University of San Carlos
Department of Chemical Engineering

CHE 3214L Chemical Engineering Laboratory Investigations 1

Experiment Plan

(Form CHE 3214L-1)

Prepared and submitted by:

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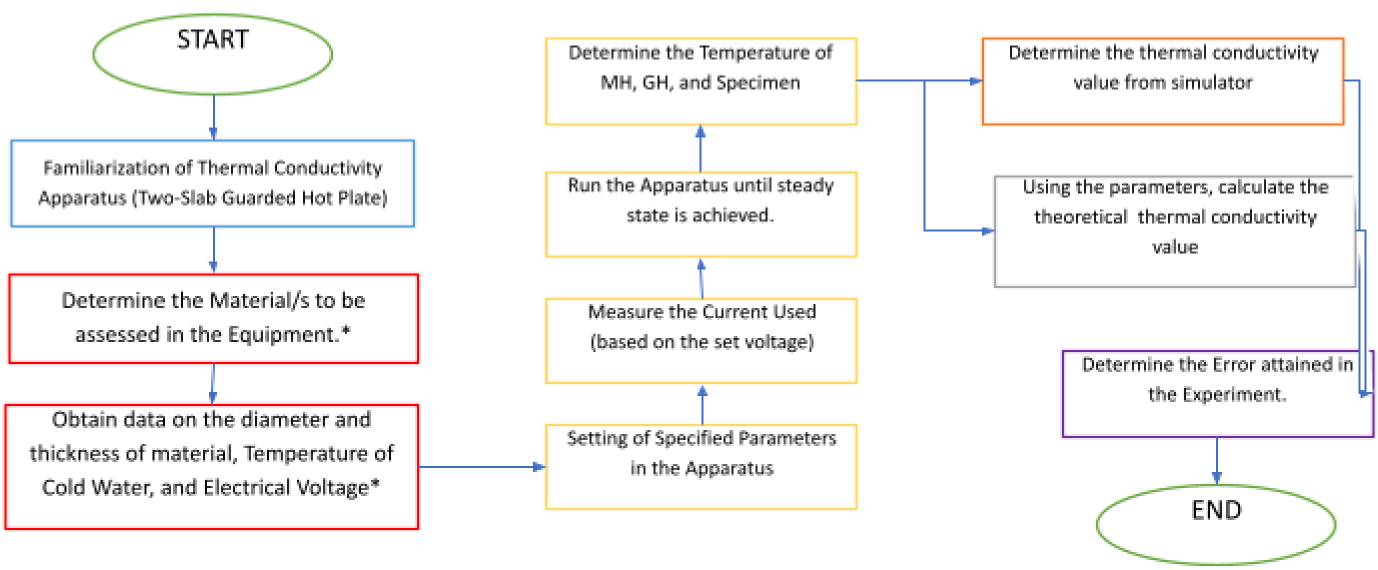
Experiment : **Heat Transfer by Conduction**

Objectives of the Experiment

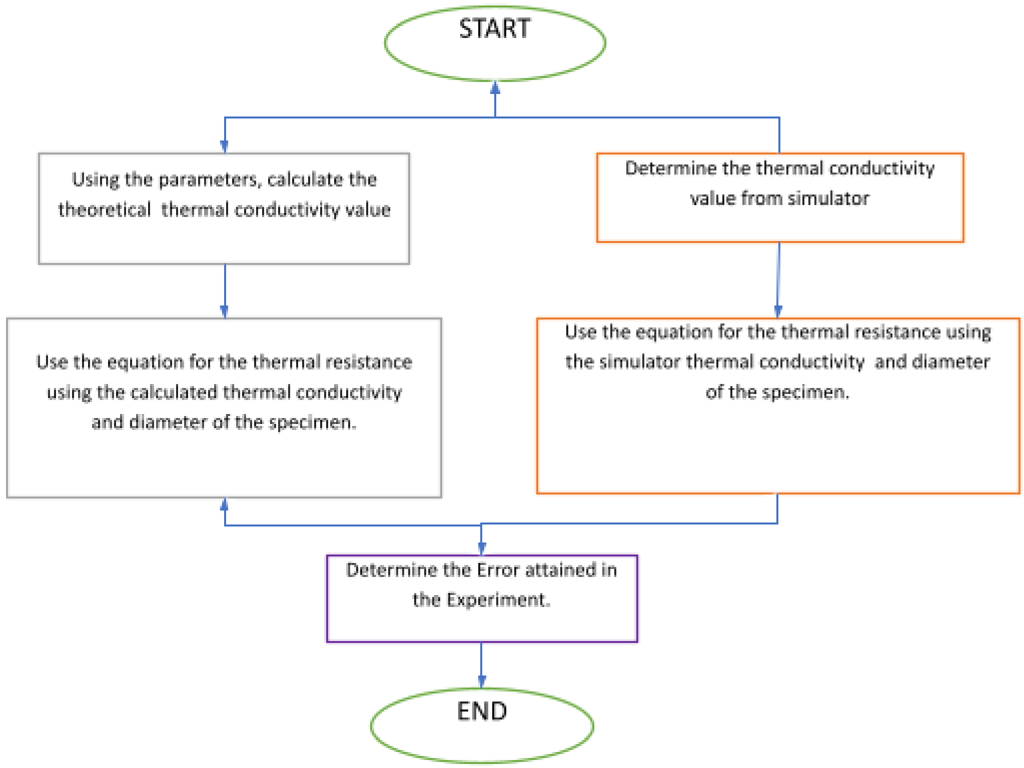
1. Determine the thermal conductivity of a material by the two slabs guarded hot plate method.
2. Determine the thermal resistance of the sample.
3. Compare the obtained experiment values to the calculated, simulator values.

