Tools for Materials Science - Challenge n°8 - 40'

USE OF IR THERMOMETER AND THERMAL CAMERA

IR (Infra-Red) thermometers and thermal cameras make contactless measurements of the temperature of objects. This means that they are not based on thermal equilibrium between tool and object as classical thermometers. Actually they measure the emissivity of the surface and from this they deduce the temperature. Therefore to use these tools correctly it's extremely important to understand how the emissivity of an object may change based on a few parameters such as: colour, material, texture, viewing angle, radiation wavelength. ***Let's make some tests!***

1. On the desk you have a **Leslie cube**. This is a cube whose sides have different colour, texture and material.
   Fill the cube with hot water and put the rubber stopper with the thermometer inserted: you will be able to monitor the internal temperature of the water which after a few minutes - once thermal equilibrium has been reached – will actually be the temperature of the whole system (cube + water).
   - All the side faces should be at the same temperature: check with the thermocouple.
   - Take the IR gun and point it at each side (keep it perpendicular to the cube surface).
   - fill in **Table 1** with your readings.
   - Take a **picture** of the cube with the thermal camera. What do you notice?

Q1. What can you say about the change of temperature readings due to colour and texture? Answer basing on data and picture collected above.

2. **Viewing angle – 2A –** On the desk you also have a paper goniometer. Position the ***black opaque side*** of the cube in the middle, so that 0°C coincide with the perpendicular to this side. Then move the IR gun step by step and take readings at different angles from 0° to 90°. [*At least 5 different angles, starting from 0°;. the last reading will be with the IR gun almost parallel to the cube surface*]. Fill in **Table 2A**.

3. **Viewing angle – 2B –** Repeat previous point A now shooting photos with the thermal camera pointing at the cube at different viewing angle. BUT before taking measurements:
   a. **"lock" the temperature scale** on the right of the screen [*just touch the temperature either the upper or the lower one: they will turn gray and a closed lock will appear. This will prevent the camera from recalibrating each time and it will be possible to compare temperatures in the different measurements*.]
   b. Choose the **right value for the emissivity** parameter [*Reflective (smooth) surfaces, opaque ones: choose "opaque". To do this touch the screen and chose the "wheel" → "other parameters"…*]

   Fill in **Table 2B**.

4. **Viewing angle – 3A – 3B –** Repeat point 2A and 2B below now with the ***shiny metal side***. Use both IR gun and thermal camera but remember to change the emissivity parameter (choose reflective) and be aware of reflections (perpendicular may not be the best option for shooting!). Fill in **Table 3A & 3B.**

Q2. Theoretically the intensity of the radiation emitted by a black body is the same in every direction. Is it the same with real objects? Is there a specific angle beyond which readings are no more reliable? Answer basing on the data collected below.

☞ **OUTPUT WANTED: ->Answer to questions Q1, Q2 + picture(1) with thermal camera + Tables**
PLEASE NOTE: Leave all pictures made by the thermal camera in the camera memory !

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Answer sheet **GROUP N°___________**

Ch.8 --- USE OF IR THERMOMETER AND THERMAL CAMERA

Table 1	Colour and texture of the faces			
TEMPERATURE (°C) measured by:	1: Shiny metal -> smooth	2: White opaque -> rough	3: Black lucid -> smooth	4:Black opaque -> rough
IR thermometer				
thermocouple				

Q1.

Table 2A	***Black opaque side***		
Angle (°)	**T_{IR}** (°C) temperature: -> whit ***IR Gun***	**T** (°C) "real" temperature: -> whit ***Thermocouple***	**Error %** = = **100 x (T-T_{IR})/T**
			%
			%
			%
			%
			%

Table 2B	***Black opaque side***		
Angle (°)	**T_{IR}** (°C) temperature: -> whit ***Thermal Camera***	**T** (°C) "real" temperature: -> whit ***Thermocouple***	**Error %** = = **100 x (T-T_{IR})/T**
			%
			%
			%
			%
			%

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Table 3A	***Shiny Metal Side***		
Angle (°)	T_{IR} (°C) temperature: -> whit ***IR Gun***	**T** (°C) "real" temperature: -> whit ***Thermocouple***	**Error %** = = **100 x (T-T_{IR})/T**
			%
			%
			%
			%
			%

Table 3B	***Shiny Metal Side***		
Angle (°)	T_{IR} (°C) temperature: -> whit ***Thermal Camera***	**T** (°C) "real" temperature: -> whit ***Thermocouple***	**Error %** = = **100 x (T-T_{IR})/T**
			%
			%
			%
			%
			%

Q2.

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