**Design Problem**

An unprecedented heat wave has hit the Tampa Bay area. A local sweet shop is losing customers because their chocolate bars are melting. The store sells 3 different kinds of chocolate bars: white, dark and milk chocolate. The owner wants to know if storing the chocolate bars in the fridge (T=4°C) or freezer (T=-2°C) will make a difference. Unfortunately, the store only owns a small fridge and freezer. At any given time, the store has about 300 chocolate bars, 100 of each type.

You have been hired by the owner to determine each type of chocolate bar and ultimately decide where to store each chocolate bar. You must first evaluate the melting points of each chocolate bar and then decide which type would need to be placed in the refrigerator, freezer or can be left in room temperature.

**Design Requirements**

The melting point of each type of chocolate bar, tabulated results, storage conditions for chocolate bar types (refrigerated, frozen or left at room temperature), report, including graphics, explaining the results to the owner.

**Materials:** White, milk and dark chocolate bars thermometer, timer, 3 paper cups.

**Part A - Pre-Activity Questions:**

1. Study content of <http://www.sciencekids.co.nz/gamesactivities/meltingpoints.html>

Melt 3 substances, record their names, and report repeated measurements of their melting points

Substance (i)\_\_\_\_\_\_\_\_\_\_\_\_ melting point measurements \_\_\_\_\_\_\_ \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_

Substance (ii) \_\_\_\_\_\_\_\_\_\_\_\_ melting point measurements \_\_\_\_\_\_\_ \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_

Substance (iii) \_\_\_\_\_\_\_\_\_\_\_\_ melting point measurements \_\_\_\_\_\_\_ \_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_

2. What is average melting point for each of the three substances?

(i) \_\_\_\_\_\_\_ (ii) \_\_\_\_\_\_(iii) \_\_\_\_\_\_\_\_

1. If asked about your weight, you answer in terms of pounds or Newtons. Those are the English and Metric units for weight (force). If someone asks you about a melting point what are the English and Metric units for that?
2. Which chocolate bar type do you think would melt the fastest (white, dark or milk chocolate)?

5. Why does chocolate need to be an emulsion?

6. Complete the following diagram by choosing from the following: liquid, solid, heat added, heat removed

1.\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 2. Add or Remove Heat 3.\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Choose: Liquid or Solid Choose: Liquid or Solid



4. Add or Remove Heat

7. If you could see the molecules a solid before and after it melts describe the difference between before and after melting (use the following keywords: molecules, temperature, movement/vibration, solid, liquid, order).

1. You are given a sample of a solid and you must determine if it is pure or a mixture. Describe how you would find out.

**Part B – Chocolate Bar Experiment Research:**

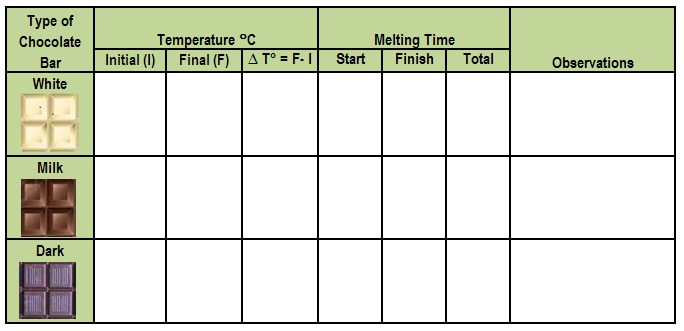
**Instructions:** Each laboratory team will receive a same size chocolate bar of each kind (white, dark and milk chocolate), a thermometer and a timer. Remove the first chocolate bar from the wrapper. Measure the temperature of the bar.

Place the chocolate bar in a plate or small paper cup and place it near the sun. Start timer when melting initiates.

Record the temperature and stop timer when the bar has melted, both when it starts and it ends melting.

Record your results in a table and compare with your assumptions.

Alternatively, each team can simultaneously observe the melting process of the three types of chocolate and visualize which one starts to melt first, which one melts the fastest, and which one takes the longest time to melt.



Note: Pay attention when bars of chocolate start to melt, which one starts melting first, which type of chocolate melts the fastest and which one takes the longest time to melt completely**.** Remember to write your observations!

**Part C – Engineer’s Report:**

1. Report the starting and finish melting point of each bar of chocolate. Include the total time required to completely melt.
2. Based on your observations, which bar of chocolate starts to melt first, which one melts the fastest, and which one takes the longest time to melt?
3. Which chocolate should be placed in the refrigerator?
4. Which chocolate should be left in room temperature?
5. Plot your results in the graph provided on the next page (Chocolate type vs. Temperature). Explain the results to the store owner, in the space under the graph.

