Understanding Global Change Cool Zone Design

Exploring the Urban Heat Island Effect and Designing a Community Based Solution

Summary of Scenario and Segments

The purpose of this task is for students to demonstrate their ability to analyze the scientific problem of urban heat islands and construct a model to explain a solution to the problem through the creation of a cool zone. Students will start by analyzing the scenario to review information about urban heat islands. They will then complete 3 segments.

In Segment 1 students will demonstrate their knowledge of energy and systems on earth and explain 5 different aspects of the urban heat island. In part 1 they match components of a model of earth's energy and then explain how they relate to surface temperature. In part 2 they analyze data from an experiment to explain how heat capacity relates to temperature change. In part 3 they again use data but this time come up with a claim from a pattern on a line graph to explain albedo's effect on temperature change. In part 4 students create a model and use the model to explain how transpiration/evaporation are related to cooler areas near vegetation. Finally in part 5 students add information to a picture of a city to explain how convection currents relate to the urban heat island effect.

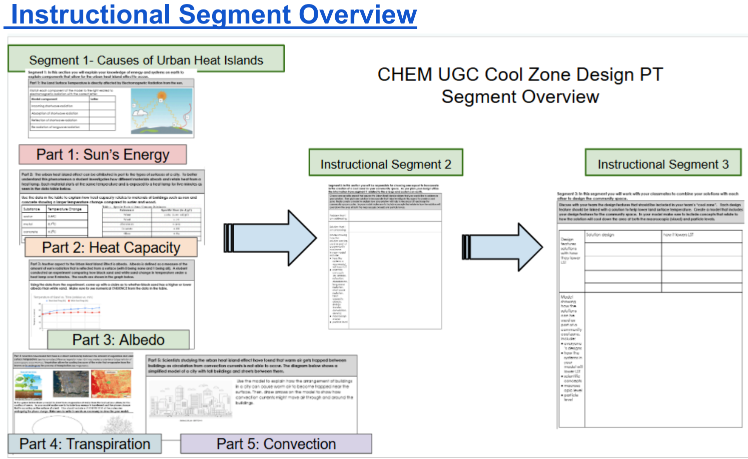
In segment 2 students are asked to come up with a design for a cool zone in their community. In particular they are modeling one cause of the urban heat island, and then modeling one change to positively impact the environment and lower the LST. After modeling the two they are asked to explain their solution.

Finally in Segment 3 students are grouped together to incorporate multiple designs into one presentation that highlights the designs needed to be included in the community cool zone. You could have students present their findings on a poster format as an extension.

Grade(s): 10-12

Time: Segment 1: 30-45 min, Segment 1 could also be given throughout a unit as exit tickets where students are synthesizing the various factors related to the urban heat island. Segment 2: 10-20 min, Segment 3: 30-60 min. Segment 3 should be given on a separate day to ensure that students can be grouped based on proposed solutions. Optional activities to enhance the PT can be used before the task is given or as part of segment 1 (see UGC Urban Heat Islands Curriculum).

Instructional Segment Overview



Video Overview

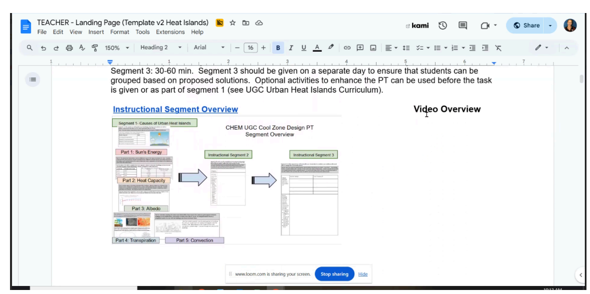


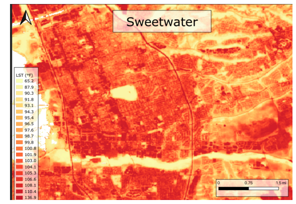
TABLE OF CONTENTS

Google Drive Folder

Teacher Handouts for Segments Link to UGC chemistry unit storyline		
TH Segment 1	TH Segment 2	TH Segment 3
Student Handouts for Segments		
Student handout linked here *(note all three segments are together but can given separately)*		
Task Implementation Guidance		
How this task is meant to be used	Supporting Diverse Sensemaking: Pre-Requisites and Scaffolds	NGSS Assessment Targets How the task was developed

Task Implementation Context

How the task is meant to be used	**Instructional Purpose** ☑ **Curriculum-Neutral Positioning:** This performance task can be integrated into any curriculum that addresses the intended assessment targets. ☐ **Diagnostic Usage:** Understand students' initial ideas before instruction. ☐ **Formative:** Supports teachers and students with knowing where they are with their learning, where they are headed, and how to support next steps with learning. ☑ **Summative:** Useful to report on student learning across a sequence of instruction. ☑ **Assessment as Learning:** The performance task serves as a learning experience itself. **Timing for Integration into Instruction** ☐ Beginning of Unit ☐ Middle of Unit ☑ End of Unit ☐ Flexible to be used in various ways **Student Configuration for Assessment Moments** ☑ Individual work ☐ Partner work ☐ Small Group work ☐ Whole Class work
Additional guidance from the developers about how the task might be most effectively used	This task was originally designed to anchor the end of a 12 lesson learning sequence from the UGC Urban Heat Islands instructional unit for High School Chemistry. It can also be used within an environmental science or physical science course where energy of the earth is being taught. The assessments and its 3 segments can all be done together at the end of a unit or segment 1 can be broken up into individual exit tickets or formative assessments throughout the unit as they link to individual lessons. (part 1 (radiation) with lesson 3, part 2 (heat capacity) with lesson 5, part 3 (albedo) with lesson 4 , part 4 (energy of phase changes) with lesson 8, and part 5 (convection) with lesson 7 . The 3rd segment is an optional extension and is not necessary to gather students' ideas related to

	the content.
Description of Phenomenon or Problem	
The surface temperature of the land differs across parts of our city (Urban Heat Islands). What are some areas hotter than others? How could we prevent the areas from being so hot? (How can we create a cool area in our community?) 	

