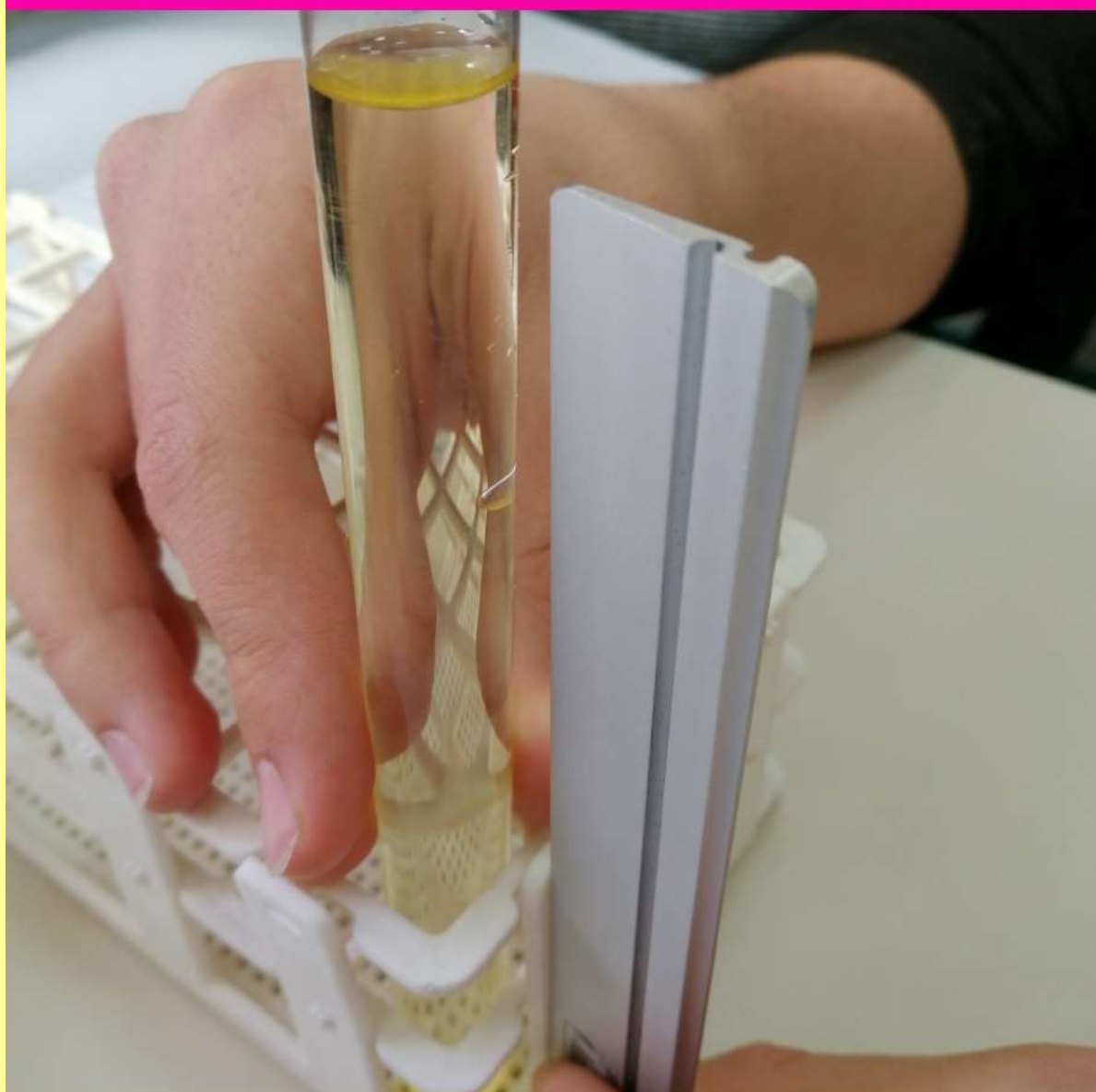


LABORATORIO DI FISICA

SMART LAB

Attività laboratoriali con app e smartphone



DONATELLA COLAMASI
SABRINA MARINO

Un'esperienza di didattica a distanza per l'insegnamento della Fisica

con approccio BYOD per compiti di realtà

REALIZZATO CON LE CLASSI 1 C e 2 C IGCSE del

Liceo Scientifico “O.M. Corbino” SIRACUSA

A Marzo, a causa del Coronavirus, le lezioni curricolari si sono interrotte e ho dovuto ripensare e rimodulare il processo di insegnamento e apprendimento.

In Sicilia, le lezioni sono state improvvisamente interrotte il 9 Marzo: all'inizio sembrava che la sospensione durasse solo una settimana, ma poi si è subito capito che non saremmo più tornati in classe per questo anno scolastico.

Dal 15 Marzo ho iniziato a incontrare i miei studenti in classe virtuale con la piattaforma digitale Moodle della mia scuola: avevo l'abitudine di alternare le lezioni in classe con l'utilizzo settimanale del laboratorio di fisica.

Durante questo periodo, non potendo svolgere attività laboratoriali ho usato un approccio diverso: far condurre esperimenti e compiti di realtà agli alunni su argomenti specifici con approccio BYOD.

Smartlab è la sezione dedicata in piattaforma all'interno del corso

L'attività si è svolta dal 20 aprile al 20 maggio 2020.

I miei studenti avevano già condotto esperimenti nel laboratorio scolastico anche con l'uso dello smartphone, sebbene la nostra scuola abbia un laboratorio di Fisica attrezzato. In ogni caso, credo che l'implementazione degli esperimenti sia molto significativa e consenta agli studenti di ottenere risultati eccellenti, perché consente agli studenti di consolidare gli argomenti e l'insegnante di verificare le proprie capacità e competenze.

Sensori e Tools

Application Sensor Toolbox (Vieyra Software)

Smartphone sensor:

1. G-Force,
2. Orientation,
3. Cronometer,
4. LightMeter
5. Proximeter

Esperienze

- 1. The g value is constant**
- 2. G-force components on inclined plane**
- 3. The length is proportional to the square of the period and the period does not depend on the mass**
- 4. The amount of heat is proportional to the change in temperature**
- 5. The measure of illuminance**
- 6. Parabolic motion**

