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EXPERIMENT – 3

AIM: To determine the Young's modulus of elasticity of the given material.

APPARATUS: Pin and microscope arrangement, scale, verniers callipers, Screw gauge, weight hanger, material bar or rod.

THEORY: If a light bar of breadth b and depth d is placed horizontally on two Knife-edges separated by a distance L and a load of mass m, applied at the midpoint of the bar, produces a depression of the bar, then Young's modulus Y of the material of the bar is given by

$$Y = \frac{gL^3m}{4bd^3l} \quad (1)$$

Where g is the acceleration due to gravity. This is the working formula of the experiment, and is valid so long as the slope of the bar at any point with respect to the unstrained position is much less than unity. Here Y is determined by measuring the quantities b, d, L and the mean depression l corresponding to a load m. If b, d, L and l are measured in cm, m in gm, g is expressed in cm/sec^2, and then Y is obtained in dyne/cm^2

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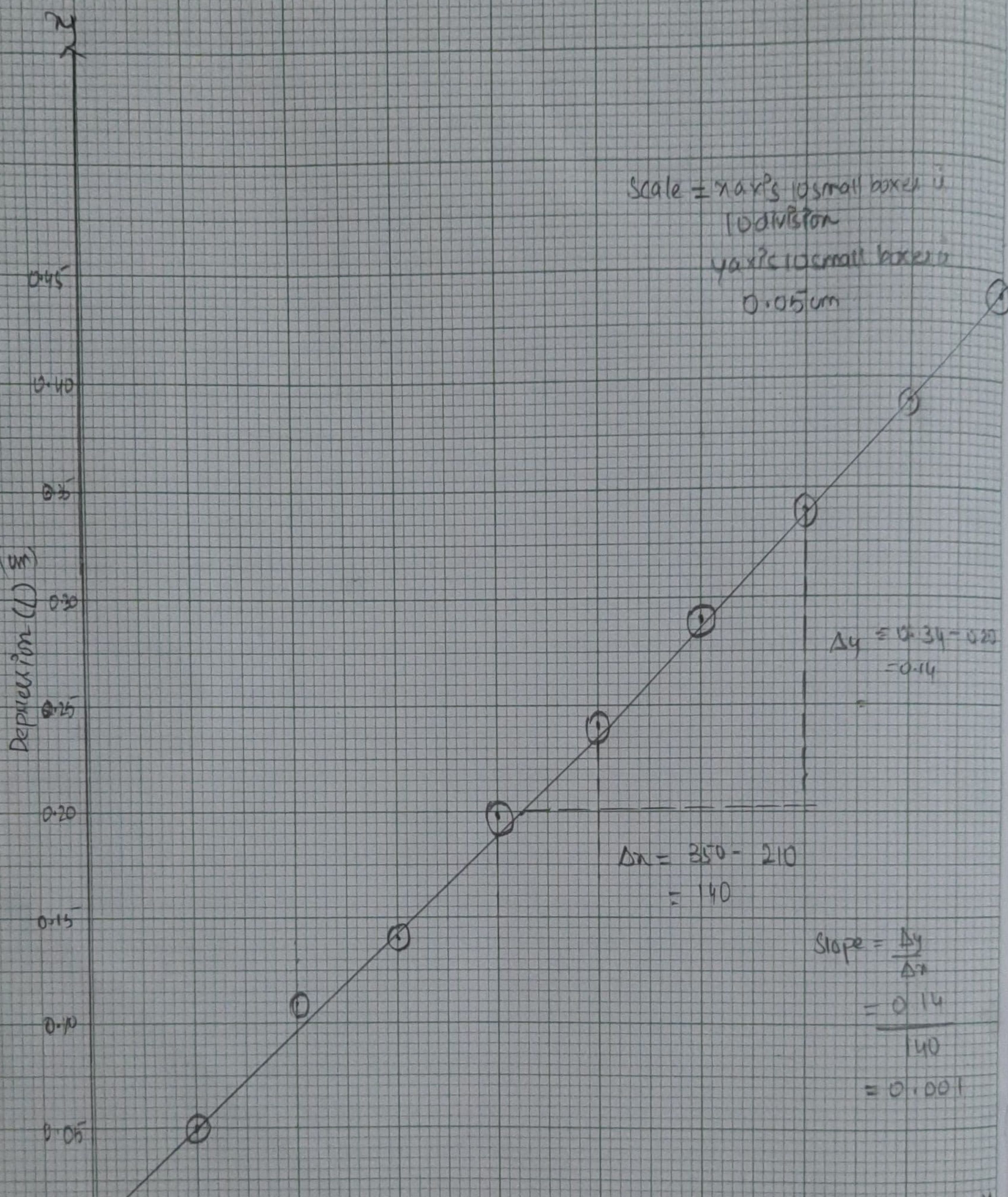
OBSERVATION:

