

## The Properties of Real Numbers and the Determination of Origin of Axis in Graphical and Computational Analysis

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### *Abstract*

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*Graphical and computational analysis is one of the widely used tools by researchers, science and engineering students. Hence, the need for precise and simplified techniques in this area of learning cannot be overemphasized. In this work we showed that every number  $x$ , an element of real set  $\mathbb{R}$  ( $x \in \mathbb{R}$ ) has one and only one greatest multiple NEXT to it of a real number  $y$ . And as an application, we showed how this can help in determination of origin of an axis in graphical work analysis.*

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### 1.0 Introduction

Graph plotting is one of the useful tools for data analysis. Though this area of learning has been well researched on over the years, yet aspects such as scale choosing [1] determination of plots and origin of axis are not well theorized. Therefore researchers and students usually rely on intuition and this is largely the reason for variation in analysis results for the same sets of data by different individuals [2,3]. Also, this has made students ‘traditionalized’ zero (0) as the origin of axis while trying to plot graphs. This however is the reason for frustration of many since the smallest observed experimental values in most cases in practice can be far greater than zero. Therefore choosing zero as origin in such cases leads to compacting of plots in a very small area; which is not good for analysis [4,5] and inefficient utilization of graph sheet.

On the other hand, number theory is one of the oldest and most researched theories of science over the years. Many properties of numbers and theorems have been found some of which we state here.

Let  $a, b, c \in \mathbb{R}$ , then,

- I.  $a + b = b + a$  : Commutative property of addition.
- II.  $ab = ba$  : Commutative property of multiplication
- III.  $a + (b + c) = (a + b) + c$  : Associative property of addition
- IV.  $a(bc) = (ab)c$  : Associative property of multiplication
- V.  $a(b + c) = ab + ac$  : Distributive property.

Determinateness of numerical subtraction; subtraction, when possible, is a determinate operation. There is but one number which satisfies the equation;

$$x + b = a \quad (1)$$

*Theorem 1 if  $a + c = b + c$  then  $a = b$*

*Theorem 2 if  $ab = bc$  then  $a = c \forall b \neq 0$*

Proof see [6,7]

### 2.0 Methodology

*Lemma 1: Every real number  $x$  has only one real number  $y$  known as complement of  $x$  that makes  $x$  equals  $Z$  i. e.*

$$Z = x + y \tag{2}$$

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Proof:

Suppose  $a$  and  $b$  satisfy equation (2), we are to show that  $a = b$

$$i. e Z = x + a \text{ and } Z = x + b$$

$$\therefore x + a = x + b$$

From theorem 1, the result follows.

**Corollary:** Every real number  $k$  can be expressed as the sum of two complementary numbers.

Proof:

consider

$$\frac{k}{a} = b + c = d \tag{3}$$

where  $b$  and  $c$  are whole and fractional part of the division  $\frac{k}{a}$ ,

Now setting  $b$  and  $c$  as complementary values, then by lemma 2,

$$d = b + c \tag{4}$$

$\therefore$  equation (3) becomes

$$\frac{k}{a} = b + c \tag{5}$$

$$k = a(b + c) = ab + ac \tag{6}$$

from property V (distributive property) and closure property of multiplication on a set of real numbers [6] the result follows

**Lemma 2:** Every real number  $x$  can be expressed as a sum products of  $y$  and  $v_i$

$$i. e. x = v_1y + v_2y + \dots \forall y, v_i \in \mathbb{R} \text{ and } i = 1, 2 \dots n \tag{7}$$

where  $v_i$  are complementary coefficient with zero being the identity coefficient.

Proof:

In [1] we defined a successive division in which divisor is constant and the quotient is in turn the dividend. And showed that if  $k$  is the dividend,  $a$  is divisor and  $P$  the final quotient of the successive division then,

$$k = a^\epsilon P_\epsilon \tag{8}$$

where  $\epsilon$  is the number of divisions carried out

Now bearing that in mind and using the corollary above, equation 8) can be written as;

$$k = a^n(v + w + \dots) \tag{9}$$

Letting  $k = x$ , and  $a^n = y$  with property V in operation the result follows.

**Theorem:** Let  $x, y \in \mathbb{R}$  if  $x$  is express as the sum of product of  $y$  and two complementary coefficients, then  $x$  has one and only one greatest multiple NEXT to it of  $y$ .

