Back to the Good Old Days

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October 9, 2019

Abstract

Before electricity is existed there's no accurate and standard way to measure a physical scalar, so in this experiment we measured the object's acceleration a without using any International System of Units (SI). With the usage of pendulum as our timing device and a whiteboard pen as our reference of length, we were be able to deliver a self-made unit using such two references.

1 Aim

Our aim in this lab is to measure the acceleration of a ball or cart without a timer and without a measuring ruler.

2 Apparatus

- solid steel ball
- inclined plane
- string
- 9× whiteboard pen: EXPO Low Odor Dry Erase Markers, Chisel Tip; can be found at `https://www.amazon.com/dp/B00006IFIL`

3 Definition of Units

- Length: 1wp, equivalent to 1 whiteboard pen, defined as the length of 1 "EXPO Low Odor Dry Erase Markers, Chisel Tip" whiteboard pen
- Time: 1pe, equivalent to 1 pendulum hit, defined as when a 3wp long string, 4wp long stand holding a weight launching at 1wp high, the time the weight takes to hit the farthest/highest point. Refer to Figure 1 for a clearer visulization

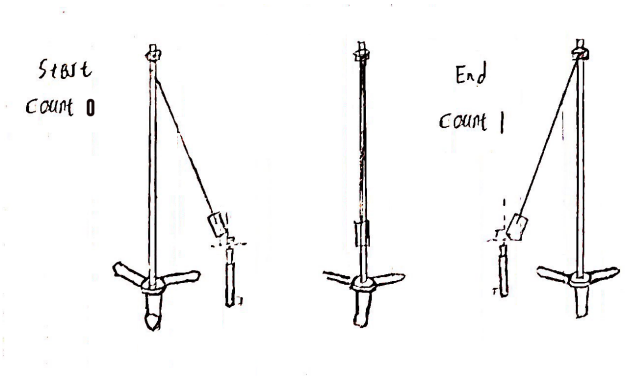

Figure 1: Time Definition

(a) Inclined Plane Setup

(b) Pendulum Setup

Figure 2: Experiment Environment Setup

4 Procedure

1. Setup the experiment environment prior to Figure 2
2. Place the ball at the highest end of the inclined plane
3. When ready, release both the pendulum and the ball at the same time

   The one MUST NOT apply additional force to either the pendulum or the ball in order to get a precise result
4. Count the pendulum hits

   Every pendulum hit was defined as when a 3wp long string, 4wp long stand holding a weight launching at 1wp high, the time the weight takes to hit the farthest/highest point
5. Repeat from step 2 for up to 5 times
6. Increment the length of the inclined plane by 1wp
7. Repeat from step 2 until you get enough data

5 Experimental data and data analysis

Experimental data has been placed in Table 1.

Table 1: Raw Data

S **length** (wp)	t **time** (pe)
1	1.5
1	1.5
1	1.5
1	1.5
1	1.5
2	2.0
2	2.1
2	2.1
2	2.2
2	2.0
3	2.8
3	2.9
3	2.9
3	2.9
3	2.9
4	3.5
4	3.4
4	3.3
4	3.3
4	3.3
5	3.8
5	3.9
5	3.9
5	3.8
5	3.9
6	4.1
6	4.1
6	4.2
6	4.2
6	4.1
7	4.8
7	4.7
7	4.5
7	4.5
7	4.7
8	4.9
8	4.9

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Table 1 – continued from previous page

S (wp)	t (pe)
8	4.9
8	4.8
8	4.9
9	5.1
9	5.1
9	5.0
9	5.1
9	5.1

We can elaborate the raw data above using the kinematic equations

$$v = at + u$$
$$a = \frac{v - u}{t}$$

to calculate the raw data into analytical data as shown in Table 2

Table 2: Analytical Data

S (wp)	$\bar{t}$ **average time** (pe)	v ($\mathrm{wp\,pe^{-1}}$)	a ($\mathrm{wp\,pe^{-2}}$)
1	1.50	0.6667	0.4444
2	2.08	0.9615	0.4623
3	2.88	1.0417	0.3617
4	3.36	1.1905	0.3543
5	3.86	1.2953	0.3356
6	4.14	1.4493	0.3501
7	4.64	1.5086	0.3251
8	4.88	1.6393	0.3359
9	5.08	1.7717	0.3488

We can see from the table above that our acceleration is constant.

6 Conclusions

After doing this experiment I realized that how will the world looks like if there's no standard in scientific area - a bunch of mess. We will be experiencing tragic loss in precision and accuracy on measures, and at last may cause huge artificial disaster. Fortunately we now have SI units which are the standards of the units, and such standard will guide the scientists having accurate and unified unit of measurement, generating much broader communication on scientific areas as well as having valuable and representable references for our futures.