NGSS Assessment Target(s)

Which performance expectation(s) is this task associated with?	
[**HS-PS3-1**] Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known. [**HS-PS3-2**] Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motion of particles (objects) and energy associated with the relative positions of particles (objects). [**HS-PS3-4**] Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics). [**HS-ESS2-2**]Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.	
Science and Engineering Practices	**SEP 2: Developing and Using models** Students will add to pre-existing models, construct models, and explain concepts using models. **SEP 4: Analyzing and Interpreting Data** Students will analyze data from graphs and data tables to explain relationships within data and various concepts. SEP 6: Constructing Explanations and Designing Solutions Students will be explaining how various factors are related to the urban heat island effect. They will then have a chance to explain a solution to the urban heat island effect.
Crosscutting Concepts	**CCC1: Patterns** Students will observe patterns in systems at different scales and cite patterns as empirical evidence in supporting their explanations of phenomena.. Students will use mathematical representations to identify certain patterns. **CCC4: Systems and System Models** Students can investigate or analyze a system by defining its boundaries and initial conditions, as well as its inputs and outputs. They can use models to simulate the flow of energy, matter, and interactions within and between systems at different scales. **CCC5: Energy and Matter: Flows, Cycles, and Conservation** Students learn that the total amount of energy and matter in closed systems is conserved. They can describe changes of energy and matter in a system in terms of energy and matter flows into, out of, and within that system. They also learn that energy cannot be created or destroyed. It only moves between one place and another place, between objects and/or fields, or between systems. Energy drives the cycling of matter within and between systems.

Disciplinary Core Ideas	**PS3A Definitions of Energy-** Energy within the system can change through transfer in/out of the system. There are many types of energy, but this unit will focus on thermal energy. Energy can be understood at the microscopic scale as the motion of particles. Motion energy (kinetic energy) can be measured within matter as the temperature(random motion of particles). Electromagnetic radiation can be modeled as a wave and the ER from the stun is a major source of energy for the earth. **PS3B Conservation of Energy and Energy Transfer** The total change in energy in any system is always equal to the total energy transferred into or out of the system (conservation of energy). Many phenomena can be explained by the transfer of energy. When objects come in contact energy can be transferred (change in temperature known as heat). Energy transfer depends on the total change in energy. Energy always transfers from the warmer to cooler object. The transfer of energy can be in three different ways (conduction, convection, radiation). Even when a system seems isolated, energy can be transferred through radiation. Radiation can be emitted or absorbed by matter. When matter absorbs iR (light) the energy is transformed to thermal energy (motion of particles). Systems evolve towards stability (uniform energy distribution **ESS2A Earth materials and Systems** Earths's surface is a complex and dynamic set of systems that interact over a wide range of temporal and spatial scales. All processes result from the energy flowing and matter cycling. This includes tectonic plates, weather and climate with sunlight, ocean atmosphere, clouds,ice, land, and life. Effects on the atmosphere result from the burning of fossil fuels. Earth exchanges mass and energy with the rest of the solar system. It gains or loses energy through incoming solar radiation, thermal radiation to space, and gravitational forces. Changes in parts of one system can affect changes in other systems. **ETS1B Developing Possible Solutions** The creative process of developing a new design to solve a problem is central to engineering. Solutions should meet the criteria and constraints on hand. Ideas can start as sketches and become more formalized through models. Models allow the designer to better understand the features of a design problem, visualize elements of a possible solution, predict a design's performance, and guide the development of feasible solutions. Data from models can be used to modify a design. **ESS3D Global Climate Change** global climate change, driven by both natural phenomena and human activities can have large consequences for all of earth's systems. The activities of humans affect every part of the environment. Global changes usually happen too slowly for individuals to recognize, but accumulated human knowledge and scientific research can help people learn about challenges and guide responses. Scientists build mathematical climate models to summarize existing evidence and are tested for their ability to match patterns and forecast the future. The impacts of climate change are uneven and may affect some regions more than others.

Supporting Diverse Sensemaking

What additional knowledge, skills, and/or information will students need to bring to the assessment?
• Students experience being hot and recognizing that certain areas are hotter than others. • Students have also done lab activities and analyzed data to recognize various factors related to how some areas are warmer than others (if they have done the UGC urban heat islands curriculum). • Students need to be able to MODEL at both the particle (zoom in boxes) and macroscopic levels
What barriers will need to be removed to support the diverse learners in the performance task?
• Students will need to have common experiences to understand the phenomenon and various factors. These can be done as lab task/activities in the unit or students can be given data within the pt to help them better understand the concepts • Students have created models throughout the unit (With teacher, in groups, individual, on their prior CFAs) so should be adept at doing this. • Students will need to be able to read the instructions in order to include the various components within the task. • Students will need to be able to read the rubric to ensure that they are completing the required aspects of each part of the assessment.

