AIM :- To study B-H curve of iron (anchor ring) and to determine the energy loss by Hysterisis.

APPARATUS REQUIRED:- A cathode ray oscillator, a metal ring having a primary and a secondary coil wound on it, a resistance box, a capacitor, connecting wires.

THEORY :- When a specimen is taken through a complete cycle of magnetism more work is done on the material that recovered from it. Thus there is net loss of energy in each cycle of hysterisis. The loss of energy per unit volume of the material per cycle is equal to the area of I-H lap $= \frac{1}{4}\pi \times$ area of B-H loop.

The A.C voltage drop across the resistance 'r' in the primary coil of the transformer is fed to the horizontal input terminal of C.R.O and the A.C voltage drop across the capacitance C in the secondary circuit of the transformer is fed to the vertical input terminals of C.R.O. The frequency of the A.C main source being 50 cycles per second, the spot traces the loop 50 times in one second and due to persistance of the vision, a stationary hysteresis loop on the CRO screen is observed.

I_p = current in the primary circuit of transformer

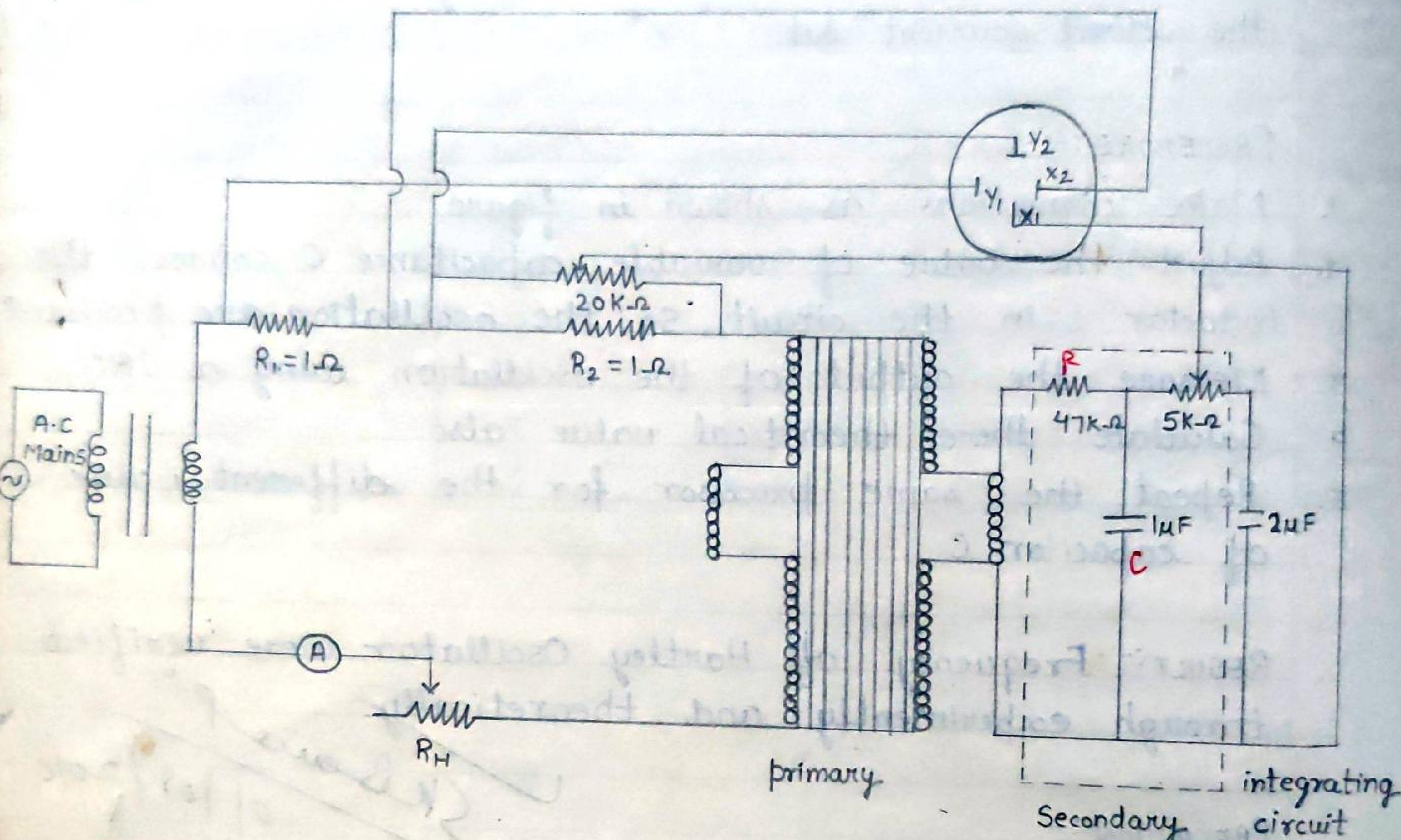
a = area of cross-section of the transformer.

