Name _____

Lesson 3: Why are growing cities hotter?

<u>Do Now:</u> During our last class, we looked at different types of information about the why certain cities in Colorado are getting hotter.

What things did we decide are NOT causing temperatures to increase?	What things did we decide ARE causing temperatures to increase?
The amount of sunshine, population, etc.	Population growth leading to land use changes that result in changes to surface cover (e.g. natural areas developed into built-up areas, roadways, etc.)
What did we decide we still need to figure out about why temperatures are getting hotter?	
Are other parts of the country and the world getting hotter or not?	

Then and Now Picture Comparisons:

Look at the pictures shown on the board, and fill in the table below. You can write more than one statement for each pair of pictures.

Location	Observations: What looks different between the two pictures?	Explanation: What caused these changes? Why did these changes happen?	Ideas: How might these changes affect temperature?
	Various answers e.g. less natural, undeveloped spaces and more urban, developed areas.	Various answers, e.g. more people living in the area, increase need for homes, roads, industry, etc.	Various thoughts or ideas based on students' answers.

Infrared Images:

Warm areas	Cool areas
Types of surfaces **White, red, orange yellow on buildings, roads, etc.**	**Types of surfaces** **Black, blue, green ice/snow, water, vegetation, etc.**
Why are they warmer? **Darker colored areas absorb more/reflect less light energy.**	**Why are they cooler?** **Lighter colored objects absorb less/reflect more light energy.**

Color and Temperature Investigation:

Question: How does the color of a surface affect how much it warms up in the sun?

Hypothesis: Student hypotheses will vary

Part A Materials (per group):
- Various colors of construction paper (black, white plus green, yellow, red, orange, blue, etc.)
- 3 thermometers
- Stopwatch or timer
- Light source (indoors: desk lamp or sunny windowsill, outdoors: sunshine)

Part A Procedure: Possible student-developed plan; ideas will vary, offer guidance:
1. Place the dark, light, and green, etc. colored paper equal distance away from the light source.
2. Place one thermometer under the center of the dark, light, and green, etc. construction paper.
3. Using a timer, record the temperatures every 1 minute for a total of 20 minutes.

Part A Observations:

Time	Temp of Dark Color	Temp of Light Color	Temp of Other Color

Part B Materials (per group):
- Various colors of construction paper (black, white plus green, yellow, red, orange, blue, etc.)
- 3 ice cubes
- Stopwatch or timer
- Light source (indoors: desk lamp or sunny windowsill, outdoors: sunshine)

Part B Procedure: Possible student-developed plan; ideas will vary, offer guidance:
1. Place the dark, light, and green, etc. colored paper equal distance away from the light source.
2. Place one ice cube in the center of the dark, light, and green, etc. construction paper.
3. Start timer (if using a desk lamp, turn it on at the same time as starting the timer).
4. Record observations during the investigation.
5. Record the time it takes for each ice cube to melt completely on each colored surface.

Part B Observations:

Ice Cube	Time to melt	Observations
Ice cube on dark colored paper		
Ice cube on light colored paper		

Conclusion:

The color that heats up the most   black, darkest color

The color that heats up the least white, lightest color

Ice cubes melt more quickly on black, darkest color

Ice cubes melt more slowly on white, lightest color

Reflection:

1. What types of land surfaces does the dark color represent?

Buildings, homes, roads, built-up areas, etc.

2. What types of land surfaces does the light color represent?

Plants, trees, crops, grass, water, snow, ice, etc.

3. What does our data tell us about the color of a surface and its temperature?

The darker the surface the warmer it will be because darker colors reflect less light energy.

Lighter surfaces reflect more light energy so they will be less warm. (Suggestion: teacher to

Introduce the term "albedo" to explain this phenomenon).

<u>Next Steps:</u> What have we learned from this lesson and what should we investigate next?

What have we learned about growing cities and heat?
Certain cities in Colorado have grown a lot in recent times. The natural environment around these cities has been built on to provide homes, buildings and schools, roads, stores, etc. to meet people's needs. These built up areas have changed the natural land surface that tend to be lighter colors of vegetation, etc. with human-made materials that tend to be darker colors. From our investigations, we learned that darker colors heat up more than lighter colors so the darker colored built-up parts of a city absorb more heat than the lighter colored undeveloped areas, which makes cities hotter than natural environments.
What do we need to figure out next about why temperatures are increasing?
We decide that we need to know if other parts of the world are getting hotter like cities are.