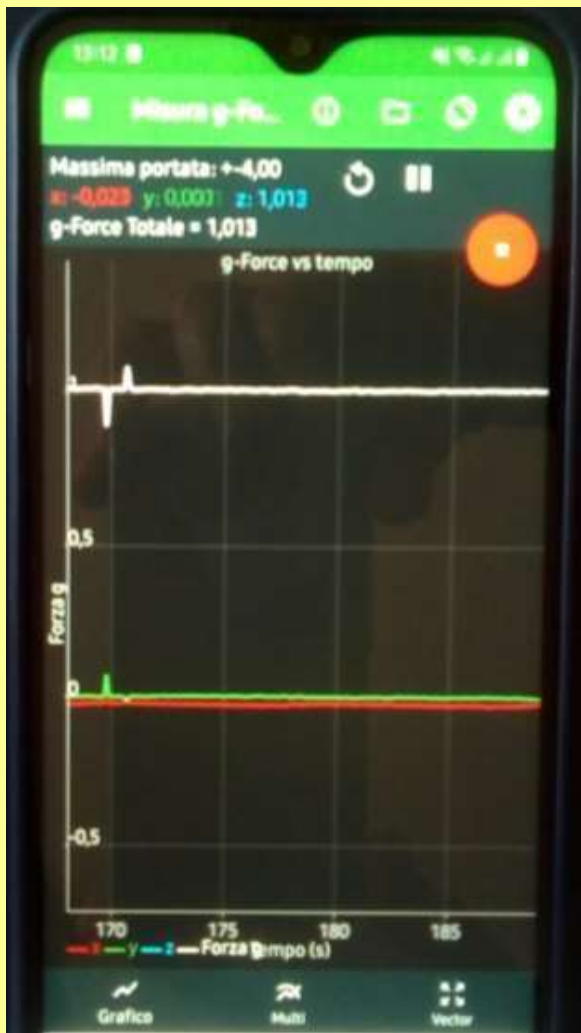
Per ogni esperimento è stata chiesta la consegna di un report dettagliato in lingua inglese con foto, tabelle e grafici allegati.

Di seguito si riportano i lavori più significativi.

A cura delle docenti Donatella Colamasi (Fisica) e Sabrina Marino (Inglese) delle classi 1 C e 2 C

Physics experiment

G-Force measure



For the experiment I used the Physics Tooblox App, which has the function of measuring the acceleration of gravity. We proceed, knowing that if the smartphone we use is stationary, the Total G-Force measurement must be constant over time and exactly equal to 1G if we are at sea level.

Looking at the graph we produce, you can immediately notice two things.

- The measured value is not constant: if it were, the white curve would be straight, while we see that it is jagged. This is due to the presence of accidental measurement errors. These errors can have various causes, for example very slight table vibrations or electrical noise inside the smartphone.

- The average measured value may not exactly 1,000 but, for example, 1,001 or 0,999. This instead is a systematic error, due to the inaccuracy of the sensor contained inside the phone (or to the fact that we are in the high mountains or at the bottom of the sea).

We place the smartphone on a table and start the measurement by clicking on the red button.

Let's wait 10 seconds and then click again to finish the measurement.

Once the measurements are obtained, we eliminate the first 3s and the last 3s of acquisition because we may have disrupted the measurement by touching the smartphone.

In any box we write = Average (cell range), same procedure to find the standard deviation = STDEV (cell range).

Our measure will therefore be $G\text{-Force} = Mg \pm \delta g$.

Remmal Oumaima

1st

File Excel

time	gFx	gFy	gFz	TgF		
3	-0,0235	-0,0117	1,0153	1,016	valore medio	1,01266
3,004	-0,023	-0,0112	1,0153	1,016	deviazione standard	0,00162
3,014	-0,0254	-0,0112	1,0129	1,013	G-Force = Valore medio \pm deviazione standard =	
3,024	-0,0249	-0,0122	1,0124	1,013		
3,034	-0,0235	-0,0132	1,0168	1,017	1,01266	\pm 0,00162
3,044	-0,023	-0,0117	1,0105	1,011		
3,053	-0,0244	-0,0088	1,0134	1,014		
3,064	-0,0215	-0,0122	1,0153	1,016		
3,074	-0,0249	-0,0107	1,0109	1,011		
3,084	-0,0225	-0,0127	1,0105	1,011		
3,094	-0,0249	-0,0103	1,0124	1,013		
3,104	-0,0259	-0,0122	1,0095	1,01		
3,113	-0,0235	-0,0112	1,0119	1,012		
3,124	-0,0235	-0,0098	1,0144	1,015		
3,134	-0,0264	-0,0103	1,0095	1,01		
3,144	-0,0259	-0,0098	1,0134	1,014		
3,154	-0,0239	-0,0093	1,0139	1,014		
3,164	-0,0235	-0,0117	1,01	1,01		
3,182	-0,023	-0,0098	1,0114	1,012		
3,185	-0,0254	-0,0093	1,0119	1,012		
3,2	-0,0249	-0,0103	1,0139	1,014		
3,204	-0,022	-0,0122	1,0105	1,011		
3,214	-0,0235	-0,0112	1,0124	1,013		

Elisabetta Giacalone

1°C

PHYSICS EXPERIMENT

INCLINED PLANE

NEEDED:

- *Physics Toolbox Sensor Suite* application on our smartphone
- drawing squares (one with an angle of 30° and another one with angles of 45°)
- hardcover book
- support surface
- calculator

MAIN FOCUS OF OUR WORK

We are going to show how the gravitational force components change.

EXPERIMENT

We will use the book as a plan and then we will use the drawing squares to tilt the book cover of known angles.

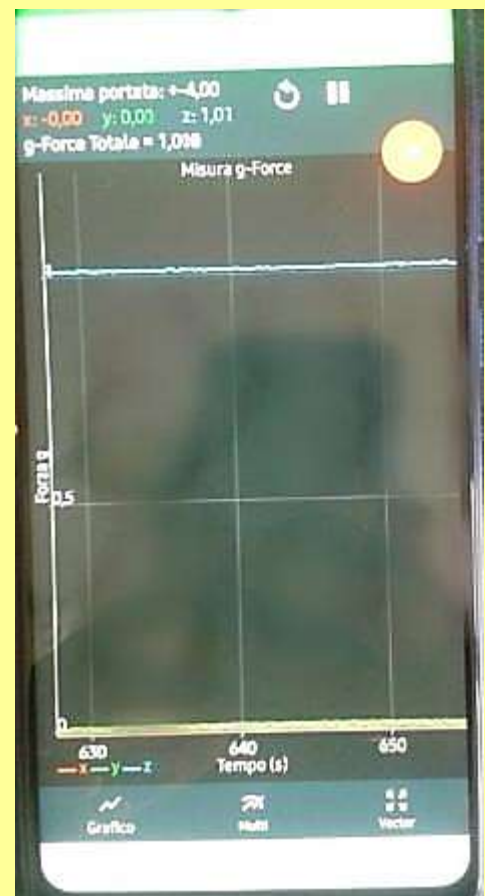
We will use the application *Physics Toolbox* in *G-Force meter* mode to perform the measurement.

