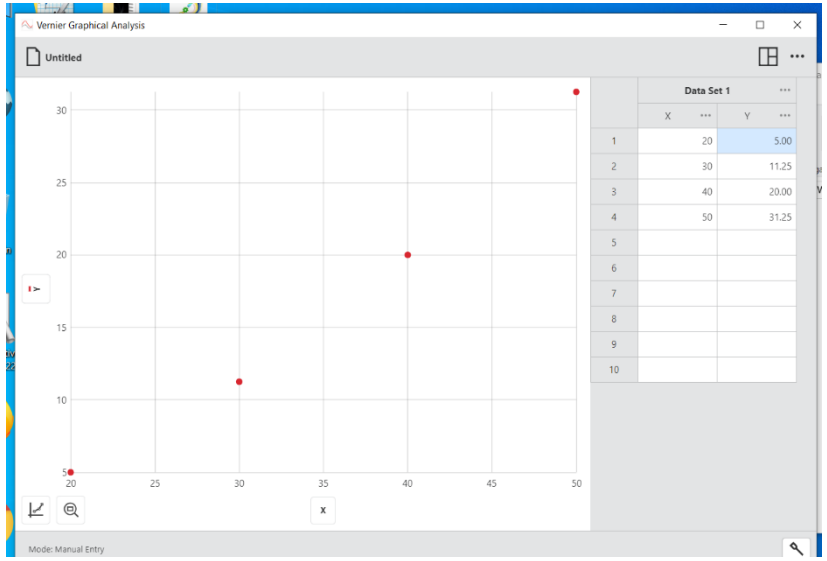
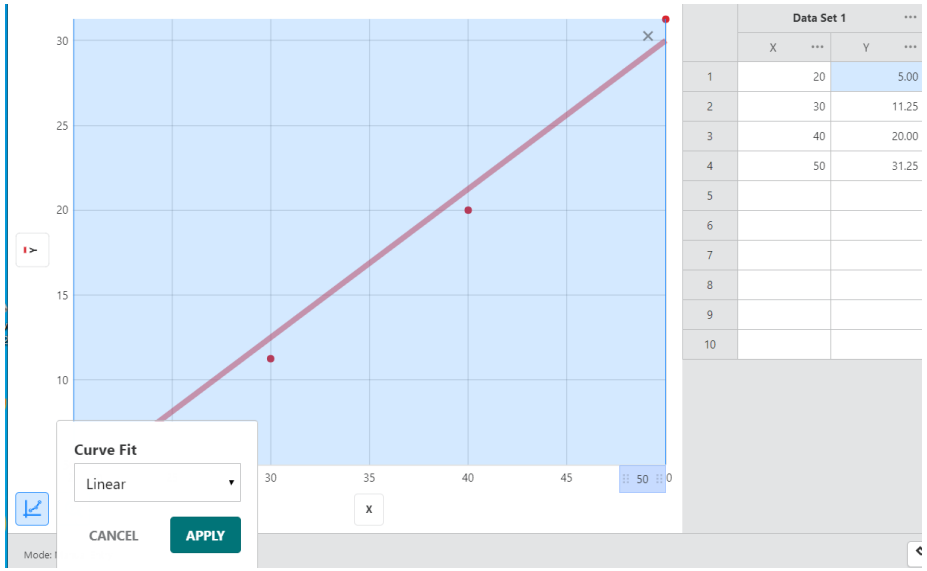
Graphing Straight Lines

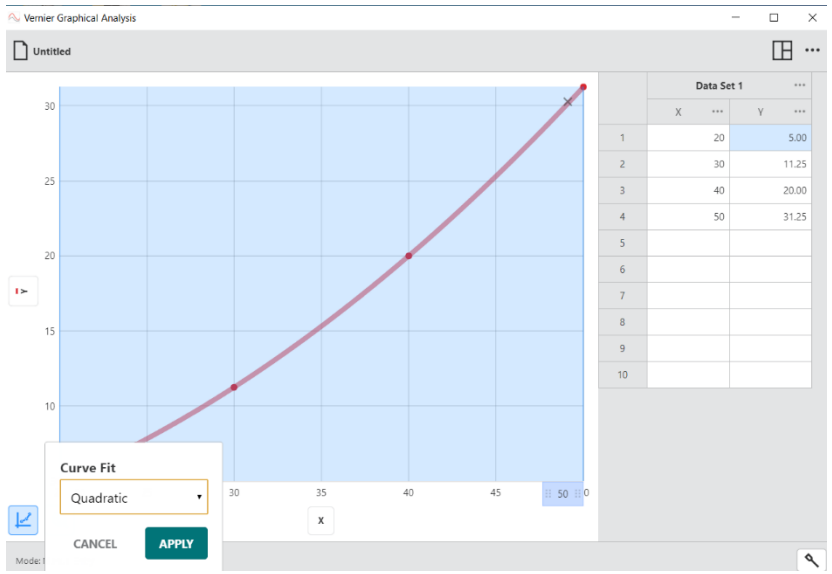
AP Physics

Graphing Software

- TI N-spire (Hopefully you remember from last year)
- Vernier Graphical Analysis -4 (See Link on Notes page)



