

THE UNIT QUESTION · SCIENCE + MATHEMATICS

“Can a city survive a heatwave?”

Today: Urban heat island: what the data show

LESSON 1 ✓ Heatwave: what we measure	LESSON 2 · TODAY What the data show	LESSON 3 Materials that cool	LESSON 4 A model of our neighbourhood	LESSON 5 A proposal to the council	LESSON 6 Presentation and Unit Report
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THE BIG IDEA Surfaces absorb and reflect solar radiation to different degrees. Asphalt stores energy and gives it back at night; greenery cools through shade and the evaporation of water. The data show a strong link between greenery and temperature, but a link does not on its own prove the cause.	THE MISCONCEPTION WE TARGET “Black attracts heat” and “if they go together, one causes the other”. Dark surfaces do not “attract” heat: they absorb more radiation. And a neighbourhood by the sea shows that other factors are at play.
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1 First pass · Knowledge

WHAT THEY WILL LEARN

#	LEARNING OBJECTIVE	SUCCESS CRITERION	EVIDENCE	MAX
O1	Uses the absorption–reflection model to explain why dark surfaces heat up more.	Uses “absorption”, “reflection” and “radiation” correctly and backs it up with the infrared readings.	Group readings · exit ticket, Q1	3
O2	Models temperature–greenery data with a straight line and interprets the gradient.	Draws a line that follows the trend; calculates the gradient with units; interprets it in words.	Hinge question · exit ticket, Q2	4
O3	Distinguishes correlation from causation by naming a possible confounding factor.	Spots the point that does not fit and names a third variable (the sea, building density).	Group analysis · exit ticket, Q3	3
R	Recall: 5 questions from lesson 1 and KS3 content (energy, heat, linear functions, gradient, scatter graphs).			5

Target vocabulary: absorption · reflection · radiation · heat island · scatter graph · gradient · correlation · causation · confounding factor. **Mastered:** at least 80% correct today; confirmed by recall in lesson 3.

2 Second pass · Growth

WHAT THEY WILL DEVELOP AND THROUGH WHICH ROUTE

GROWTH TARGET	WHY IN THIS LESSON	HOW IT SHOWS TODAY		
EXECUTIVE FUNCTIONS Cognitive flexibility ROUTE · WITHIN THE TASK	One point in the data does not fit the original hypothesis.	S · WITH SUPPORT Revises when shown the point that does not fit.	I · INDEPENDENTLY Revises on their own and says what changed their thinking.	N · IN A NEW CONTEXT Does the same with data from another subject.
HOLISTIC COMPETENCIES Systems thinking ROUTE · WITHIN THE TASK	The “obvious” solution, air conditioning, cools the inside and heats the street.	S · WITH SUPPORT Completes the cause map with a guiding question.	I · INDEPENDENTLY Spots on their own that a solution moves the problem elsewhere.	N · IN A NEW CONTEXT Finds a similar “moved problem” in another field.
HOLISTIC COMPETENCIES Ethical thinking, integrity and responsibility ROUTE · BRIDGE	A heatwave does not hit everyone equally; “allowed” does not mean “right”.	S · WITH SUPPORT Separates legal from right with an example they are given.	I · INDEPENDENTLY Separates legal from right on their own and backs up their position.	N · IN A NEW CONTEXT Applies the distinction to a new issue, without prompting.

Also cultivated, without being recorded today: Communication and collaboration (jigsaw) · Inhibitory control (warm-up) · Empathy (in the Bridge).
Three routes of cultivation: **within the task** (the academic problem itself) · **Bridge** (a neighbouring social, emotional, ethical or cultural theme) · **way of working** (roles, climate, natural difficulty). Each lesson records the day’s mark (S · I · N); a level is given only in the Developmental Profile.

