ANSWER SHEET

Problem E1

IPhO
Estonia 2012

Problem E1. The magnetic permeability of water *(10 points)*

Part A. Qualitative shape of the water surface *(1 points)*

The surface is described by Option ......

This corresponds to μ ...... 1.

Part B. Exact shape of the water surface *(7 points)*

i. (1.6 pts) You may use empty columns for intermediate results.

caliper reading x (mm)	spot height on screen y (mm)		water slope $\tan\beta$ ($\times 10^{-3}$)			water surface height h (μm)

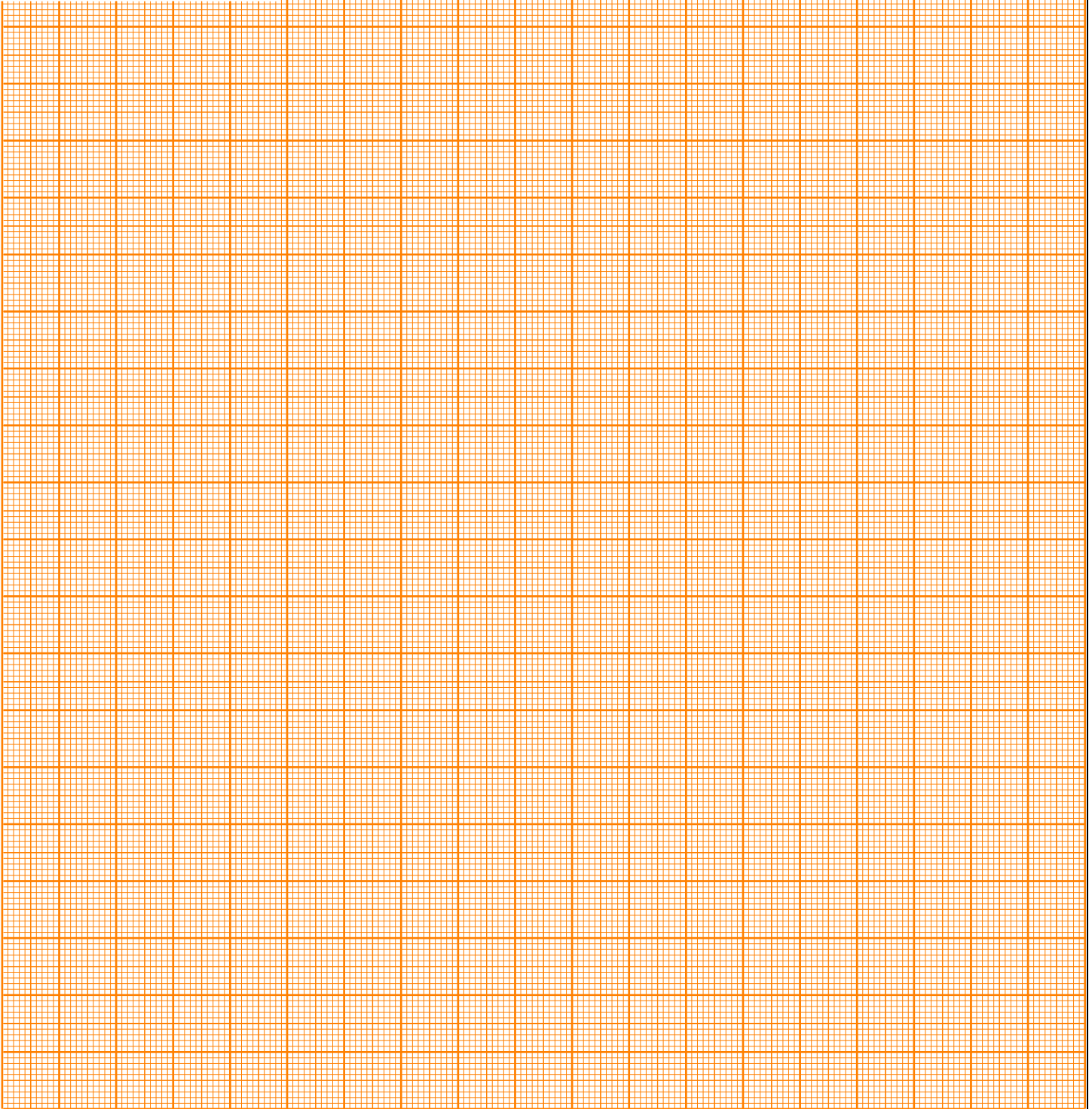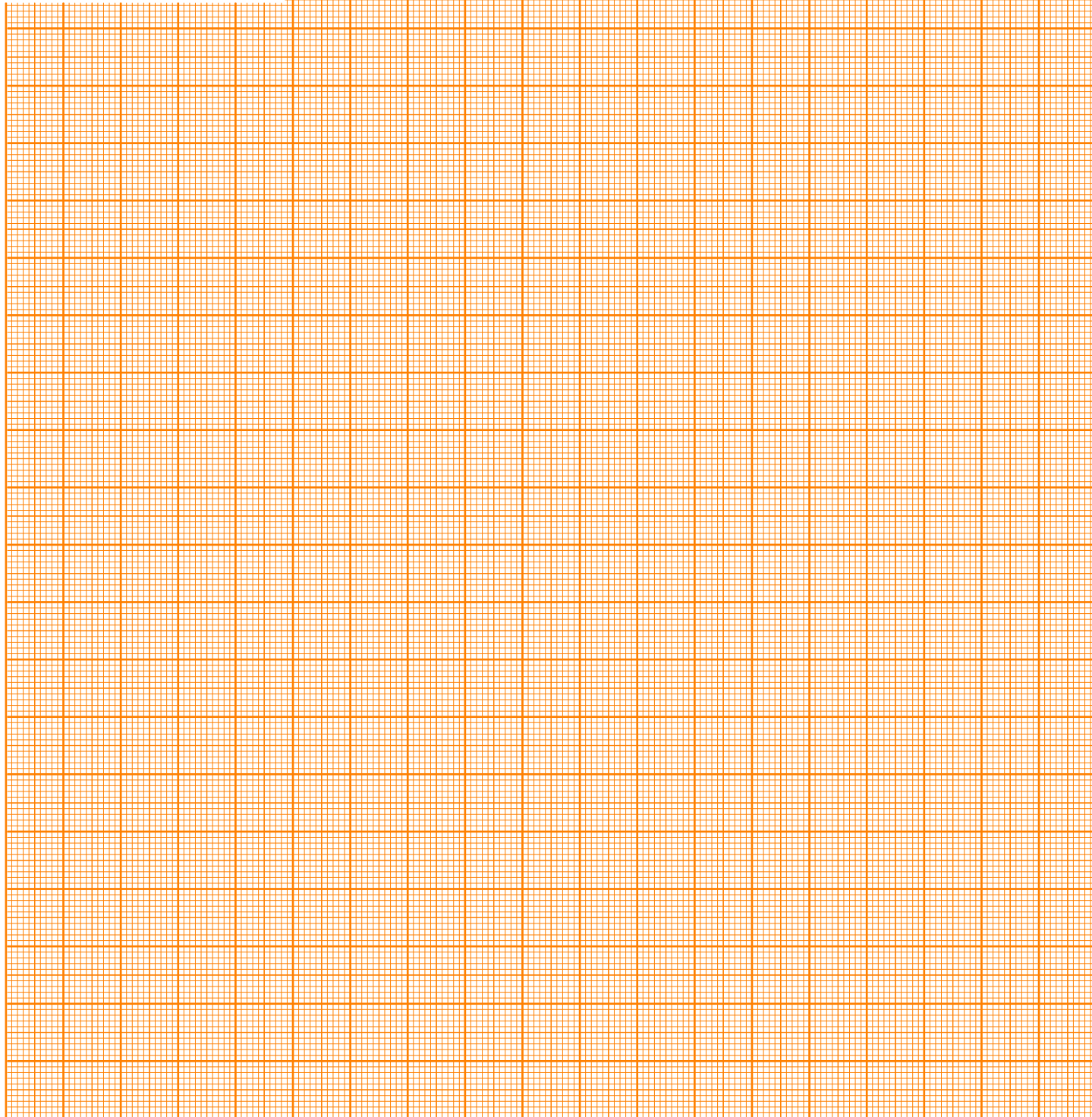**ii. (0.7 pts)** Graph: y versus x