Proof:

Using corollary and lemma 2, we can precisely write

$$x = vy + wy \tag{10}$$

with  $vy$  as the greatest multiple

Let  $w$  be a necessary complementary coefficient and suppose that  $yn$  is greatest

$$i. e. yv < yn \tag{11}$$

this implies;

$$v < n \tag{12}$$

but by lemma1,  $w$  has only one complement hence 12 is not possible.

But suppose (12) is possible then  $w$  is not constant and is less. End of proof.

### 2.1 Application

scale formula,[1]the scale factor  $\lambda$ :  $K$  for  $M$  and  $H$  is 8: 1 and 8: 0.125 respectively.

To determine the origin  $\mu$ , for  $M$ , we express  $L = 40.050$  as a sum of two multiples of  $K$  which are complementary numbers and let  $\mu$  = the greatest multiple.

$$\text{Now, } \frac{L}{K} = \frac{40.050}{1} = 40.050 = 40 + 0.050$$

$$\therefore L = 40.050 = 1 \times 40 + 1 \times 0.05 \tag{13}$$

comparing 12 and 9, and letting  $y = K$ ,

$$\mu = Kv = 1 \times 40 = 40 \tag{14}$$

Following the same steps, we can find  $\mu$  for  $H$  as 0.875

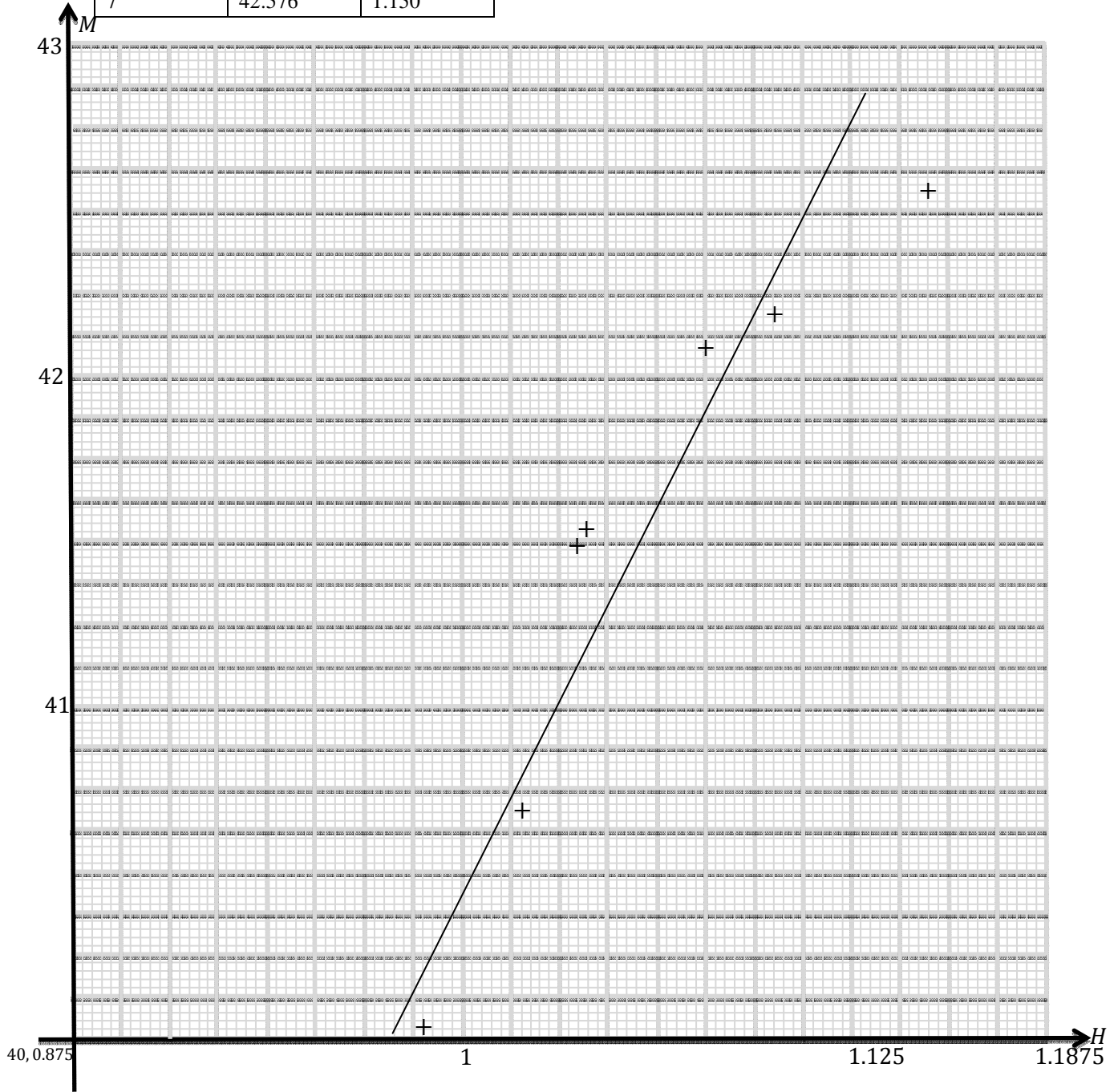
$$\text{Note, if } w = 0, \text{ then } \mu = K(v - 1) \tag{15}$$