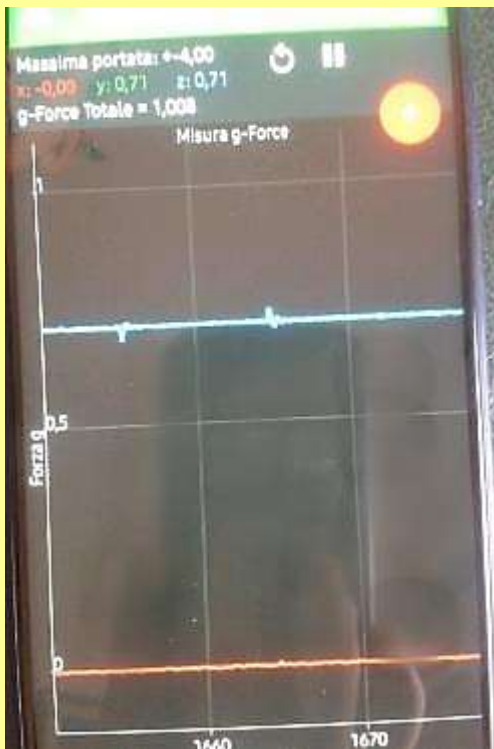
From our mobile phone menu settings, we must disable the options *G-Force* and *Include total G-Force* because we won't need them in this experiment.

The mode *G-Force Meter* gives us the value of G-Force as unitary vector (the G-force module is equal to 1N) whose direction is parallel to the gravitational force, so these two forces are proportional (G-Force = Weight Force = 1 N).

Now let's begin the experiment.

1) We fix our phone on the book. At this point we can use the application. If the mobile phone is in a perfectly horizontal position on the cover of the book, the application shows that the components F_x and F_y of *G-Force* will be equal to 0 when the phone is stationary (as shown in the photo to the right).





2) We take one of the two drawing squares, for example the one with an angle of 45° . We have to put it between the cover and the first page of the book, so the cover book will be tilted by 45° .

3) The application shows the new values of the components F_x , F_y and F_z of G -Force. We can read these values without moving the cover book. We can see that F_x remains 0, F_y and F_z components are the same and they are worth about 0.71 (as shown in the photo to the left).

4) We repeat the measurement using the drawing square with an angle of 30° . We have to put it between the cover and the first page of the book, so the cover book will be tilted at 30° .

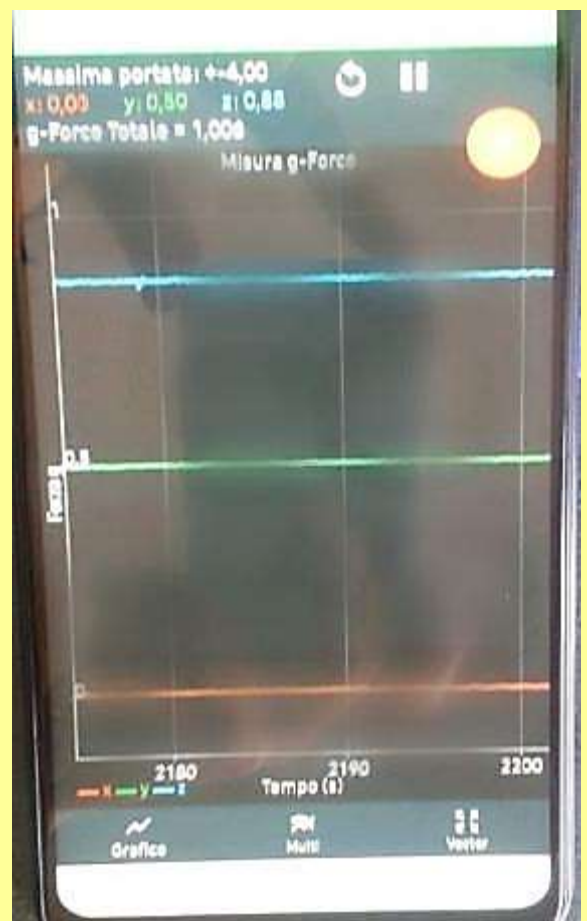
Let's look at the values of the components:

F_x remains 0

F_y is equal to 0.5

F_z is equal to 0.88

(as shown in the photo to the right).



To be sure that our measurement is correct, we have to check the values with a calculator (remember that the value of the *G-Force* module is approximately equal to 1 N).

We know that the components of the weight force on an inclined plane by α degree are:

- parallel component = $F \times \sin \alpha$

- perpendicular component = $F \times \cos \alpha$

Let's calculate these values using the mathematical formula.

If the plane is tilted at 45° , the components are:

$$F_y = 1 \times \sin \alpha = \sin 45^\circ = 0.707 \leftarrow \text{very close to } 0.71$$

$$F_z = 1 \times \cos \alpha = \cos 45^\circ = 0.707 \leftarrow \text{very close to } 0.71$$

If the plane is tilted at 30° , the components are:

$$F_y = 1 \times \sin \alpha = \sin 30^\circ = 0.5$$

$$F_z = 1 \times \cos \alpha = \cos 30^\circ = 0.866 \leftarrow \text{very close to } 0.88$$

So, the values obtained by the mathematical formula are comparable with those found in the experimental measurement: the obtained measures are correct

COLLECTION OF DATA IN A TABLE

We can write our data in the following table

ANGLES	F_x	F_y	F_z
45°	0.00	0.71	0.71
30°	0.00	0.50	0.88

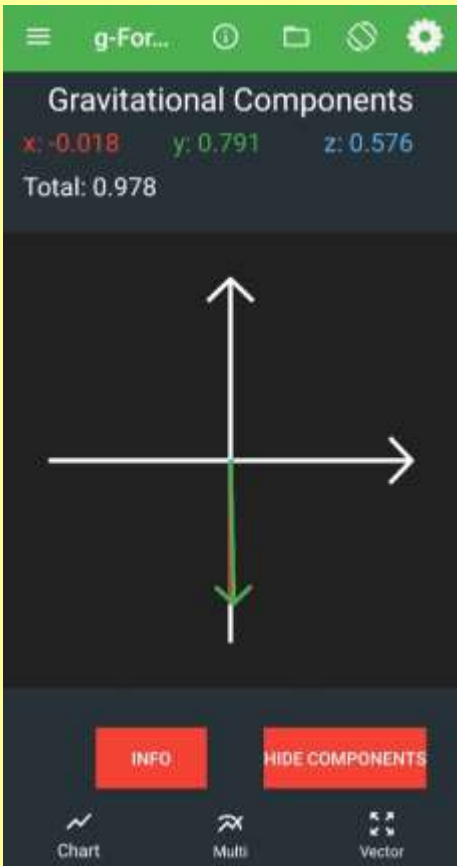
CONCLUSIONS

The experiment shows that, when a body is on an inclined plane, the weight force must be divided into its components that are parallel and perpendicular to the inclined plane. The components value changes according to the inclination of the plane. We can see that as the angle increases, the F_y value increases and the F_z value decreases and vice-versa. That is why the inclined plane has mechanical advantages: the smaller the tilting angle is, the smaller the force needed to raise a weight is.

The values obtained by this experimental measurement are comparable with those found by the mathematical formula.