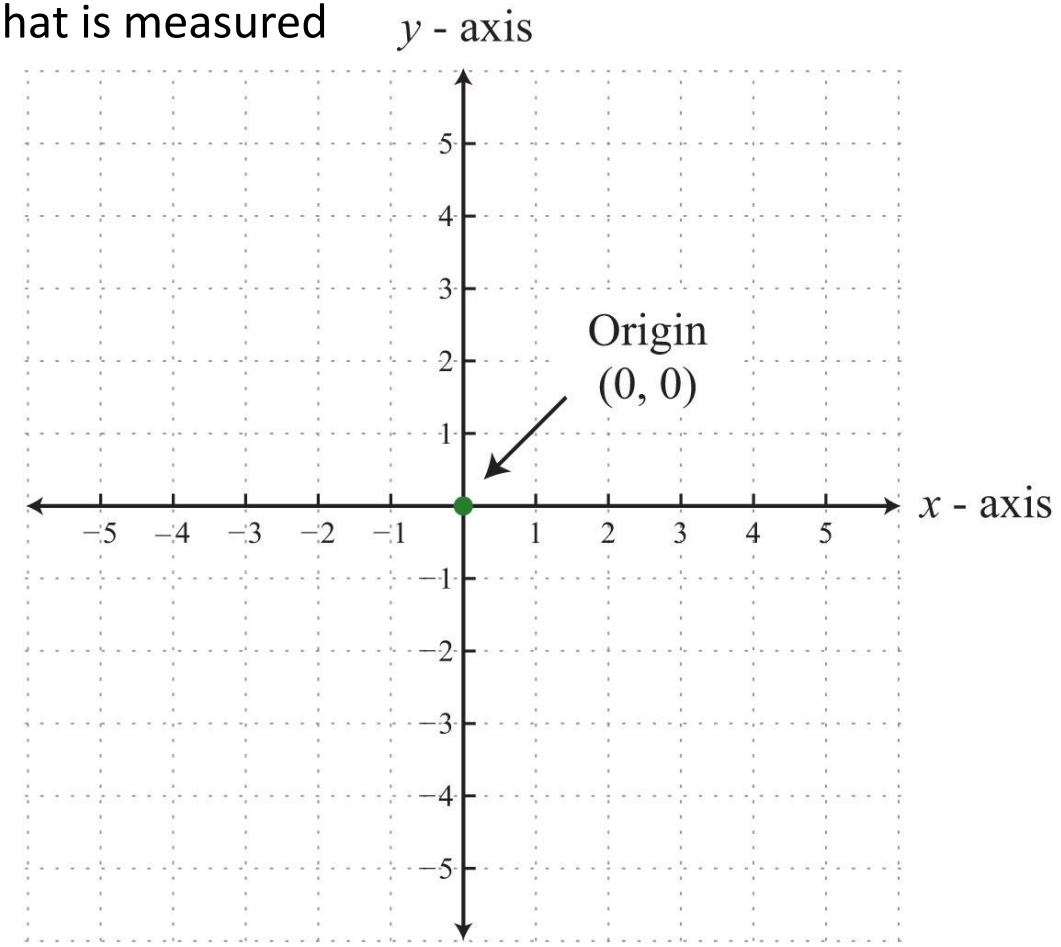




GRAPHING RELATIONSHIPS

Y – axis

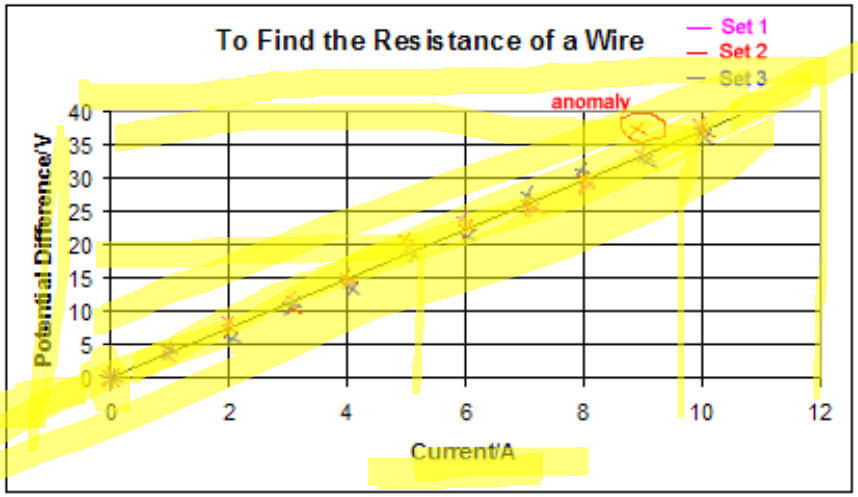
- Dependent Variable
  - What is measured

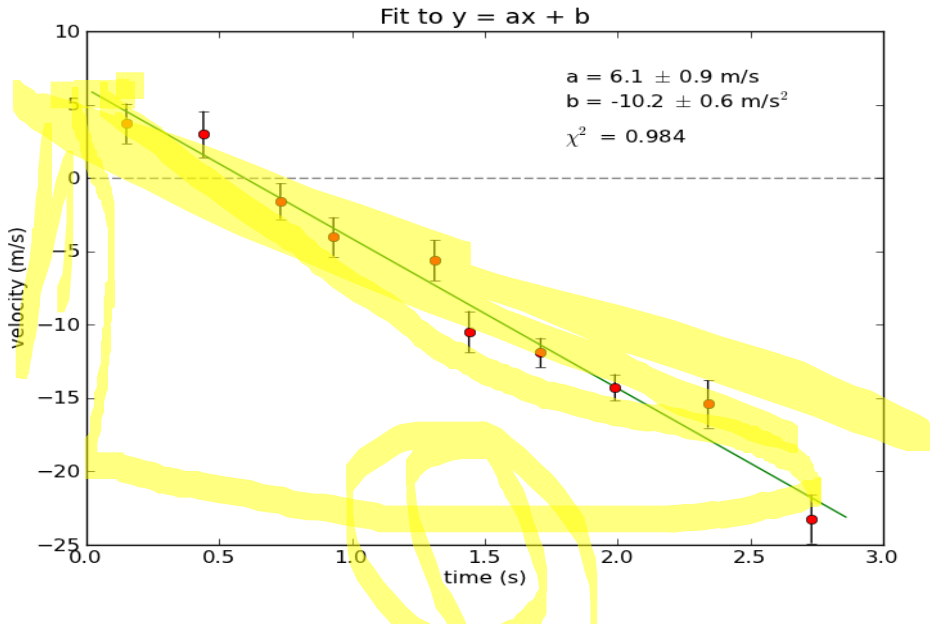


X – axis

- Independent Variable
- Predetermined

Types of Relationships: **Direct Relationship**





- Straight Line
- Δy constant as x changes
- EASY TO MAKE PREDICTIONS

- $y = mx + b$
- m = slope = $\frac{\Delta y}{\Delta x}$
- b = y-intercept = starting point

Describing Relationship

- Y is DIRECTLY related to X

Direct Relationship: Example

The current (I) in a simple circuits is increased in 2 Amp increments.
The potential difference (V) across a resistor measured (Volts)
This Data is used to determine the Resistance.

