat and cool our houses comes from power plants, most of which use fossil fuels. The burning of fossil fuels has been linked to increased levels of carbon dioxide in the atmosphere, which in turn has been linked to increases in global temperature. This change in temperature has widespread effects on Earth, including effects on the life of penguins. If homes were better insulated, they would require less energy for heating and cooling, reducing fossil fuel use and carbon dioxide emissions.

One particular species of animals, penguins have been greatly affected. As the Earth warms, the oceans warm, pack ice melts, and penguins lose habitat. They also lose food sources such as krill, which rely on the protection of pack ice and feed on the algae that grow underneath the ice (Gross 2005). The emperor penguins in Antarctica are in severe decline due to climate change (Jenouvrier et al. 2008). South African penguins are actually leaving their nests to cool off in the water, placing their eggs at risk to attacks by gulls. Park rangers at Boulders Beach in Cape Town, South Africa, have created little semi-enclosed "huts" for penguins to nest in, which keep them cooler and protect their eggs from predation (Nullis 2009).

Your have been hired as a habitat restoration engineer to apply scientific and engineering principles to design, construct, and test a cost-effective shelter for a penguin (penguin-shaped ice cube) where it can beat the heat without leaving its eggs unprotected. Your shelter must keep the penguin cool (keep the penguin ice cube from melting) by reducing heat transfer.

Available Materials:

- Electronic balance
- Rulers
- Penguin ice cubes (one per group)
- Tweezers or tongs
- Materials to build the penguin shelter from the Igloo Depot (see below)
- Glue, tape, scissors
- Plastic cup

Igloo Depot Materials Cost Sheet

Material	*Price*	*Material*	*Price*
Cotton Balls (5)	*$25.00*	*Popsicle Sticks (4)*	*$10.00*
Construction Paper (½ sheet)	*$10.00*	*Foam Sheet*	*$50.00*
Aluminum Foil (30-cm off roll)	*$10.00*	*Mylar Sheet*	*$15.00*
Paper Towel- white (1 sheet)	*$20.00*	*Packing Peanuts (8)*	*$30.00*
Bubble Wrap (30-cm off roll)	*$40.00*	*Paper Towel- brown (1 sheet)*	*$5.00*

Constraints:

1. The penguin shelter must be no more than 10 cm x 10 cm for the base without being more than 15-cm high.
2. The penguin ice cube will be placed in a plastic cup with a lid and must fit in the shelter.
3. The shelter must have a door to get the penguin easily in and out. It cannot be taped shut.

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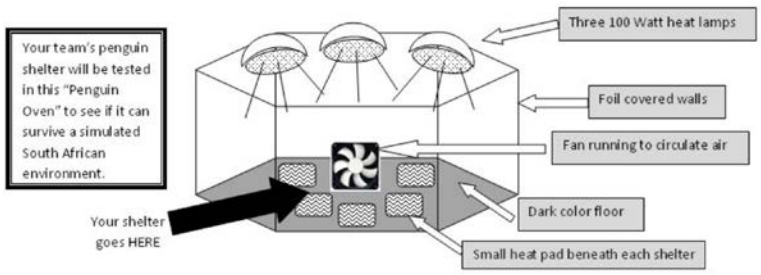
Testing Site: The Penguin Habitat



- Thermal energy from below from pocket hand warmers (simulating the warm rocks/sand below the penguins)
- Thermal energy in the air, circulated by a fan (simulating the warm ocean breezes)
- Thermal energy from floodlights above (simulating the Sun)

Part 2: Research

Write any notes below that may be helpful in creating your design and/or help demonstrate your knowledge of thermal energy and heat transfer. Think about how to reduce all types of heat transfer. Helpful resources may include your notes, videos, and/or demonstrations we've done.

NOTES:

Part 3: Imagine Possible Solutions:

Using the materials list given, how could you design a shelter that will help an ice cube penguin from melting? Think about materials on the inside vs the outside of the shelter. Record your ideas in the spaces below by drawing your initial designs. These will be done individually! ***Label the materials you chose.***

Idea 1:	Idea 2:

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Part 4: Choose a Solution

Once every member of your group has finished their rough drawings, engage in a conversation about each idea. Talk about the pros and cons of each design. Select one design, or combinations of several designs and draw your chosen solution here. ***Label the materials you chose and include notes about how they will reduce heat transfer.***

Final Design

Igloo Depot Materials Cost Sheet:

Material	***Price***	***Amount***	***Total***	***Material***	***Price***	***Amount***	***Total***
Cotton Balls (5)	*$25.00*			*Popsicle Sticks (4)*	*$10.00*		
Construction Paper (½ sheet)	*$10.00*			*Foam Sheet*	*$50.00*		
Aluminum Foil (30-cm off roll)	*$10.00*			*Mylar Sheet*	*$15.00*		
Paper Towel-white (1 sheet)	*$20.00*			*Packing Peanuts (8)*	*$30.00*		
Bubble Wrap (30-cm off roll)	*$40.00*			*Paper Towel-brown (1 sheet)*	*$5.00*		
		Grand Total					