iii. (0.7 pts) $\alpha_0 =$

iv. (1.4 pts) Use the fourth column of the table from question **i.**

v. (1.6 pts) Use the seventh column of the table from question **i.**

vi. (1 pt) Graph: h versus x

Part C. Magnetic permeability *(2 points)*

Formula: $\mu - 1 =$

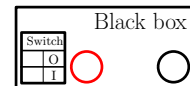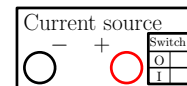Value: $\mu - 1 =$

Problem E2. Nonlinear Black Box *(10 points)*

Part A. Circuit without inductance *(7 points)*

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i. (1 pt) Minimal and maximal current:

$I_{\min} =$

$I_{\max} =$
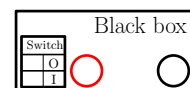
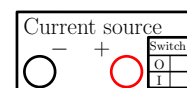Circuit diagram (mark also the positions of the switches):

Multimeter
IN   OUT   GND
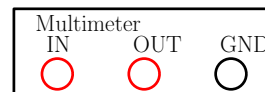
Current source
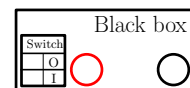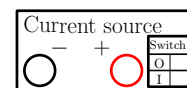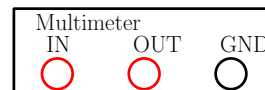− +   Switch
O
I

Black box
Switch
O
I

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ii. (1.2 pts)

$V_0 =$

$C_0 =$

Circuit diagram (mark also the positions of the switches):

Multimeter
IN   OUT   GND

Current source
− +   Switch
O
I

Black box
Switch
O
I

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iii. (2.2 pts)

Circuit diagram used for obtaining $I(V)$ (mark also the positions of the switches):

Multimeter
IN   OUT   GND

Current source
− +   Switch
O
I

Black box
Switch
O
I

Write the values of $I(V)$ and any necessary intermediate results into the table on the next page. (Use as few columns as you need.) Plot the graph on page 6.

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iv. (2.6 pts)

Circuit diagram used for obtaining $C(V)$ (mark also the positions of the switches):