Elisabetta Giacalone 1^aC

Other measuring g-force



time	gFx	gFy	gFz	TgF
116.40.00	-2.36.00	121.30.00	136.58.00	2.39
133.20.00	-0.49.00	113.12.00	139.35.00	2.18
133.20.00	1.57	110.45.00	143.59.00	2.30
133.20.00	-0.20.00	112.42.00	143.00.00	2.32
133.20.00	-2.56.00	124.16.00	136.49.00	2.49
150.00.00	-3.35.00	133.23.00	114.40.00	1.56
233.20.00	-3.06.00	140.24.00	96.15.00	1.22
500.00.00	-3.25.00	140.43.00	79.29.00	16.10
516.40.00	-2.56.00	138.07.00	64.49.00	15.16
516.40.00	-2.56.00	135.50.00	56.02.00	14.42
750.00.00	-3.25.00	136.19.00	57.00.00	14.47
766.40.00	-3.25.00	138.07.00	68.24.00	15.25
766.40.00	-3.55.00	138.46.00	84.32.00	16.15
800.00.00	-4.14.00	135.31.00	104.24.00	1.27
850.00.00	-2.46.00	128.01.00	124.55.00	2.13
950.00.00	-0.49.00	122.39.00	134.32.00	2.32
1050.00.00	-0.10.00	118.34.00	138.46.00	2.35
1116.40.00	-0.39.00	117.36.00	135.31.00	2.17
1183.20.00	-2.17.00	120.12.00	127.51.00	1.53
1266.40.00	-3.25.00	127.02.00	116.27.00	1.34
1350.00.00	-3.15.00	133.53.00	102.17.00	1.11
1450.00.00	-3.15.00	138.26.00	89.05.00	16.28
1533.20.00	-3.35.00	139.35.00	76.53.00	15.56
1616.40.00	-3.15.00	139.06.00	68.34.00	15.31
1683.20.00	-2.46.00	137.47.00	68.15.00	15.23
1783.20.00	-3.06.00	136.00.00	75.25.00	15.33
1916.40.00	-4.14.00	134.03.00	88.26.00	16.04
1933.20.00	-4.14.00	131.46.00	103.06.00	1.04
2033.20.00	-3.25.00	129.19.00	115.58.00	1.42
2116.40.00	-2.27.00	126.43.00	126.04.00	2.13
2183.20.00	-1.28.00	123.47.00	131.16.00	2.23
2366.40.00	-2.17.00	121.59.00	126.23.00	1.54
2383.20.00	-2.17.00	121.59.00	126.23.00	1.54
2500.00.00	-2.46.00	124.36.00	116.47.00	1.25
2516.40.00	-2.56.00	128.50.00	106.02.00	1.01
2616.40.00	-3.15.00	134.51.00	89.54.00	16.13
2683.20.00	-3.15.00	137.18.00	80.57.00	15.57
2783.20.00	-3.25.00	137.57.00	76.23.00	15.46
2850.00.00	-2.56.00	137.47.00	75.54.00	15.44
2950.00.00	-2.27.00	136.10.00	79.19.00	15.46
3016.40.00	-2.46.00	133.53.00	88.17.00	16.02
3116.40.00	-2.56.00	131.07.00	98.52.00	16.25
3200.00.00	-2.46.00	129.29.00	109.07.00	1.16
3300.00.00	-2.56.00	127.41.00	118.05.00	1.44
3350.00.00	-2.27.00	126.13.00	123.57.00	2.02
3450.00.00	-2.17.00	125.34.00	124.36.00	2.01
3550.00.00	-2.27.00	126.04.00	119.13.00	1.41
3600.00.00	-2.36.00	127.41.00	111.24.00	1.17
3700.00.00	-2.56.00	130.18.00	101.57.00	16.33
3783.20.00	-3.15.00	133.14.00	93.10.00	16.16
3850.00.00	-3.45.00	135.01.00	85.40.00	16.00
3950.00.00	-3.55.00	136.19.00	81.16.00	15.53
4033.20.00	-3.55.00	136.19.00	80.47.00	15.51
4133.20.00	-3.15.00	136.00.00	83.33.00	15.58
4183.20.00	-3.15.00	134.22.00	90.14.00	16.11
4283.20.00	-3.06.00	131.56.00	98.13.00	16.27

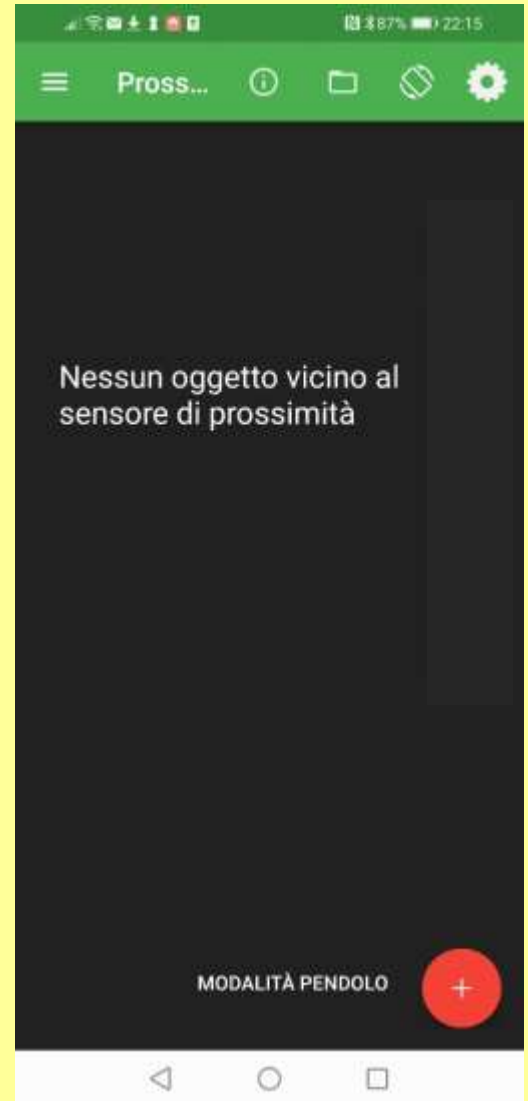
Flavia Carpinteri 1C

PERIOD OF A PENDULUM

First hypothesis (constant length and variable mass)

SMART TOOLS

- The proximity sensor (PROXIMETER) is a sensor that tells us if an object is near the Smartphone. It is above the screen and its main function is to lock the headboard when the Smartphone is resting on the ear in order to prevent accidental contacts from ending conversations or activating other features during the call. It can take only two values: 0 (object not present) and 1 (object present).
- From the Physics Toolbox menu, we choose Proximeter. No object near proximity sensor will appear on the screen. If we pass the hand on the sensor we see that the inscription becomes Object near proximity sensor: the sensor has detected the presence of the hand. Let's click the Pendulum mode button.
- Now every time we pass the hand on the sensor, a sequential number (1,2,3) and another number representing the time interval in thousandths of a second from the previous step appear. At this point we place the Smartphone so that the oscillating mass of the pendulum passes close to the sensor and activates it. Now let's swing the pendulum and start the measurement by clicking on the plus button. We collect 20 values, then click the red button to stop the capture.
- Let's save the file and upload it to an Excel sheet. There is only one column of data, which represents the ranges in ms. We calculate the average value and the standard deviation of the 20 intervals.