Name:_____ Date:_____ Hr.:____

Part 5: Create and Test Prototype

Stamp

1.) Create your prototype making sure to follow the constraints and your materials cost sheet.
2.) Please add any additional materials you use to your materials cost sheet.
3.) Penguin Shelter Testing Steps:
   - Obtain a stamp from your teacher to show you have met the constraints for your penguin shelter.
   - Put the plastic cup on an electronic balance and zero it out.
   - Obtain an ice penguin and measure its mass as quickly as possible. Record the mass in the data table.
   - Place the ice penguin in your shelter as quickly as possible and add place it in the penguin habitat.
   - When time is up, retrieve the remainder of the ice penguin and place it in the plastic cup. Measure the mass of the ice remaining (no liquid water should be included in the mass) as quickly as possible. Record mass in the data table.
     - If you left your penguin in your plastic cup during testing, be sure to drain the "penguin juice" out of the cup before you find the mass.
   - Calculate the percent survival of your team's penguin.

Your Data:

Qualitative Data:

Quantitative Data:

Starting Mass *Not including the mass of the cup	**Final Mass** *Not including the mass of the cup	**Percent Survival** (final ÷ starting x 100)

Part 6: Improve:

You will be given a chance for a redesign after the initial testing. Follow the same procedure for testing after you have made your improvements. Make note of any improvements that you made during the testing process. **If you purchase any new materials add them to your Igloo Depot Materials Cost Sheet.**

Starting Mass *Not including the mass of the cup	**Final Mass** *Not including the mass of the cup	**Percent Survival** (final ÷ starting x 100)
Notes about improvements:		

Final

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Communication:

Group comparison:

Group Number	Percent Survival	Cost of Shelter	Notes about cost and design:

Answer the following questions in your communication:

1. What group was most successful in preventing heat transfer and saving their penguins?
2. Which design features were most effective at preventing heat transfer?
3. Why were these design features effective at preventing heat transfer?
4. Provide an example of how **conduction** was reduced in one of the designs.
5. Provide an example of how **radiation** was reduced in one of the designs.
6. Provide an example of how **convection** was reduced in one of the designs.

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Save the Penguins Grading Rubric:

	Exceeding (5 pts)	Meeting (4 pts)	Approaching (2 pts)	Below (1 pt)
Part 2: Research	Research is accurate and complete	Research is complete but not accurate	Research is incomplete	Research is missing
Part 3: Imagine possible solutions	Both ideas are presented and complete with materials needed	Both ideas are presented but missing materials needed	There is only 1 idea presented	Possible ideas are missing
Part 4: Choose Solution	Final design completed by student and includes materials; order form is complete and 100% accurate	Final design is completed by student and includes materials but order form is complete but NOT 100% accurate	Final design is NOT completed by student (may be missing materials) or order form is NOT complete Or both are NOT 100% accurate	Final design is NOT completed by student and/or order form is NOT complete
Part 5: Create Prototype	Students created prototype and finished by the time official testing began; all constraints were followed	Students created prototype and finished by the time official testing began; most constraints were followed, but minor errors made	Prototype was tested after the official testing time limit	Prototype was not ready for testing or or many of the constraints were not followed
Part 5 cont...: Test Prototype	Student recorded the starting and final masses; the survival rate was complete and accurate	Student recorded the starting and final masses; survival rate is complete but not accurate	Student recorded the starting and final masses	Testing is not recorded
Part 5 cont…: Testing Execution	Survival rate is 75% or higher in either testing	Survival rate is 50% or higher OR your survival rate increased after improvements	Survival rate is less than 50%	Testing is not recorded or penguins did not survive (totally melted)
Part 6: Improve	Improvements have been made, calculated, and explained thoroughly	Improvements have been made and calculated, but not thoroughly explained	Improvements have been made and calculated but not explained	Improvements are missing from the Improve Section
Communicate	Group comparison table is 100% complete and accurate; recommendation is supported by data; recommendation is detailed and written in complete sentences; all questions are answered completely and accurately	Group comparison table is 100% complete and accurate; recommendation is supported by data; all questions are answered mostly completely and accurately	Group comparison is partially complete and/or accurate; recommendation is not supported by data	Recommendation and/or group comparison are not complete or missing
Due Date	Document turned in early or on time			Document(s) turned in late
Team work	Creates a positive and constructive environment in which everyone in the group can thrive; contributed significantly to the project	Listens to the opinions of others and makes constructive contributions to the team effort.	Cooperates as a team member but makes few original contributions to the effort or makes contributions to the team, but doesn't cooperate as a team member	Requires prompting in order to function as an effective member of the team.
Focus	Always on task; no redirection needed	Overall focused on task; may have been slightly distracted	Need some redirecting to remain focused	Lack of focus or effort to remain focused; redirection needed several times

Total: _____
55 points