Methodological Framework

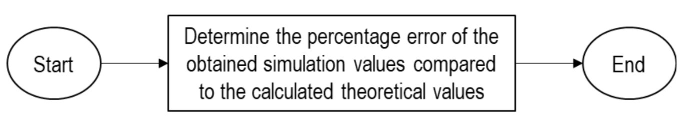
Objective 1: Determine the thermal conductivity of a material by the two slabs guarded hot plate method.



Objective 2: Determine the thermal resistance of the sample.



Objective 3: Compare the obtained experiment values to the calculated simulator values.



*Selection of Material and Specified Parameters will be decided by the **instructor ONLY.**

Materials, Measuring Apparatus & Equipment

Material	Quantity
Cardboard	**Diameter:** 10 cm **Thickness:** 0.5 cm
Mica	**Diameter:** 30 cm **Thickness:** 0.7 cm
Ebonite Solid	**Diameter:** 50 cm **Thickness:** 0.9 cm
Cold Water	**Temperature Range:** 0°C to 30°C
Equipment	**Specifications**
Stopwatch	Measures from 0 milliseconds to as much as 99 hours, 59 minutes, 59 seconds, and 999 milliseconds **Resolution:** ±1 millisecond
Thermal Conductivity Apparatus (Two-Slab Guarded Hot Plate)	Contains a thermometer, voltmeter, ammeter, and knobs for control
Thermometer	**Resolution:** ±0.01 K
Ammeter	**Resolution:** ±0.02 A Automatically adjusts with the voltage measurement
Voltmeter	**Resolution:** ±10 V Cardboard: 100 V Mica: 180 V Ebonite Solid: 260 V

Task Plan

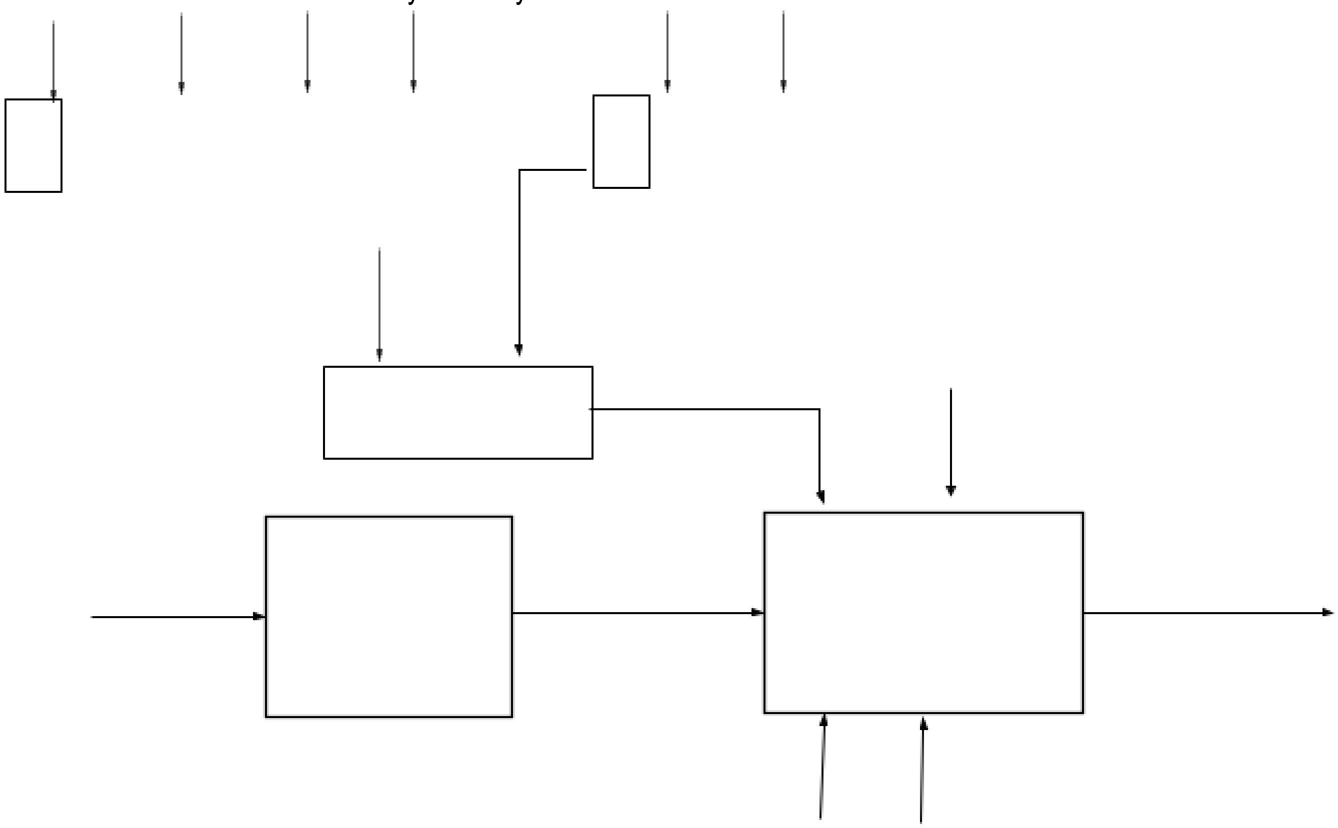
Time	Task	Person Responsible
1:30-2:30	Pre-Laboratory Virtual Questioning	Canama Delco Talandron
2:30 – 2:35	Open Virtual Laboratory Link > Simulator Set-up Selection of material from combo box Fixing of diameter and thickness Adjustment of cold-water temperature Fixing of voltage and current for both main heater and guard heater Note: The same voltage and current values are used for both heaters. Turn the unit on.	Canama Delco Talandron (Note: Each member shall do the procedures **individually and simultaneously**)
2:35 – 2:40	Reading of temperatures T_1 to T_8.	Canama Delco Talandron (Note: Each member shall do the procedures