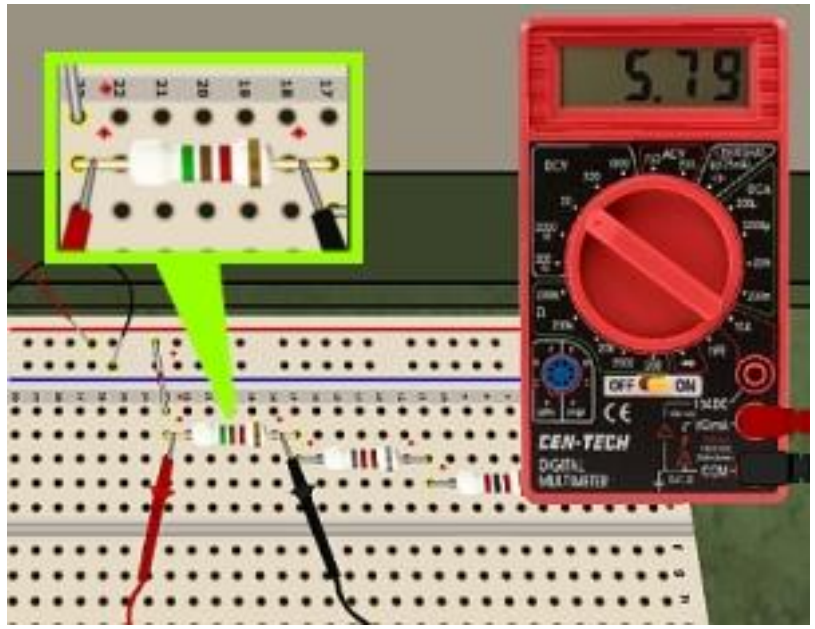
Independent Variable? I

Dependent Variable? V

$m = \frac{V}{I} = \frac{1}{S}$

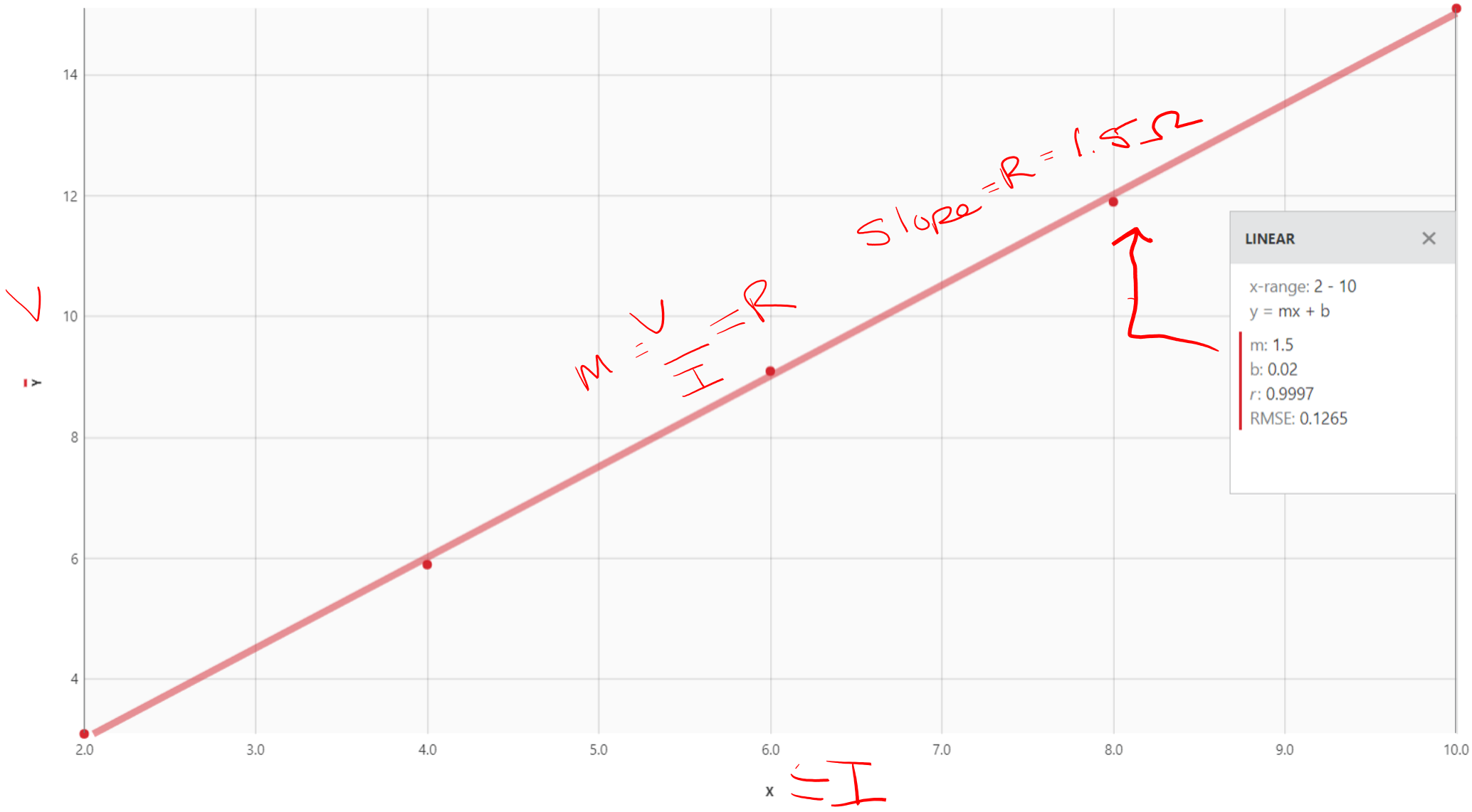
$V = IR$

$\frac{V}{I} = R$



CURRENT (amps):	POTENTIAL DIFFERENCE (volts)
2	3.1
4	5.9
6	9.1
8	11.9
10	15.1

Analyze w/
Vernier Software


14
12
10
8
6
4
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
y
x
V
I
m = V/I = R
Slope = R = 1.5Ω
LINEAR
x-range: 2 - 10
y = mx + b
m: 1.5
b: 0.02
r: 0.9997
RMSE: 0.1265

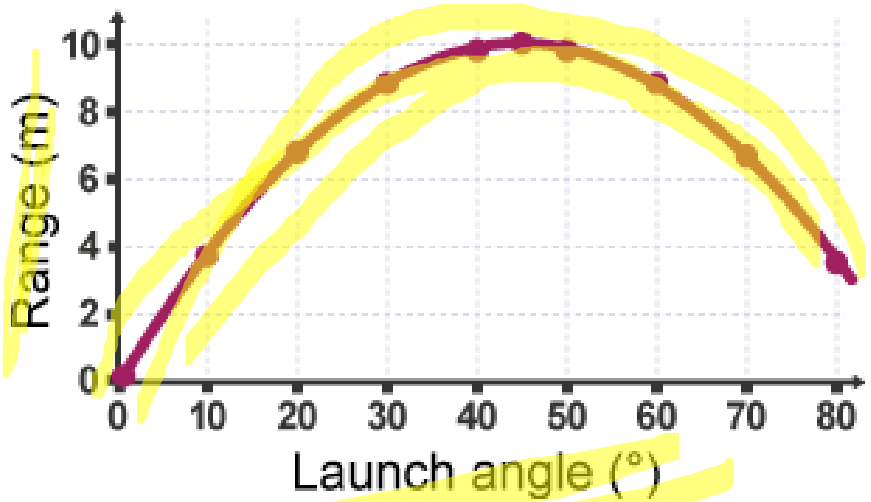
Types of Relationships: Exponential Relationship