B = magnetic induction.

$$Q_s = Ba$$

$$V_s = N_s \frac{dQ_s}{dt} = N_s a \frac{dB}{dt} \quad \text{— (1)}$$

V_c = voltage drop across the capacitor.



OBSERVATIONS :-

Date:

$$V_s = V_c + RI_s$$

$$Q = CV_c$$

$$I_s = \frac{dQ}{dt} = \frac{C\,dV_c}{dt}$$

$$V_s = Rc\,\frac{dV_c}{dt} \quad \text{—(2)}$$

$$N_s\,a\,\frac{dB}{dt} = Rc\,\frac{dV_c}{dt}$$

$$dB = \frac{Rc}{N_s a}\,dV_c$$

$$B = \frac{RC}{N_s a} \quad , V_c \rightarrow \text{Vertical input}$$

The magnetic field 'H'

$$'H' = \frac{4\pi N_p I_p}{10 l}$$

$$I_p = V_x / r \;, \; H = \frac{4\pi N_p V_x}{10\,r\,l} \;, \; V_x = \text{horizontal input}$$

The energy loss per unit volume per cycle of hysterisis in C.G.S units is given by

$$u = \frac{1}{4x} \int H\,dB$$

$$u = \frac{1}{4x}\,\frac{RC}{N_s d}\,\frac{4\pi N_p}{10\,r\,l} \int V_x\,dV_c$$

The total loss of energy in the transformer cell

$$u = u \times \text{volume of the cell}$$

$$= u\,al$$

$$u = \frac{R}{r}\left|\frac{N_p}{N_s}\right| \frac{C}{10} \int V_x\,dV_c \quad \text{Joule}$$

Teacher's Signature

NAVNEET

S.No	Channel (X)	Channel (Y)	I (A)	Total boxes	$u (J m^{-3} cycle^{-1})$
1.	0.5V	0.5V	0.1	264 mm^2	0.017178
2.	0.2 V	0.5 V	0.1	398 mm^2	0.010357
3.	0.5 V	2.0 V	0.5	415 mm^2	0.10802
4.	0.5 V	1.0 V	0.5	602 mm^2	0.078338
5.	0.5 V	0.5 V	0.3	862 mm^2	0.056072
6.	2.0 V	1.0 V	0.7	291 mm^2	0.15142

CALCULATIONS :-

Area of B-H curve

when $X = 2V$

$y = 1.0V$

Total number of small boxes = 291

Hysterises loss per cycle per unit volume $= \frac{1}{4\pi} \times 291 \times \frac{2}{10} \times \frac{1}{10}$

$$= \frac{582}{1256}$$

$$= 0.463 \text{ erg cm}^{-3} \text{ cycle}^{-1}$$

Total loss of energy $(u) = \frac{R}{r} \left|\frac{N_p}{N_s}\right| \frac{C}{10} \int V_x dV_c$

$$= \frac{47 \times 10^3}{1.15} \times 800 \times \frac{1 \times 10^{-6}}{10} \left[0.463\right]$$

