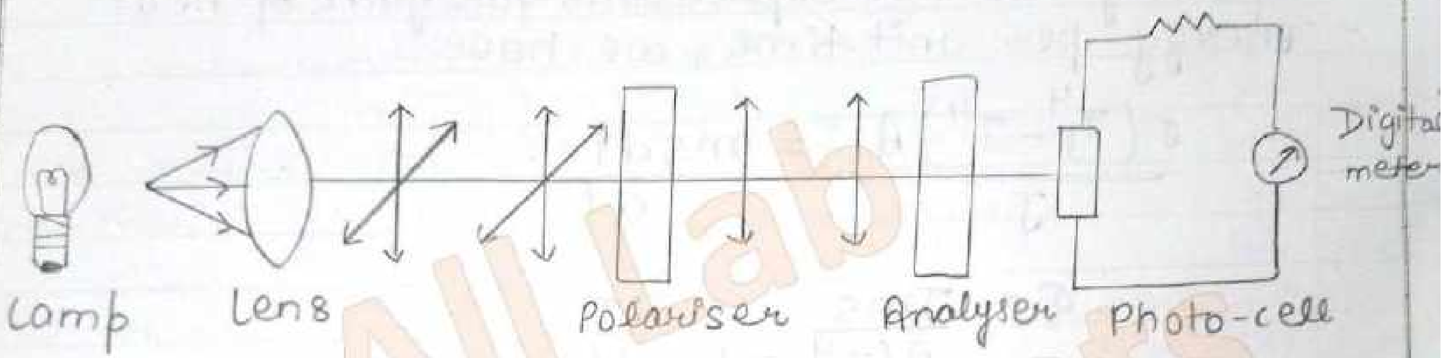
Aim: To verify the law of Malus for plane polarised light



Angle of analyser θ_a	Intensity	ϕ	$\cos^2\phi$
0	2		
10	3		
20	27		
30	85		
40	144		
50	217		
60	280		
70	337		
80	377		
90	392		
100	395	0	1
110	375	10	0.969
120	339	20	0.883
130	291	30	0.75

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Apparatus: A lamp, a convex lens, an optical bench, a polariser and an analyser with graduated circular scales, a photo-cell with digital voltmeter or a milliammeter and uprights for holding accessories.

Theory:

Law of malus tells us how the intensity transmitted by the analyser varies with the angle that its plane of transmission makes with that of polariser. It states that when a beam of completely plane polarised light is incident on an analyser, the resultant intensity of light (I) transmitted from the analyser varies directly as the square of the cosine of the angle (ϕ) between the plane of transmission of analyser and polariser.

i.e $I \propto \cos^2\phi$

Let us suppose that the angle between the planes of transmission of the polariser and the analyser is ϕ at any instant. The electric vector $\vec{AB} = \vec{a}$ in the plane polarised light emerging from the polariser may be resolved into two components AC ($= a\cos\phi$) and AD ($= a\sin\phi$) which are respectively along and perpendicular to the plane of transmission of the analyser. The perpendicular component is