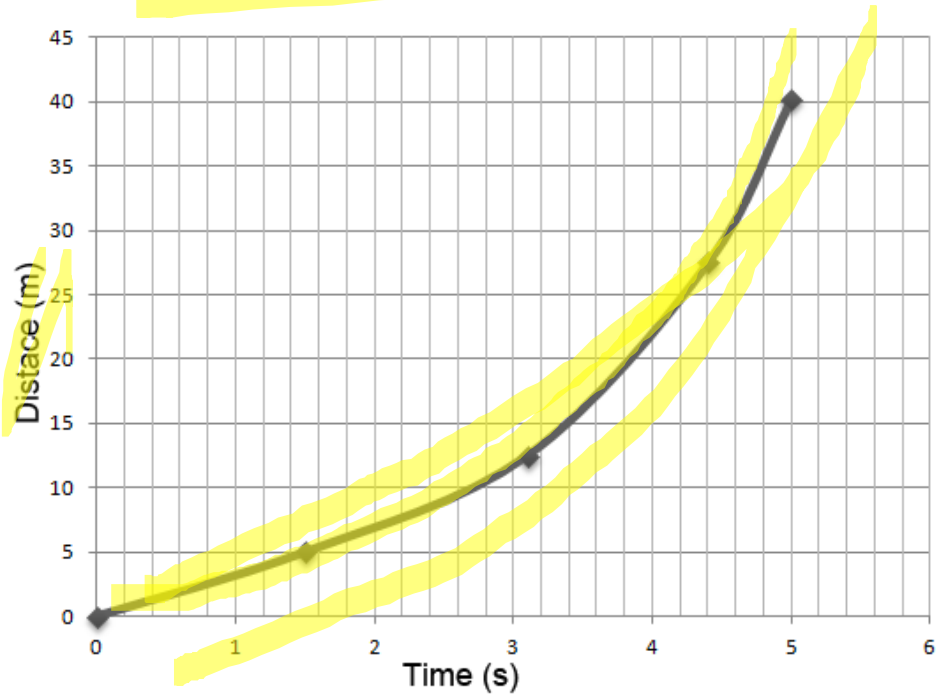
- Parabola
- Δy will increase and decrease as x changes.

- $y = Ax^2 + Bx + C$

How to describe relationship:

- y exponentially related to x
- y directly related to x^2





GRAPHING RELATIONSHIPS

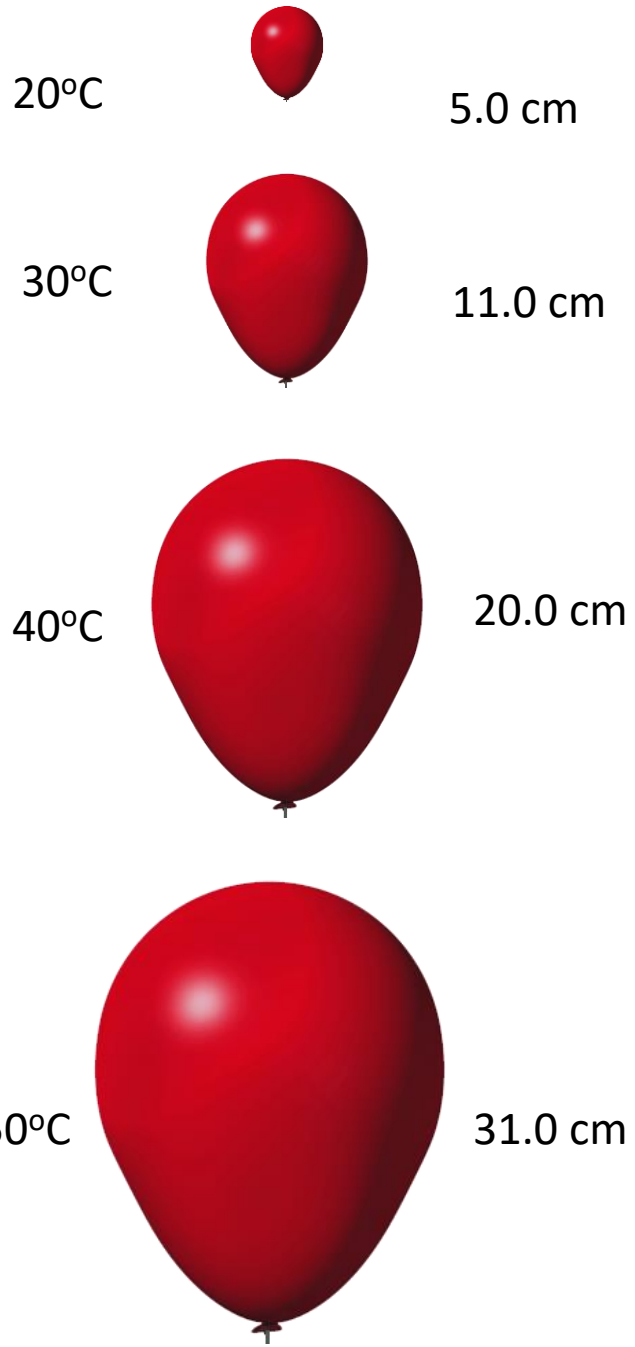
Lab Example:

The temperature of a balloon is increased from 20°C in 10 degree increments.

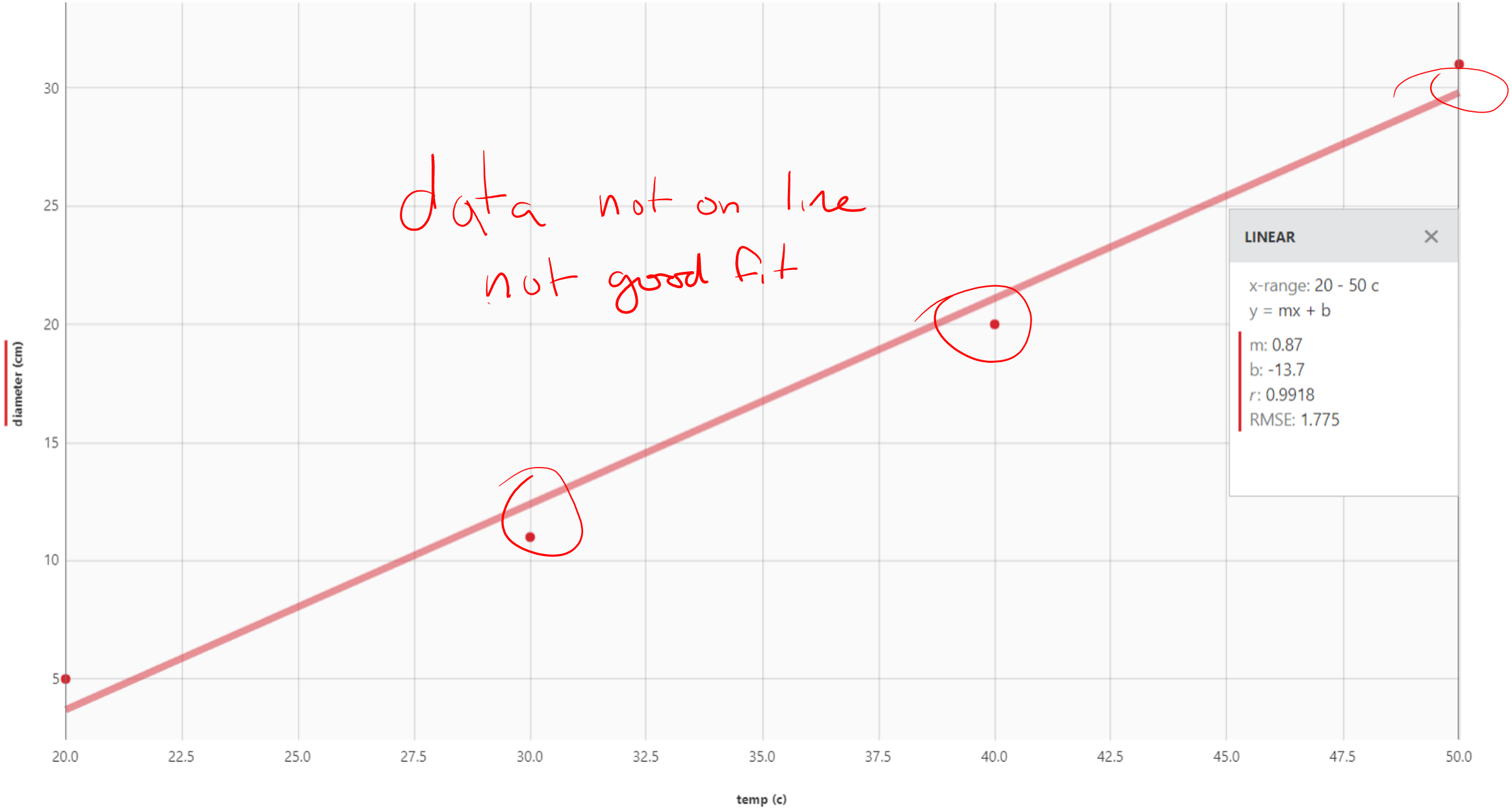
The diameter of the balloon is measured and recorded as the temperature increases.