3 The flow of the lesson

90 MINUTES · SIX STAGES

5' Welcome	10' Warm-up	28' Academic core	24' Application & creation	14' Bridge	9' Reflection
5' 0:00–0:05 Welcome	Each student writes an initial hypothesis on a card: <i>Why is the square 6 °C hotter than the park next to it?</i> The card stays on the table until the close. LINK TO LESSON 1 INITIAL HYPOTHESIS		A Shows the two thermal photographs; does not comment on the hypotheses. B Photographs the cards for the comparison at the close.		
10' 0:05–0:15 Warm-up	Recall (5'): 5 interleaved questions. Myth or fact? (5'): five quick claims (“Black attracts heat”). Rule: 10 seconds of silence before each answer. RECALL · R/5 INHIBITORY CONTROL		A Keeps to the 10" rule; does not give the answers yet. B Records the recall score.		
28' 0:15–0:43 Academic core	Measurements (8'): infrared thermometer on four surfaces under a lamp: black, white, tile, damp soil with a plant. Worked example (9'): the absorption–reflection model; then 12 neighbourhoods on a scatter graph, a line and a gradient triangle. Hinge question (3'): “The gradient is –0.15. What does it mean?” Practice (8'): gradient from a second pair of points; interpretation in words. O1 · O2 COGNITIVE FLEXIBILITY		A Models; asks “What does this number mean for a person in the street?” B Counts the answers to the hinge question.		
24' 0:43–1:07 Application & creation	Jigsaw with three “specialisms”: - Gradient and prediction: how much would the temperature fall with 10 points more greenery? - The point that does not fit: the seaside neighbourhood. What else explains its temperature? - Cause-and-effect map: what happens when everyone turns on the air conditioning? Each “specialist” teaches their group. O2 · O3 SYSTEMS THINKING FLEXIBILITY		A Moves between groups; asks for evidence for every claim. B Records systems thinking and flexibility in the map and the analysis.		
14' 1:07–1:21 Bridge	“Whitewash, plane trees and the delivery rider”. Two photographs and what the old builders knew; three people on the same street; a line of positions on “allowed ≠ right”; one principle for the proposal to the council (p. 3). APPLYING O1 ETHICAL THINKING EMPATHY		A Leads the line of positions; asks for “one piece of evidence and one value”. B Records who separates legal from right on their own.		
9' 1:21–1:30 Reflection	Exit ticket (5'): three questions with confidence 1–4 (p. 4). The hypothesis card (2'): “Has my hypothesis changed? What convinced me?” Challenge (2'). O1–O3 SELF-REGULATED LEARNING		A Hands out and collects the exit ticket. B Compares the hypothesis cards before and after.		

4 Bridge · from knowledge to life

14 MINUTES · A ROUTE OF CULTIVATION

BRIDGE · CULTURAL KNOWLEDGE · FAIRNESS IN A HEATWAVE

“Whitewash, plane trees and the delivery rider”

The absorption–reflection model explains why houses in the Cyclades are whitewashed and why a square with a plane tree stays cool. The same data show that a heatwave does not hit everyone equally.

HOW IT UNFOLDS

1. **Two photographs (3').** A whitewashed Cycladic village and a square shaded by a plane tree. “What did the old builders know?”
2. **Three people (4').** On the same street at 3 in the afternoon: a delivery rider, an 80-year-old woman in a top-floor flat, a child in a school playground with no trees. Who is most exposed, and why?
3. **Line of positions (4').** “If something is allowed, is it also right?” Each student stands on the line and gives reasons.
4. **One principle (3').** The group writes one principle for the proposal to the council (lesson 5).

Cultivates: Ethical thinking · Empathy · Cultural identity.

QUESTIONS FOR DISCUSSION

- Who decides where trees are planted? Who pays for the heat?
- How is “it is allowed” different from “it is right”?
- Which knowledge of earlier generations is worth rediscovering?

CARE

We assess the reasoning, never the position. We avoid generalisations about jobs, neighbourhoods and groups of people. The photographs show places, not people in difficulty.

The Bridge is not a moral lesson. We ask, we listen, and the children take a position; the day’s learning gives them the tools to think it through.

5 How · Methods, strategies, practices

MODEL 2 IN PRACTICE

METHODS

Phenomenon-based learning. A square 6 °C hotter than the park. **Inquiry-based learning.** Measurements and a real dataset.

STRATEGIES

Retrieval practice with interleaving · **Worked example** for the gradient · **Hinge question** · **Explicit teaching of metacognition** with the hypothesis card.

CLASSROOM PRACTICES

Jigsaw in the application · **Cause-and-effect map** · **Line of positions** in the Bridge · **Exit ticket**.

6 Differentiation

SAME OBJECTIVES, DIFFERENT SUPPORT

MORE SUPPORT

- Axes already drawn and a gradient-triangle template.
- Sentence frame: “For every ... more ..., the temperature ...”.
- Vocabulary card.

MORE CHALLENGE

- Which study design would test the cause? (intervention: trees in one neighbourhood).
- Is the relationship linear across the whole range?

FADING THE SUPPORT

In lesson 4 students choose the variables themselves and draw the graph for their own neighbourhood.

