



TeachEngineering

STEM Curriculum for K-12

ECOLOGY IN ACTION: ROOFTOP GARDENS



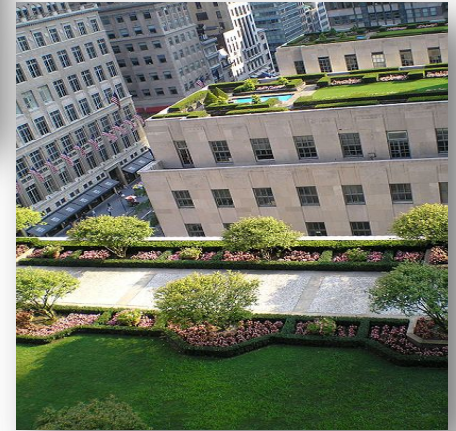
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WHY A ROOFTOP GARDEN

- Reduce the “urban heat island effect”
- Reduce amount of greenhouse gas
- Provide more space for agriculture
- Reduce and clean storm water runoff
- Reduce energy consumption
- Increase the beauty of cities



URBAN HEAT ISLAND EFFECT

A phenomenon in which the ambient air temperature in cities is higher than in its surrounding suburban and rural areas

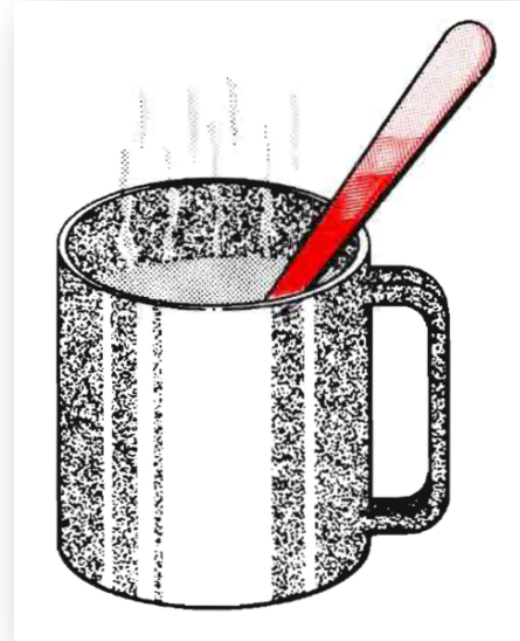


- Causes:
 - **Materials** (such as concrete and asphalt) absorb and radiate more heat than natural surfaces found in rural settings
 - **Tall buildings** - more surfaces that reflect and absorb light and block wind
 - **Waste heat** from energy usage – includes cars, air conditioning, industries
- Creates higher energy demands to keep buildings cool
- Affects weather and climate

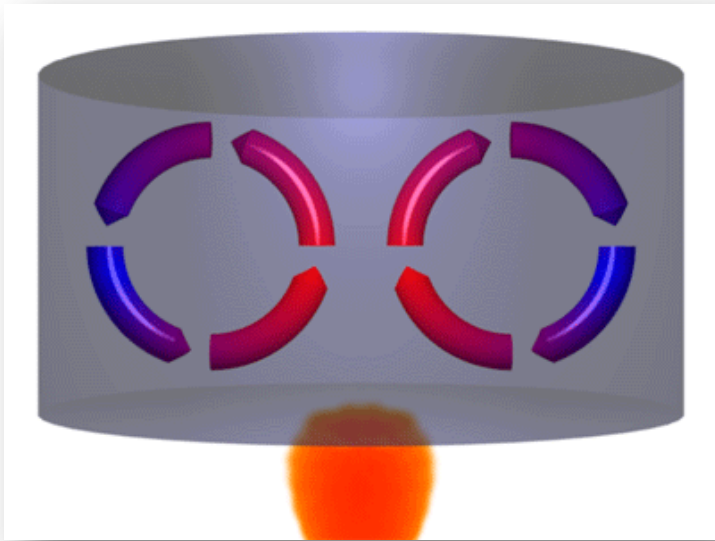
HEAT TRANSFER BASICS

CONDUCTION

- Transfer of heat by direct contact of particles in matter
- In solids, close vibration of atoms next to each other