Independent Variable:
Temperature

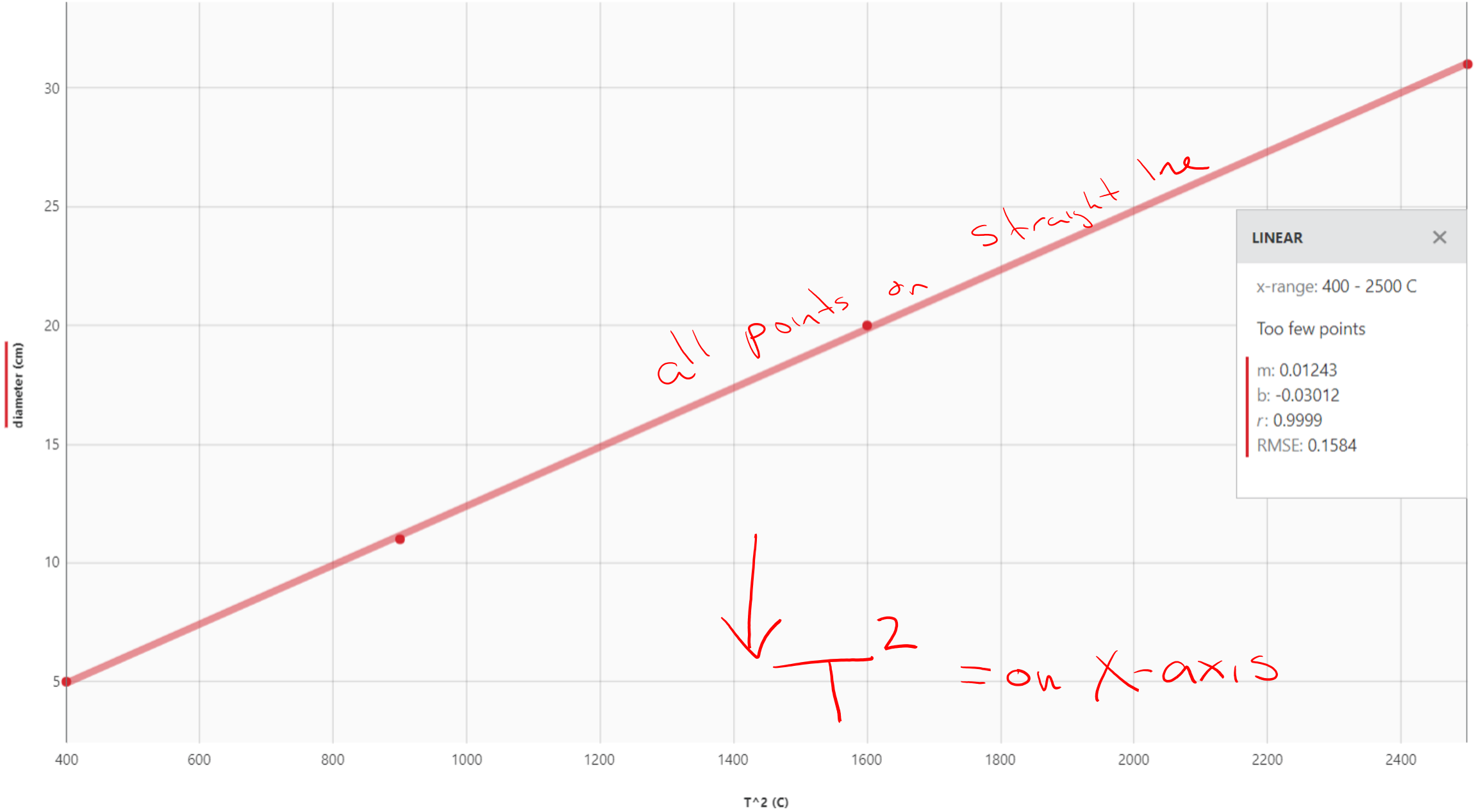
Dependent Variable:
Diameter



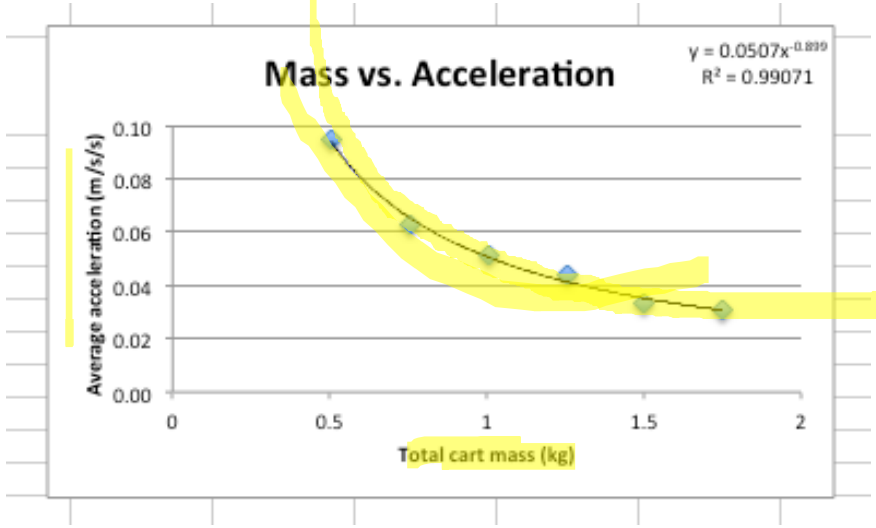
Analyze w/
Vernier Software

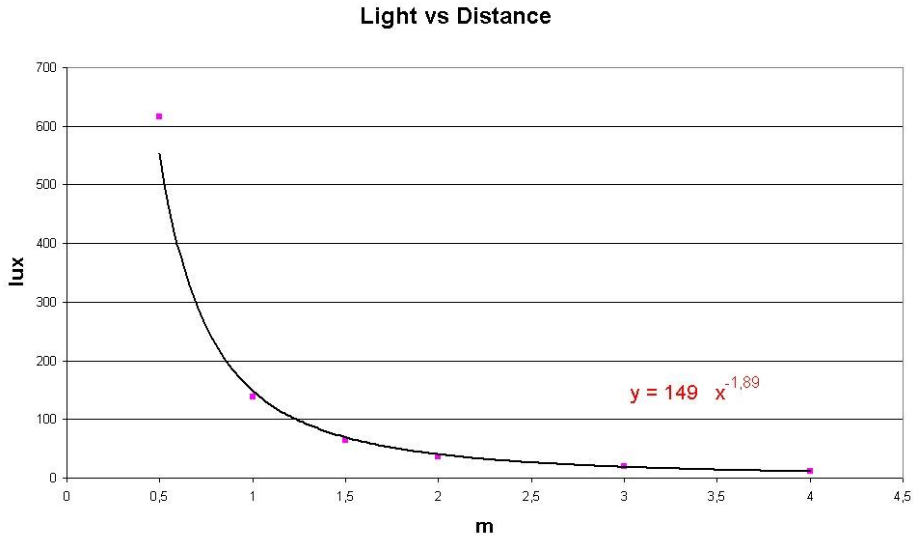

data not on line
not good fit
LINEAR
x-range: 20 - 50 c
y = mx + b
m: 0.87
b: -13.7
r: 0.9918
RMSE: 1.775
diameter (cm)
temp (c)
30
25
20
15
10
5
20.0
22.5
25.0
27.5
30.0
32.5
35.0
37.5
40.0
42.5
45.0
47.5
50.0


all data on curve
good fit
QUADRATIC
x-range: 20 - 50 c
y = ax2 + bx + c
a: 0.0125
b: -0.005
c: 0.05
RMSE: 0.1118
diameter (cm)
temp (c)
30
25
20
15
10
5
20.0
22.5
25.0
27.5
30.0
32.5
35.0
37.5
40.0
42.5
45.0
47.5
50.0


diameter (cm)
30
25
20
15
10
5
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
T^2 (C)
LINEAR
x-range: 400 - 2500 C
Too few points
m: 0.01243
b: -0.03012
r: 0.9999
RMSE: 0.1584
all points on straight line
T^2 = on X-axis