$$= 15147.8946 \times 10^{-4} \text{erg} / cm^3 / \text{cycle}$$

$$= 1.5147 \times 10^{-1} \; J / m^3 / \text{cycle}$$

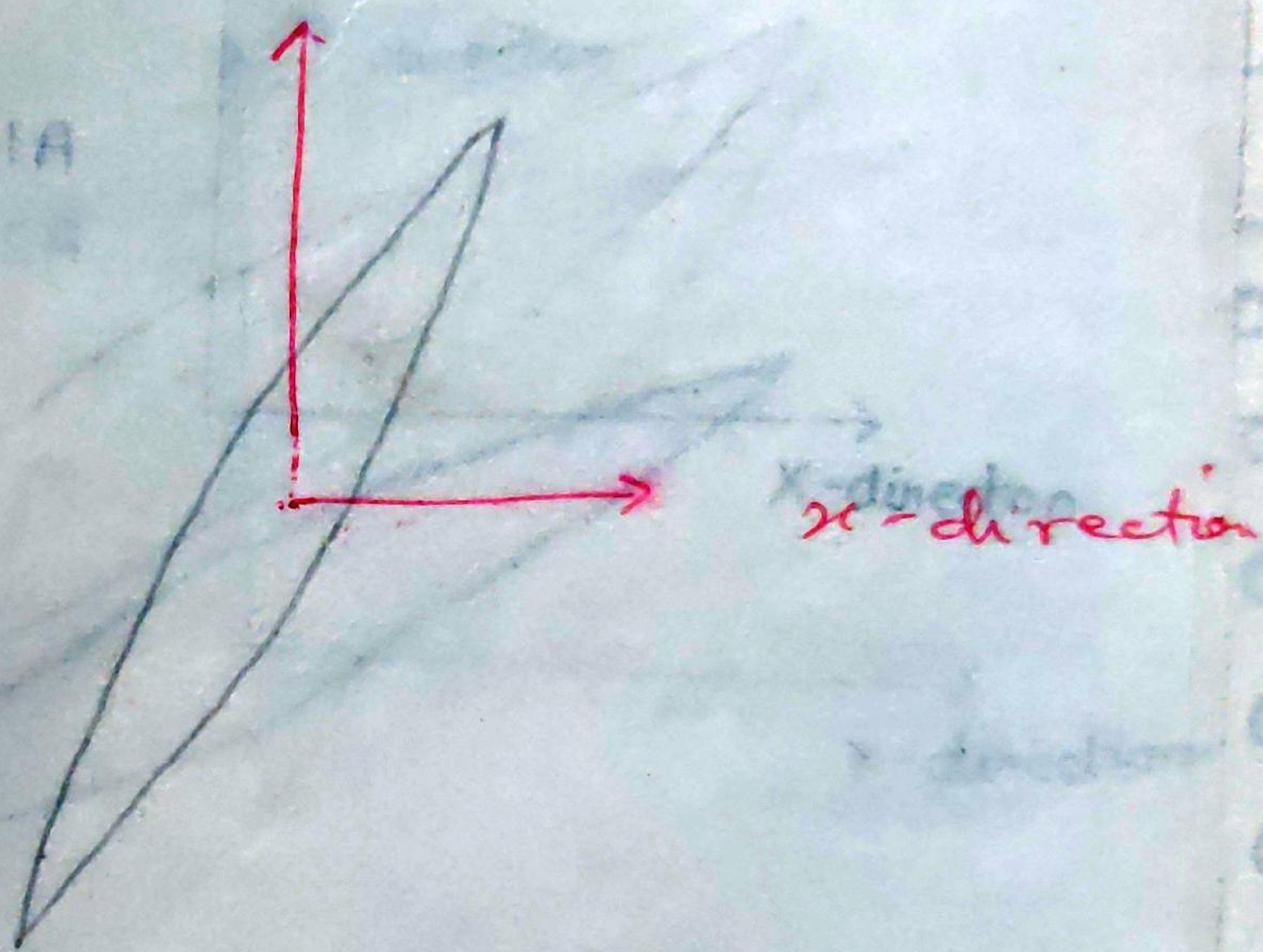
$$= 0.1514 \; J / m^3 / \text{cycle}$$

Time = 10msec