Vernier constant of travelling microscope (L.C) = 0.001 cm
Distance between the two knife edges (l) = 55 cm

SL NO	MASS (in gm)	MICROSCOPE READING FOR INCREASING LOAD (cm)			MICROSCOPE READING FOR DECREASING LOAD (cm)			MEAN READING (cm)	DEPRESSION (l) (cm)
		M.S.R (cm)	V.S.R (cm)	TOTAL(cm)	M.S.R (cm)	V.S.R (cm)	TOTAL(cm)		
1	0	5.50	13	5.50+13×0.001 =5.51	5.50	13	5.50+13×0.001 =5.51	5.51	0.00
2	50	5.55	17	5.55+17×0.001 =5.56	5.55	17	5.55+17×0.001 =5.56	5.56	0.05
3	100	5.60	22	5.60+22×0.001 =5.62	5.60	22	5.60+22×0.001 =5.62	5.62	0.11
4	150	5.65	5	5.65+5×0.001 =5.65	5.65	5	5.65+5×0.001 =5.65	5.65	0.14
5	200	5.70	10	5.70+10×0.001 =5.71	5.70	10	5.70+10×0.001 =5.71	5.71	0.20
6	250	5.75	6	5.75+6×0.001 =5.75	5.75	6	5.75+6×0.001 =5.75	5.75	0.24
7	300	5.80	5	5.80+5×0.001 =5.80	5.80	5	5.80+5×0.001 =5.80	5.80	0.29
8	350	5.85	7	5.85+7×0.001 =5.85	5.85	7	5.85+7×0.001 =5.85	5.85	0.34
9	400	5.90	4	5.90+4×0.001 =5.90	5.90	4	5.90+4×0.001 =5.90	5.90	0.39
10	450	5.95	7	5.95+7×0.001 =5.95	5.95	7	5.95+7×0.001 =5.95	5.95	0.44
11	500	6.00	8	6.00+8×0.001 =6.00	6.00	8	6.00+8×0.001 =6.00	6.00	0.49



y
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
Depression (l) (cm)
x
0
50
100
150
200
250
300
350
400
450
Load (m) (g)
Scale = x axis 10 small boxes is
100 division
y axis 10 small boxes is
0.05 cm
Δy = 0.34 - 0.20
= 0.14
Δx = 350 - 210
= 140
Slope = Δy / Δx
= 0.14 / 140
= 0.001

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CALCULATION :-

Young's Modulus $Y = \frac{gL^3 m}{4bd^3 l}$

Here, Y = young's Modulus

g = acceleration due to gravity

L = distance between two knife edges

m = mass of the load

b = breadth of the steel bar

d = depth of the steel bar

l = depression produced

Values: $g = 9.8 \, m/s^2$ or $980 \, cm/s^2$

$L = 55 \, cm$

$b = 1.5 \, cm$

$d = 0.25 \, cm$

Slope of graph $= \frac{\Delta y}{\Delta x} = \frac{\Delta L}{\Delta m} = 0.001 \, cm/g$

Therefore, according to the formula.

$$Y = \frac{980 \times (55)^3}{4 \times 1.5 \times (0.25)^3 \times 0.001} = 1.739 \times 10^{12} \, dyne/cm^2$$

CONCLUSION :- The Young's modulus is 1.739×10^{12} dyne/cm²

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