EXPERIMENT DESCRIPTION

- Let's build an elementary pendulum: we tie a paper clip at the end of a cotton thread and add two more staples by inserting them in the first one. We suspend the wire by fixing it with tape at the edge of a table, making sure that the bottom edge of the table and strip of tape coincide.

We move the staples away from the central position, keeping the wire stretched, and let them go pendulum will begin to swing around the central position.

We measure the pendulum period with a stopwatch. The period of a single oscillation it is quite short and the error due to the sensitivity of the instrument is great compared to the measure.

We can reduce the error by measuring the period of ten consecutive fluctuations and dividing then for 10 both the measure and the error. Repeating the operation with ten more oscillations we can verify that there is no appreciable difference between the period of the first 10 fluctuations and

the next group. Another technique is to make more measurements of the period and then the average among them.

What characteristics of the pendulum does the value of the period depend on? The first hypothesis is that the period depends on the mass of the pendulum, therefore the number of staples. To check the validity of this hypothesis, we construct three or four pendulums with the same length but to number of staples, and we measure the period of each pendulum.

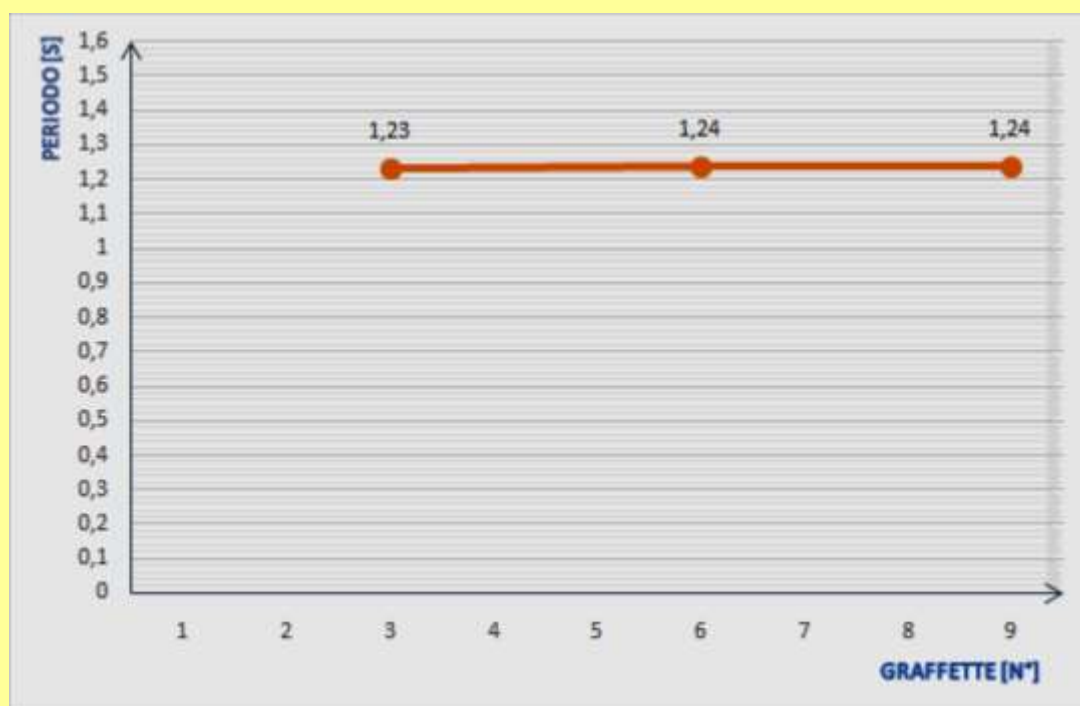
- First hypothesis. We collect data in a table on pendulums of fixed length and variable mass.



The screenshot shows a mobile application interface with a green header bar containing the text 'Pross...' and several icons. Below the header is a table with two columns: 'Evento #' and 'Tempo (ms)'. The table contains 10 rows of data. A dark grey vertical bar is positioned on the right side of the table, partially obscuring the data.

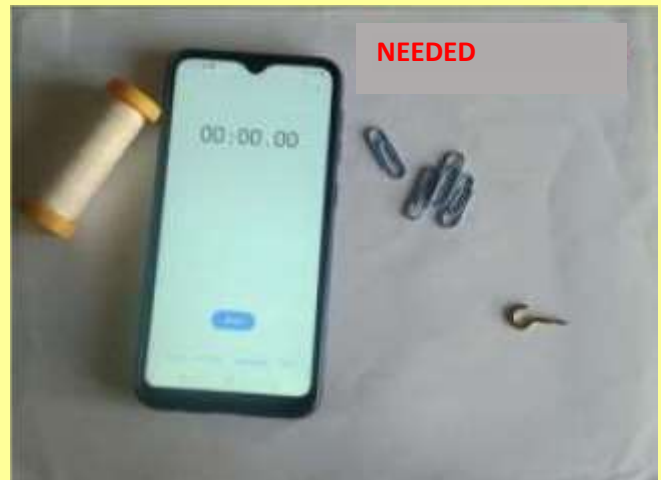
Evento #	Tempo (ms)
1	79
2	79
3	80
4	80
5	80
6	78
7	81
8	79
9	80
10	81

	l (cm)	m (n staples)	T (s)
Pendulum 1	$30,6 \pm 0,5$	3	$1,23 \pm 0,01$
Pendulum 2	$30,6 \pm 0,5$	6	$1,24 \pm 0,01$
Pendulum 3	$30,6 \pm 0,5$	9	$1,24 \pm 0,01$



Padula Paolo 1C

Second hypothesis (variable length and constant mass)



NEEDED:

- Wire (20cm, 40cm, 60cm, 80cm)
- Four staples
- Support surface (table)
- Nail to hang the wire
- Manual stopwatch (in my case with a sensitivity of 0.01 s)

PURPOSE OF EXPERIENCE: measurement of the period of a pendulum by changing the length of the wire.

EXPERIMENT

We tie four staples to the wire (in the first measuring the length of the wire is 80 cm). We open the application of the stopwatch on our smartphone and we measure a complete swing, then we write down the results on a table. The wire has a length of 80.0 cm



In the photo: the pendulum is in equilibrium. The forces acting on it are the gravitational force and the force exerted by the wire (whose modulus is equal to the weight but the direction of the vector is opposite). If we move the staples from the initial equilibrium position and let them go, the pendulum will start to oscillate. The pendulum can oscillate and the duration of a complete swing is measured.

00:01.84

The pendulum takes about 1.84 seconds to make one complete swing.

This time is called period.

Riprendi

Ripristina

Sveglia

Fusi orari

Cronometro

Timer



We repeat the experiment by changing the length of the wire (60 cm, 40 cm and 20 cm), keeping unchanged the mass. Then we report the measurements of the periods in a table and on the basis of it we create a graph.