Multimeter
IN   OUT   GND

Current source
− +   Switch
O
I

Black box
Switch
O
I
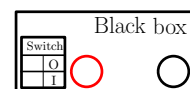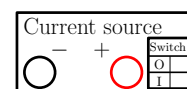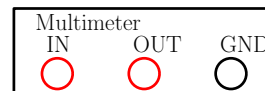
Write the values of $C(V)$ and any necessary intermediate results into the table on the next page. (Use as few columns as you need.) Plot the graph on page 7.
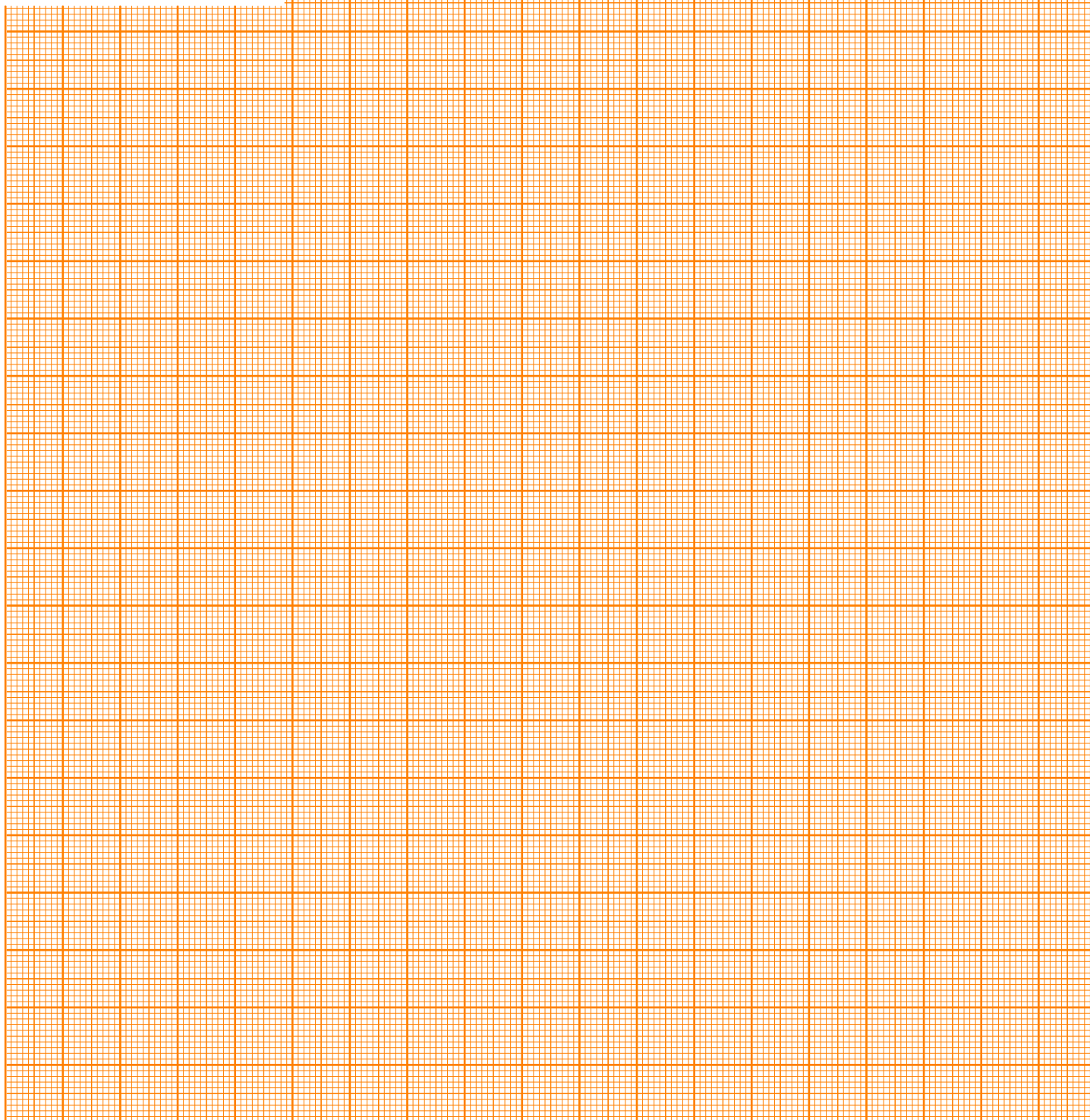
$C_{\min} =$