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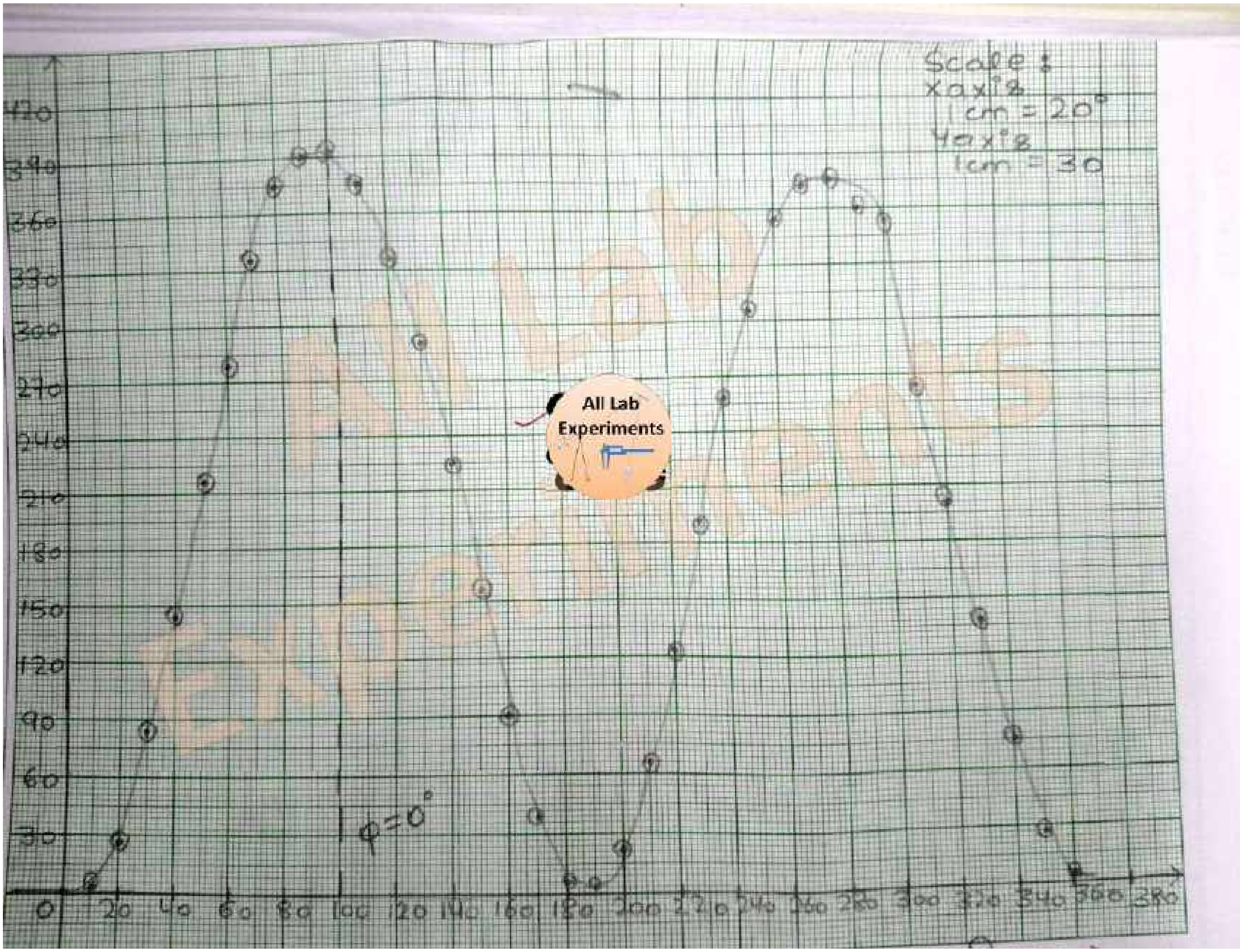
140	225	40	0.586
150	156	50	0.430
160	90	60	0.25
170	40	70	~~0.030~~ 0.116
180	6	80	0.030
190	2	90	0
200	21	100	0.030
210	66	110	0.116
220	125	120	0.25
230	191	130	0.413
240	259	140	0.586
250	307	150	0.75
260	354	160	0.883
270	374	170	0.969
280	376	180	1
290	361	190	0.969
300	320	200	0.883
310	263	210	0.75
320	202	220	0.586
330	138	230	0.413
340	75	240	0.25
350	26	250	0.116
360	2	260	0.030



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eliminated in the analyser while parallel component is freely transmitted through it. Therefore, the intensity I of light that emerges from the analyser is given by

$$I = a^2 \cos^2 \phi$$

$$= I_0 \cos^2 \phi$$

where I_0 is the intensity of the plane polarised light incident on the analyser. The intensity of the transmitted light is maximum when $\phi = 0$ and is zero when $\phi = 90°$ or when the polariser and analyser are crossed.

To verify this law, the light from analyser is made to enter a photovoltaic cell. The photocurrent produced is directly proportional to the intensity of light falling on photovoltaic cell. The analyser is rotated in its own plane. The angle ϕ of the rotation and the corresponding photocurrent I is noted. Hence if a graph is plotted between I and $\cos^2\phi$ it would be a straight line thus verifying Malus law.