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Consider the table of values in Table 1 as an example. M is plotted against H on a graph sheet provided.

**Table 1:** Arbitrary Values For M And H

S/N	M	H
1	40.050	0.988
2	40.700	1.019
3	41.500	1.037
4	41.560	1.040
5	42.090	1.078
6	42.200	1.100
7	42.576	1.150



**Figure 1:** The Graph Of M Against H For Calculated Scale Using Scale Formula.

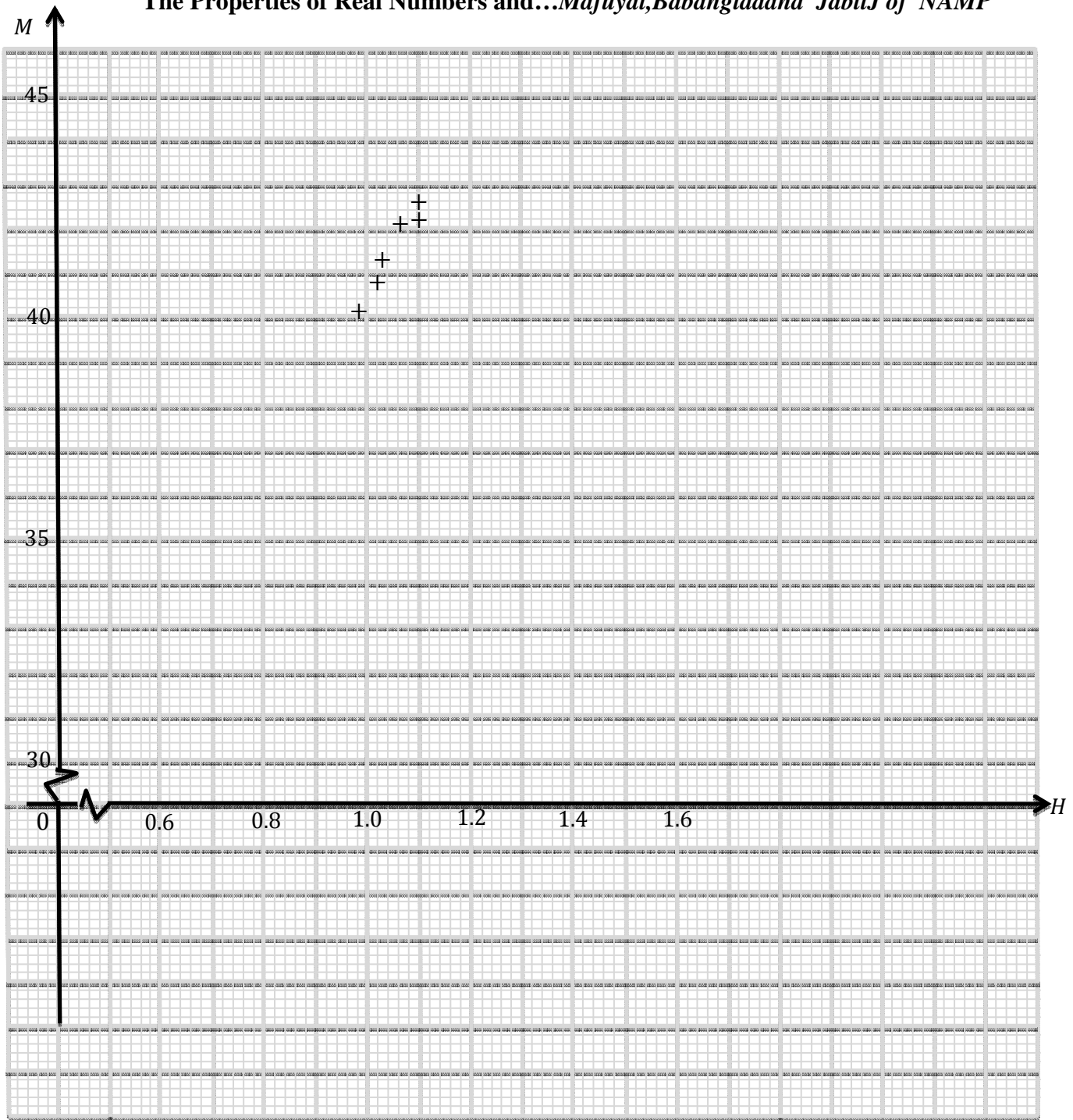


Figure 2: The Graph Of M Against H Plotted By One Of The Below Average Students Using The Arbitrary Choosing Method.

