

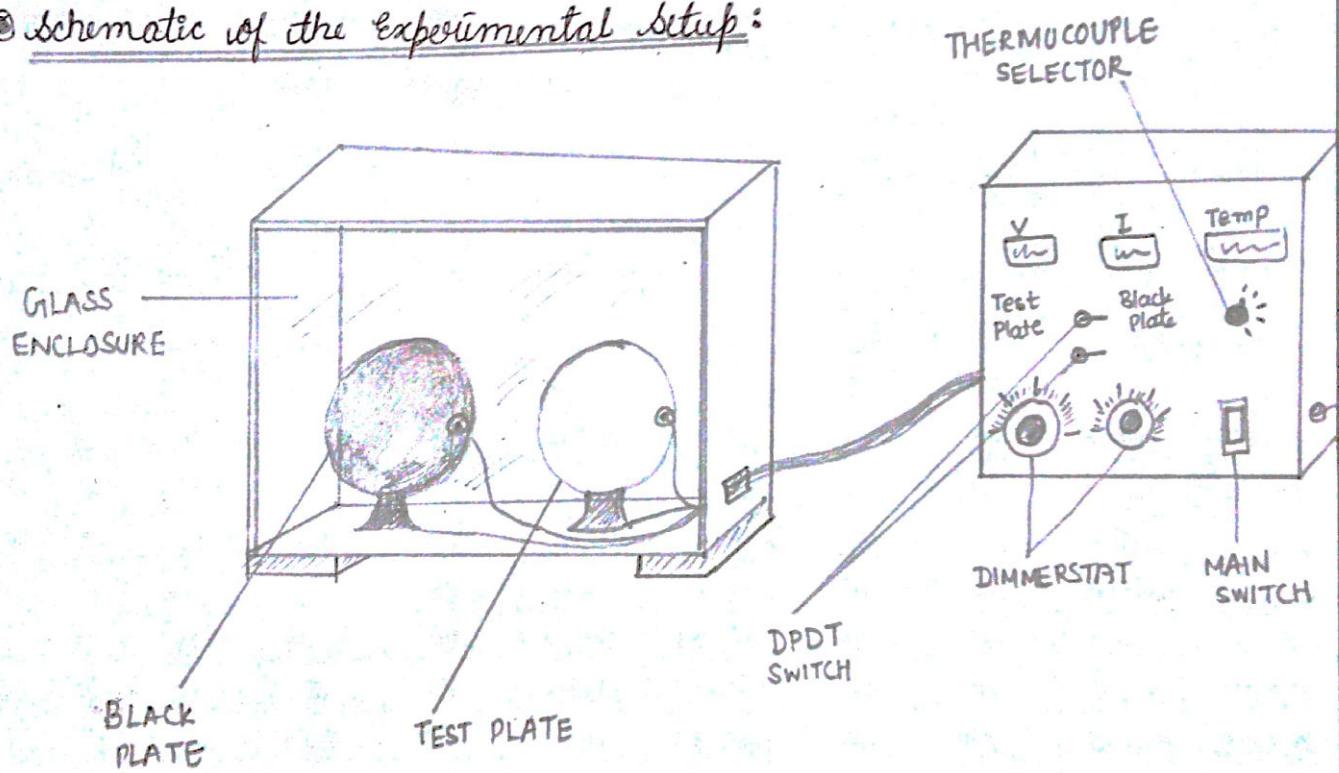
DATE

EXPERIMENT No. - 3

SHEET NO.

MEASUREMENT OF EMISSIVITY

- Objective: Determination of emissivity using principles of radiation heat transfer.
- Schematic of the experimental setup:



DATE

SHEET NO.

① Observations

Size of enclosure = $50\text{ cm} \times 30\text{ cm} \times 30\text{ cm}$

Diameter of test and black plate, $D = 160\text{ mm}$

Area of each Plate, $A = 0.04021\text{ m}^2$

Stefan Boltzmann constant, $\sigma = 5.67 \times 10^{-8}\text{ W/m}^2\text{K}^4$

Room Temperature = 33°C

Run No. : 1

SL. NO.	TIME (MIN)	AMBIENT TEMP. T_3 ($^\circ\text{C}$)	TEST PLATE (PLATE 1)				BLACK PLATE (PLATE 2)			
			T_1 ($^\circ\text{C}$)	V_1 (V)	I_1 (A)	W_1 (W)	T_2 ($^\circ\text{C}$)	V_2 (V)	I_2 (A)	W_2 (W)
1	0	36	46	53	0.225	11.925	55	79	0.325	25.675
2	5	37	51	53	0.226	11.978	61	79	0.325	25.675
3	10	38	56	53	0.226	11.978	65	79	0.326	25.754
4	15	39	59	59	0.249	14.691	69	78	0.321	25.038
5	20	39.5	63	58	0.247	14.326	72	78	0.321	25.038
6	25	40	67	59	0.252	14.868	74	78	0.322	25.116
7	30	40.5	69.5	59	0.249	14.691	75.5	78	0.321	25.038
8	35	41	72	58	0.247	14.326	77	79	0.323	25.517
9	40	41	73.5	58	0.246	14.268	78	77	0.318	24.486
10	45	41.5	75	57	0.244	13.908	78.5	77	0.317	24.409
11	50	42	76	59	0.250	14.76	79	79	0.324	25.596
12	55	42	77	58	0.248	14.384	79	78	0.319	24.882
13	60	42	78	60	0.253	15.18	80	79	0.323	25.517
14	65	42	78.5	58	0.248	14.384	80	76	0.315	23.94
15	70	42.5	79	59	0.250	14.75	80	77	0.317	24.409
16	75	43	80	59	0.250	14.75	80.5	77	0.316	24.382
17	80	43	80	59	0.250	14.75	81	77	0.318	24.486

Run No.: 2

SL. NO.	TIME (MIN)	AMBIENT TEMP T_3 ($^{\circ}$ C)	TEST PLATE (PLATE 1)				BLACK PLATE (PLATE 2)			
			T_1 ($^{\circ}$ C)	V_1 (V)	I_1 (A)	W_1 (W)	T_2 ($^{\circ}$ C)	V_2 (V)	I_2 (A)	W_2 (W)
1	0	43	81	67	0.284	19.028	81	85	0.353	30.005
2	5	43	83	68	0.288	19.584	84	86	0.355	30.53
3	10	43.5	85	67	0.285	19.095	85.6	85	0.349	29.665
4	15	44	86	67	0.286	19.162	86.5	86	0.353	30.358
5	20	44	88	67	0.285	19.095	87.5	86	0.353	30.358
6	25	44	89	68	0.287	19.516	88.5	86	0.353	30.358
7	30	44	90	69	0.290	20.01	89	87	0.357	31.059
8	35	45	91	69	0.293	20.217	90	88	0.360	31.68

Run No.: 3

SL. NO.	TIME (MIN)	AMBIENT TEMP T_3 ($^{\circ}$ C)	TEST PLATE (PLATE 1)				BLACK PLATE			
			T_1 ($^{\circ}$ C)	V_1 (V)	I_1 (A)	W_1 (W)	T_2 ($^{\circ}$ C)	V_2 (V)	I_2 (A)	W_2 (W)
1	0	45	92	78	0.330	25.74	91	93	0.380	35.34
2	5	44.5	95	78	0.331	25.818	93	83	0.382	35.526
3	10	45	98	80	0.338	27.04	95	95	0.389	36.955
4	15	45	100	80	0.338	27.04	96	95	0.390	37.05
5	20	45	101.5	79	0.333	25.974	97.5	99	0.388	36.472
6	25	45	103	79	0.333	25.974	98	94	0.384	36.096
7	30	45	104	80	0.339	27.12	99	95	0.391	37.145

