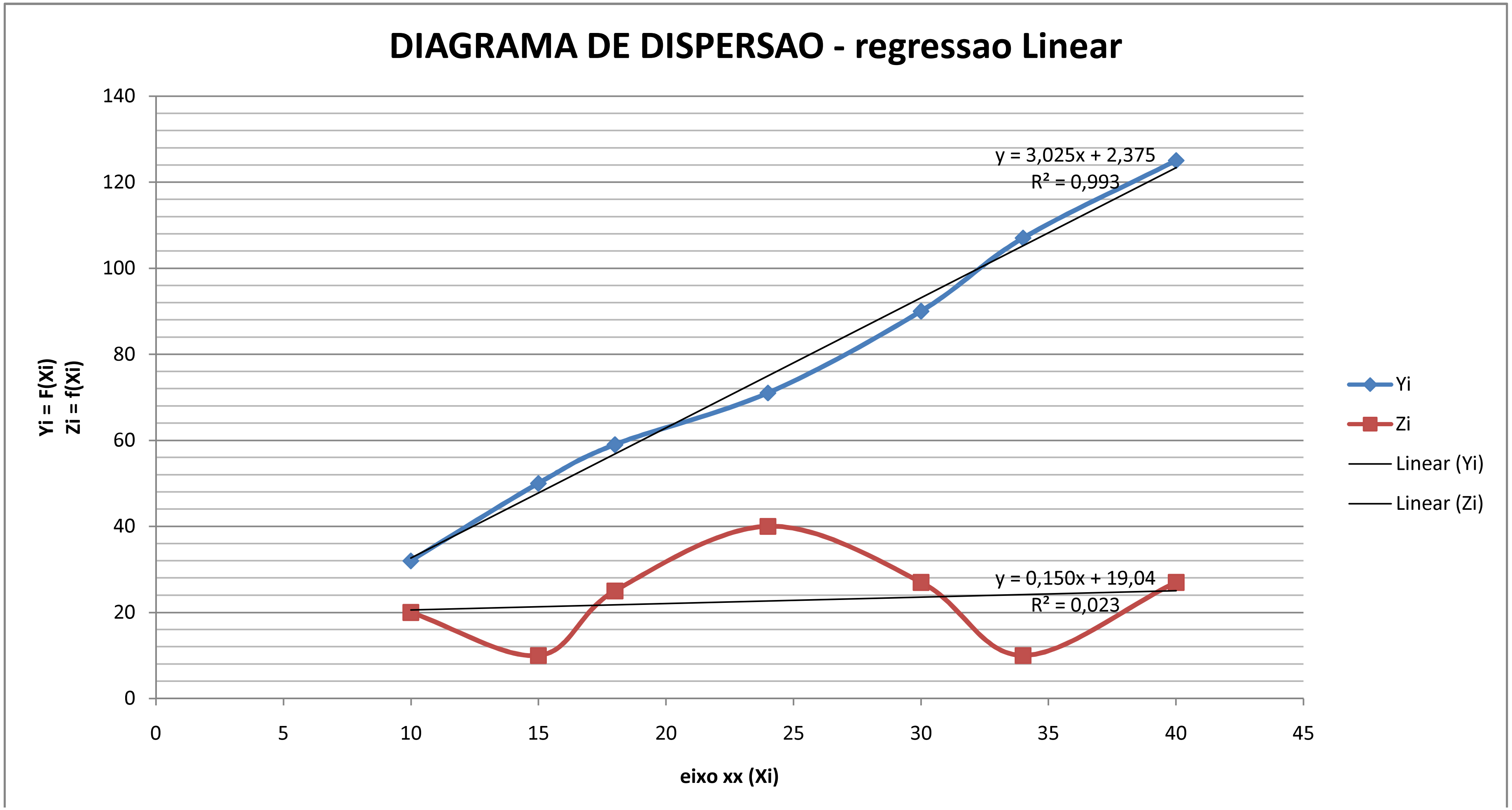
	INPUT DATA
	FORMULA

Xi	Yi	Zi
10	32	20
15	50	10
18	59	25
24	71	40
30	90	27
34	107	10
40	125	27



(green)	INPUT DATA
(yellow)	FORMULA
(light green)	CONSTANTS
(black)	TITLE

TUBO DE THOMSON

q (carga electrica: C)	campo E (: V/m)	massa (electrao: Kg)
-1,602E-19	-1,000E+00	9,110E-31
constante		constante