Types of Relationships: **Inverse Relationship**



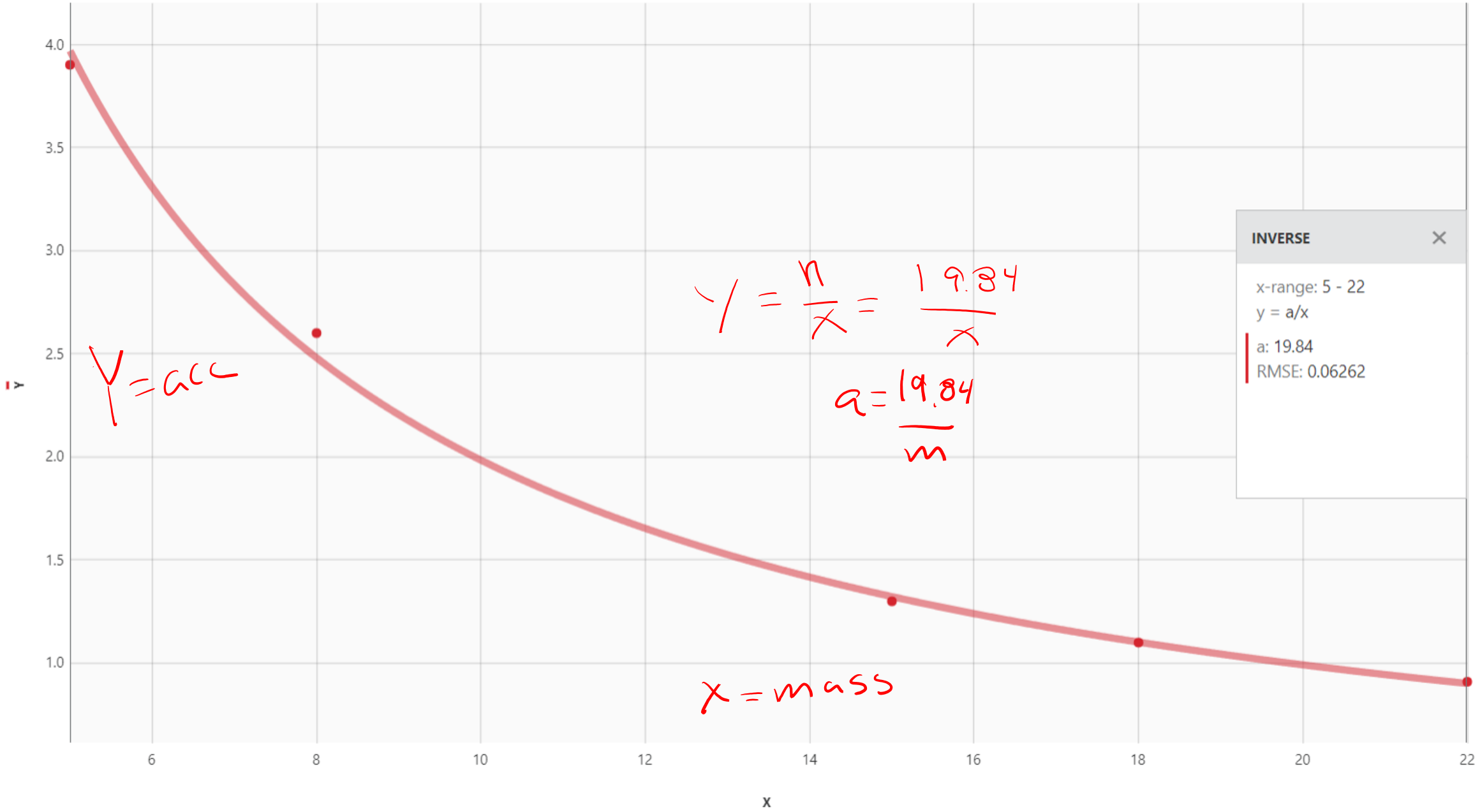


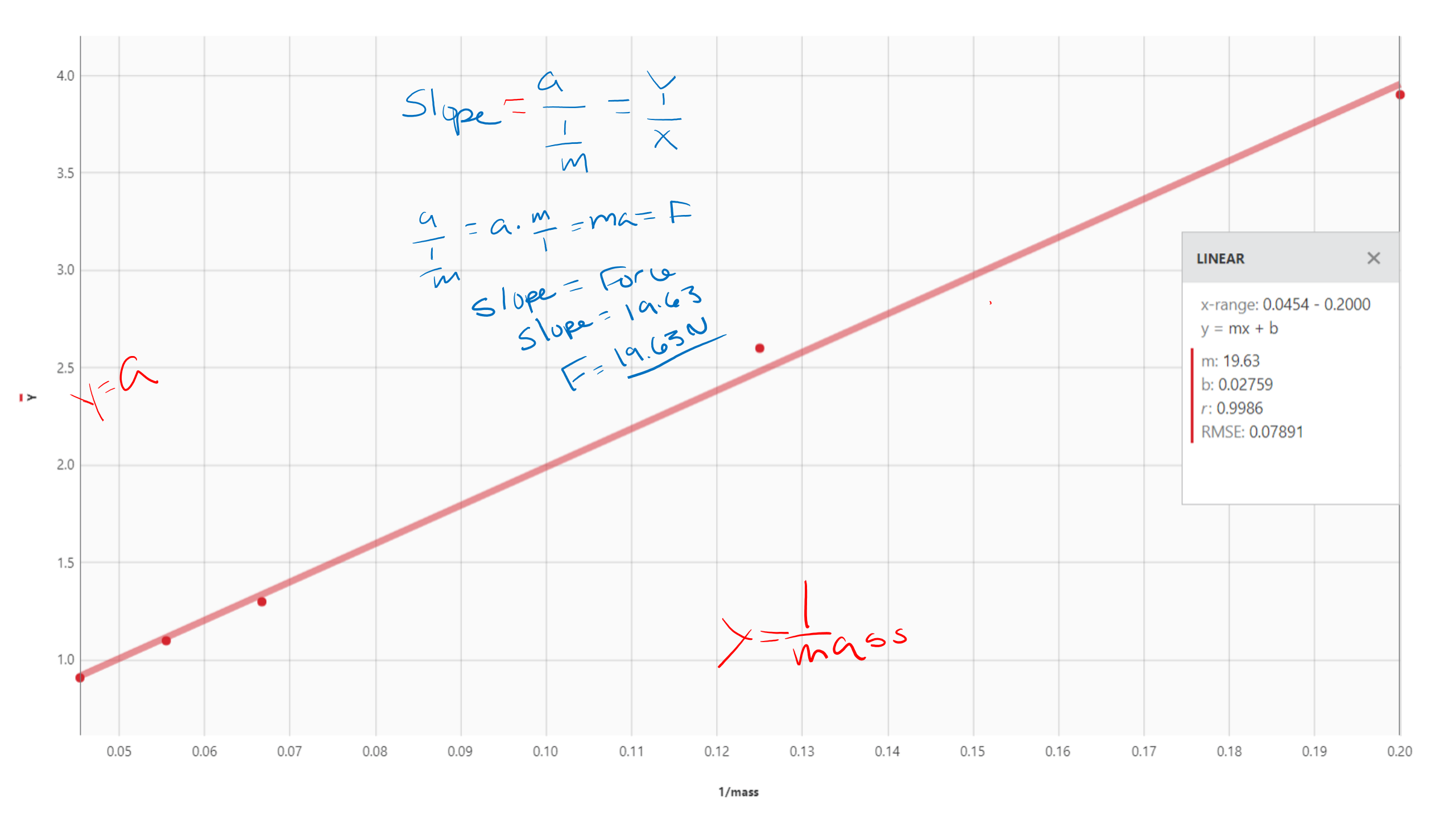
- Hyperbola
- Δy will decrease as x changes.
- Never reaches zero

- $y = \frac{n}{x}$ $= n x^{-1}$

- y inversely related to x
- y directly related to the inverse of x

$y = \frac{149}{x^2}$


4.0
3.5
3.0
2.5
2.0
1.5
1.0
y
6
8
10
12
14
16
18
20
22
x
INVERSE
x-range: 5 - 22
y = a/x
a: 19.84
RMSE: 0.06262
Y = acc
y = n/x = 19.84/x
a = 19.84/m
x = mass


Slope = a/(1/m) = Y/X
a/(1/m) = a · m/1 = ma = F
slope = Force