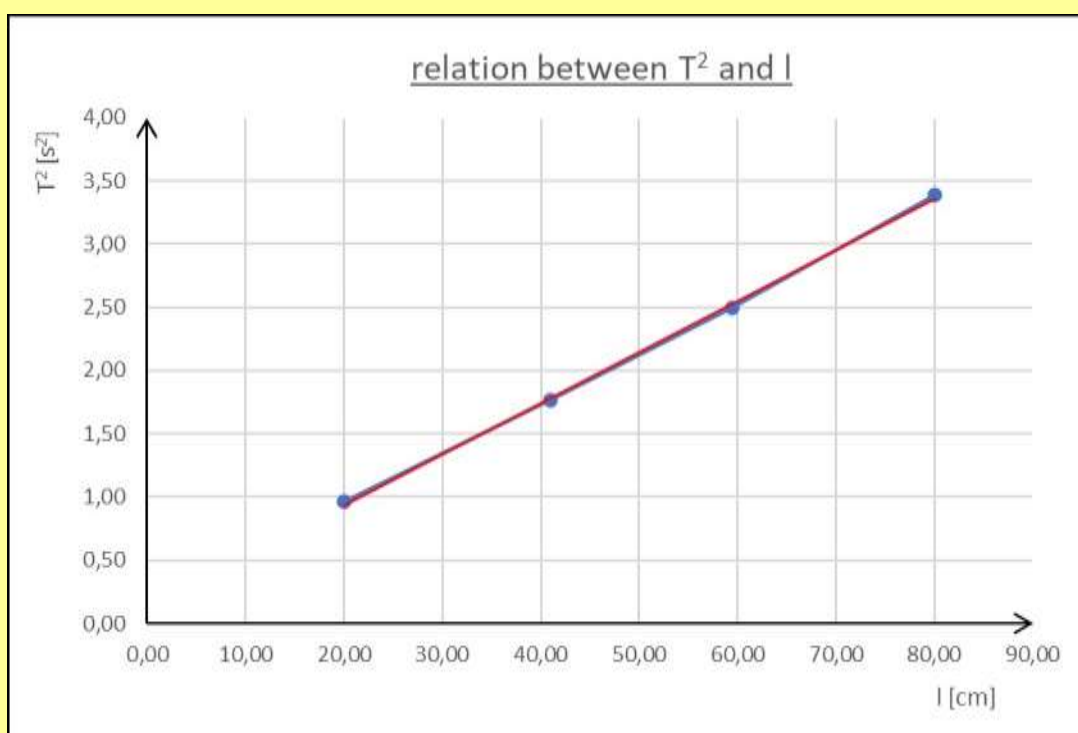
TABLE

	l (cm)	m (number of staples)	T (s)
pendulum 1	80.0 cm \pm 0.1 cm	4	1.84 s \pm 0.01 s
pendulum 2	59.5 cm \pm 0.1 cm	4	1.58 s \pm 0.01 s
pendulum 3	41.0 cm \pm 0.1 cm	4	1.33 s \pm 0.01 s
pendulum 4	20.0 cm \pm 0.1 cm	4	0.98 s \pm 0.01 s

RELATION BETWEEN LENGTH (l) AND SQUARE OF PERIOD (T²)

	l (cm)	m (numero graffette)	T (s)	T ₂ (s ²)	T ² / l (s ² /cm)
Pendolo 1	80,0 ± 0,1	4	1,84 ± 0,01	3,39	0,04
Pendolo 2	59,5 ± 0,1	4	1,58 ± 0,01	2,50	0,04
Pendolo 3	41,0 ± 0,1	4	1,33 ± 0,01	1,77	0,04
Pendolo 4	20,0 ± 0,1	4	0,98 ± 0,01	0,96	0,05

As the length of the pendulum changes, keeping a constant mass, the ratio between T² and l is almost constant.



The data obtained and the graph show that there is a direct proportionality between the length of the pendulum and its squared period.

OBSERVATIONS

The experiment shows that as the length increases, keeping an unchanged mass, the period increases unlike what we saw in the previous experiment in which, keeping the length constant and varying the mass, the period remained constant. So, the period of the pendulum doesn't depend on the mass, but depends on the length of the pendulum.

Elisabetta Giacalone 1^aC

Scientific report



1) Purpose of the experience:

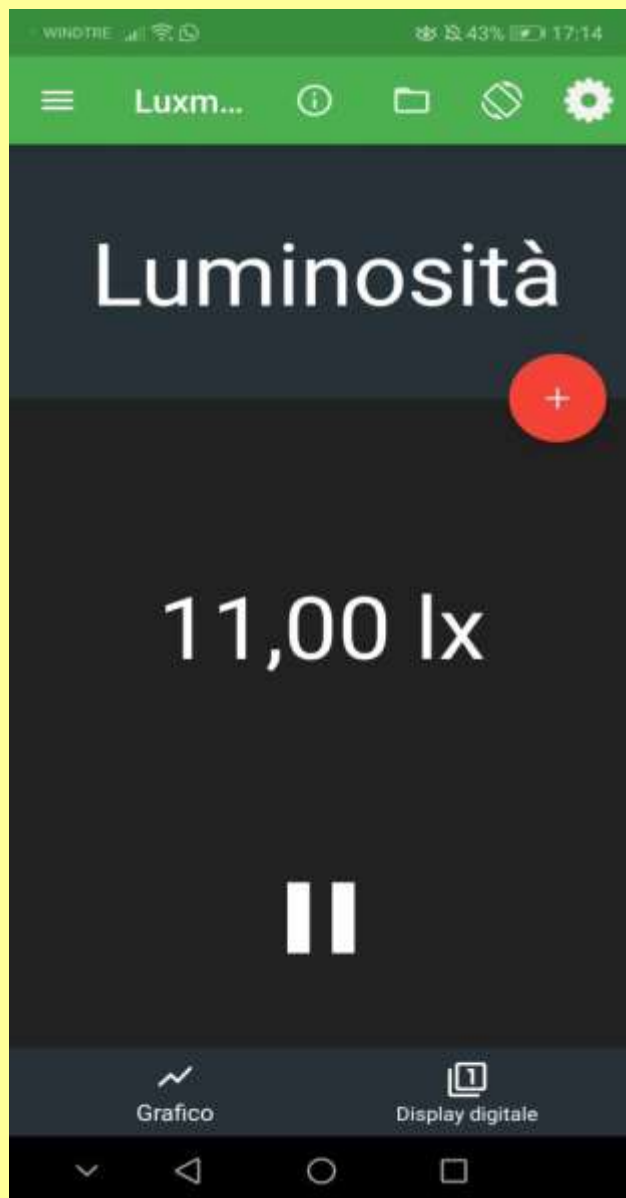
I did this experiment to prove Stefan-Boltzmann's law, which claims that a body, if heated, emits more thermal power, which is emitted as electromagnetic waves and it can be measured by a light meter.

2) Smart tools:

To carry out the experiment, I used a mobile app called "Physics Toolbox", that I used for measure the illuminance of an electric oven at different temperatures.