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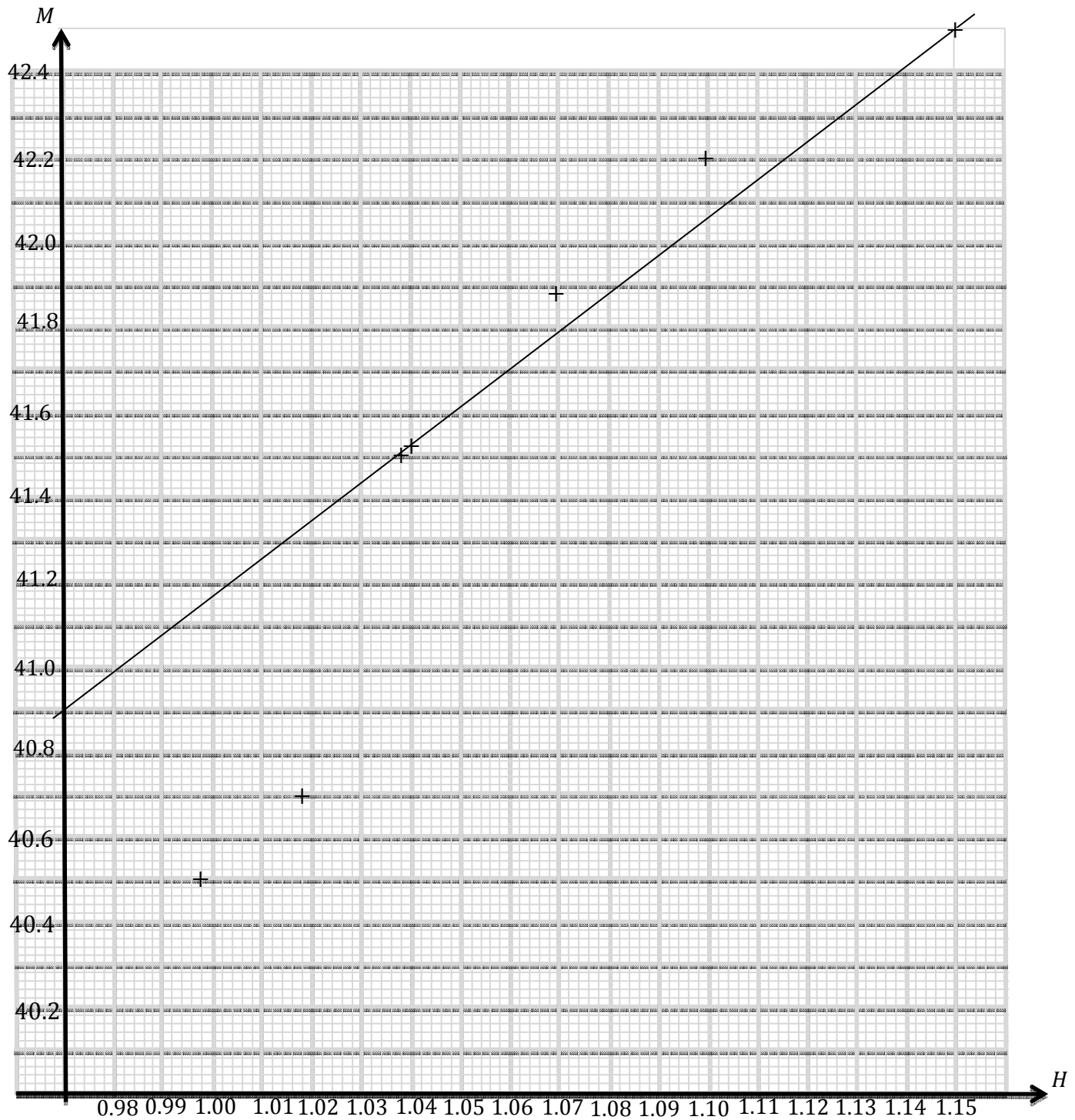


Figure 3: The Graph Of  $M$  Against  $H$  Plotted By Another Good Student Using The Arbitrary Choosing Method.