		individually and simultaneously)
2:40 – 3:00	Calculation of thermal conductivity of test slab.	Canama Delco Talandron (Note: Each member shall do the procedures **individually and simultaneously**)
3:00 – 3:30	Repetition of procedures for the other combinations of parameters.	Canama Delco Talandron (Note: Each member shall do the procedures **individually and simultaneously**)
3:30 – 4:25	Collection of raw data and Documentation Analysis and Processing of Observed Mechanisms and Data Values from the Simulator	Canama Delco Talandron (Note: Each member shall do the procedures **individually and simultaneously**)
4:25 – 4:30	Final discussion	Canama Delco Talandron

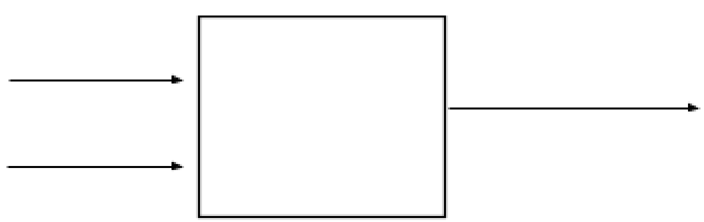
OBJECTIVE 1: Determine the thermal conductivity of a material by the two slabs guarded hot plate method.

Assumptions:

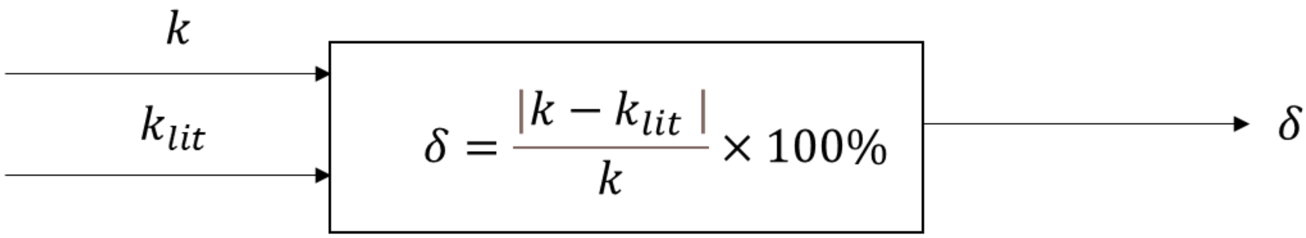
- Negligible Kinetic Energy, Potential Energy (for the entire system)
- Steady-State System

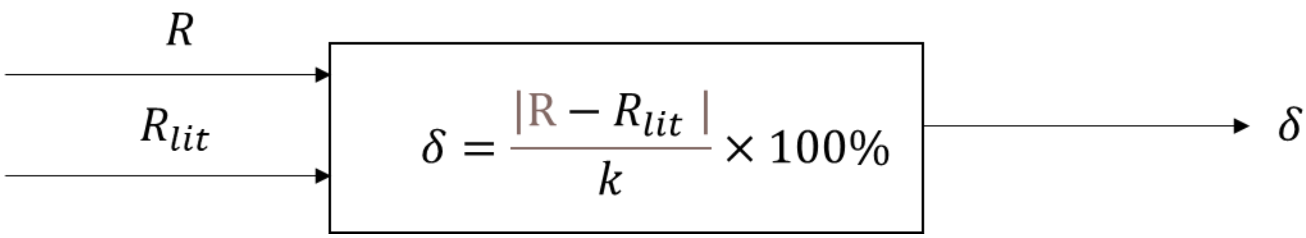


OBJECTIVE 2: Determine the thermal resistance of the sample.