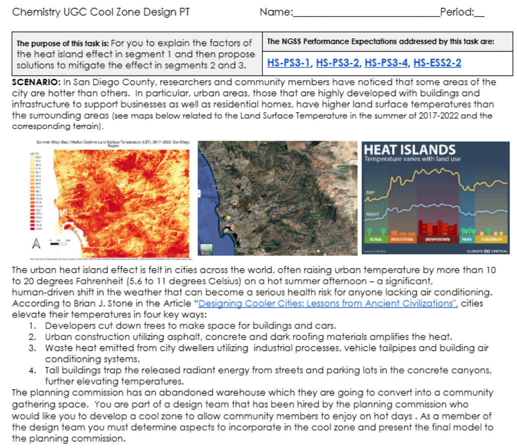
Task Scenario and Prompts-
Segment 1: Task Scenario, prompts, and scoring guidance

Segment Scenario : *Setting the stage for how students will engage with the task.*

SCENARIO: In San Diego County, researchers and community members have noticed that some areas of the city are hotter than others. In particular, urban areas, those that are highly developed with buildings and infrastructure to support businesses as well as residential homes, have higher land surface temperatures than the surrounding areas (see maps below related to the Land Surface Temperature in the summer of 2017-2022 and the corresponding terrain).

The planning commission has an abandoned warehouse which they are going to convert into a community gathering space. You are part of a design team that has been hired by the planning commission who would like you to develop a cool zone to allow community members to enjoy on hot days . As a member of the design team you must determine aspects to incorporate in the cool zone and present the final model to the planning commission.

Segment 1: In this section you will explain your knowledge of energy and systems on earth to explain components that allow for the urban heat island effect to occur.



Chemistry UGC Cool Zone Design PT Name:____________________Period:__

The purpose of this task is: For you to explain the factors of the heat island effect in segment 1 and then propose solutions to mitigate the effect in segments 2 and 3.	The NGSS Performance Expectations addressed by this task are: HS-PS3-1, HS-PS3-2, HS-PS3-4, HS-ESS2-2

SCENARIO: In San Diego County, researchers and community members have noticed that some areas of the city are hotter than others. In particular, urban areas, those that are highly developed with buildings and infrastructure to support businesses as well as residential homes, have higher land surface temperatures than the surrounding areas (see maps below related to the Land Surface Temperature in the summer of 2017-2022 and the corresponding terrain).

The urban heat island effect is felt in cities across the world, often raising urban temperature by more than 10 to 20 degrees Fahrenheit (5.6 to 11 degrees Celsius) on a hot summer afternoon – a significant, human-driven shift in the weather that can become a serious health risk for anyone lacking air conditioning. According to Brian J. Stone in the Article "Designing Cooler Cities: Lessons from Ancient Civilizations", cities elevate their temperatures in four key ways:

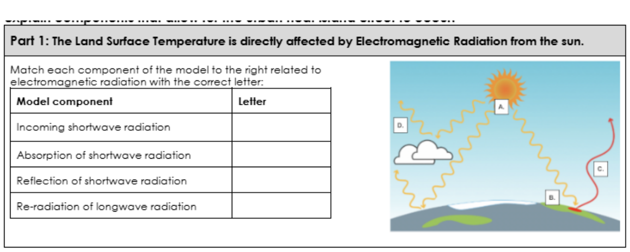
1. Developers cut down trees to make space for buildings and cars.
2. Urban construction utilizing asphalt, concrete and dark roofing materials amplifies the heat.
3. Waste heat emitted from city dwellers utilizing industrial processes, vehicle tailpipes and building air conditioning systems.
4. Tall buildings trap the released radiant energy from streets and parking lots in the concrete canyons, further elevating temperatures.

The planning commission has an abandoned warehouse which they are going to convert into a community gathering space. You are part of a design team that has been hired by the planning commission who would like you to develop a cool zone to allow community members to enjoy on hot days . As a member of the design team you must determine aspects to incorporate in the cool zone and present the final model to the planning commission.

Teacher Materials

- Student Handout
- Slides
- Rubric
- Link to optional lessons with UGC storyline

Student Prompts

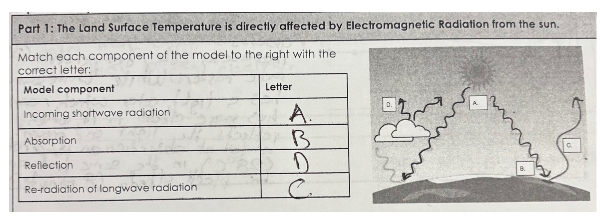


Part 1: The Land Surface Temperature is directly affected by Electromagnetic Radiation from the sun.

Match each component of the model to the right related to electromagnetic radiation with the correct letter:

Model component	Letter
Incoming shortwave radiation	
Absorption of shortwave radiation	
Reflection of shortwave radiation	
Re-radiation of longwave radiation	

Ideal Student Responses



Part 1: The Land Surface Temperature is directly affected by Electromagnetic Radiation from the sun.

Match each component of the model to the right with the correct letter:

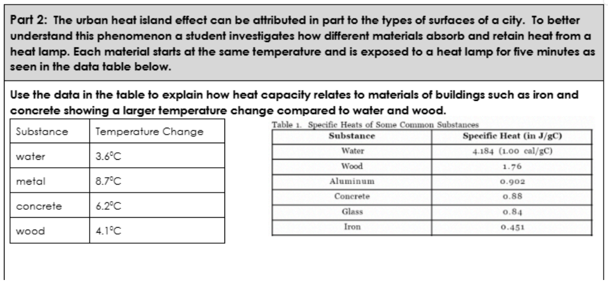
Model component	Letter
Incoming shortwave radiation	A.
Absorption	B
Reflection	D
Re-radiation of longwave radiation	C.