Volt/div(X) = 0.5 V/cm

Volt/div(Y) = 0.5 V/cm

Primary current = 0.1 A



Total No. of boxes = 264 mm^2

Area in V^2 $= 0.5 \times 0.5 \times 10^{-1} \times 10^{-1} \times 264$

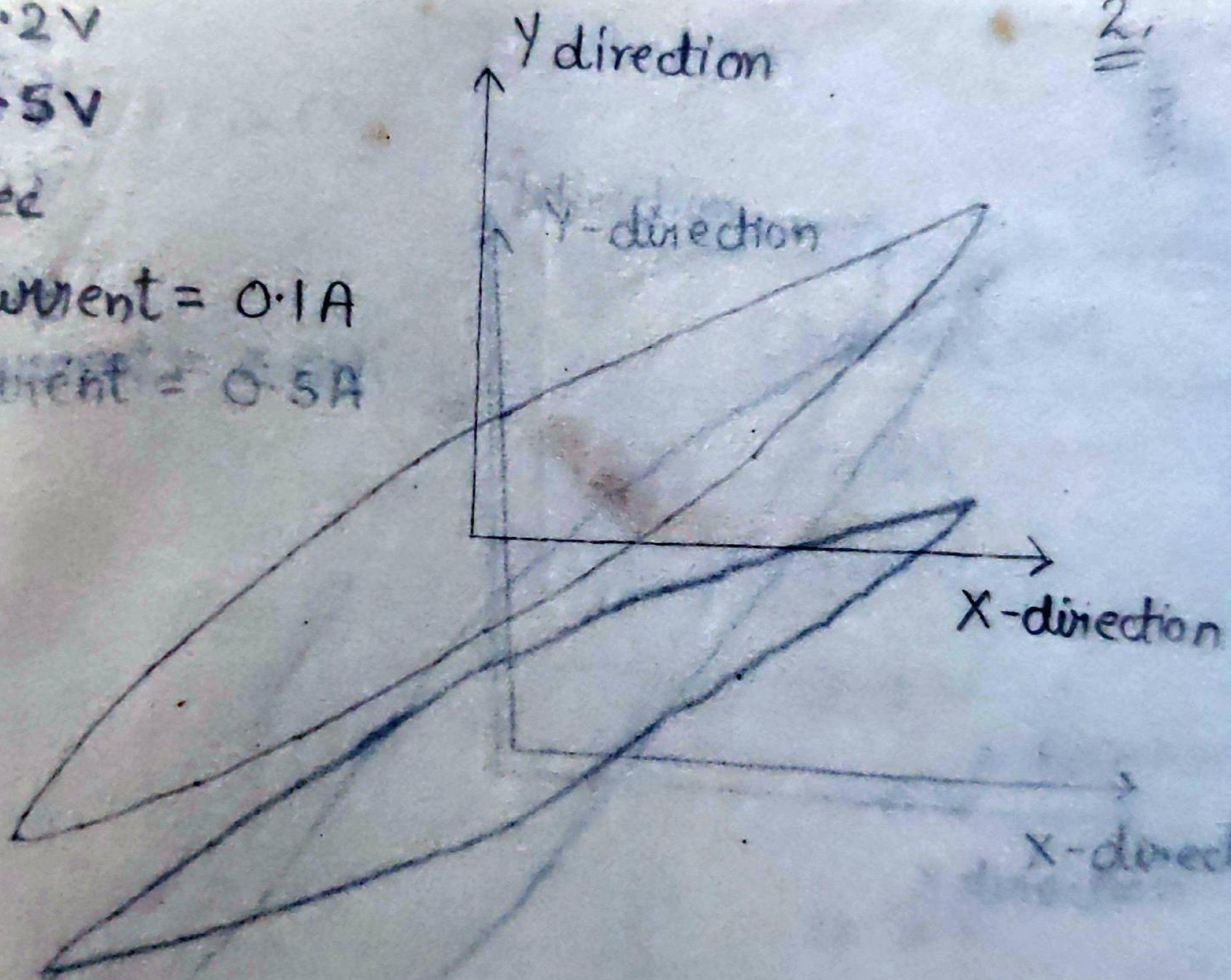
