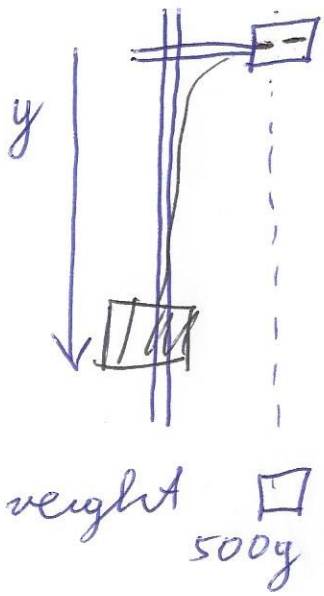
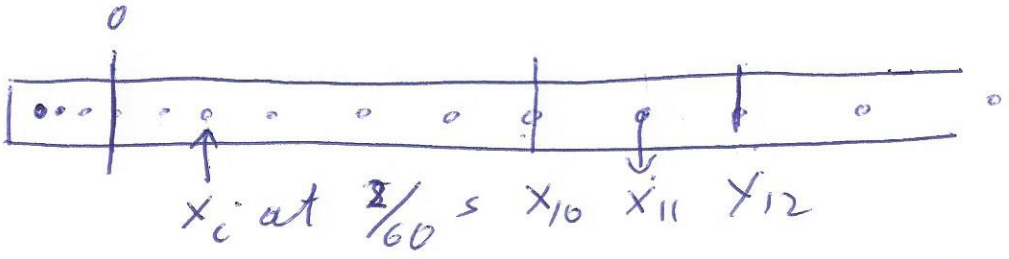
Lab 2: Freefall

Freefall acceleration $g = 9.80 \frac{m}{s^2}$



← Sparktimer, creates a spark every $1/60$ s. We allow a tape to fall through the sparktimer and create a dot every $1/60$ s.



We want to verify the kinematic formulas

$$y(t) = \frac{1}{2} g t^2 + v_0 t + 0$$

$$v_y = g \cdot t + v_0$$

$$v_y^2 = v_{0y}^2 + 2 g y$$

} linear

$$v(t = 11/60) = \frac{x_{12} - x_{10}}{2/60\ s} = (x_{12} - x_{10}) \cdot 30$$

Each student must have his/her tape.

Create a column in Excel for the time:

t	y	v	
0	0		
1/60	1		
2/60	2.5		
	3.9		
	5.8		
	7.9		
20/60			

Prove that $v(t) = \dfrac{x(t+\Delta t) - x(t-\Delta t)}{2\Delta t} \overset{?}{=} at + v_0$

You can use the kinematic formulas to prove this.

$$x(t+\Delta t) = \frac{1}{2} a (t+\Delta t)^2 + v_0 \cdot (t+\Delta t)$$

To calculate $v(t)$ in Excel you do the following

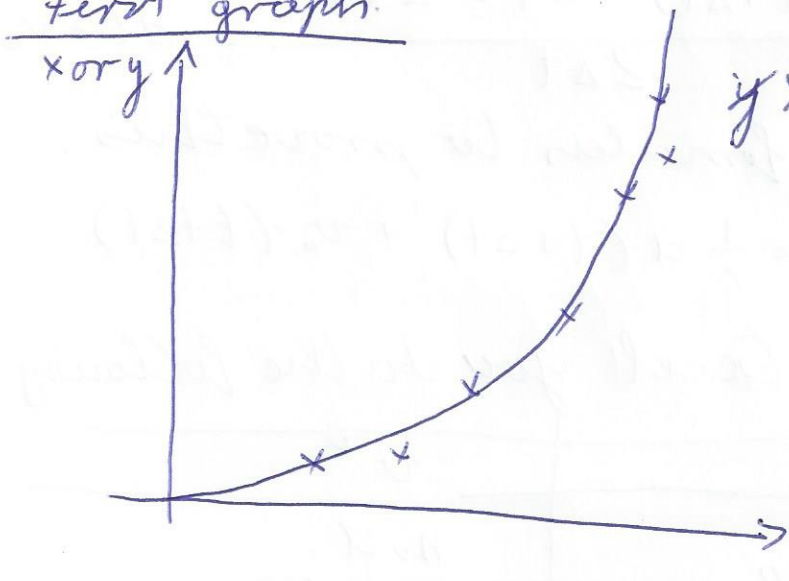
	A	B	C	
	t	X	v	v^2
1	0	0	n.a.	#n.a.
2	1/60	1	=(B3-B1)*30	=C2^2
3		2.5	copy this formula	
4		3.9	to the second to last	
5		5.8	x value	
6		7.9		
		18.3		
		21.2	n.a.	n.a.