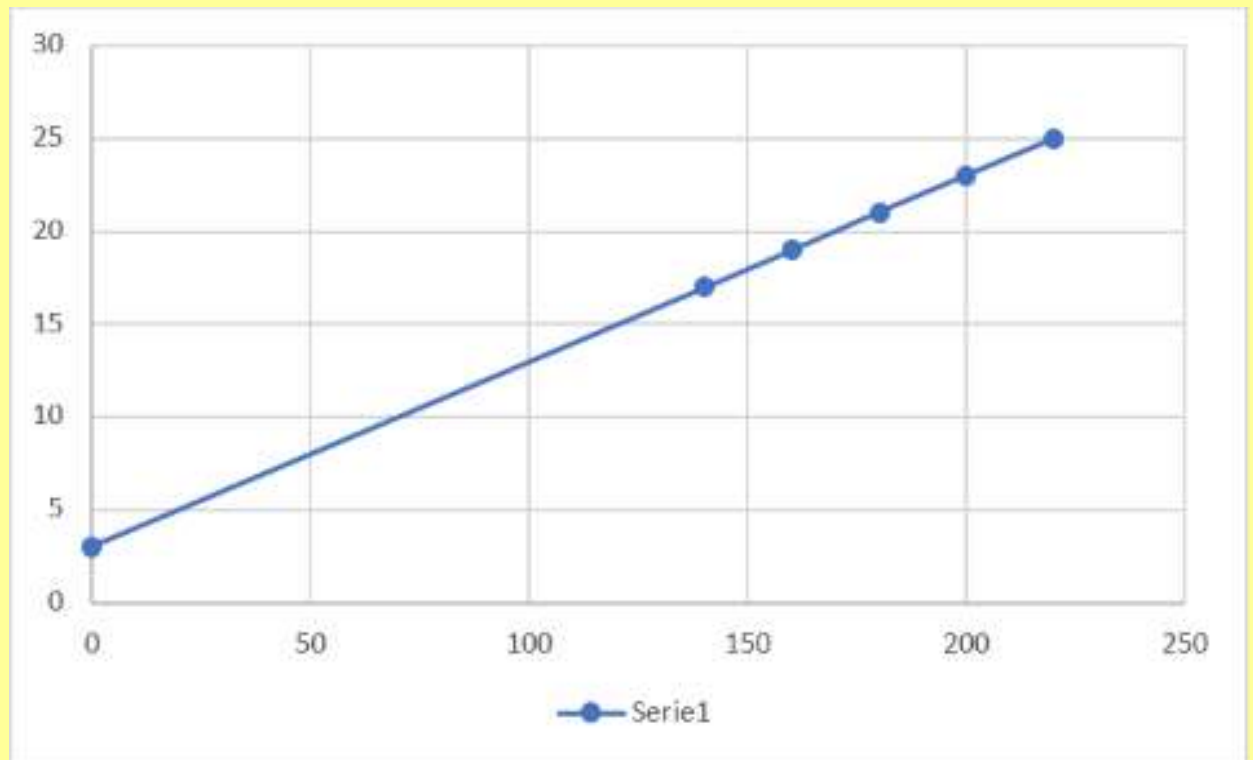
3) Description of the experience:

I opened the Light Meter menu in the app "Physics Toolbox", which measures the illuminance in lux. Then I selected "Digital readout" in the settings. I brought mobile phone's screen close to the turned off electric oven and I wrote the illuminance value. Then I brought the oven to a temperature of 140 °C, 160 °C, 180 °C, 200 °C and 220 °C and I wrote the illuminance value. Then I made a table and I made the graph.



4) Data analysis:

Temperatura	Illuminamento
0 °C	3 lx
140 °C	17 lx
160 °C	19 lx
180 °C	21 lx
200 °C	23 lx
220 °C	25 lx



CONCLUSIONS

I obtained the law :

$$L = 3 + \frac{19 - 17}{20} T$$

$$L = 3 + 0.1 T$$

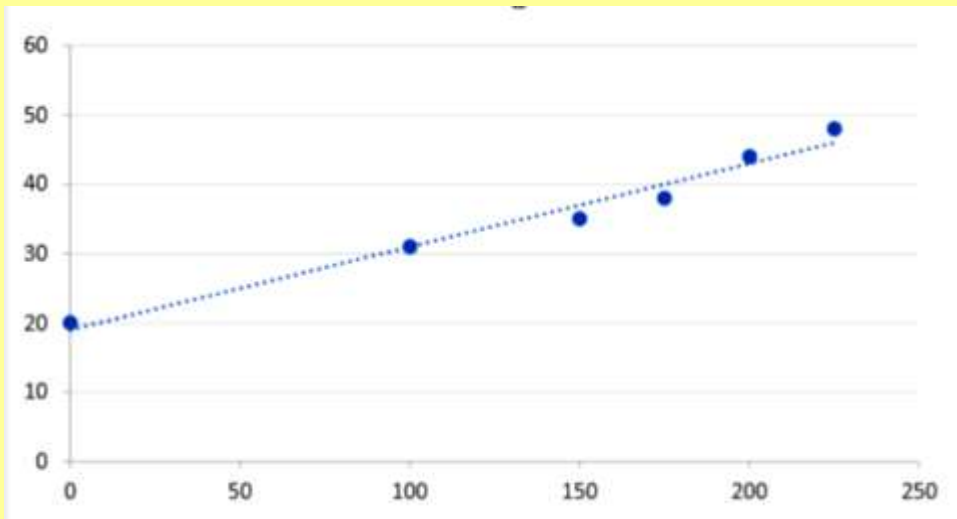
Marco Restivo

2C

Another relationship between temperature and light

I downloaded an application called “Physics toolbox” and I choose the option “luxmeter - digital readout”. Then I started to heat my oven until it reached the first temperature I needed, then I looked at my phone and, after having done it several times changing the oven’s temperature, I made the following table and diagram with these data.

	0	100	150	175	200	225
Temperature (oC)						
Light (lux)	20	31	35	38	44	48



CONCLUSIONS

I obtained a straight line which doesn't pass through the origin of the axes. If I was right, the relationship of temperature and light would be in the form " $L = kT + L_0$ " where:

L is light

k is a constant

T is temperature

L_0 is the original light in the room

Daniele D'Amico

2C

THE MEASURE OF ILLUMINANCE

PURPOSE OF THE EXPERIENCE

The purpose of the experiment is to demonstrate that there is a relation between the light that arrives to an object and the distance of the light source.

