S. Kunal Keshan

RA2011004010051

ECE – A

Physics: Electromagnetic Theory, Quantum Mechanics, Waves and Optics- 18PYB101J

EXPERIMENT - I

21.04.2021 DETERMINATION OF DIELECTRIC CONSTANT OF THE SAMPLE

AIM:

To determine the dielectric constant of the given sample at different temperatures.

APPARATUS REQUIRED:

The given sample, capacitance meter, dielectric sample cell, digital temperature indicator etc.

FORMULA:

1. The dielectric constant of the sample is given by,

$$\varepsilon_r = C / C_0 \text{ (No unit)}$$

where C = Capacitance of the sample (farad)
C_0 = Capacitance of the air capacitor having the same area and thickness as the sample (farad)

2. The capacitance of air is given by,

$$C_0 = \frac{\varepsilon_0 A}{d} \text{ (farad)}$$

where, ε_0 = permittivity of free space
$= 8.854 \times 10^{-12}$ farad/metre.

A = Area of the plates of the capacitor
($A = \pi r^2$, r = radius of the plate)

d = Thickness of the sample (or) the distance between the plates.

PRINCIPLE:

The capacitance of a capacitor increases when it is filled with an insulating medium. This increase in the capacitance depends on the property of the medium, called dielectric constant (ε). It can be measured using either static or alternating electrical fields.

The static dielectric constant is measured with static fields or with low frequency AC fields. At higher frequencies, values of dielectric constant becomes frequency dependent. The dielectric constant varies with temperature

OBSERVATION:

The radius of the sample (r) = 1 cm
The thickness of the sample (d) = 1.83 mm
Area of the capacitor plate = 3.14×10^{-4} m^2
Capacitance of the air capacitor = 1.5192 10^{-12} farad.

CALCULATIONS:

$$C_o = \frac{\varepsilon A}{d} = \frac{8.854 \times 10^{-12}\ F/m \times 3.14 \times 10^{-4}\ m^2}{1.83 \times 10^{-3}\ m}$$

$$= 1.5192 \times 10^{-12}\ F.$$

Dielectric Constant $\varepsilon_r = C/C_o$.

1. 2.97 nF / 1.51 pF = 1.966×10^3
2. 3.02 nF / 1.51 pF = 2×10^3
3. 3.08 nF / 1.51 pF = 2.039×10^3
4. 3.12 nF / 1.51 pF = 2.066×10^3
5. 3.16 nF / 1.51 pF = 2.092×10^3
6. 3.20 nF / 1.51 pF = 2.119×10^3
7. 3.25 nF / 1.51 pF = 2.152×10^3
8. 3.29 nF / 1.51 pF = 2.178×10^3
9. 3.33 nF / 1.51 pF = 2.205×10^3
10. 3.37 nF / 1.51 pF = 2.231×10^3
11. 3.41 nF / 1.51 pF = 2.258×10^3
12. 3.45 nF / 1.51 pF = 2.284×10^3

RESULT:

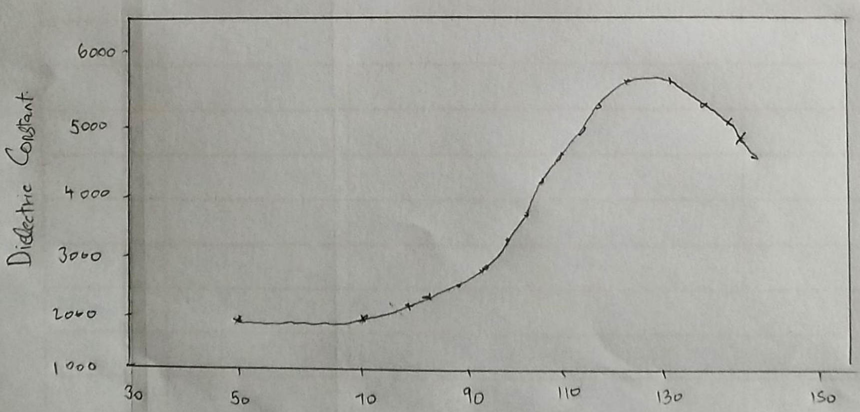
The dielectric constants of the given sample at different temperature are measured and a graph is plotted between the temperature and dielectric constant.