WHERE THEY WILL MEET IT AT SCHOOL

National Curriculum, KS3 Mathematics: graphs of linear functions, $y = mx + c$ and the gradient; scatter graphs of bivariate data. KS3 Science: energy transfer by radiation, heating and cooling. Correlation and confounding go a step beyond the curriculum.

HOW IT BUILDS ON THE PREVIOUS LESSON

In lesson 1 they learned what we measure in a heatwave and how. Today they move from measuring to modelling: what relationship the data show, and what they do not show.

7 Assessment

EVERY ASSESSMENT LEADS TO A DECISION

HINGE QUESTION · MIDWAY THROUGH THE CORE

"The gradient of the line is -0.15 . What does it mean?" A: for every one point (%) more greenery, about $0.15\text{ }^{\circ}\text{C}$ lower temperature · B: greenery lowers the temperature by 15% · C: neighbourhoods with 15% greenery are $-0.15\text{ }^{\circ}\text{C}$.

CORRECT: A

DECISION RULE

If at least 6 of the 8 choose A, we move on to the jigsaw. Otherwise teacher A works through the gradient again with two points on the line (3').

WHEN	TYPE	TOOL	WHAT WE DECIDE	WHERE IT IS RECORDED
Warm-up	Diagnostic	Recall: 5 interleaved questions	Whether the gradient needs a reminder before the core	Progress: before → today
Core	Formative	Hinge question: the gradient -0.15	Jigsaw, or a second worked example	Not scored
Application	Developmental	Observation: systems thinking, flexibility	Which group needs a guiding question	Mark S / I / N
Bridge	Developmental	Line of positions · the group's principle	What goes into the proposal in lesson 5	Mark S / I / N · ethical thinking
Close	Summative	Exit ticket · 10 marks	Mastered ($\geq 80\%$) or revisited	Score per objective O1–O3
Close	Self-assessment	Hypothesis card · confidence 1–4	Who needs a conversation about their confidence	Self-regulated learning

In the Bridge we do not assess what the child believes, but how they think, and only when that is a target for the day.

8 Exit ticket

10 MARKS · ONE QUESTION PER OBJECTIVE · CONFIDENCE 1–4 ON EACH QUESTION

QUESTION 1 · O1

CONFIDENCE ☐1☐2☐3☐4 3 MARKS

At 2 in the afternoon a white roof measures $38\text{ }^{\circ}\text{C}$ and a black one $62\text{ }^{\circ}\text{C}$. Explain the difference. Why does the white roof also help the flat below?

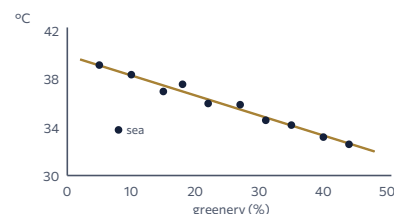
Absorption and reflection (1) · radiation, not heat being "attracted" (1) · less energy passes into the building (1).

QUESTION 2 · O2

CONFIDENCE ☐1☐2☐3☐4 4 MARKS

On the graph, the line passes through the points (10, 38) and (40, 33). Calculate the gradient, explain it in words and predict the temperature for 25% greenery.

Gradient $(33 - 38) / (40 - 10) \approx -0.17$ (2) · interpretation with units (1) · prediction $\approx 35.5\text{ }^{\circ}\text{C}$ (1).



QUESTION 3 · O3

CONFIDENCE ☐1☐2☐3☐4 3 MARKS

An article says: "In neighbourhoods with more trees, people live longer. Let's plant trees so we live longer." What else could explain the link?

Correlation $\neq$ causation (1) · a possible third factor, e.g. income (1) · how it affects both (1).

CHALLENGE · ~15' WITH THE FAMILY

Find the coolest and the hottest spot in your neighbourhood at 6 in the evening. What is different about them? Ask an older person: where did people go to keep cool in summer when they were children?

Bring back: two photographs and the answer. They go into the neighbourhood model (lesson 4).

MATERIALS

4 infrared thermometers · heat lamp · black and white card, a tile, a pot with damp soil · data sheet for 12 neighbourhoods (illustrative data) · graph paper · photographs of the Cyclades and of a square with a plane tree · hypothesis cards · A/B/C cards · exit tickets.

WHAT GOES INTO THE LESSON REPORT

Score and level on each knowledge objective · progress in recall · S / I / N mark for systems thinking, flexibility and ethical thinking · the hypothesis before and after · the Bridge with one question for home · the Challenge. The family receives the report after the lesson.