t/div (X) = 0.2V

t/div (Y) = 0.5V

ime = 10 msec

primary current = 0.1A

2



Total No. of boxes = 398 mm²

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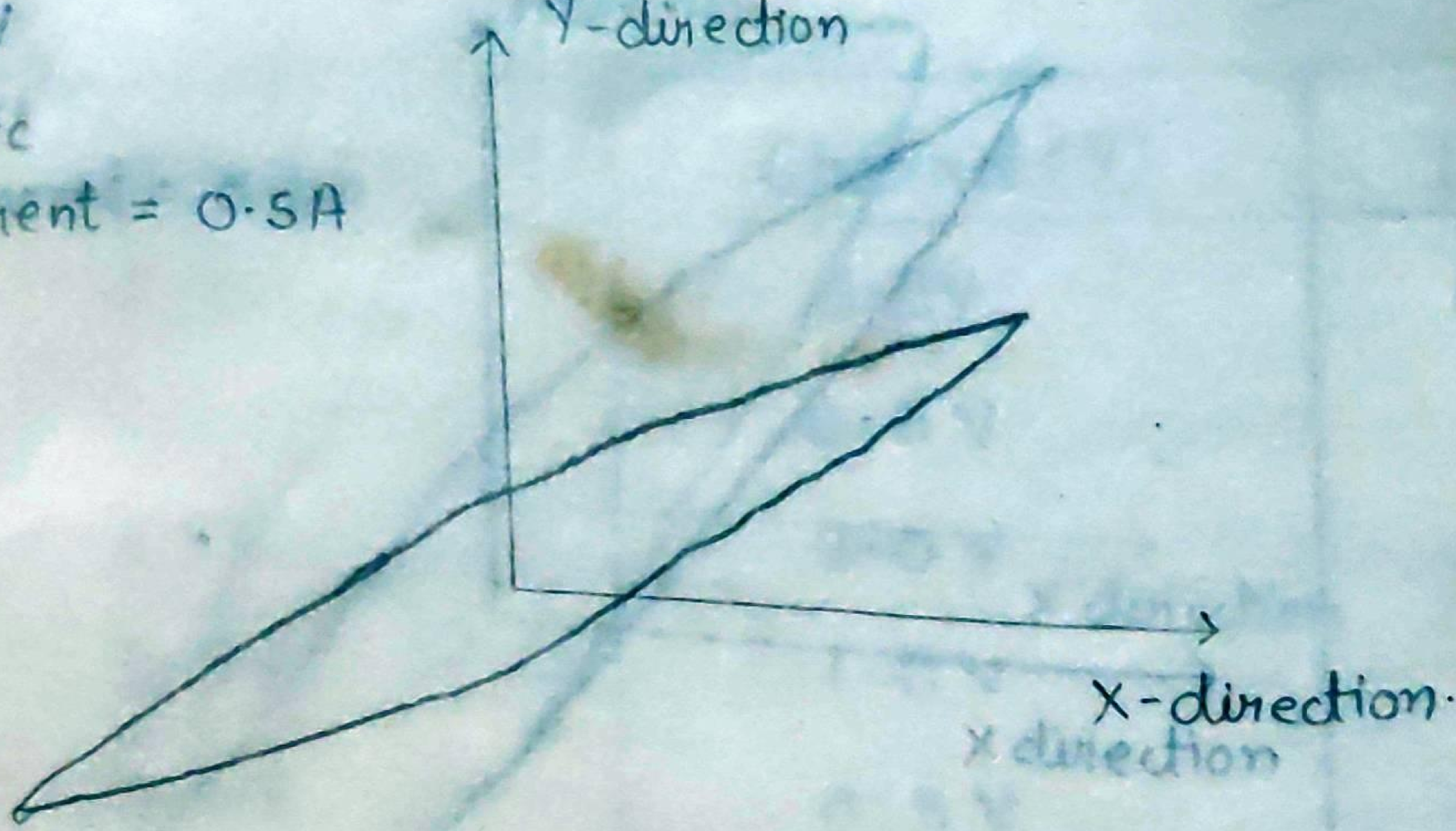
3.