The energy that determines surface temperature comes from the sun through solar radiation. About 71% of the sunlight that reaches the earth is absorbed by its surface and atmosphere in the form of shortwave radiation. Absorption of sunlight causes the molecules of the object or surface it strikes to vibrate faster which can be measured as an increase in temperature. This energy is then re-radiated as longwave, infrared radiation. Infrared radiation is what we experience as heat that warms the earth. The more sunlight a surface absorbs, the warmer it gets and the more energy it re-radiates as heat.

🔴 Potential Sticking Point: Students may struggle with the various types of radiation.

🟢 Teacher Move: Focus on the overall ideas of short wave radiation from the sun and long wave radiation from the sun. Use the resources from UGC linked above to help.

Completing the lessons that are part of the [UGC curriculum] as part of lesson 3 are also suggested.



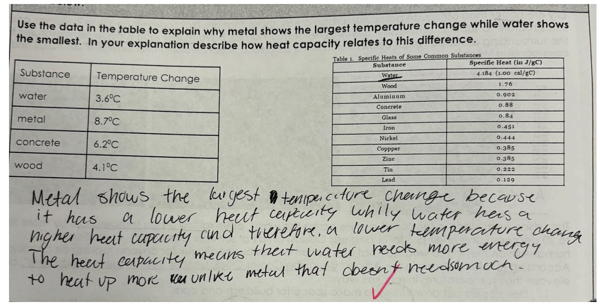
Part 2: The urban heat island effect can be attributed in part to the types of surfaces of a city. To better understand this phenomenon a student investigates how different materials absorb and retain heat from a heat lamp. Each material starts at the same temperature and is exposed to a heat lamp for five minutes as seen in the data table below.

Use the data in the table to explain how heat capacity relates to materials of buildings such as iron and concrete showing a larger temperature change compared to water and wood.

Substance	Temperature Change
water	3.6°C
metal	8.7°C
concrete	6.2°C
wood	4.1°C

Table 1. Specific Heats of Some Common Substances

Substance	Specific Heat (in J/gC)
Water	4.184 (1.00 cal/gC)
Wood	1.76
Aluminum	0.902
Concrete	0.88
Glass	0.84
Iron	0.451



Use the data in the table to explain why metal shows the largest temperature change while water shows the smallest. In your explanation describe how heat capacity relates to this difference.

Substance	Temperature Change
water	3.6°C
metal	8.7°C
concrete	6.2°C
wood	4.1°C

Table 1. Specific Heats of Some Common Substances

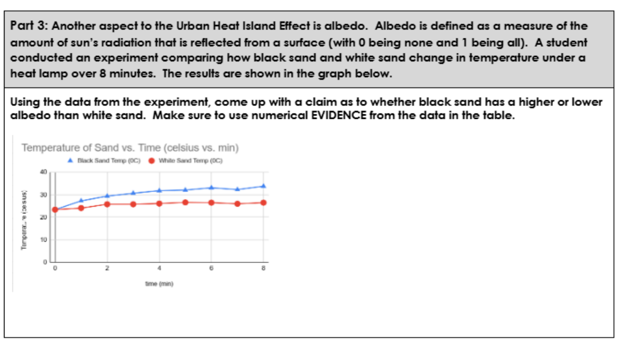
Substance	Specific Heat (in J/gC)
Water	4.184 (1.00 cal/gC)
Wood	1.76
Aluminum	0.902
Concrete	0.88
Glass	0.84
Iron	0.451
Nickel	0.444
Coppper	0.385
Zinc	0.385
Tin	0.222
Lead	0.129

Metal shows the largest temperature change because it has a lower heat capacity whily water has a higher heat capacity and therefore, a lower temperature change The heat capacity means that water needs more energy to heat up more unlike metal that doesn't needsomuch.

[Different types of substances heat up faster or slower than others]. Those types of materials in cities and hotter areas of the city tend to be those that have low heat capacities such as concrete, glass, metal, etc.

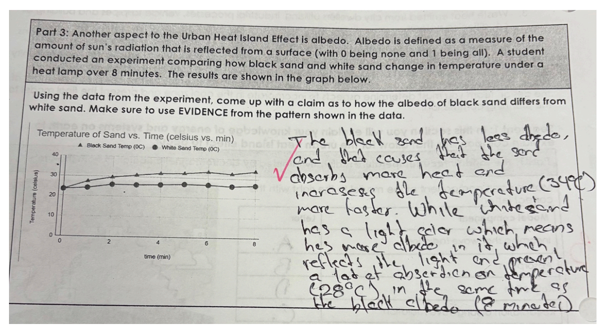
🔴 Potential Sticking Point: Some students get confused between heat capacity and albedo. Some students have a hard time using the definition of heat capacity with energy to change the temperature of a substance including heating up and cooling down. Some students also get confused with the amount of mass that is used and how this relates to temperature change as well (which can sometimes cause different than expected answers in a lab setting).

🟢 Teacher Move: It is important to have students recognize how heat capacity relates to the type of material with how much energy to change temperature. Completing the lessons that are part of the [UGC curriculum] as part of lesson 5 are also suggested.



Part 3: Another aspect to the Urban Heat Island Effect is albedo. Albedo is defined as a measure of the amount of sun's radiation that is reflected from a surface (with 0 being none and 1 being all). A student conducted an experiment comparing how black sand and white sand change in temperature under a heat lamp over 8 minutes. The results are shown in the graph below.

Using the data from the experiment, come up with a claim as to whether black sand has a higher or lower albedo than white sand. Make sure to use numerical EVIDENCE from the data in the table.