OBJECTIVE 3: Compare the obtained experiment values to the calculated, simulator values.





Legend:

$k = Thermal\ Conductivity\ of\ Material\ (\frac{W}{m.K})$

$A = Area\ of\ Material\ (cm^2)$

$d = diameter\ of\ the\ material\ (cm)$

$\Delta x = Thickness\ of\ the\ material\ (cm)$

$V = Voltage\ (V)$

$I = Current(A)$

$\Delta T = Temperature\ difference\ of\ hot\ plate\ \&\ cold\ plate\ (K)$

$T_h = Mean\ temperature\ at\ the\ surface\ of\ the\ specimen\ on\ the\ heater\ side\ (K)$

$T_c = Mean\ temperature\ at\ the\ surface\ of\ the\ specimen\ on\ the\ cold\ plate\ side\ (K)$

$T_i = Temperature\ difference\ of\ hot\ plate\ \&\ cold\ plate\ (K)[i = 1, 2, 3, 4]$

$T_i = Temperature\ difference\ of\ hot\ plate\ \&\ cold\ plate\ (K)[i = 5, 6]$

$R = Thermal\ Resistance\ (\frac{K}{W})$

$\delta = Relative\ Error\ (\%)$

Raw Data Sheets

CANAMA

RUN 1

Material	Diameter (m)	Thickness (m)	Cold Water Temperature (˚C)	Voltage (V)	Current (A)
Ebonite Solid	50	0.9	25	260	0.94

Temperature of Main Heater					Temperature of Cold Heater		
T_1 (°C)	T_2 (°C)	T_3 (°C)	T_4 (°C)	Mean T_h (°C)	T_5 (°C)	T_6 (°C)	Mean T_c (°C)
40.78	41.45	40.49	41.45	**41.01**	25.00	25.00	**25.00**
Guard Hot Plate Temp			T_7 (°C)	40.49	T_8 (°C)	41.45	
Thermal Conductivity (W/m.K) from Simulator					0.17		
Thermal Conductivity (W/m.K) from Calculations					**0.17498**		

RUN 2

Material	Diameter (m)	Thickness (m)	Cold Water Temperature (˚C)	Voltage (V)	Current (A)
Mica	30	0.7	15	180	0.73

Temperature of Main Heater					Temperature of Cold Heater		
T_1 (°C)	T_2 (°C)	T_3 (°C)	T_4 (°C)	Mean T_h (°C)	T_5 (°C)	T_6 (°C)	Mean T_c (°C)
19.15	19.60	19.29	19.60	**19.41**	15.00	15.00	**15.00**
Guard Hot Plate Temp			T_7 (°C)	19.29	T_8 (°C)	19.60	
Thermal Conductivity (W/m.K) from Simulator					0.71		
Thermal Conductivity (W/m.K) from Calculations					**0.7377**		

RUN 3

Material	Diameter (m)	Thickness (m)	Cold Water Temperature (˚C)	Voltage (V)	Current (A)
Cardboard	10	0.5	5	100	0.20

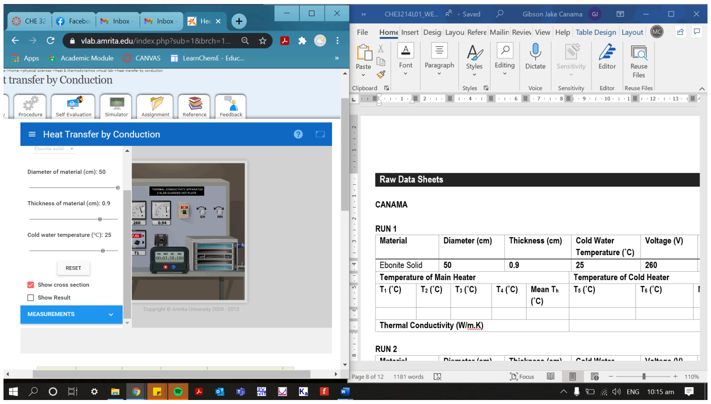
Temperature of Main Heater					Temperature of Cold Heater		
T_1 (°C)	T_2 (°C)	T_3 (°C)	T_4 (°C)	Mean T_h (°C)	T_5 (°C)	T_6 (°C)	Mean T_c (°C)
19.92	20.16	19.46	20.16	**19.93**	5.00	5.00	**5.00**
Guard Hot Plate Temp			T_7 (°C)	19.29	T_8 (°C)	20.16	
Thermal Conductivity (W/m.K) from Simulator					0.21		
Thermal Conductivity (W/m.K) from Calculations					**0.2133**		