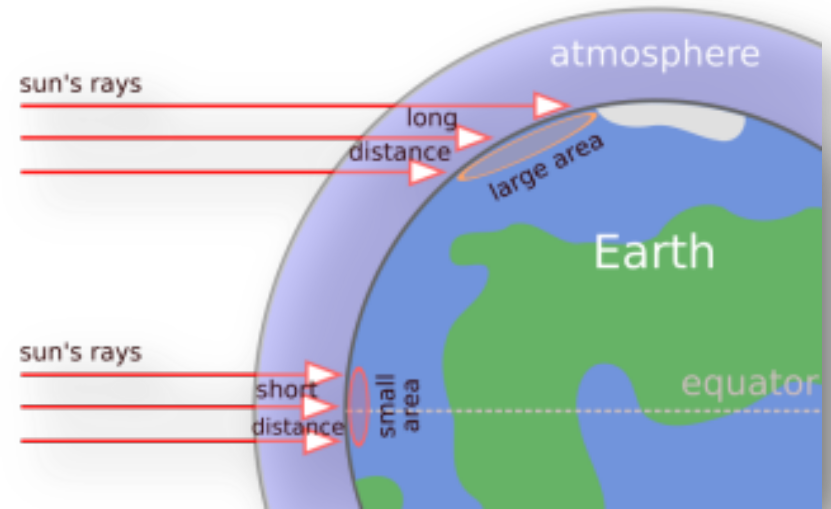
CONVECTION



- Transfer of heat by fluid or gas moving across a boundary
- Natural convection occurs by buoyancy forces

RADIATION

- Transfer of thermal energy through space
- This is how the sun heats the surface of the Earth!
- Radiation can be transmitted, reflected and emitted from a surface



MATERIALS

- **Insulators**

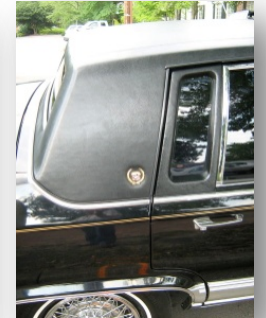
- materials that reduce the rate of heat transfer

- **Absorbers**

- materials that take up the energy of light

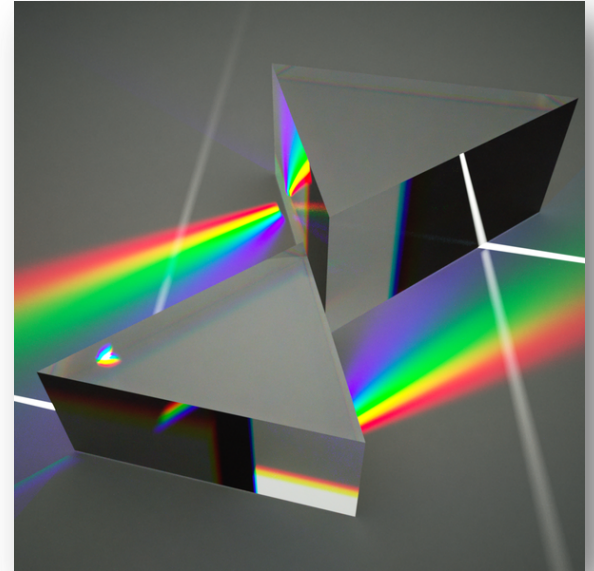
- **Reflectors**

- materials that change the direction of light waves



COLOR, LIGHT, AND HEAT

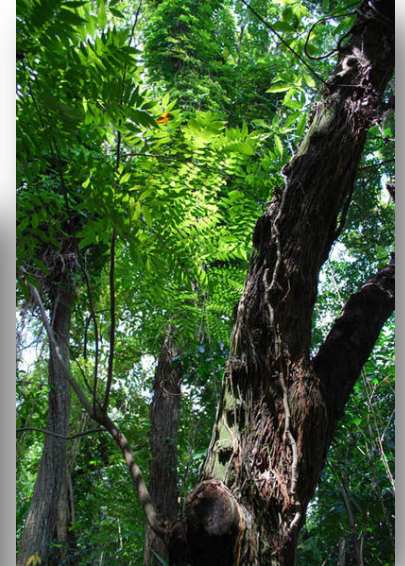
- All colors absorb light and reflect only the wavelengths of their color
- White reflects all wavelengths of light
- Black absorbs all wavelengths of light
- The energy of the absorbed light is transferred into heat energy...
 - Black surfaces get **hotter** than other colors!



PLANTS TO THE RESCUE

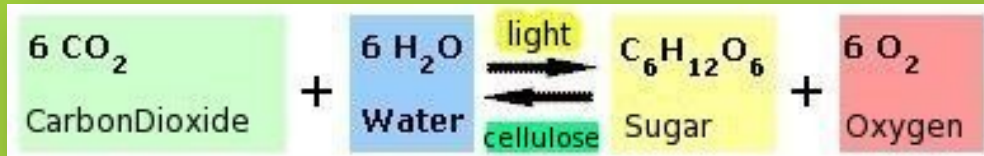
HOW DO PLANTS REDUCE TEMPERATURE?

- Provide an alternative to common roof materials
- Absorb CO₂ and sunlight during photosynthesis
- Create shade



PHOTOSYNTHESIS

- **Photosynthesis:** how plants feed themselves
 - Occurs in the leaves of plants
 - Uses carbon dioxide and energy from the sun
 - Represented by the equation:
 - Produces oxygen

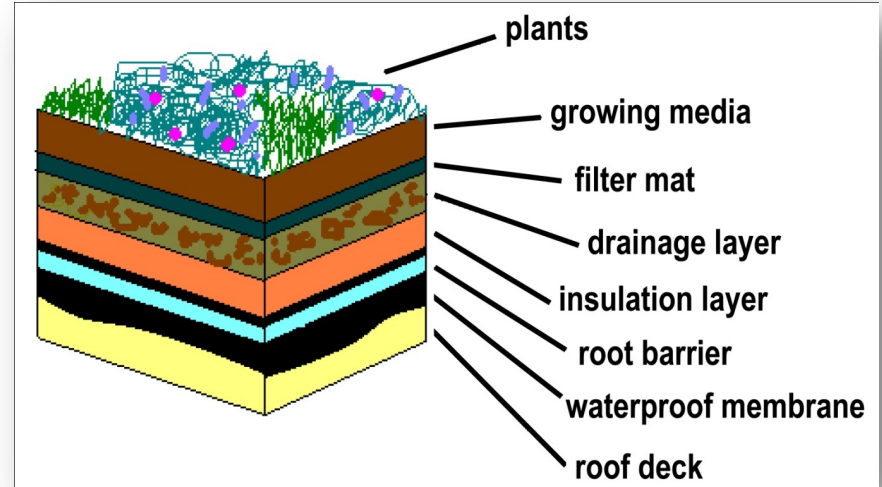


- **Additional benefit:** Photosynthesis helps reduce global warming by converting carbon dioxide molecules (a greenhouse gas)

CONSTRUCTING A ROOFTOP GARDEN

CONSTRAINTS OF A ROOFTOP GARDEN

- Condition of the roof
- Structural capacity of the roof
- Access to the roof
- Cost
- Irrigation
- Drainage



EXAMPLE

This demonstration plot on a sidewalk in Portland, OR, shows the exact composition of the “green roof” on the building above it.



OUR ROOFTOP GARDEN PROJECT

- **TEAM OBJECTIVES:**
 - Construct two identical model buildings
 - **One with a black tar roof**
 - **One with a rooftop garden**
 - Measure the temperatures inside and on the roof of the buildings while under a heat lamp (sun)
 - Graph the data

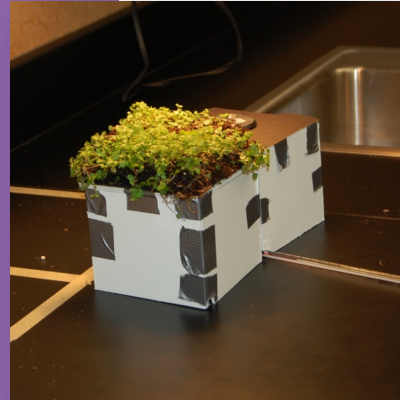


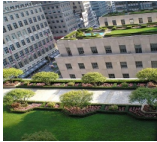
IMAGE SOURCES



http://www.explorechicago.org/city/en/about_the_city/green_chicago/Green_Roofs_.html



http://www.explorechicago.org/city/en/things_see_do/attractions/tourism/pepsico_rooftop_garden.html



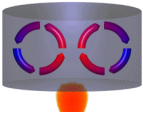
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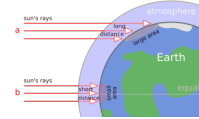
http://www.cityofchicago.org/content/dam/city/depts/doe/general/GreenBldsRoofsHomes/GuidetoRooftopGardening_v2.pdf



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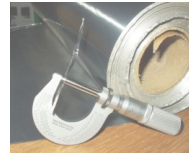
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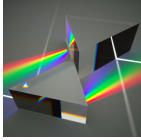


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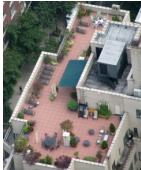
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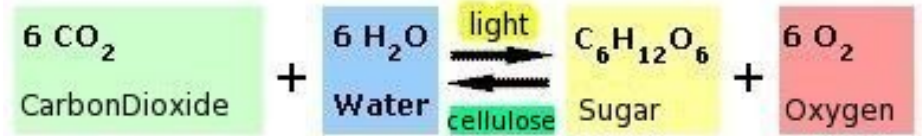
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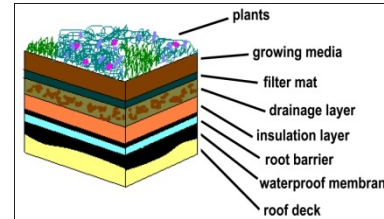
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