Name: _____ Date: _____

Cloud Opacity Experiment - Answer Key

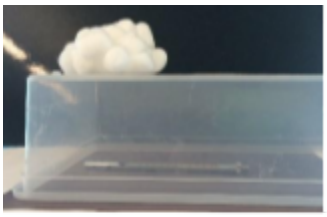
Required materials:

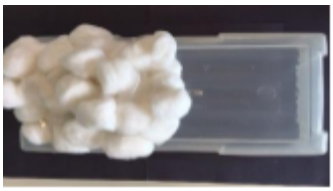

Fahrenheit Thermometer

- 3 thermometers*
- pencil
- 3 identical, clear, food containers with the lids off* (large enough to hold a thermometer inside)
- Tape
- 1 bag of cotton balls (to represent clouds)
- 3 pieces of black construction paper large enough to fit under each container*
- 1 stopwatch or timer

***Alternatives**: You may use a desk lamp with an incandescent light bulb. Energy efficient light bulbs will not work.*
**If materials are limited, you may opt to use 1 food container and 1 thermometer, testing the models individually.*

Setup:


Cumulus Clouds side view
Note that the cotton balls are on top of the thermometer bulb


Cumulus Clouds top view


Cirrus Clouds top view

1. Find a sunny area outside.
2. Measure and record the air temperature_____^{0}F
3. Remove the lids on all of the containers and turn the containers upside down.
4. Tape a thick layer of cotton balls to ½ of the outside of one of the containers. These will represent cumulus clouds.
5. Pull apart a few cotton balls and tape them in a very thin layer across ½ of the outside of the second container. These will represent cirrus clouds.
6. Leave the third food container as is. This will represent a clear sky.
7. Sketch a picture to represent each of the containers you made in the chart.
8. Lay down the black paper and place the food containers with the tops removed upside down on the paper.
9. Place a thermometer underneath each of the containers where the clouds produce a shadow.
10. Position the containers so each will receive an equal amount of sunlight.
11. Record the starting temperature for all 3 containers in the data table. All of the thermometers should read the same temperature.
12. Complete the remainder of the data table, recording the temperature in each container every minute for 6 minutes. When checking the temperature, gently lift the container and quickly take a reading.

This activity was modified from the original NASA EPDC Badging - Earth Cloud Experiment.

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	Temperature Measurements in ^{0}F							Temperature difference ^{0}F *final temperature – starting temperature*
	0 minutes	**1 minute**	**2 minutes**	**3 minutes**	**4 minutes**	**5 minutes**	**6 minutes**	
#1 Clear container *Clear sky*								Increased temperatures with the most change.
#2 Cloudy container *Cumulus clouds*								Increased temperature with the smallest change.
#3 Cloudy container *Cirrus clouds*								Increased temperature with the medium change.

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Draw Conclusions:

1. Identify 3 similarities and 3 differences between the tubs you tested.
    a. Similarities
        i. Similar or same materials used for the set up including color of paper used underneath the thermometer.
        ii. Temperature changes with time.
        iii. The temperature measurements were taken at the same time in all three set ups.
    b. Differences
        i. The scenarios included no cotton balls (clear sky), a thin layer of stretched out cotton balls (transparent) and lots of cotton balls (translucent or opaque).
        ii. The changes in temperature per scenario varied. With no cotton balls there was the largest temperature increase. With lots of thick cotton balls, the temperature increase was the least. With thin stretched out cotton, the temperature increase was in between the other two scenarios.
        iii. The temperature changes took longer for scenario 3.

2. Which cloud conditions, scenario 2 or 3, resulted in the higher temperatures?

    There two scenarios that used cotton balls to simulate clouds and cloud cover. The scenario that results in the highest temperatures simulating cloud cover is the cirrus cloud (container #3).

    Note: Clear skies are considered a cloud condition, as a 0% cloud cover report. Clear skies, compared to the other two scenarios, will result in the highest temperatures.

3. Why do you think this happened?

    More light from the sun is able to travel through the cirrus cloud conditions to reach the surface and heat up the thermometer than in the cumulus cloud conditions.

4. Which scenario resulted in the lowest temperatures?

    The scenario that results in the lowest temperatures is the cumulus cloud (container #2). This represents the translucent and opaque clouds. Opaque clouds will block the most incoming light or energy.

5. How are the different temperatures related to the opacity of the clouds?

The opacity of low, thick clouds like the cumulus clouds (container #2) is either translucent or even opaque. The opacity of high, thin clouds like the cirrus clouds (container #3) is transparent. The more opacity a cloud has, the less incoming energy it will allow in resulting in lower temperatures.