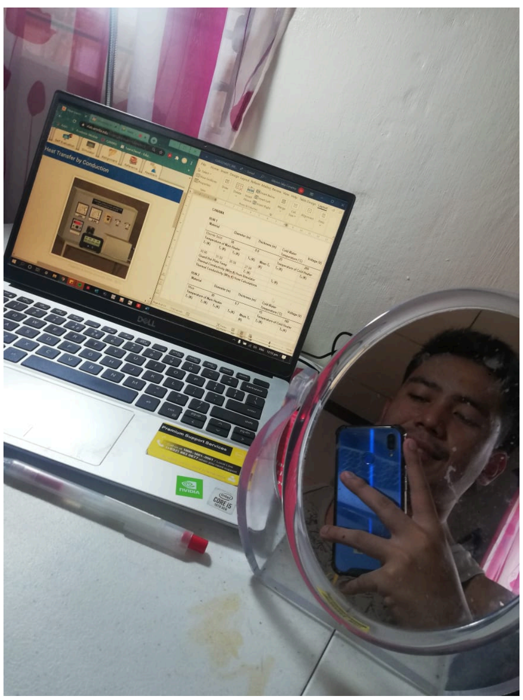
Observation:

- The simulator showed that the units of the temperature were at K. However, the values presented for temperature is in degrees Celsius, which is in contrast with the shown data.
- Temperature Readings from 1 to 4 are of precise value with each other while readings 5 and 6 are precise with one another. For readings 7 and 8 are close with the values with the first four readings.

- It was found out that the area of the plate is only referred to a single hot plate. Further, the simulator shows that there are two plates considered. Thus, it is appropriate to consider that the calculate Area must be multiplied by 2 as to consider the total area inside the apparatus.
- The simulator thermal conductivity are close to the calculated thermal conductivity.

DOCUMENTATION:





DELCO

RUN 1

Material	Diameter (m)	Thickness (m)	Cold Water Temperature (˚C)	Voltage (V)	Current (A)		
Ebonite Solid	50	0.9	25	260	0.94		
Temperature of Main Heater					Temperature of Cold Heater		
T_1 (K)	T_2 (K)	T_3 (K)	T_4 (K)	Mean T_h (K)	T_5 (K)	T_6 (K)	Mean T_c (K)

311.33	311.46	310.72	311.46	311.2425	298.15	298.15	298.15
Thermal Conductivity (W/m.K) from Simulator					0.17		
Thermal Conductivity (W/m.K) from Calculations					0.213910078		

RUN 2

Material	Diameter (m)		Thickness (m)		Cold Water Temperature (˚C)	Voltage (V)	Current (A)
Mica	30		0.7		15	180	0.73
Temperature of Main Heater					Temperature of Cold Heater		
T_1 (K)	T_2 (K)	T_3 (K)	T_4 (K)	Mean T_h (K)	T_5 (K)	T_6 (K)	Mean T_c (K)
291.79	292.75	292.64	292.75	292.4825	288.15	288.15	288.15
Thermal Conductivity (W/m.K) from Simulator					0.71		
Thermal Conductivity (W/m.K) from Calculations					0.750866021		

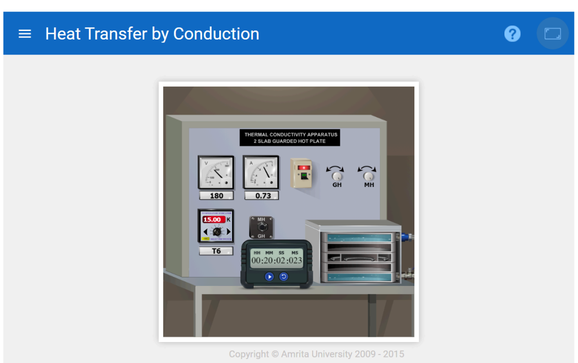
RUN 3

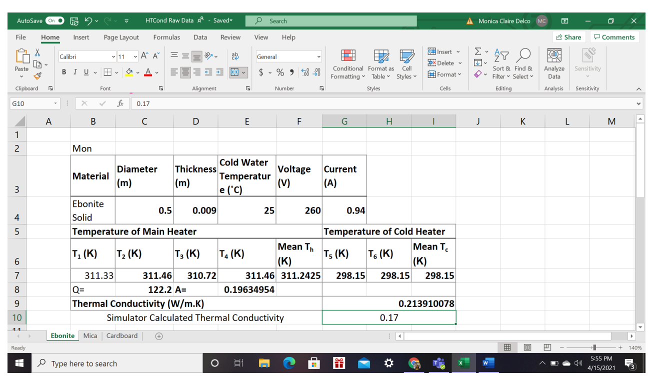
Material	Diameter (m)		Thickness (m)		Cold Water Temperature (˚C)	Voltage (V)	Current (A)
Cardboard	0.1		0.005		5	100	0.2
Temperature of Main Heater					Temperature of Cold Heater		
T_1 (K)	T_2 (K)	T_3 (K)	T_4 (K)	Mean T_h (K)	T_5 (K)	T_6 (K)	Mean T_c (K)
292.56	293.31	293.23	293.31	293.1025	278.15	278.15	278.15
Thermal Conductivity (W/m.K) from Simulator					0.21		
Thermal Conductivity (W/m.K) from Calculations					0.212880713		