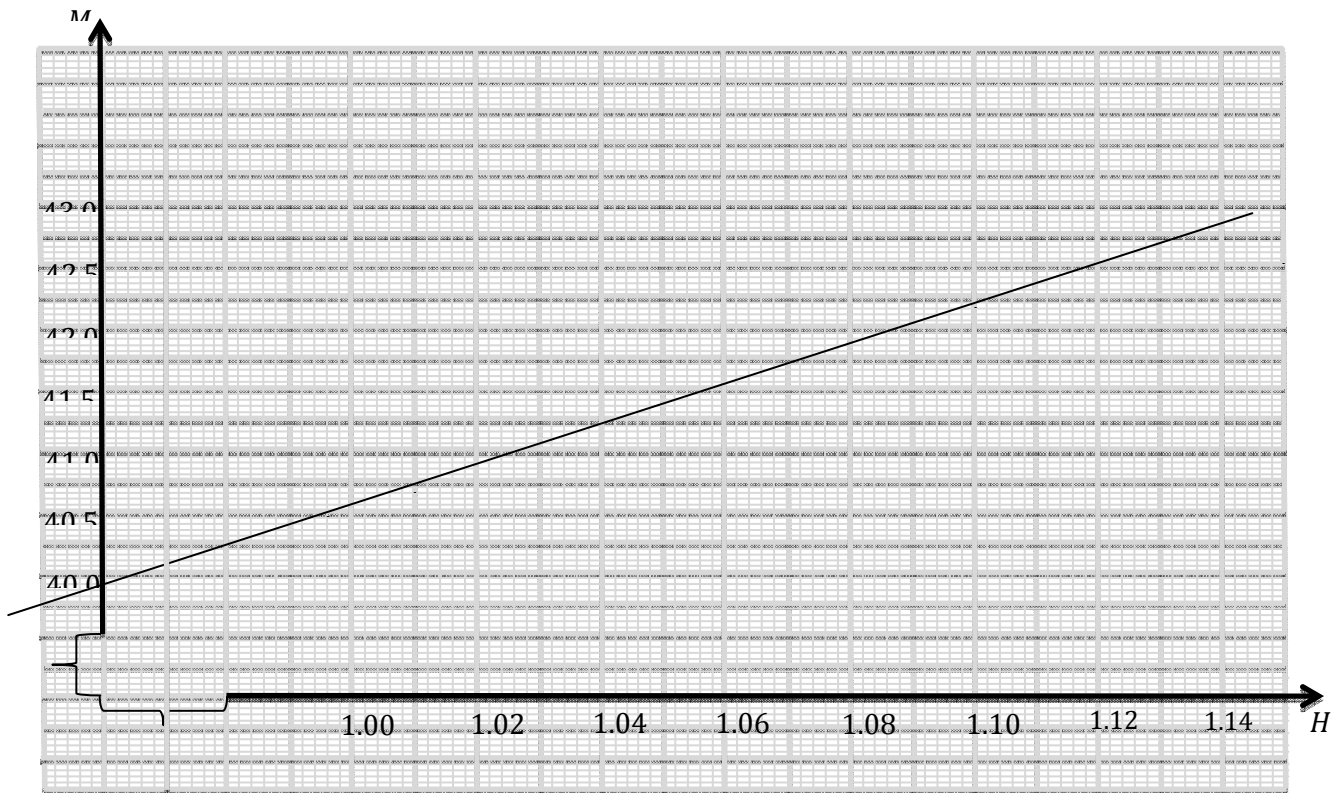


Figure 4: The Graph of M against H Plotted By One of the Best Students Using the Arbitrary Choosing Method.

### 3.0 Results Discussion and Conclusion

1. Figure 1 is plotted from calculated scale and origin. This gives a good separation of plots with optimum utilization of graph sheet.
2. Figure 2, 3 and 4 are the worst and the two best plotted by a university graduating class of fifty (50) students of physics department. The challenges faced by the three students are common which range from choosing appropriate scale and determination of origin to fixing of points.
3. The variation in graphs obtained by the students for the same table I is of great concern most especially when the result is to be used for further research or decision making. It is for reasons such as these that the research is undertaken so as to provide a unified method of graph plotting. We can therefore, in conclusion, say that the challenges are resolved as seen from Figure 1.

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