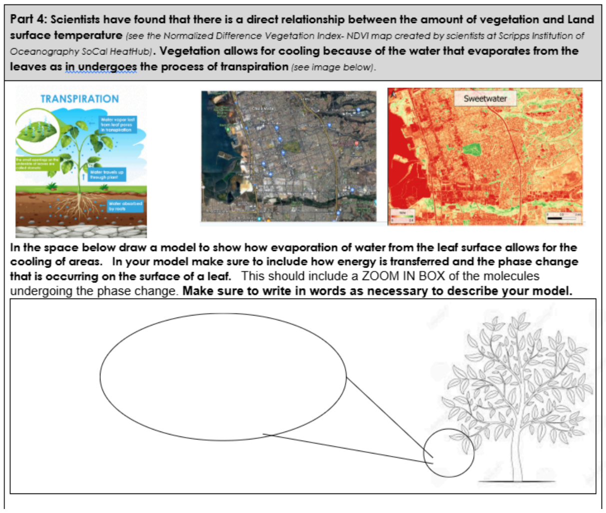
Part 3: Another aspect to the Urban Heat Island Effect is albedo. Albedo is defined as a measure of the amount of sun's radiation that is reflected from a surface (with 0 being none and 1 being all). A student conducted an experiment comparing how black sand and white sand change in temperature under a heat lamp over 8 minutes. The results are shown in the graph below.

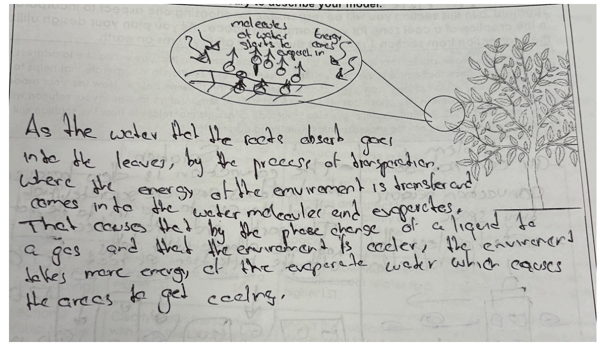
Using the data from the experiment, come up with a claim as to how the albedo of black sand differs from white sand. Make sure to use EVIDENCE from the pattern shown in the data.

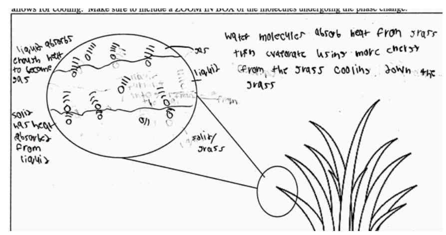
Darker surfaces get hotter than lighter surfaces. If light is not absorbed and transformed into heat by a surface then it is reflected. Albedo is the reflection of sunlight. Darker surfaces have lower albedo so absorb more energy while lighter surfaces have higher albedo so reflect more solar radiation and are not as hot.

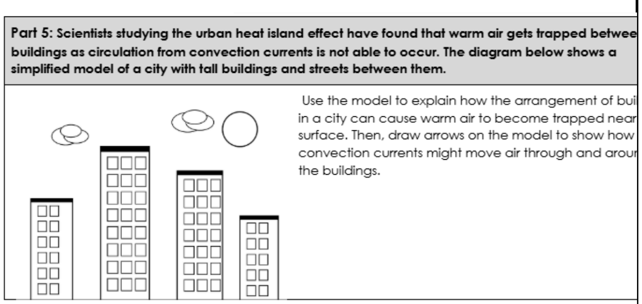
🔴 Potential Sticking Point: Some students get confused between heat capacity and albedo. Some students get confused in terms of a higher albedo relating to more reflection.

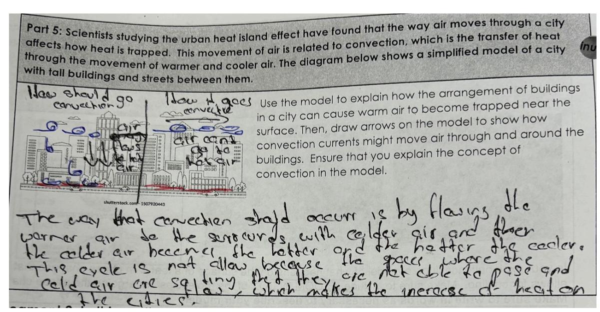
🟢 Teacher Move: It is important to have students recognize how albedo relates to reflection of energy from the sun (short wave). Reading about albedo is helpful as well (check out the [UGC website] for information on

<table>
<tr>
<td></td>
<td>reflection/absorption of sunlight) Completing the lessons that are part of the UGC curriculum as part of lesson 4 are also suggested.</td>
</tr>
<tr>
<td>


</td>
<td>
It is cooler near water and parks because of transpiration and evaporative cooling. Water evaporates and absorbs energy from the surroundings (endothermic) from surroundings.




🔴 Potential Sticking Point: Some students use the word transpiration without understanding how evaporative cooling is involved. Additionally some students get confused with the idea that the energy to evaporate is coming from the sun vs. coming from the surrounding air as well (which causes the air to cool)
🟢 Teacher Move: It is important to have students recognize how evaporative cooling relates to temperature differences. Completing the lessons that are part of the UGC curriculum as part of lesson 8 are suggested to help student understand what is happening at the particle level to allow the water to evaporate and cool the surrounding air.
</td>
</tr>
<tr>
<td>


</td>
<td>


The air in the city gets trapped by hot cities with tall buildings etc. Allowing air circulation (convection) helps to cool down cities. (sources: UGC What is Global change)
🔴 Potential Sticking Point: Some students get confused with how convection currents work in terms of density and
</td>
</tr>
</table>

	the movement of warm/cool air. 🟢 Teacher Move: It is important to have students recognize how density relates to convection currents in air. Completing the lessons that are part of the [UGC curriculum](#) as part of lesson 7 are suggested to help student understand the various ways of energy transfer.