Result :

1. The graph of I versus θa shows that intensity is maximum for two positions of analyser and minimum in between. This is what is expected as the two positions of analyser giving maximum intensity are when the plane of

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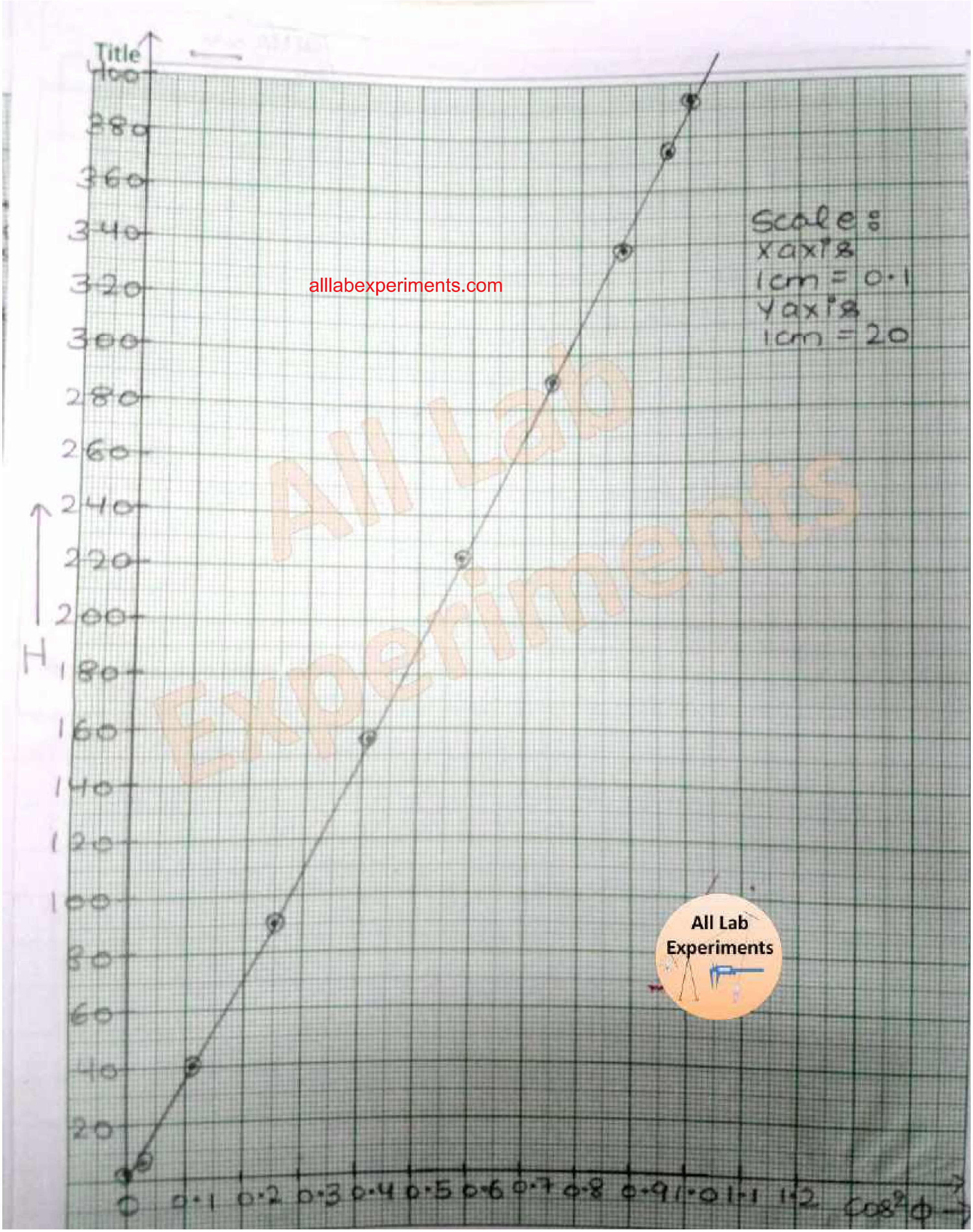

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transmission of the analyser is parallel and antiparallel with respect to that of the polariser i.e $\phi = 0°$ and $\phi = 180°$. The minimum intensity corresponds to the condition when the plane of transmission of the analyser is perpendicular to that of polariser for $\phi = 90°$.

2. The graph of I versus $\cos^2\phi$ is a straight line thus verifying the Malus law.