Name | Section

Climate

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Save the **Penguins**

Grade 10 Science: **Climate Unit**

People have the responsibility to assess their impact on climate change and to identify effective courses of action to reduce this impact.

Penguins are threatened. Warming oceans melt pack ice, and so penguins lose both habitat and food sources like krill, which feed on algae growing underneath the ice. Emperor penguins and other Antarctic penguins are in decline, but more tropical species are also affected by climate change. In South Africa hotter temperatures mean penguins are leaving their nests on the beach to cool off in the ocean; while they are gone gulls attack their eggs and chicks. At Boulders Beach in Cape Town, park rangers have created small semi-enclosed shelters for penguins to nest in, which keep the penguins cooler and protect their eggs from predators like gulls.

Real size of model penguins

Your Task

Your task is to **design** a hut to help keep penguins cool, **build** a model of the hut so it can be tested, and **document** your design.

Your model must be big enough for a model penguin (see actual-size outline) and include an opening for the penguin to enter and leave by. (Penguins can't use doorknobs!)

Design Considerations

When designing your penguin hut, keep in mind all you have learned about heat transfer. The hut will be sitting on a hot beach in direct sunlight, so you must allow for *radiation*, *convection*, and *conduction*.

It would be wise to build some prototypes and test them, so you can improve your design.

The Simulation

We are simulating penguins with penguin-shaped ice cubes. The more ice remains unmelted at the end of the test, the better your design is.

The beach will be an old aquarium with a black bottom and aluminum foil on the sides. To simulate sunlight, we will use a powerful light shining from above.

Your Scale Model

Make your scale model out of common materials. Carefully consider the properties of the materials when you select them.

Documentation

Make a technical drawing or blueprint of your design, giving the dimensions and materials.

Explain the physical properties of the materials you selected and your design (how it works).

What to hand in

- **scale model** of your penguin hut
- **documentation** of your design

Date due	

Actual size of model hut and penguin

Maximum footprint of hut:

6 cm × 10 cm

Maximum height of hut:

3 cm

Expectation	Level 0	Level 1	Level 2	Level 3	Level 4
D2.5 investigate, through laboratory inquiry, the effects of heat transfer	Consideration given to: □ absorption, □ reflection, □ radiation, □ conduction, □ convection.				
	Design gives no consideration to energy transfer. **0 1 2 3 4**	Design addresses one type of energy transfer. **5**	Design addresses two types of energy transfer. **6**	Design addresses three types of energy transfer. **7**	Design addresses three types of energy transfer well. **8 9 10**
A1.11 communicate plans in writing using appropriate language	Drawing does not accurately document model. **0 1 2**	Drawing documents model with limited accuracy. **2.5**	Drawing documents model with some accuracy. **3**	Drawing documents model with considerable accuracy. **3.5**	Drawing documents model with high degree of accuracy. **4 5**
D3.2 describe and explain heat transfer	Explanation given for: □ absorption, □ reflection, □ radiation, □ conduction, □ convection.				
	Explanation missing or inaccurate. **0 1 2**	Explains energy transfer with limited accuracy. **2.5**	Explains energy transfer with some accuracy. **3**	Explains energy transfer with considerable accuracy. **3.5**	Explains energy transfer with a high degree of accuracy. **4 5**

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Penguin Hut **Teachers Notes**

This project can be as elaborate as you want to make it, with multiple design iterations evolving towards ever-better designs.

I use a silicone ice cube tray to make the penguins, ordered online from Amazon.

An hour in the freezer is long enough to make the ice cubes, so it is easy to make a steady supply of penguins.

For a beach I took an old aquarium, lining the walls with reflective foil and the bottom with a black cloth. This is big enough for ten huts at once. Pieces of glass over the top stop the heat leaking out.

https://www.amazon.ca/HIC-Silicone-Penguin-Baking-4-Inch/dp/B008CXTW7E


Sample setup: aquarium, black "beach", reflective foil, and lamp. Any similar setup will work: the key is to raise the temperature quickly.

As the sun I use an old 1000 W photographic light, which quickly raises the temperature of the aquarium to 50°. Be very careful around lights, as they get very hot and can cause bad burns.

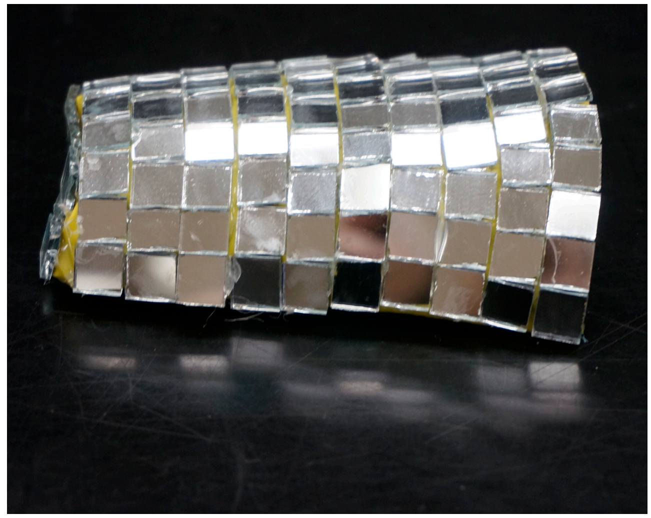
How I run my Penguin Day

Place the first batch of huts ‘on the beach’ with a thermometer and a penguin in the open, then turn the light on. Have another activity for students to do while they wait (15-25 minutes depending on your light and the type of huts they’ve built).

When the unprotected penguin is melted, turn the light off and quickly take out the huts. Students can have fun comparing their penguins (and maybe taking pictures). If necessary put the next batch of huts in, and so on.

After 20 minutes all penguins are melting, although some will still be mostly intact.

If you want to be accurate about the relative efficiency of different hut designs, you’ll need to weigh each penguin before it went under the light and after, to see which had lost the least mass. I don’t bother with that.



There are many variables that will affect how fast a penguin melts: the location of the hut in the aquarium, the humidity of the air, whether it was in the first or second trial batch… Rather than worry about those details, I leave an unprotected penguin on the ‘beach’ and see how much of the protected penguins are left when it is melted. Only once have I had a design that was worse than the beach!

The key thing I want my students to do is apply what they know of the concepts of conduction, convection, and albedo to a practical problem.

Most designs make careful use of albedo to minimize absorbed energy. Most students also use styrofoam and similar materials to minimize conduction. The careful ones also realize that hot air will convect and so minimize the possibilities of air circulation. (One of my rules is “no doors”, but they’ve used flaps and curtains to good effect.)

Based on the “Save the Penguins” activity by Christine Schnittka, Randy Bell, and Larry Richards, from the book *Fuel for Thought* published by NSTA Press.

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