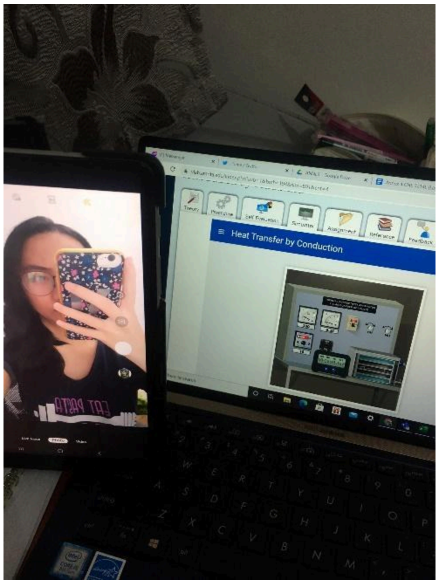
Observations:

In the simulator, the indicated unit at the temperature indicator is Kelvin. However, it must have been in degrees Celsius as these temperatures may have been too low to be in Kelvin. In all 3 runs, the temperatures of the thermocouples at the cold heater are equal.

DOCUMENTATION:







TALANDRON

RUN 1

Material	**Diameter (m)**	**Thickness (m)**	**Cold Water Temperature (˚C)**	**Voltage (V)**	**Current (A)**		
Ebonite Solid	**0.5**	**0.009**	**25**	**260**	**0.94**		
Temperature of Main Heater					**Temperature of Cold Heater**		
T_1 (K)	**T_2 (K)**	**T_3 (K)**	**T_4 (K)**	**Mean T_h (K)**	**T_5 (K)**	**T_6 (K)**	**Mean T_c (K)**
313.96	**314.6**	**314.24**	**314.6**	**314.35**	**298.15**	**298.15**	**298.15**
Q=	**122.2**	**A=**	**0.19634954**				
Thermal Conductivity (W/m.K)							**0.172877636**

Simulator Calculated Thermal Conductivity 0.17

RUN 2

Materia l	Diamete r (m)	Thicknes s (m)	Cold Water Temperature (˚C)	Voltag e (V)	Curren t (A)		
Mica	**0.3**	**0.007**	**15**	**180**	**0.73**		
Temperature of Main Heater					**Temperature of Cold Heater**		
T_1 (K)	**T_2 (K)**	**T_3 (K)**	**T_4 (K)**	**Mean T_h (K)**	**T_5 (K)**	**T_6 (K)**	**Mean T_c (K)**
292.64	**292.75**	**291.94**	**292.75**	**292.52**	**287.74**	**288.1**	**287.92**
Q=	**65.7**	**A=**	**0.070686**				
Thermal Conductivity (W/m.K)							**0.70720153**

Simulator Calculated Thermal Conductivity 0.71

RUN 3

Material	Diamete r (m)	Thicknes s (m)	Cold Water Temperature (˚C)	Voltage (V)	Curren t (A)		
Cardboar d	**0.1**	**0.005**	**5**	**100**	**0.2**		
Temperature of Main Heater					**Temperature of Cold Heater**		
T_1 (K)	**T_2 (K)**	**T_3 (K)**	**T_4 (K)**	**Mean T_h (K)**	**T_5 (K)**	**T_6 (K)**	**Mean T_c (K)**
292.42	**293.31**	**292.5**	**293.31**	**292.88 5**	**278.15**	**278.15**	**278.15**
Q=	**10**	**A=**	**0.007854**				
Thermal Conductivity (W/m.K)							**0.216022997**