V/div(X) = 0·5 V
V/div(Y) = 2·0 V
Time = 10msec
primary current = 0·5A



Total no. of boxes = 415 mm^2

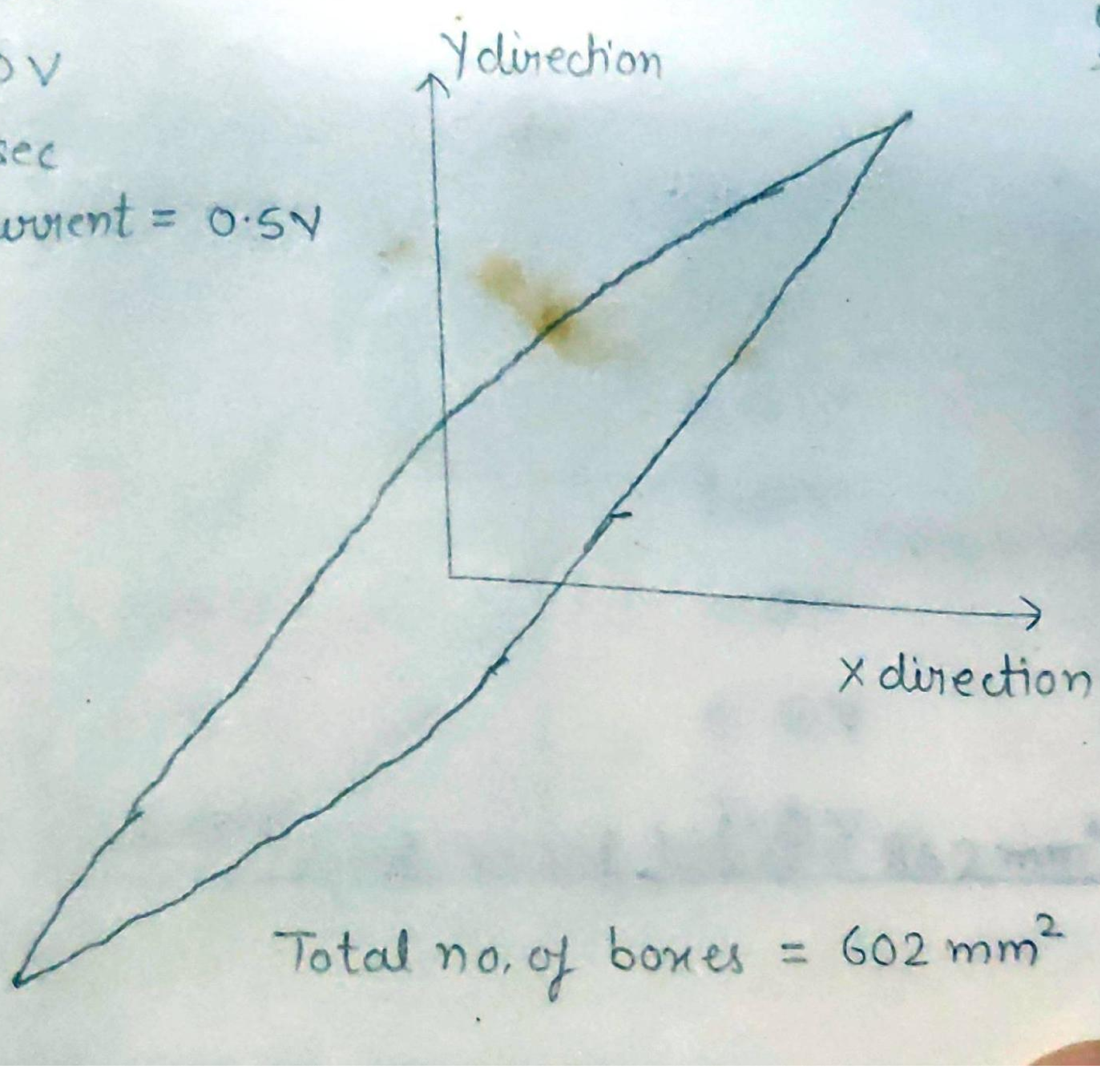
div(X) = 0.5V

div(Y) = 1.0V

Time = 10m sec

primary current = 0.5V

4.