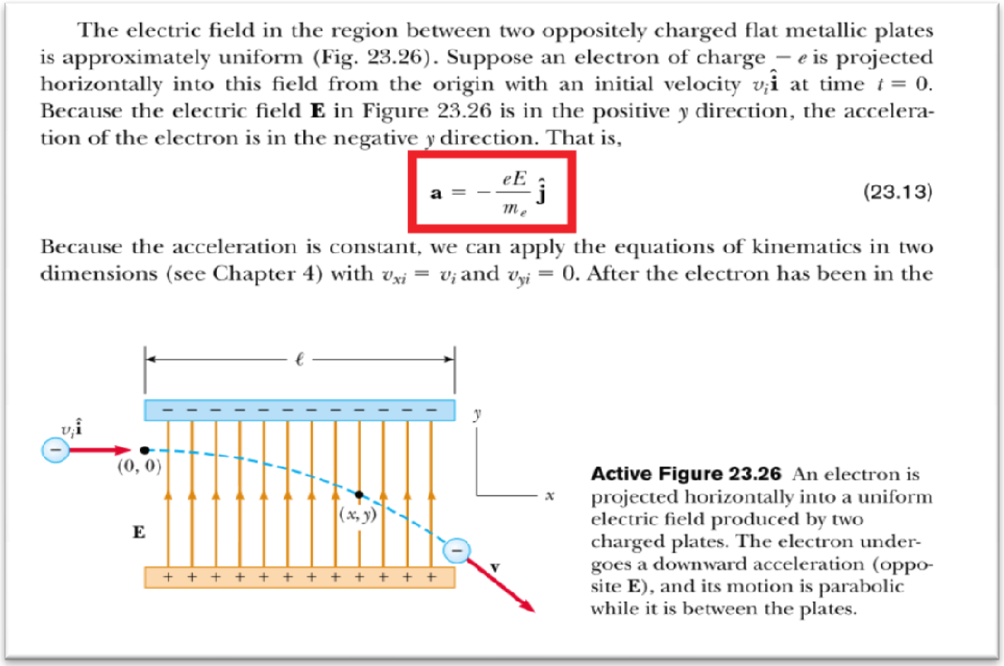
x = d	x0	v0x	t	ax
5	0	2	desaparece	0
y = h	**y0**	**v0y**	**t**	**ay**
2	0	0	desaparece	1,759E+11

Sabendo: q, m, E, d, v0x

h (altura)	5,496E+11

Sabendo: q, m, E, h, v0x

d (distancia)	9,538E-06



The electric field in the region between two oppositely charged flat metallic plates is approximately uniform (Fig. 23.26). Suppose an electron of charge $-e$ is projected horizontally into this field from the origin with an initial velocity $v_i\hat{\mathbf{i}}$ at time $t = 0$. Because the electric field $\mathbf{E}$ in Figure 23.26 is in the positive y direction, the acceleration of the electron is in the negative y direction. That is,

$$\boxed{\mathbf{a} = -\frac{eE}{m_e}\hat{\mathbf{j}}} \qquad (23.13)$$

Because the acceleration is constant, we can apply the equations of kinematics in two dimensions (see Chapter 4) with $v_{xi} = v_i$ and $v_{yi} = 0$. After the electron has been in the

Active Figure 23.26 An electron is projected horizontally into a uniform electric field produced by two charged plates. The electron undergoes a downward acceleration (opposite E), and its motion is parabolic while it is between the plates.

	INPUT DATA
	FORMULA
	CONSTANTS
	TITLE

q (carga electrica: C)	potencial diference V; [V]	massa (electrao: Kg)
-1,602E-19	1,000E+00	9,110E-31
constante		constante

velocidade inicial vi; [m/s]
0,000E+00

TUBO DE THOMSON

Sabendo: q, deltaV, m

v (ponto b)	5,931E+05

verificacao (vi=0) 5,931E+05

Example 25.2 Motion of a Proton in a Uniform Electric Field Interactive

A proton is released from rest in a uniform electric field that has a magnitude of 8.0×10^4 V/m (Fig. 25.6). The proton undergoes a displacement of 0.50 m in the direction of **E**.

(A) Find the change in electric potential between points A and B.

Solution Because the positively charged proton moves in the direction of the field, we expect it to move to a position of lower electric potential. From Equation 25.6, we have

$$\Delta V = -Ed = -(8.0 \times 10^4 \text{ V/m})(0.50 \text{ m}) = \boxed{-4.0 \times 10^4 \text{ V}}$$

(B) Find the change in potential energy of the proton–field system for this displacement.

Solution Using Equation 25.3,

$$\Delta U = q_0\,\Delta V = e\,\Delta V$$
$$= (1.6 \times 10^{-19} \text{ C})(-4.0 \times 10^4 \text{ V})$$
$$= \boxed{-6.4 \times 10^{-15} \text{ J}}$$

The negative sign means the potential energy of the system decreases as the proton moves in the direction of the electric field. As the proton accelerates in the direction of the field, it gains kinetic energy and at the same time the system loses electric potential energy.

(C) Find the speed of the proton after completing the 0.50 m displacement in the electric field.

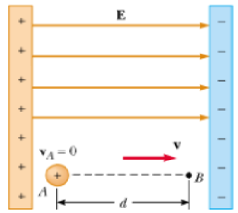


Figure 25.6 (Example 25.2) A proton accelerates from A to B in the direction of the electric field.