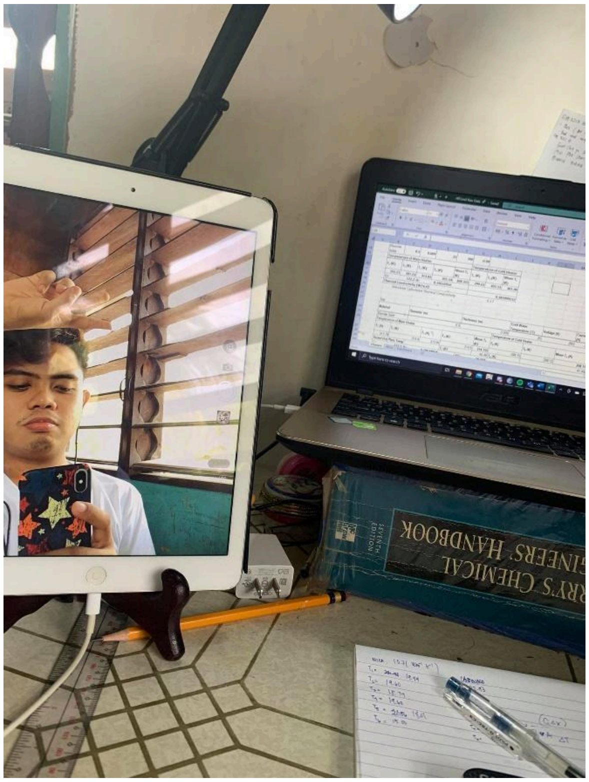
Simulator Result Thermal Conductivity 0.21

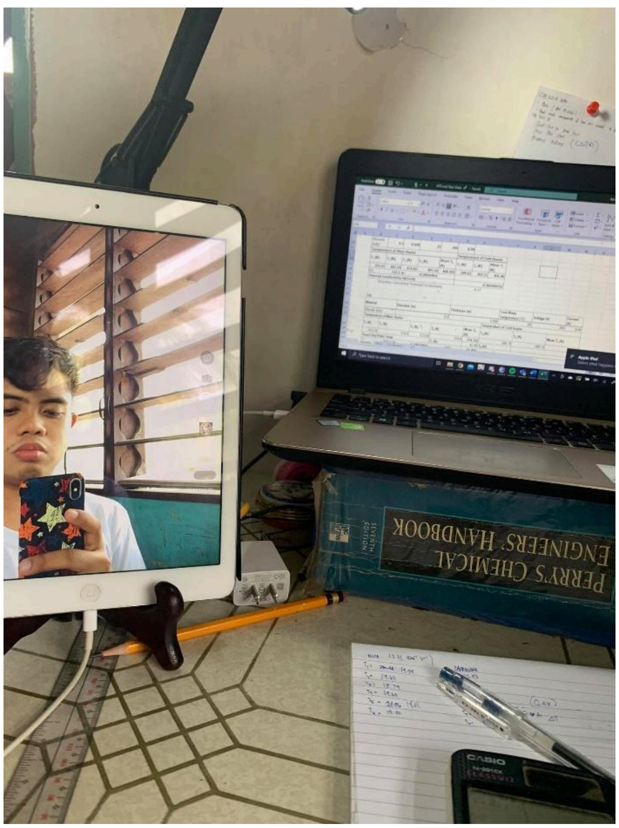
Observation:

Among the three materials, Mica has the largest thermal conductivity.

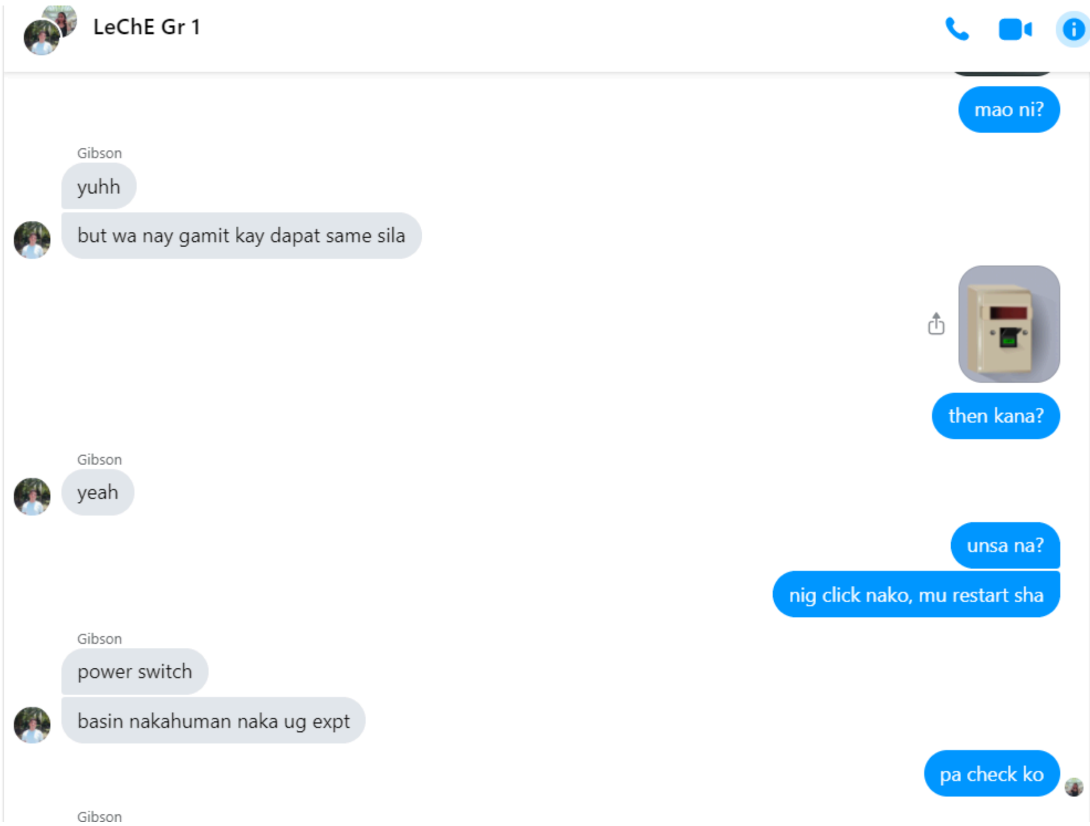
There was an error in the computation provided by the AMRITA virtual laboratory simulator. Instead of multiplying the area by 2, it only took into account a single area of contact.

