Tangent Galvanometer and Earth's Magnetic Field

Aim:

(i) To determine the reduction factor of a tangent galvanometer

(ii) To determine the horizontal component of earth's magnetic field.

Apparatus used:

* Tangent Galvanometer (TG)
* Commutator (C)
* Rheostat (R)
* Battery (E)
* Ammeter (A)

Theory:

Tangent Galvanometer is used to measure small electric currents. It consists of a coil of insulated copper wire wound on a circular non-magnetic frame. Its working is based on the principle of the tangent law of magnetism.

When a current (I) is passed through the circular coil, a magnetic field ($\vec{B}_{coil}$) is produced at the centre of the coil in a direction perpendicular to the plane of

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the coil.

When no current is flowing through the coil, angle (θ) between the horizontal component of the earth's magnetic field and the compass is zero.

When the current is passed through the coil, magnetic compass is then under the action of two mutually perpendicular fields ($\vec{B}_H$ and $\vec{B}_{coil}$) and points in the direction of the resultant magnetic field.

Formulas used:

i) the deflection of magnetic compass (θ):

$$\tan\theta = \frac{B_{coil}}{B_H} \Rightarrow B_{coil} = B_H \tan\theta$$

ii) magnetic field generated by current carrying circular coil at its center:

$$B_{coil} = \frac{\mu_0 n I}{2a}$$

by using i) and ii):

$$\frac{2aB_H}{\mu_0 n} = \frac{I}{\tan\theta}$$

$\downarrow$

iii) reflection factor, $K = \frac{I}{\tan\theta}$ where $K = \frac{2aB_H}{\mu_0 n}$

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iv) as, $K = \dfrac{2aB_H}{\mu_0 n}$

so, $B_H = \dfrac{\mu_0 n K}{2a}$

Experiment 1:

a) Calculation of the reduction factor (K) at variable current values for given radius and number of turns of the coil, respectively.

Radius of the coil : 5 cm
Number of turns : 10

b) Plot a graph between (I) vs. $\tan\theta$ and calculate reduction factor (K) using the slope.

c) Calculate the value of the horizontal component of the earth's magnetic field using formula iv)

Observation Table:

Radius of coil (cm)	No. of turns	Ammeter readings I(A)	Pointers deflection in degrees Direct θ_1		Reverse θ_3		Mean θ (Degree)	$\tan\theta$ (Degree)	K(from graph) (A)	B_H (T)
			θ_1	θ_2	θ_3	θ_4				
		0.1	19	21	20	21	20.25	0.369		
		0.2	35	37	35	36	35.75	0.720		
5	10	0.25	41	43	41	42	41.75	0.892	0.277	3.48×10^{-5}
		0.5	61	62	60	62	61.25	1.823		
		1	74	76	73	76	74.75	3.670		

Experiment 2:

a.) Calculate the reduction factor (K) at varied number of turns of the coil for a given radius of the coil and current.