Navigation Across Segments

In this segment students had a chance to express their knowledge about causes of the urban heat island effect. In the next segment students will use their knowledge to design a solution for the urban heat island problem within their own community.

Scoring Guidance (Rubric)

This is an assessment rubric that can be used for segments 1.

Chem UGC Cool Zone Design Assessment Rubric Segment 1: Name:____________________

Criteria	Exemplary (3)	Applying (2)	Approaching (1)
Part 1	Correct letter for each model component.	Incorrect letter for 1 or 2 of the model components.	Incorrect letter for 3 or 4 of the model components.
Part 2	Explains why metal has the largest temperature difference in terms of heat capacity and the transfer of energy to change temp.	Partially explains why metal has a higher temperature difference but missing the concept of heat capacity.	Does not explain why metal has the higher temperature difference.
Part 3	Correct claim for which material has a higher or lower albedo using evidence from the table including numbers and concept of albedo.	Partial claim for which material has a higher or lower albedo but missing either evidence from the table (numbers) or the concept of albedo.	Incomplete or incorrect claim missing both data and concept of albedo.
Part 4	Complete model to explain cooling using the concepts of: evaporation with phase change including how particles change with phase change in terms of energy transfer.	Incomplete model to explain cooling with missing 1 of the following: evaporation with phase change including how particles change with phase change in terms of energy transfer.	Incomplete model to explain cooling with missing most of the following: evaporation with phase change including how particles change with phase change in terms of energy transfer.
Part 5	Shows how warm air gets trapped and uses the model to draw arrows to show how convection works in terms of warm and cool air flow with sinking/rising.	Shows how warm air gets trapped but has an incomplete explanation on model in terms of how convection works in terms of warm and cool air flow with sinking/rising.	Missing how warm air is trapped and Incomplete model to draw.

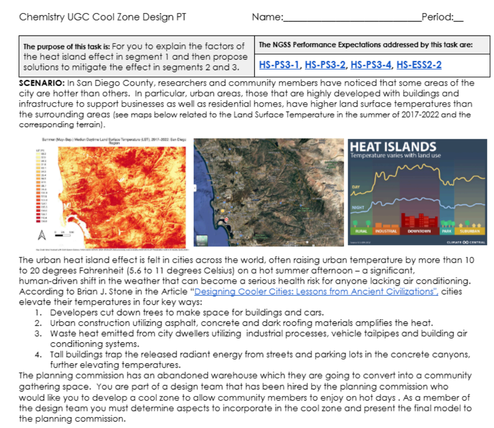
Total: __________/15 = ____________%

Comments:

Segment 2: Design Challenge (individual)

Scenario

In this section you will be responsible for choosing one aspect to create in the creation of a cool zone for your community space. As you plan your design utilize the information from section 1 related to the energy and systems on earth.



Chemistry UGC Cool Zone Design PT Name:__________________________Period:__

The purpose of this task is: For you to explain the factors of the heat island effect in segment 1 and then propose solutions to mitigate the effect in segments 2 and 3.	**The NGSS Performance Expectations addressed by this task are:** HS-PS3-1, HS-PS3-2, HS-PS3-4, HS-ESS2-2

SCENARIO: In San Diego County, researchers and community members have noticed that some areas of the city are hotter than others. In particular, urban areas, those that are highly developed with buildings and infrastructure to support businesses as well as residential homes, have higher land surface temperatures than the surrounding areas (see maps below related to the Land Surface Temperature in the summer of 2017-2022 and the corresponding terrain).

The urban heat island effect is felt in cities across the world, often raising urban temperature by more than 10 to 20 degrees Fahrenheit (5.6 to 11 degrees Celsius) on a hot summer afternoon – a significant, human-driven shift in the weather that can become a serious health risk for anyone lacking air conditioning. According to Brian J. Stone in the Article "Designing Cooler Cities: Lessons from Ancient Civilizations", cities elevate their temperatures in four key ways:

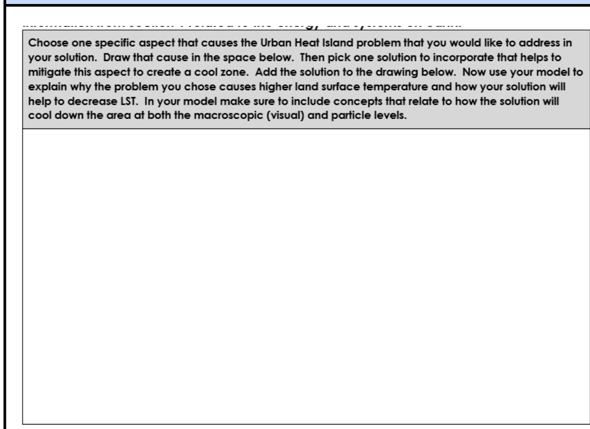
1. Developers cut down trees to make space for buildings and cars.
2. Urban construction utilizing asphalt, concrete and dark roofing materials amplifies the heat.
3. Waste heat emitted from city dwellers utilizing industrial processes, vehicle tailpipes and building air conditioning systems.
4. Tall buildings trap the released radiant energy from streets and parking lots in the concrete canyons, further elevating temperatures.

The planning commission has an abandoned warehouse which they are going to convert into a community gathering space. You are part of a design team that has been hired by the planning commission who would like you to develop a cool zone to allow community members to enjoy on hot days . As a member of the design team you must determine aspects to incorporate in the cool zone and present the final model to the planning commission.

Teacher Materials

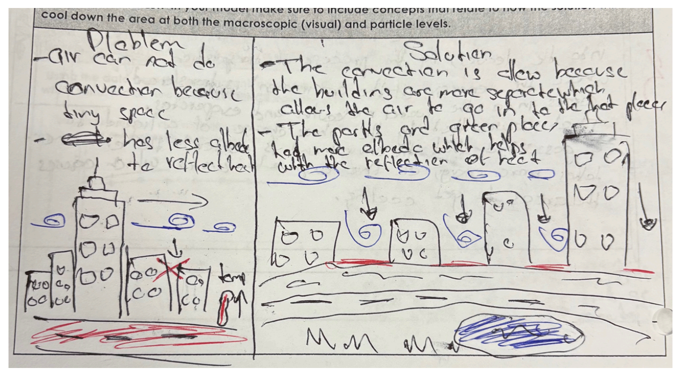
- Student Handout
- Slides
- Rubric

Student Prompts



Choose one specific aspect that causes the Urban Heat Island problem that you would like to address in your solution. Draw that cause in the space below. Then pick one solution to incorporate that helps to mitigate this aspect to create a cool zone. Add the solution to the drawing below. Now use your model to explain why the problem you chose causes higher land surface temperature and how your solution will help to decrease LST. In your model make sure to include concepts that relate to how the solution will cool down the area at both the macroscopic (visual) and particle levels.

Ideal Student Responses



A possible solution to help cool down cities would be to create an area that blocks out more of the sun's energy (has additional shade). Additionally the area could be created to have water features (to allow for evaporative cooling) and green plants/vegetation (for increased cooling through transpiration). Additionally the areas can be built using materials with higher heat capacities (to allow them to absorb more energy before heating up) and utilize lighter colored surfaces (to have high albedo and reflect more of the sun's energy). Finally the areas can be created to allow for air circulation (convection to allow hot air to rise and move away and cooler air to flow in).

Navigation Across Segments

In the previous segment students had a chance to express their knowledge about causes of the urban heat island effect. In this segment students used their knowledge to design a solution for the urban heat island problem within their own community. In the final segment (segment 3) students will work as a team to design a community center using the solutions that they developed in segment 2. Students will then have a chance to present their model.

Scoring Guidance

This is an assessment rubric that can be used for segment 2

Chemistry UGC Cool Zone Design PT Name:_____________________________Period:__

Assessment Rubric for Segment 2:

Criteria	**Exemplary (3)**	**Applying (2)**	**Approaching (1)**
Section 2 Proposed Solution/Problem	Clearly identifies a specific solution that relates to an aspect of the urban heat island.	Identifies a solution but lacks specific clarity with how it relates to a problem	The solution is vague, inappropriate or does not address cooling.
Section 2 Visual Model (cooled)	Clearly shows the solution with how the LST decreases. Shows how the solution affects the area both at the visual and particle levels.	Shows the solution with a decreased LST but missing some of the features such as visual level, particle level or specific concepts.	Missing the solution or has very minimal explanation of the solution in terms of concepts related to the visual level, particle level or specific concepts.

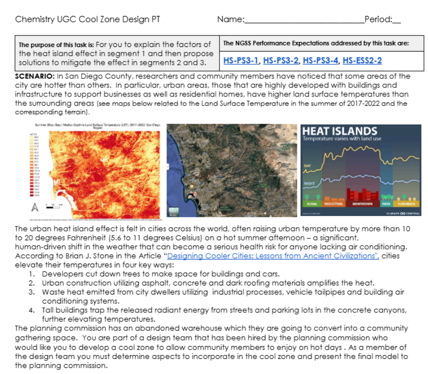
Total: ___________/6 = _____________%

Comments:

Segment 3: Design Challenge (group)

Scenario:

In this segment you will work with your classmates to combine your solutions with each other to design the community space.



Chemistry UGC Cool Zone Design PT Name:___________________________Period:__

The purpose of this task is: For you to explain the factors of the heat island effect in segment 1 and then propose solutions to mitigate the effect in segments 2 and 3.	**The NGSS Performance Expectations addressed by this task are:** HS-PS3-1, HS-PS3-2, HS-PS3-4, HS-ESS2-2

SCENARIO: In San Diego County, researchers and community members have noticed that some areas of the city are hotter than others. In particular, urban areas, those that are highly developed with buildings and infrastructure to support businesses as well as residential homes, have higher land surface temperatures than the surrounding areas (see maps below related to the Land Surface Temperature in the summer of 2017-2022 and the corresponding terrain).

The urban heat island effect is felt in cities across the world, often raising urban temperature by more than 10 to 20 degrees Fahrenheit (5.6 to 11 degrees Celsius) on a hot summer afternoon – a significant, human-driven shift in the weather that can become a serious health risk for anyone lacking air conditioning. According to Brian J. Stone in the Article "Designing Cooler Cities: Lessons from Ancient Civilizations", cities elevate their temperatures in four key ways:

1. Developers cut down trees to make space for buildings and cars.
2. Urban construction utilizing asphalt, concrete and dark roofing materials amplifies the heat.
3. Waste heat emitted from city dwellers utilizing industrial processes, vehicle tailpipes and building air conditioning systems.
4. Tall buildings trap the released radiant energy from streets and parking lots in the concrete canyons, further elevating temperatures.