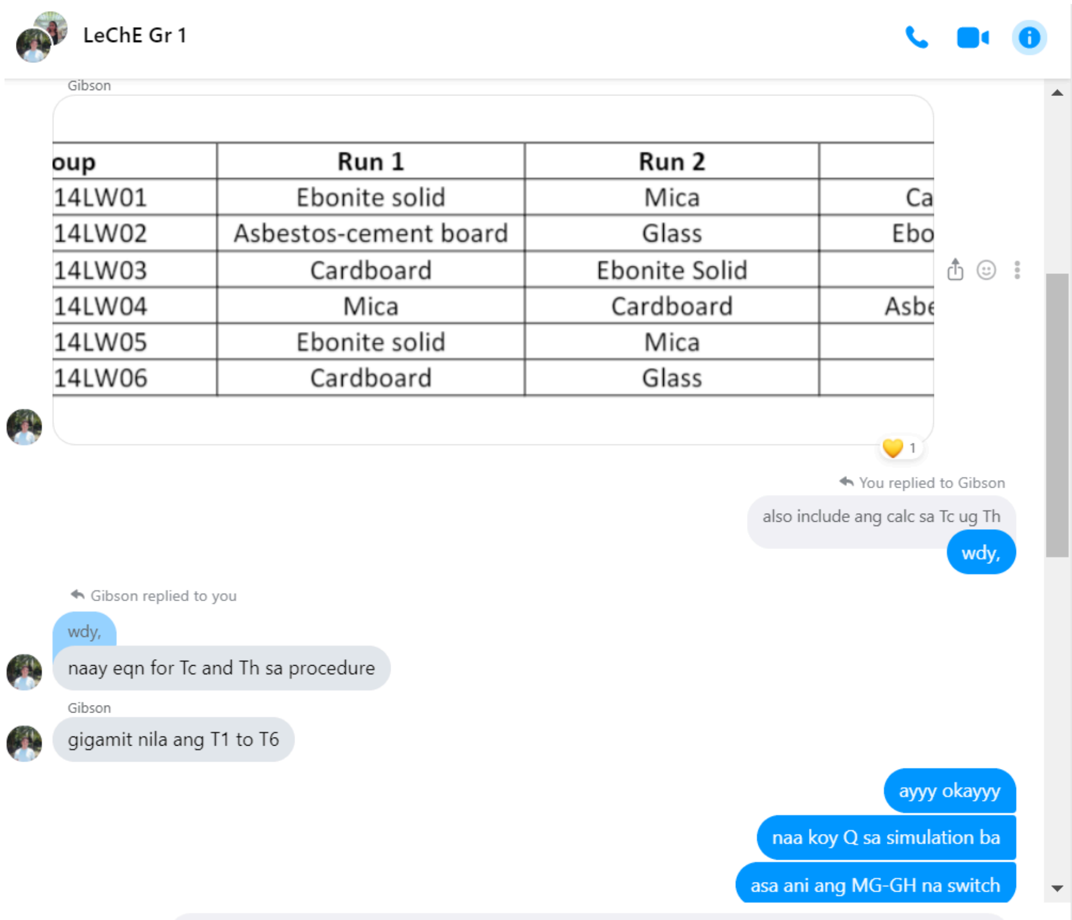
DOCUMENTATION:





TEAM DOCUMENTATION:




LeChE Gr 1
Gibson
oup | Run 1 | Run 2
14LW01 | Ebonite solid | Mica | Ca
14LW02 | Asbestos-cement board | Glass | Ebo
14LW03 | Cardboard | Ebonite Solid
14LW04 | Mica | Cardboard | Asbe
14LW05 | Ebonite solid | Mica
14LW06 | Cardboard | Glass
1
You replied to Gibson
also include ang calc sa Tc ug Th
wdy,
Gibson replied to you
wdy,
naay eqn for Tc and Th sa procedure
Gibson
gigamit nila ang T1 to T6
ayyy okayyy
naa koy Q sa simulation ba
asa ani ang MG-GH na switch