DETERMINATION OF DIELECTRIC CONSTANT OF THE SAMPLE

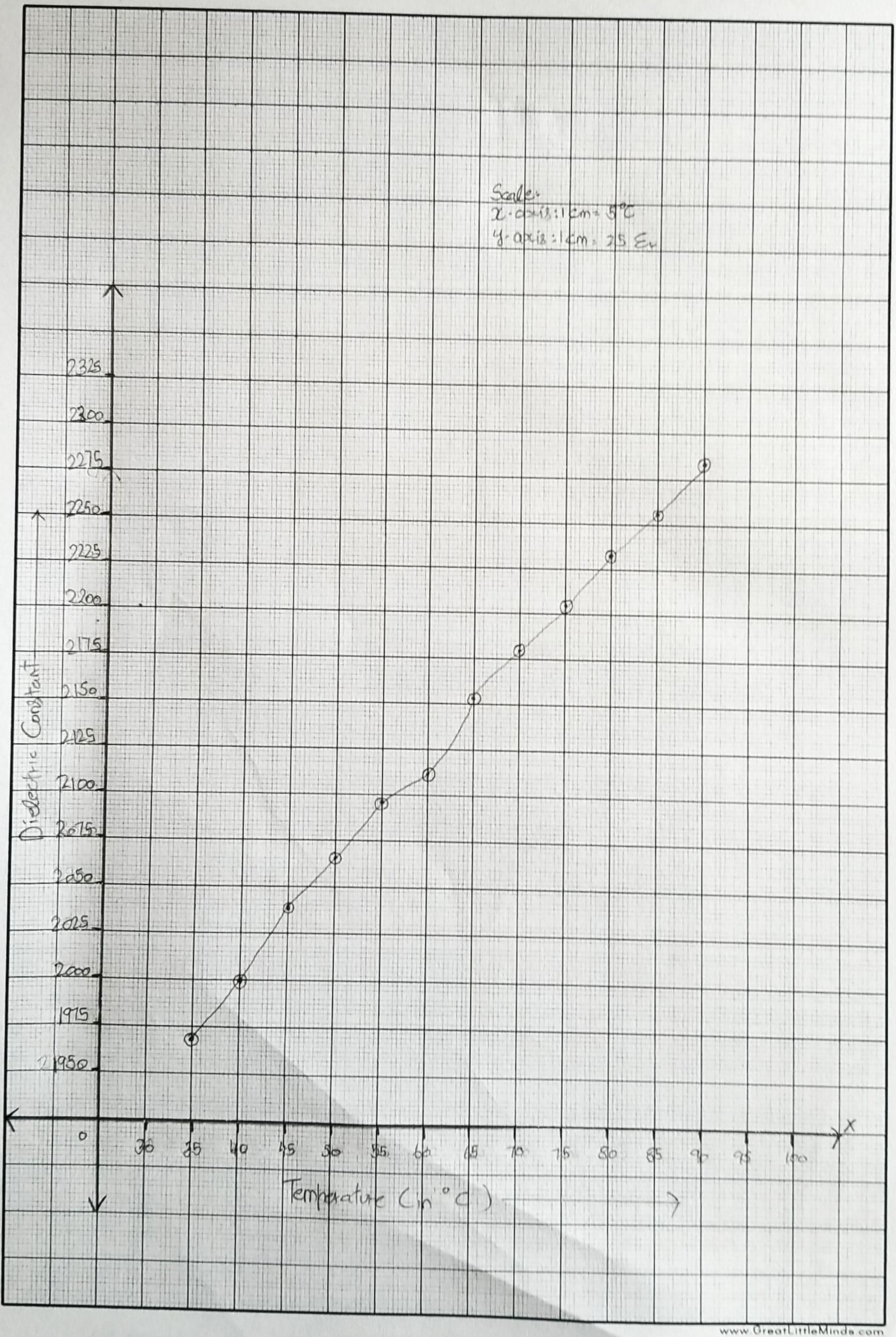
Table: Determination of Dielectric Constant

S. No	Temperature (°C)	Capacitance (C) (Nano Farad)	Dielectric Constant $[\varepsilon_r = \frac{C}{C_0}]$
1.	35	2.97	1966
2.	40	3.02	2000
3.	45	3.08	2039
4.	50	3.12	2066
5.	55	3.16	2092
6.	60	3.20	2119
7.	65	3.25	2152
8.	70	3.29	2178
9.	75	3.33	2205
10.	80	3.37	2231
11.	85	3.41	2258
12.	90	3.45	2284

Model Graph:



ε_r vs T for Barium Titanate



Scale:
x-axis : 1 cm = 5°C
y-axis : 1 cm = 25 εr
Dielectric Constant
Temperature (in °C)
2325
2300
2275
2250
2225
2200
2175
2150
2125
2100
2075
2050
2025
2000
1975
1950
0
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
X