Total no. of boxes = 602 mm^2

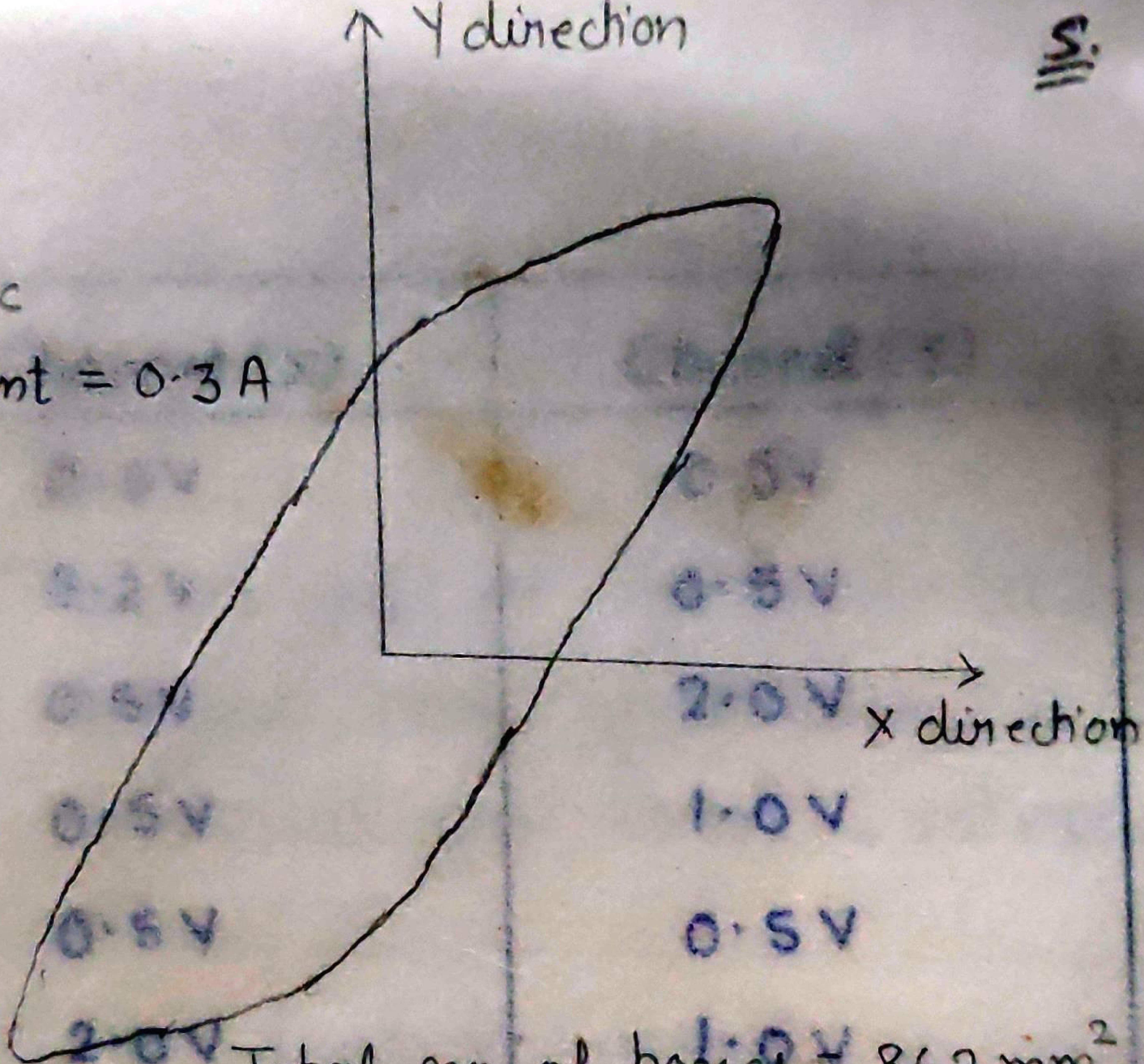
S.