slope = 19.63
F = 19.63N
Y = a
Y = 1/mass
LINEAR
x-range: 0.0454 - 0.2000
y = mx + b
m: 19.63
b: 0.02759
r: 0.9986
RMSE: 0.07891
Y
1/mass
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.05
0.06
0.07
0.08
0.09
0.10
0.11
0.12
0.13
0.14
0.15
0.16
0.17
0.18
0.19
0.20

Inverse Relationship:

The acceleration of a cart is measured when the mass is added to a cart pulled along a frictionless track.

Use the data below to determine the Force on the cart.

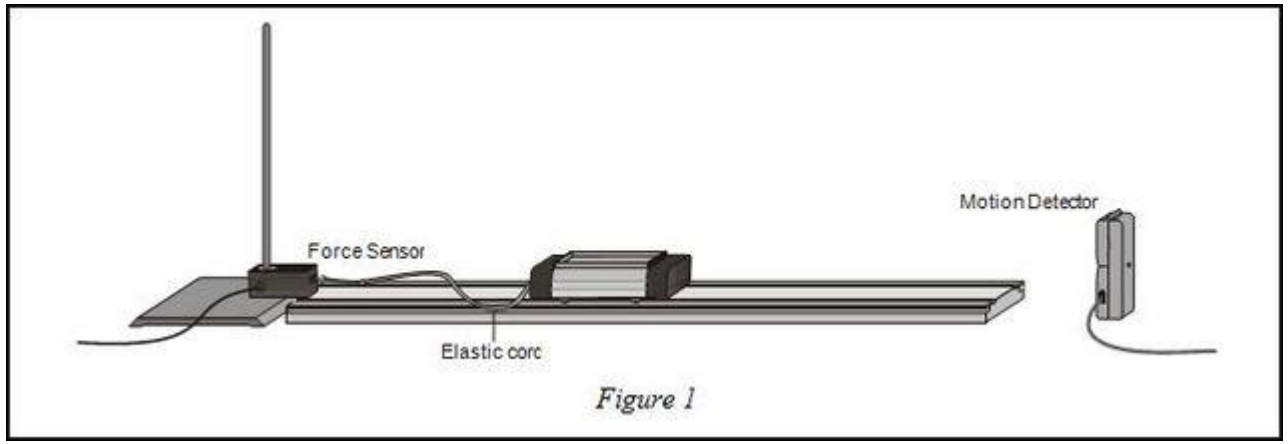
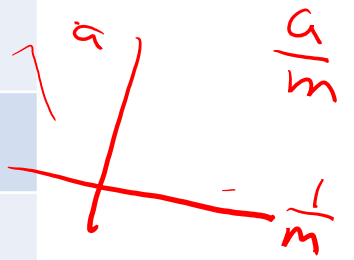