Radius of the core: 5 cm
Current passing through the coil: 0.25A

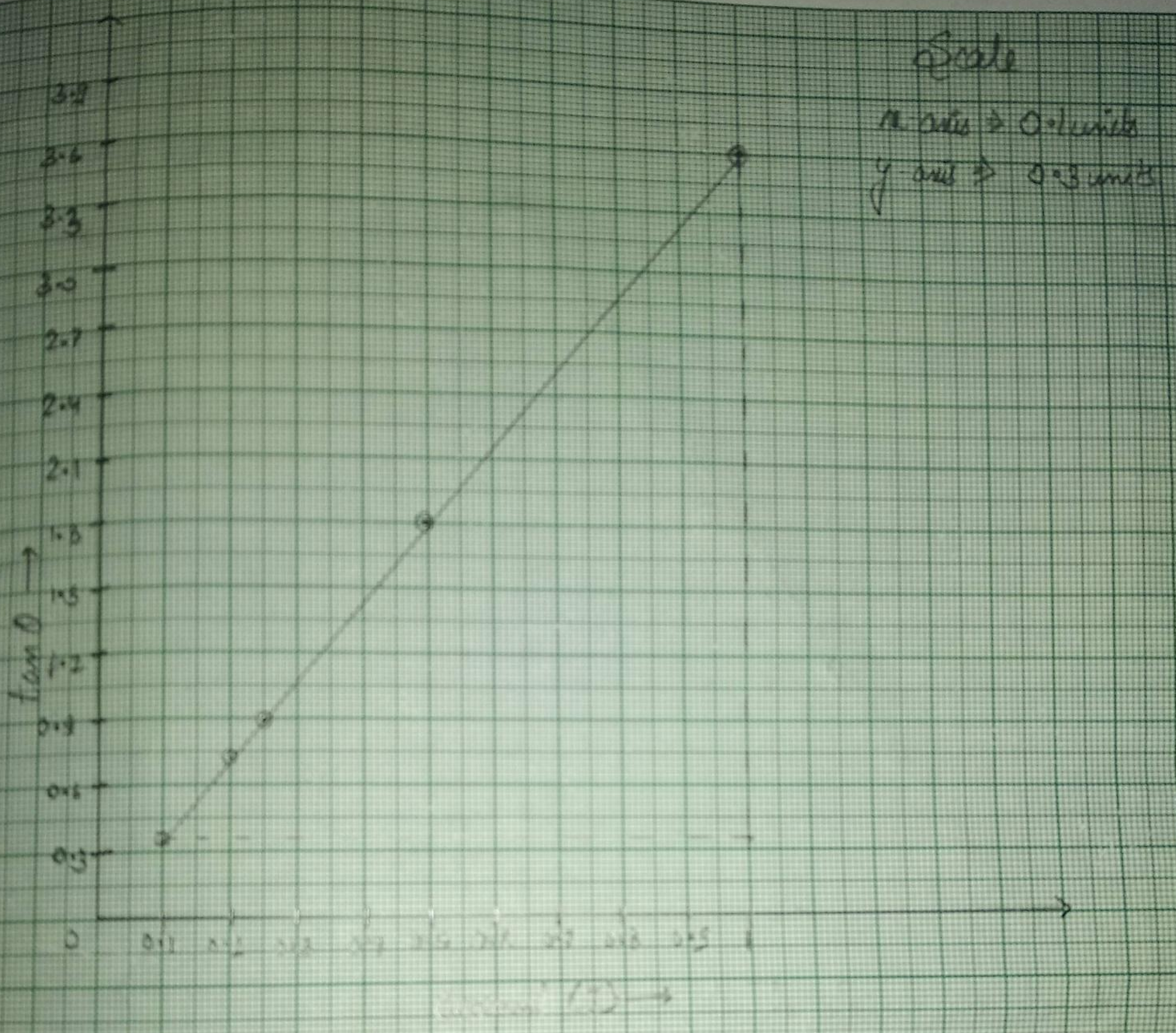
b.) Plot a graph between K (A) vs. 1/no. of turns of the coil and calculate the value of the horizontal component of the earth's magnetic field (B_H) using the slope of the curve.
[$\mu_0 = 4\pi \times 10^{-7}$ H/m]

Observation Table:

Radius of coil (cm)	Ammeter readings I(A)	No. of turns	Pointers deflection in degrees: Direct θ_1	Direct θ_2	Reverse θ_3	Reverse θ_4	Mean θ (Degree)	$\tan\theta$ (Degree)	$K = \frac{I}{\tan\theta}$ (A)	B_H (from graph) (T)
		10	~~[illegible]~~ 41	~~[illegible]~~ 43	41	42	41.75	0.892	0.28	
		15	~~[illegible]~~ 52	55	53	54	53.5	1.351	0.185	
5	0.25	20	~~[illegible]~~ 60	62	60	62	61	1.804	0.138	3.6×10^{-5}
		25	~~[illegible]~~ 65	67	65	67	66	2.246	0.111	
		35	71	73	71	73	72	3.078	0.081	
		45	75	77	75	77	76	4.010	0.062	

Result:

- Reduction factor ⇒ 0.277 A
- Horizontal component of earth's magnetic field ⇒ 3.6×10^{-5} T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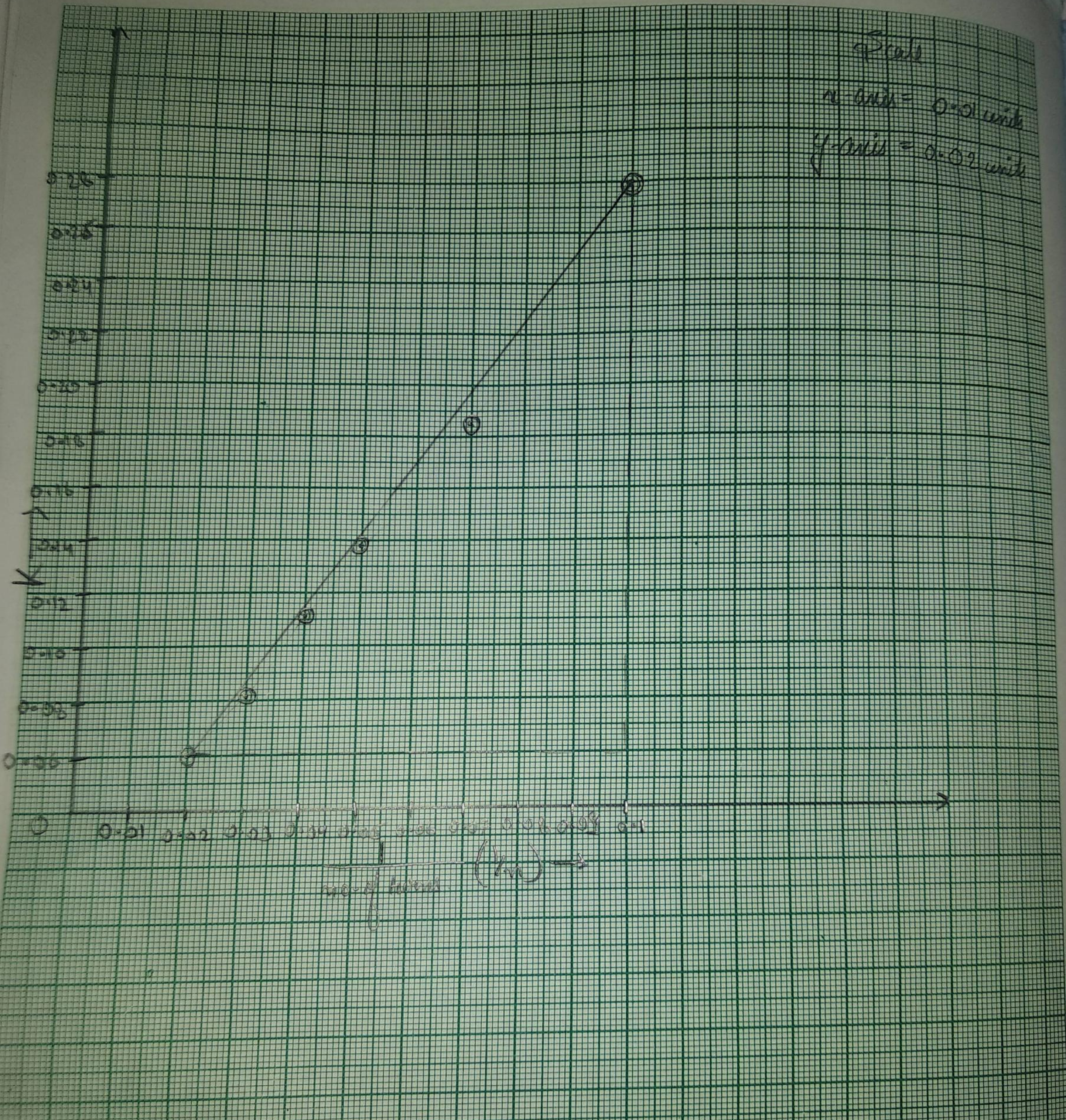
y axis ⇒ 0.3 units
3.6
3.3
3.0
2.7
2.4
2.1
1.8
1.5
1.2
0.9
0.6
0.3
tan θ
0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0.16
0.14
0.12
0.10
0.08
0.06
0
0.01
0.02
0.03
0.1
(1/n)