/div(X) = 0·5 V

/div(Y) = 0·5 V

Time = 10 msec

primary current = 0·3 A



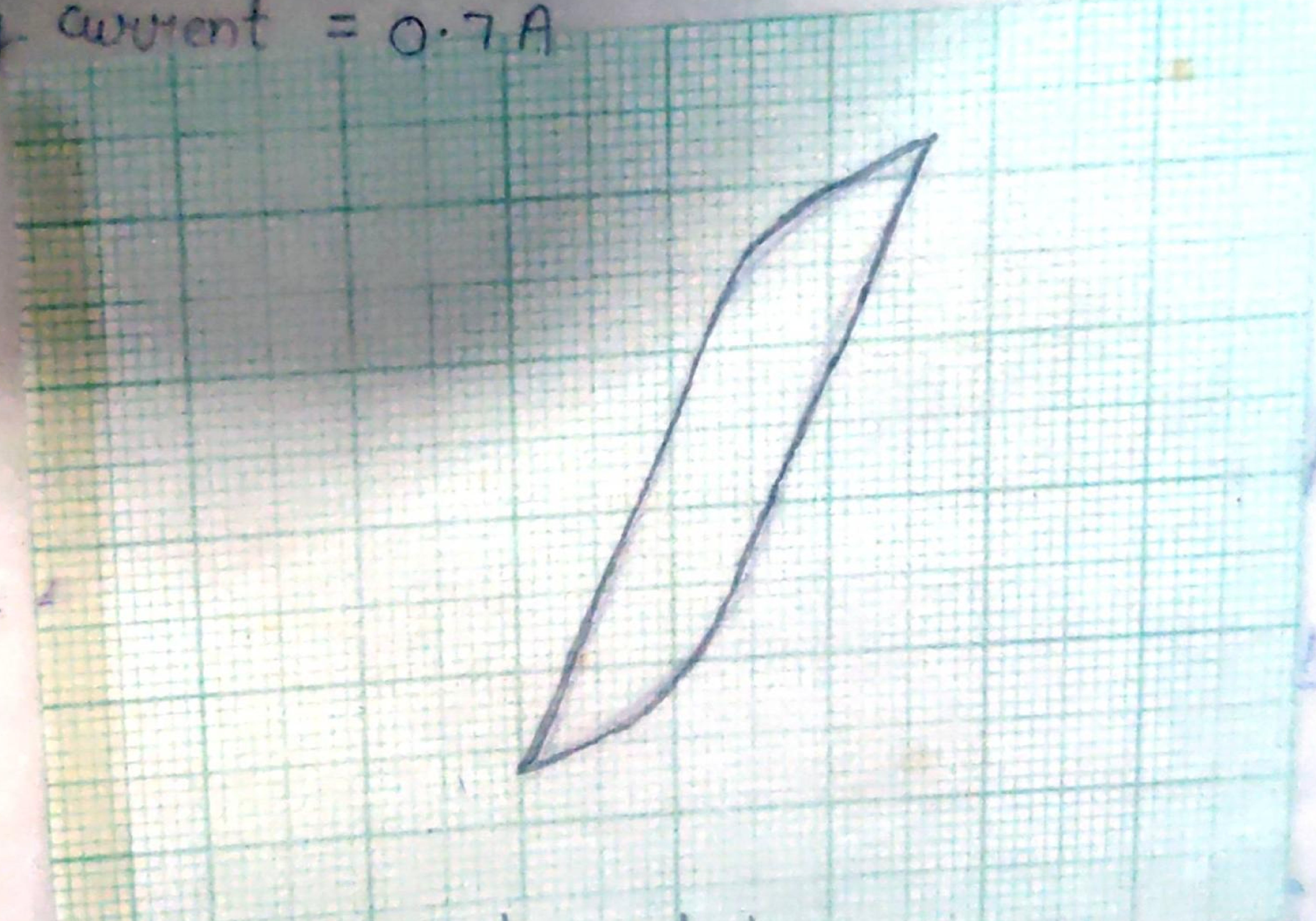
Total no. of boxes = 862 mm^2

me/sec = 10 ms

l/div(X) = 2·0 V

Volt/div(Y) = 1·0 V

primary current = 0·7 A



Total number of boxes = 291 mm^2

= 1·5177

PROCEDURE :-

1. A diagram showing the connections is drawn and connection is made accordingly. The resistance box 'r' is a fractional resistance box.
2. The CRO is connected to the A.C mains and a fine bright spot in the screen (at centre) is obtained. The sweep control is turned to different position by setting it to ext. input position.
3. A resistance of about 2000 Ω is taken out from the resistance box R and about 2 Ω from 'r'. A.C mains supply to the transformer is switch on a hystersis leep will be obtained on the screen. The vertical and horizontal gains are adjusted as to get a loop of the proper size. The values of R and r are adjusted. The loop is obtained on a transparent paper.
4. The position of the vertical and the horizontal gains is kept constant. The vertical and horizontal sensitivity for the gain position as already explained. The observations by varying R and H

RESULT :- $I_1 = 0.1\,A$, $u_1 = 0.017178\ J\,m^{-3}\,cycle^{-1}$

Hysterises loss per cycle per unit volume = $0.1514\ J\,cm^{-3}\,cycle^{-1}$ at $I = 0.7\,A$

$I_2 = 0.1\,A$, $u_2 = 0.010357\ J\,m^{-3}\,cycle^{-1}$; $I_4 = 0.5\,A$, $u_4 = 0.078\ J\,m^{-3}\,cycle^{-1}$

$I_3 = 0.5\,A$, $u_3 = 0.10802\ J\,m^{-3}\,cycle^{-1}$; $I_5 = 0.3\,A$, $u_5 = 0.056\ J\,m^{-3}\,cycle^{-1}$

PRECAUTIONS :-

1. The magnetic current in the primary coil of the solenoid should be large enough to properly magnetise the given material.
2. The B-H loop should be stable.