Steady state wasn't achieved due to shortage of time

④ Sample Calculations

We have, for the last reading in RUN NO.:1,

$$W_2 = 24.486 \text{ W}$$

$$W_1 = 14.75 \text{ W}$$

$$A = 0.04021 \text{ m}^2$$

$$T_{ss} = 80 + 273 = 353 \text{ K}$$

$$T_3 = 43 + 273 = 316 \text{ K}$$

$$\text{We have, } W_2 - W_1 = (1-\epsilon) \sigma A (T_{ss}^4 - T_3^4)$$

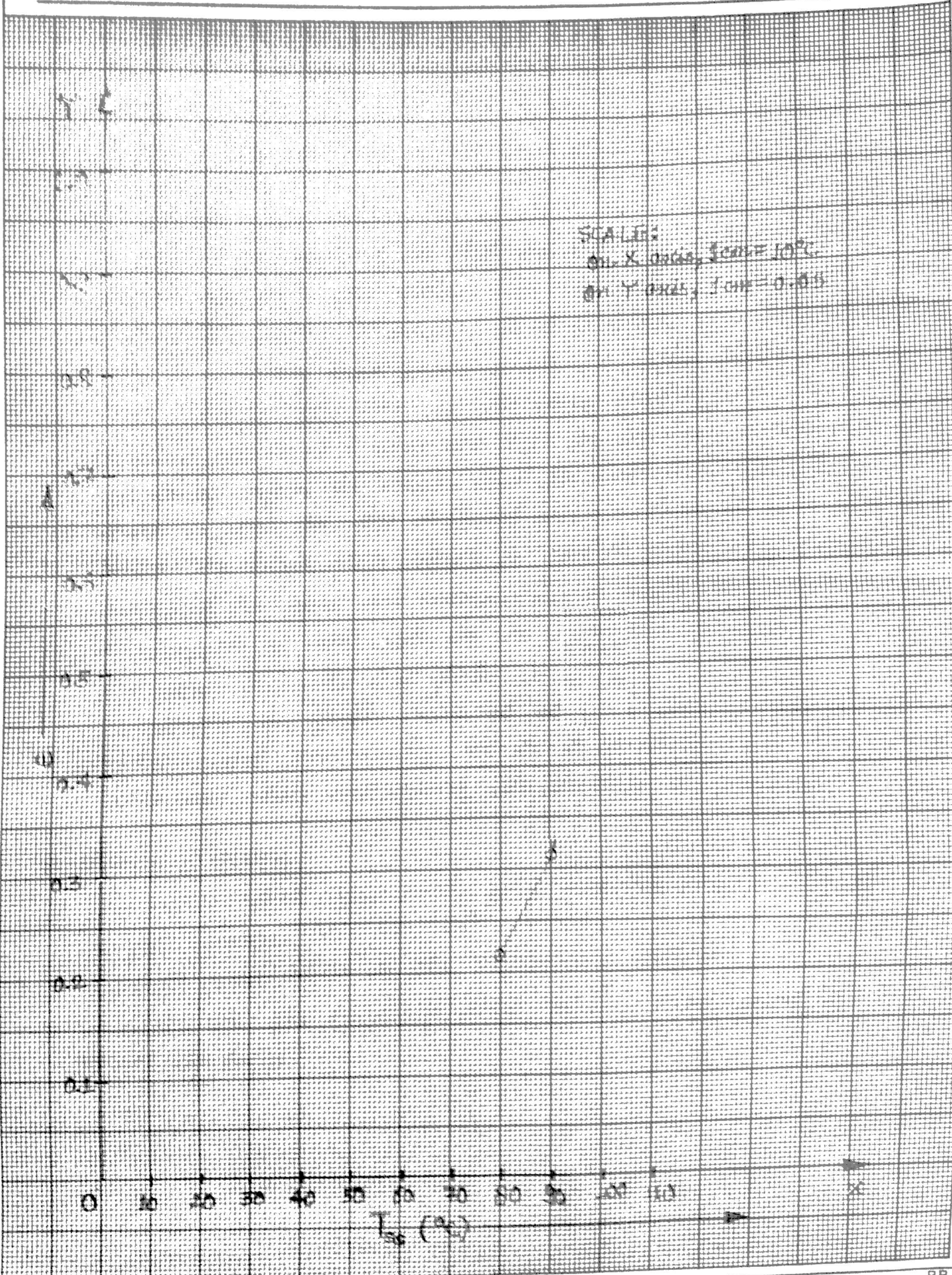
$$\Rightarrow 24.486 - 14.75 = (1-\epsilon) \times 5.67 \times 10^{-8} \times 0.04021 \times (353^4 - 316^4)$$

$$\Rightarrow \boxed{\epsilon = 0.231}$$

⑤ SUMMARY TABLE FOR CALCULATIONS

	ϵ	$T_{ss} (\text{°C})$	ϵ_{avg}	$T_{ssavg} (\text{°C})$
RUN : 1	0.222	79	0.232	79.67°
	0.244	80		
	0.231	80		
RUN : 2	0.328	89	0.325	90°
	0.333	90		
	0.314	91		

PLOT OF G VS T_{ss}



① Discussions :

In our experiment, we see that on supplying different set of powers to both the plates, they eventually reach a common temperature (within 1° error). At this point, the conduction and convection heat losses from both the plates are same because they are at the same temperature, have identical dimensions and are kept in identical surroundings. The only difference occurs due to radiation heat loss which is due to the different emissivities of both the plates. The black plate, which is coated with lamp black is assumed to have an emissivity of unity. Due to this assumption, we are able to measure the emissivity of the other plate, the test plate.

② Sources of Errors :

- assumption that the black plate has an emissivity of perfect unity.