The planning commission has an abandoned warehouse which they are going to convert into a community gathering space. You are part of a design team that has been hired by the planning commission who would like you to develop a cool zone to allow community members to enjoy on hot days . As a member of the design team you must determine aspects to incorporate in the cool zone and present the final model to the planning commission.

Teacher Materials

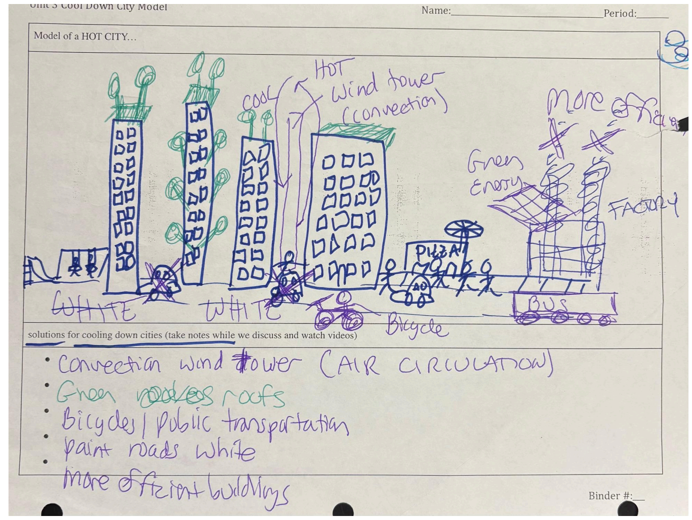
- Student Handout
- Slides
- Rubric

Student Prompts	**Ideal Student Responses**

Segment 3: In this segment you will work with your classmates to combine your solutions with each other to design the community space.

Discuss with your team the design features that should be included in your team's "cool zone". Each design feature should be linked with a solution to help lower land surface temperature. Create a model that includes your design features for the community space. In your model make sure to include concepts that relate to how the solution will cool down the area at both the macroscopic (visual) and particle levels.

Design features solutions with how they lower LST	Solution design	how it lowers LST
Model showing how the solutions can be used as part of a community cool zone. Include: • everyone's designs • how the systems in your model will lower LST • scientific concepts • macroscopic level • particle level		



Student response should have components similar to the image above (but for a single community center) and the following concepts: A possible solution to help cool down cities would be to create an area that blocks out more of the sun's energy (has additional shade). Additionally the area could be created to have water features (to allow for evaporative cooling) and green plants/vegetation (for increased cooling through transpiration). Additionally the areas can be built using materials with higher heat capacities (to allow them to absorb more energy before heating up) and utilize lighter colored surfaces (to have high albedo and reflect more of the sun's energy). Finally the areas can be created to allow for air circulation (convection to allow hot air to rise and move away and cooler air to flow in).

Navigation Across Segments

This is a synthesis event. Students are now demonstrating their knowledge of the urban heat island effect to develop solutions as a team to design a cool community space.

Scoring Guidance

Student Facing Rubric

Criteria	Not Yet	Almost There	Got It!
1. My Solution Does my solution clearly connect to the problem and show how it will make the space cooler?	☐	☐	☐
2. Using Science to Explain Have I used science ideas about **energy transfer, sunlight, reflection, or temperature** to explain how it works?	☐	☐	☐
3. My Model Does my model show the **parts of the system** and how energy or heat moves through it? Is it neat, labeled, and easy to understand?	☐	☐	☐
4. Working with My Group Did I share my ideas, listen to others, and help combine our solutions into one design that keeps our community space cooler?	☐	☐	☐

Student Reflection

What part of your model are you most proud of?

____

____

What part could you improve or explain more clearly?

____

____

Rubric for Segment 3:

Criteria	Proficient (Meets the Standard)	Areas for Growth	Areas of Strength
Design Solution Proposal *(SEP: Designing Solutions; DCI: ESS3.C; CCC: Cause and Effect)*	Proposes a **realistic, evidence-based solution** that directly addresses the identified problem. Explains the **cause-and-effect relationship** between the problem and how the solution mitigates heat (e.g., adding trees provides shade that lowers LST).		
Use of Scientific Principles *(SEP: Constructing Explanations; DCI: ESS3.C, PS3.B; CCC: Energy and Matter)*	Applies **accurate scientific reasoning** about **energy transfer and system interactions** to explain how the solution decreases **land surface temperature (LST).** Explanation includes both **macroscopic (visible)** and **particle (microscopic)** levels.		
Model Development and Representation *(SEP: Developing and Using Models; CCC: Systems and System Models)*	Creates a **clear and labeled model** that shows how the solution functions within the **community system** to reduce heat. The model includes **components, energy flow**, and how **matter and energy move through** the system.		
Collaboration and Integration (Segment 3) *(SEP: Engaging in Argument from Evidence; CCC: Stability and Change)*	**Collaborates effectively** to combine multiple individual solutions into a **cohesive group model.** Explains how the group design maintains a **stable, cooler microclimate** and supports the **long-term health** of the community system.		

How the Performance Task Was Developed

This performance task comes from the San Diego Science Project at UC San Diego with phenomena and resources from the SoCal Heat Hub.

Task Name and Version History	CHEM UGC Cool Zone Design PT 2025
Task Developer(s)	Rachel Stein Meisner
Institution(s)	Castle Park High School, Sweetwater Union High School District. San Diego Science Project, UC San Diego
Sources	Article reference: Resources: Climate Central urban heat islands