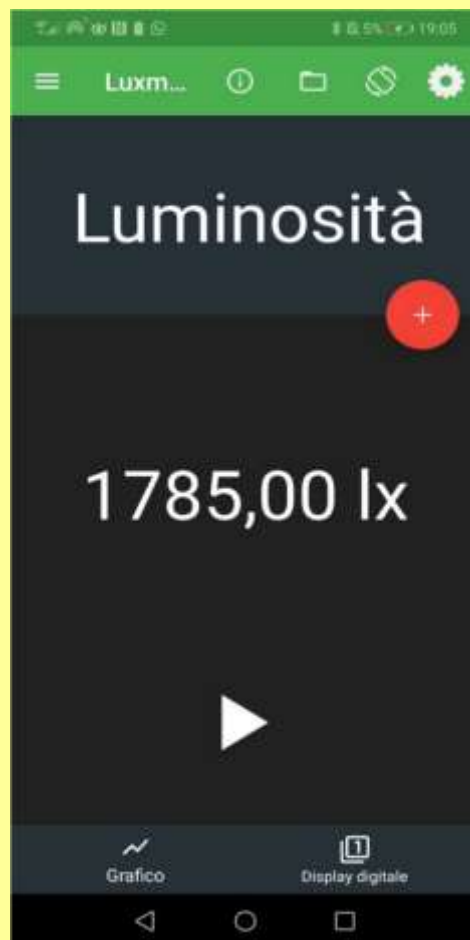
TOOLS AND APPS

For the experience I used the app Phisics Toolbox,a small box,a black paper,a small light,a metre,some scotch tape and Office Excel.

DESCRIPTION OF THE EXPERIENCE

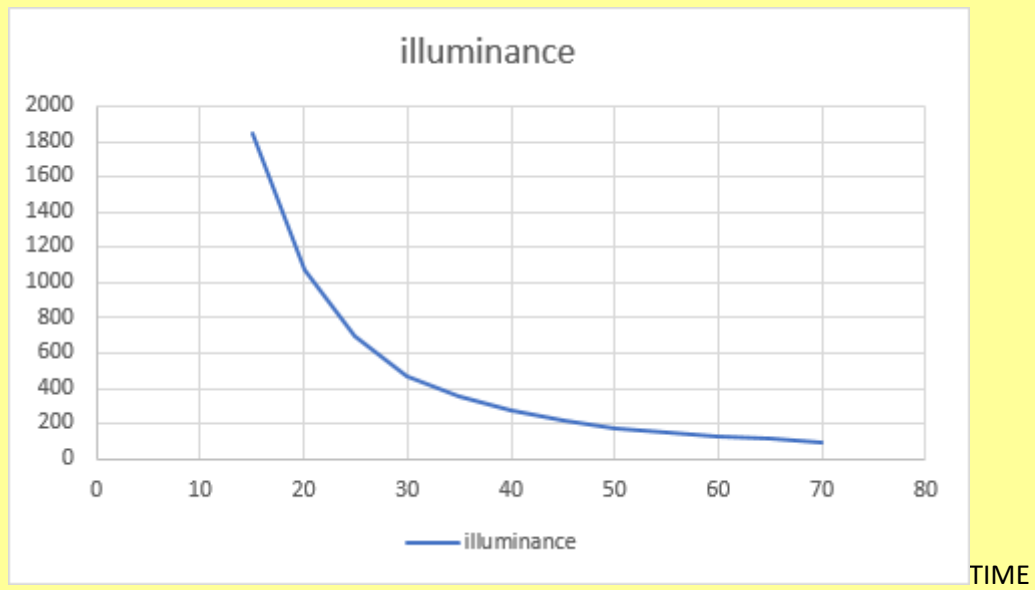
First of all I open the app phisics Toolbox set on the digital luxmetre. Then,I close the windows,I set the light,the black paper and the metre,all covered with the scotch tape.

After I've done various measurements,I've collected all the data in a table. At the end,I settled down a graph with Excel.



DISTANCE FROM THE LIGHT SOURCE (cm)	ILLUMINANCE (lux)	VERIFY (yx2)
15 cm	1844 lux	414900
20 cm	1071 lux	428400
25 cm	692 lux	432500
30 cm	470 lux	423000
35 cm	352 lux	431200
40 cm	277 lux	443200
45 cm	222 lux	449500
50 cm	179 lux	447500
55 cm	146 lux	441650
60 cm	123 lux	442800
65 cm	112 lux	473200
70 cm	96 lux	470400

TABLE WITH DATA ILLUMINANCE



PHOTOS OF THE EXPERIMENT





I used a lamp holder, a phone holder and a ruler to reproduce the apparatus showed in the book. I then set the dark in the room and switched the lamp on. I put the lamp at different distances from the phone (that was the light meter, thanks to the application “Physics toolbox”) and took the lux value on it. With these data I made the following table and graph.

CONCLUSION

According to my data yx^2 isn't constant but increases a little bit time by time, however the line on the graph doesn't only look like an exponential function graph, but it can also be reconducted to a $y=k/x^2$ graph (first quadrant only in both cases).

Assuming that yx^2 is a constant called k , it means that $L=k/D^2$ where L is light and D is distance, both in the SI system (respectively measured in lux and meters).

Alessio Storaci

Daniele D'Amico

2 C

Parabolic Motion

Materials: glass, book and little ball.

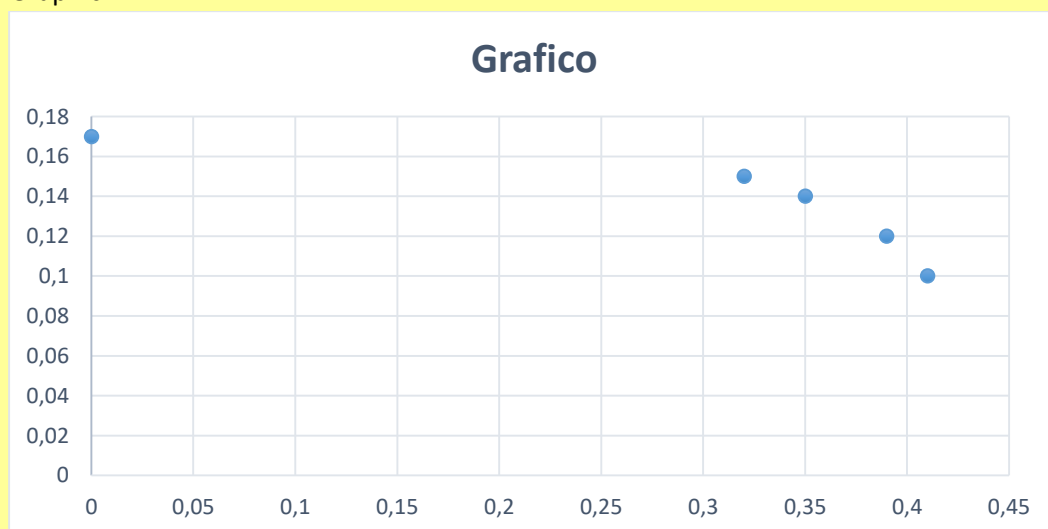
1. Photo



2. Excel

	Posizione iniziale	Misura 1	Misura 2	Misura 3	Misura 4
X	0,00 m	0,32 m	0,35 m	0,39 m	0,41 m
Y	0,17 m	0,15 m	0,14 m	0,12 m	0,10 m

3. Graphic



Davide Catena 2 C