Print out formulas for each column!!!

Use these data to create three graphs:

A) x versus t; put quadratic (polynomial order 2) trendline on the graph. Put equation on graph and R^2.

First graph



v_0

4.9 meters.

$y\,x = \cancel{18.753}\,t^2 + (5)t + \ldots$

or $\cancel{1875}\,t^2 + \ldots$

490 if you use cm !

$x = \left(\frac{1}{2}g\right)t^2 + v_0 t$

$y = 483x^2 + 15x + \ldots$

You can use v_0 from the equation & in the Excel calculation for v_0.

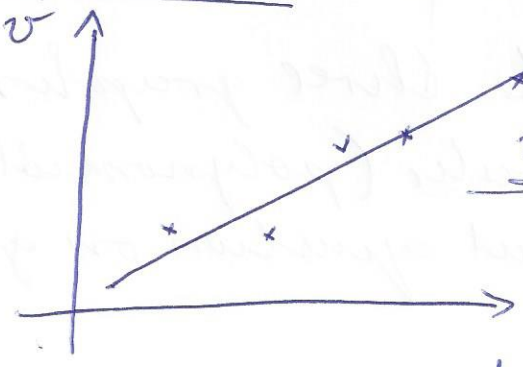
Find the percent error between your value of g and the ~~except~~ accepted value

$$\frac{980 - g'}{980} \cdot 100\%$$

if less than 0.5% you get 1 extra point

" 1% " 1/2 " "

2nd graph: v versus t



Equation and R^2 ?

$v = 979.35\,t + \ldots$

g'

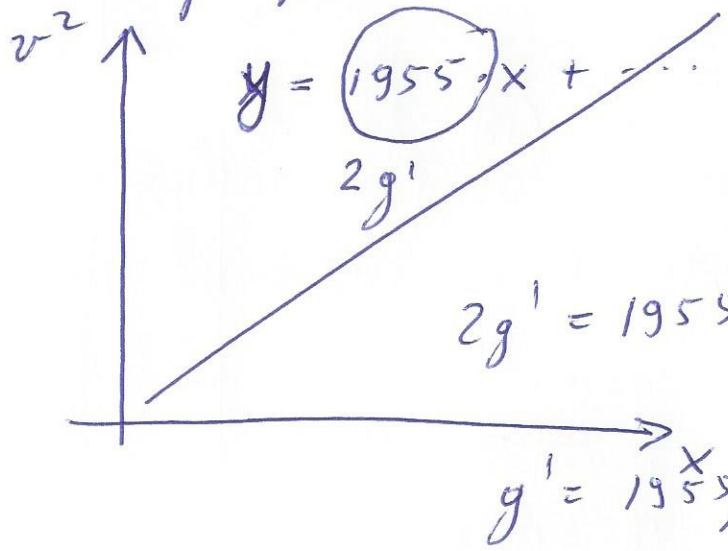
percent error: $\left|\frac{g - g'}{g}\right| \cdot 100\%$

$g = 980$

Graph 3 : v^2 versus x

Pay attention : your independent variable is x, not t.

Linear trendline : Put equation and R^2 on the graph.



$v^2 = v_0^2 + 2 \cdot g' \cdot x$

Percent error : 1/2 point, 1 point