$C_{\max} =$

V				$I(V)$				$C(V)$

Graph: I versus V

Graph: C versus V

Part B. Circuit with inductance *(3 points)*

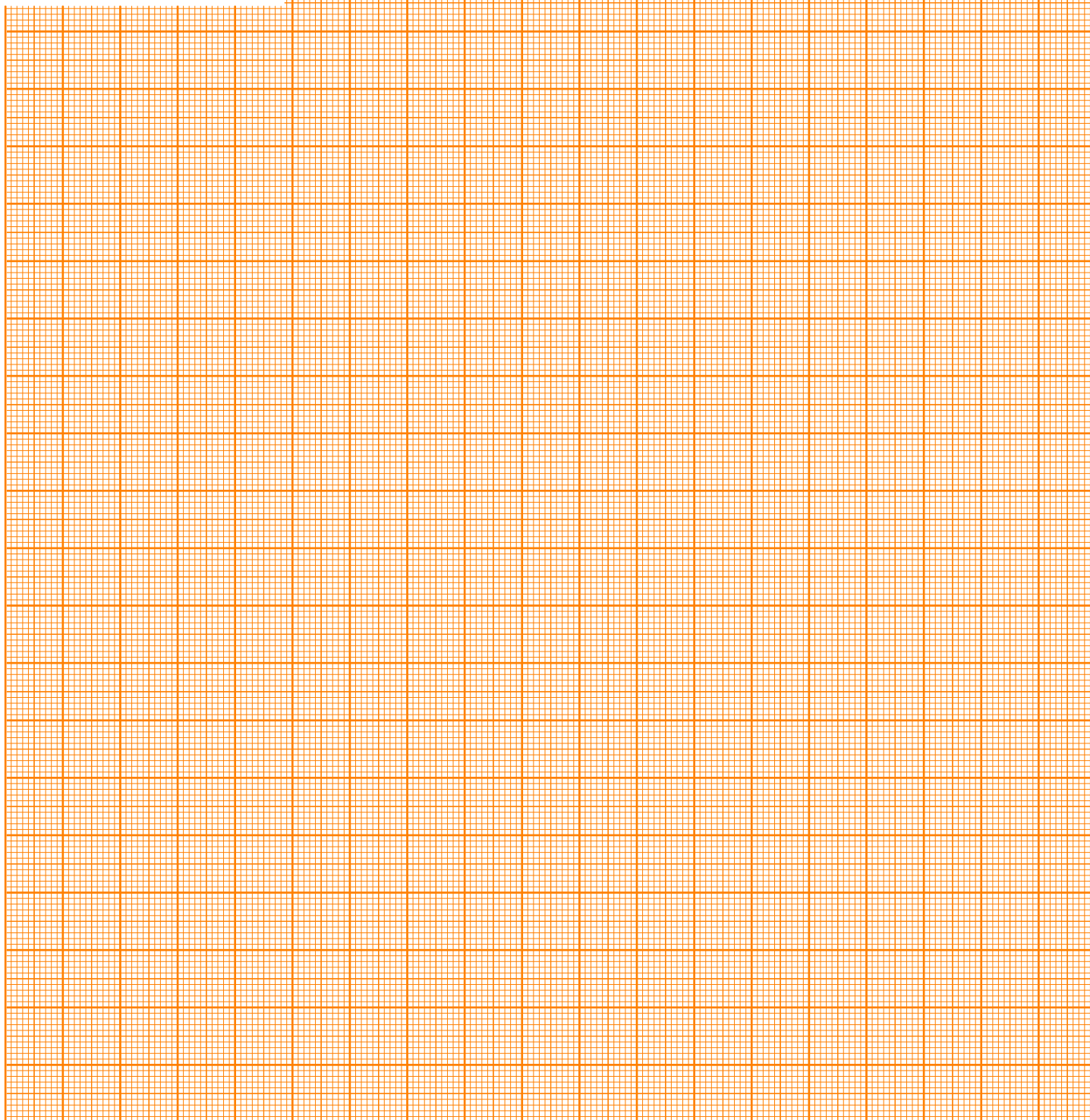| V				$I(V)$
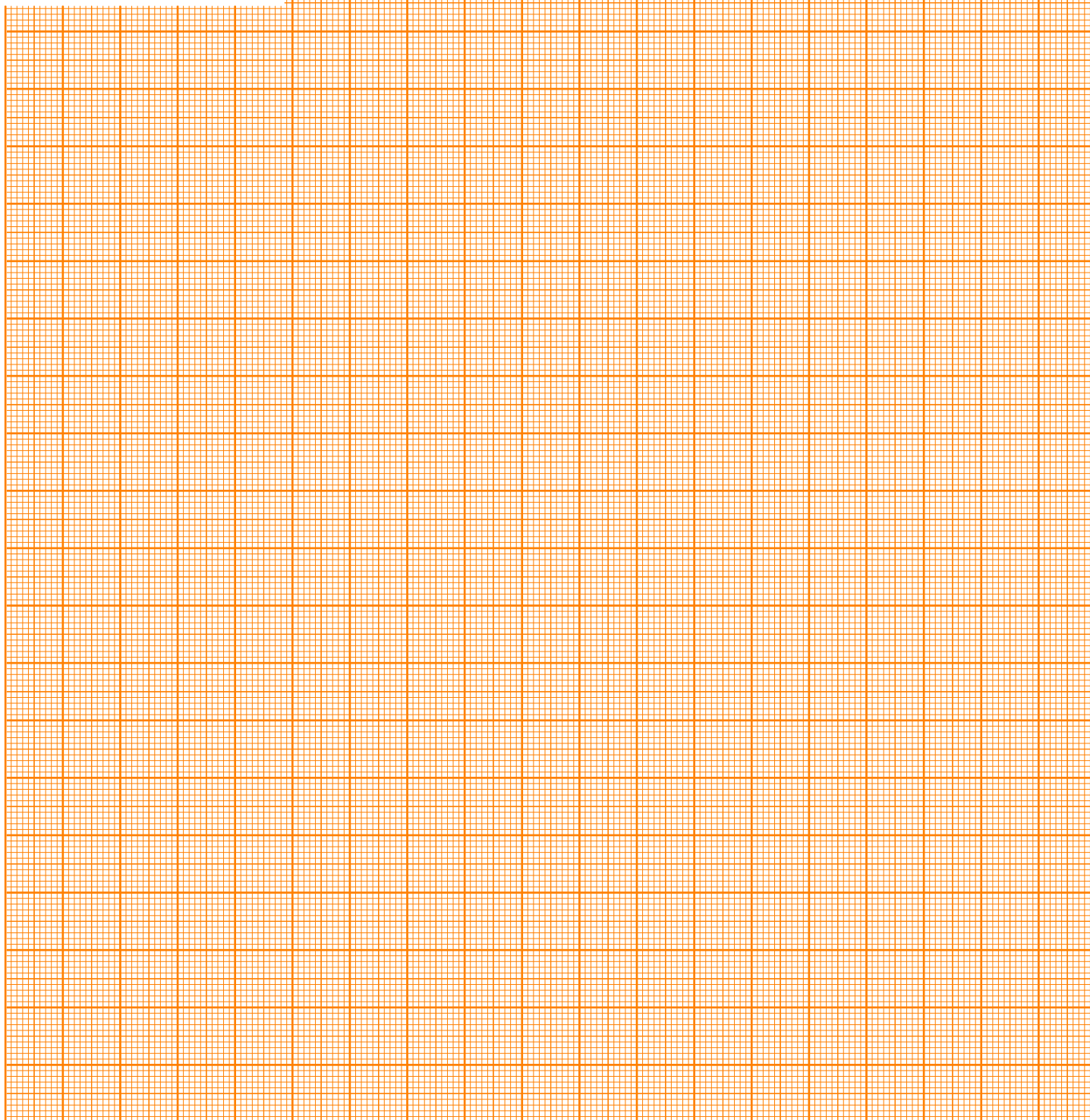
Graph: I versus V

There are significant differences between the curves
of Parts A and B when

Condition for V	
Condition for I(V) from Part A	

Explanation of those differences: