**Materials ScienceExploration - Challenge n°2 - 40’**

**Cool Roofs: Paint it Cool!**

*Rising energy costs, pronounced urban heat-island effect and global warming, increase the need for intelligent solar heat management solutions such as cool paints. Roughly 50 % of solar radiation are absorbed at the Earth’s surface. Black surfaces usually absorb up to 90 % of this energy and therefore get hot. White surfaces, on the other hand, absorb only up to 25 % and tend to stay much cooler. The impact in building can be dramatic. It’s a well known experience that rooms directly under the roof become suffocating and stuffy. Cool paints may help in that.*

*But white is not always an option, much more often colour and especially dark shades are desirable (like in cars) or even required. Cool roof paints have a very high reflectance together with a high emissivity.*

On the desk you have a model village with 4 houses. Their roofs have been painted with different colours.

**Q1.** Which house do you think will reach the highest temperature inside if exposed to light/IR? Which one the lowest? Why?

**Q2.** Take a picture with the thermal camera of the four roofs BEFORE switching on the light. What do you observe? Can you explain it?

At your disposal you have:

* 4 sensors:
1. a temperature probe (placed under the roof - inside) - **Arduino1**
2. a surface temperature probe (placed on the roof - outside) - **Arduino2**
3. 2 IR contactless temperature probes (a little over the roof, one directed upward, measuring IR incoming radiation on the roof; the second directed downward, measuring IR outgoing radiation from the roof, both reflected and/or emitted) - **Arduino2**

[*NOTE: they should measure temperature, but actually they do this by measuring IR radiation: so, by dividing the two measures, we will get the (percent) ratio between outgoing and ingoing IR radiation – doing so we don’t have to care about unit of measure*]

* Arduino connected with the four sensors: you can read the measures of the four sensors on the serial monitor of Arduino on the PC connected to them (time sampling is set on 1 sample/5 sec)
1. Choose one roof, position the halogen lamp focusing on it (this will be our “sun”) and:
2. Write down the (initial) temperature both inside and outside;
3. Write down the measures of the IR probes, both upward and downward;
4. Switch on the light and leave it on for exactly 5 minutes;
5. During the illumination time (let’s say approximately at half the time) write down the measures of the IR probes, both upwards and downwards;
6. Just before switching off the light, write down the (final) temperature, both inside and outside;
7. Just after having switched off the light (it will be our “night”), write down the measures of the IR probes, both upwards and downwards;
8. Fill in the Table (on the Answer sheet) with all the data collected and do the requested calculation.
9. Repeat experiment A (from point 1 to 6) for the other roofs.

***Warning:***

* *BE SURE that the distance from the lamp and the roof is the same during all 4 Data Collections!*
* *During each measurement be sure that light DO NOT fall on the other “houses” that you are not testing (otherwise they will warm up!): protect them from incident light with a cardboard.*

**Q3.** After you have completed the test with all 4 houses, can you tell which/which ones are “cool paints”? Why? Justify your answer basing on the collected data.

**☞OUTPUT WANTED : Answer to Q1 ... Q3 + Data Tables + 1 photo of apparatus and/or detail**

**Answer sheet GROUP N°\_\_\_\_\_\_\_\_\_\_\_**

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**Q1**

**Q2**

|  |  |
| --- | --- |
| **House n.** | **Colour and texture of roof:**  |
|  | **T inside** | **T outside** | **IR incoming** | **IR outgoing** | **R% = IRout/IRin 100** |
| **Initial ->Ti**[*Before lightening*] |  |  |  |  |  |
| [*During lightening*] | ### | ### |  |  |  |
| **Final ->Tf**[*Just* ***before*** *turning light off*] |  |  | ### | ### | ### |
| Final[*Just* ***after*** *turning light off*] | ### | ### |  |  |  |
| Temperature change**T = Tf - Ti** |  |  | ### | ### | ### |

|  |  |
| --- | --- |
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| **Final ->Tf**[*Just* ***before*** *turning light off*] |  |  | ### | ### | ### |
| Final[*Just* ***after*** *turning light off*] | ### | ### |  |  |  |
| Temperature change**T = Tf - Ti** |  |  | ### | ### | ### |

**Answersheet GROUP N°\_\_\_\_\_\_\_\_\_\_\_**

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**Q3**

**PICTURES [*Sent by Whatsapp to your group* – *See general instruction to share pictures or files*]**

* **Pictures description:**

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