Figure 1

mass (kg): X	Acceleration (m/s²) Y
5	3.9
8	2.6
15	1.3
18	1.1
22	0.91

Analyze w/ Vernier Software



$F = ma$

$\text{slope} = \frac{a}{\frac{1}{m}} = am = ma = F$

$F = 19.63N$

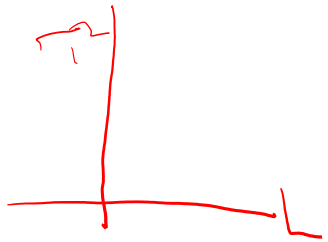
The period of a pendulum is can be found with the following equation:

$$T = 2\pi\sqrt{\frac{L}{g}}$$

Solve equation for g:

$$g = 4\pi^2\frac{L}{T^2}$$

Use the data given and the equation to graph a straight line, and use the slope of the line to determine the acceleration of gravity:



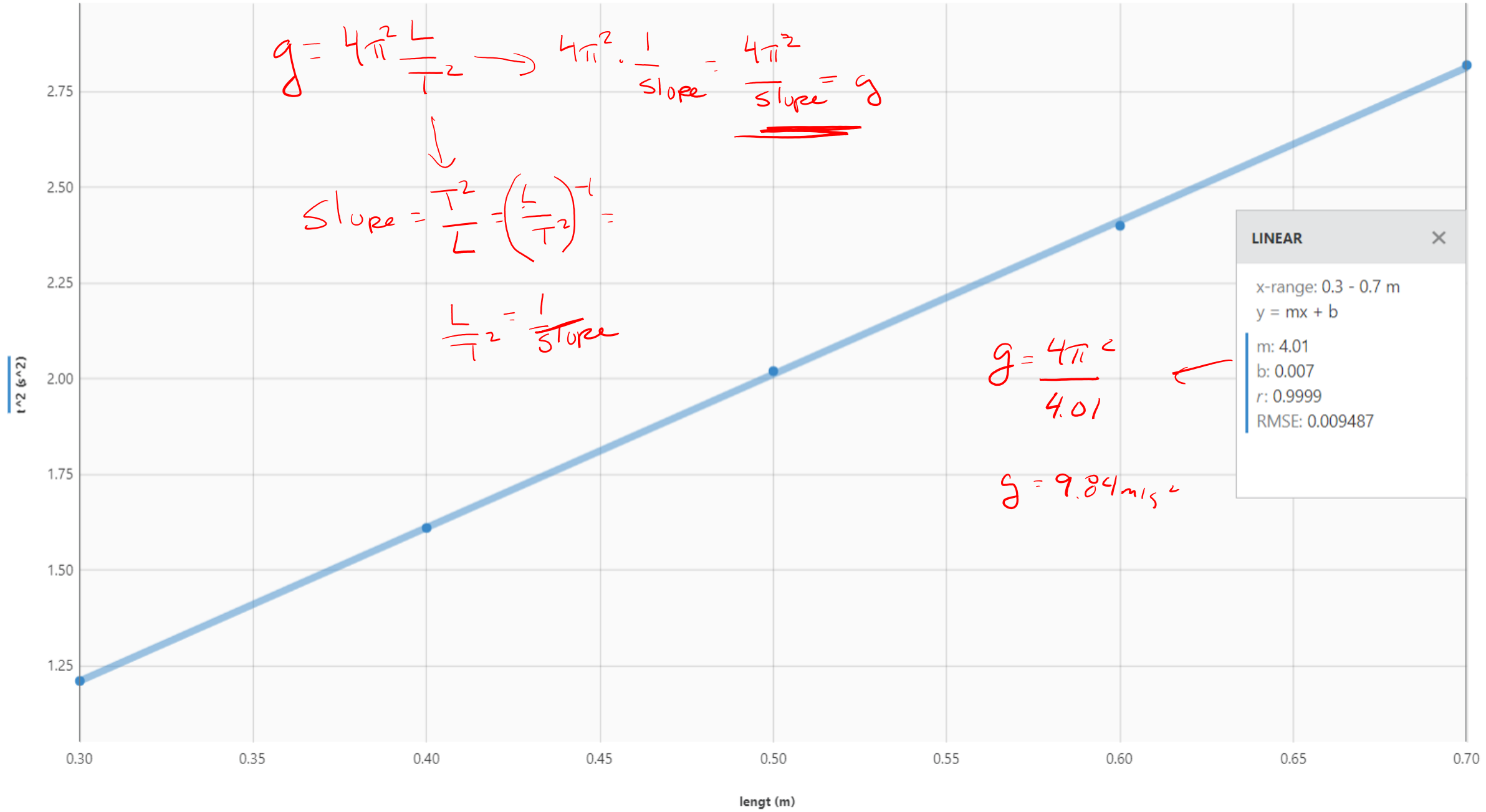
Length (m)	Period (s)	T^2
0.3	1.10	
.4	1.27	
.5	1.42	
.6	1.55	
.7	1.68	

L is independent variable
(x-axis)

Period / Period squared id dependent variable.
(Y-axis)

Slope of straight line is $\frac{T^2}{L}$

$$g = 4\pi^2\frac{L}{T^2} \qquad g = 4\pi^2\frac{1}{slope} \qquad g = \frac{4\pi^2}{Slope}$$


t^2 (s^2)
2.75
2.50
2.25
2.00
1.75
1.50
1.25
0.30
0.35
0.40
0.45
0.50
0.55
0.60
0.65
0.70
lengt (m)
LINEAR
x-range: 0.3 - 0.7 m
y = mx + b
m: 4.01
b: 0.007
r: 0.9999
RMSE: 0.009487
$g = \frac{4\pi^2 L}{T^2} \rightarrow 4\pi^2 \cdot \frac{1}{\text{slope}} = \frac{4\pi^2}{\text{slope}} = g$
$\text{slope} = \frac{T^2}{L} = \left(\frac{L}{T^2}\right)^{-1} =$
$\frac{L}{T^2} = \frac{1}{\text{slope}}$
$g = \frac{4\pi^2}{4.01}$
$g = 9.84 \, m/s^2$