Solution The charge–field system is isolated, so the mechanical energy of the system is conserved:

$$\Delta K + \Delta U = 0$$
$$(\tfrac{1}{2}mv^2 - 0) + e\,\Delta V = 0$$
$$v = \sqrt{\frac{-(2e\,\Delta V)}{m}}$$
$$= \sqrt{\frac{-2(1.6 \times 10^{-19} \text{ C})(-4.0 \times 10^4 \text{ V})}{1.67 \times 10^{-27} \text{ kg}}}$$
$$= \boxed{2.8 \times 10^6 \text{ m/s}}$$

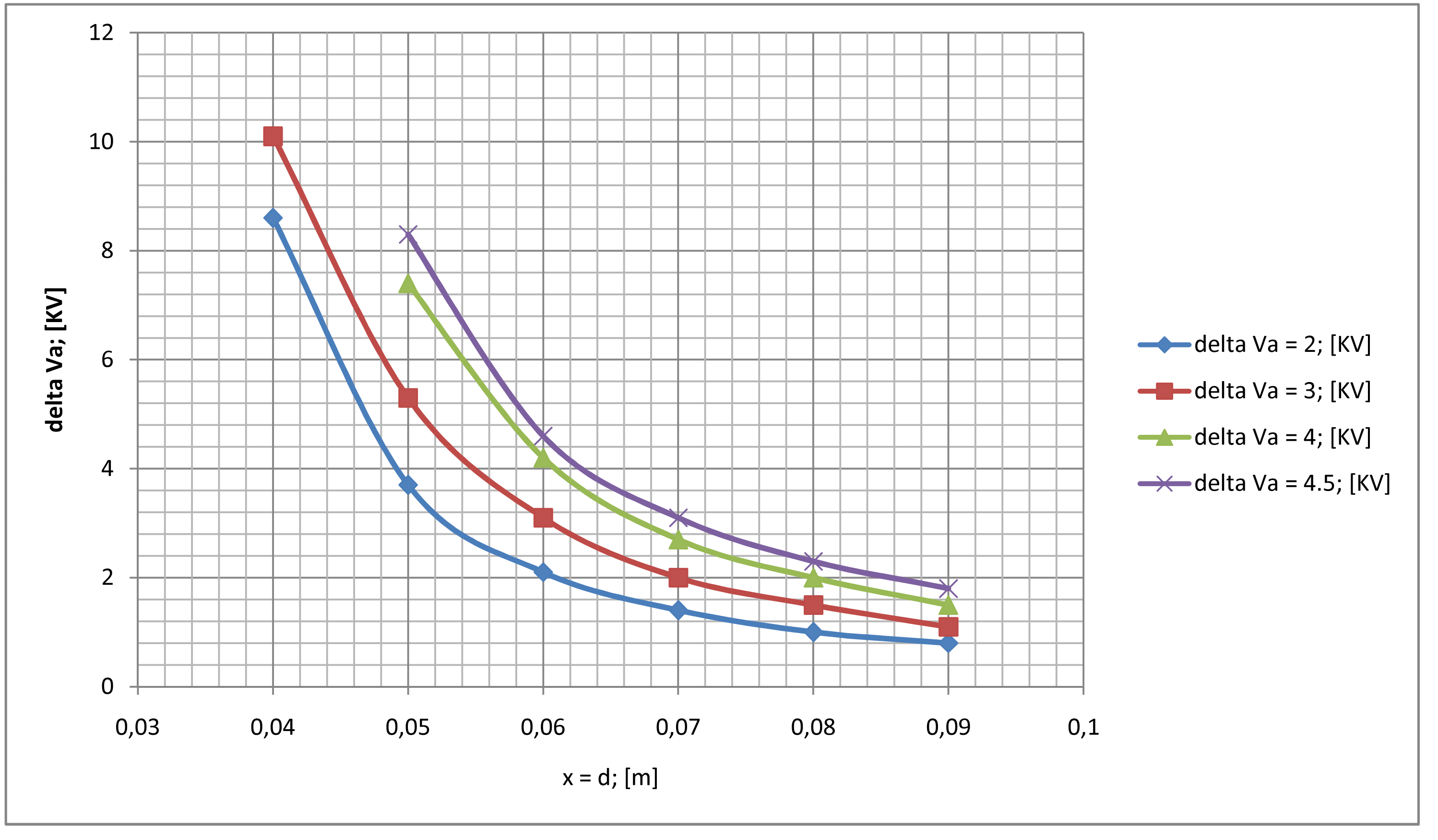
What If? What if the situation is exactly the same as that shown in Figure 25.6, but no proton is present? Could both parts (A) and (B) of this example still be answered?

deltaV (KV)

y = h = 0,01; [m]

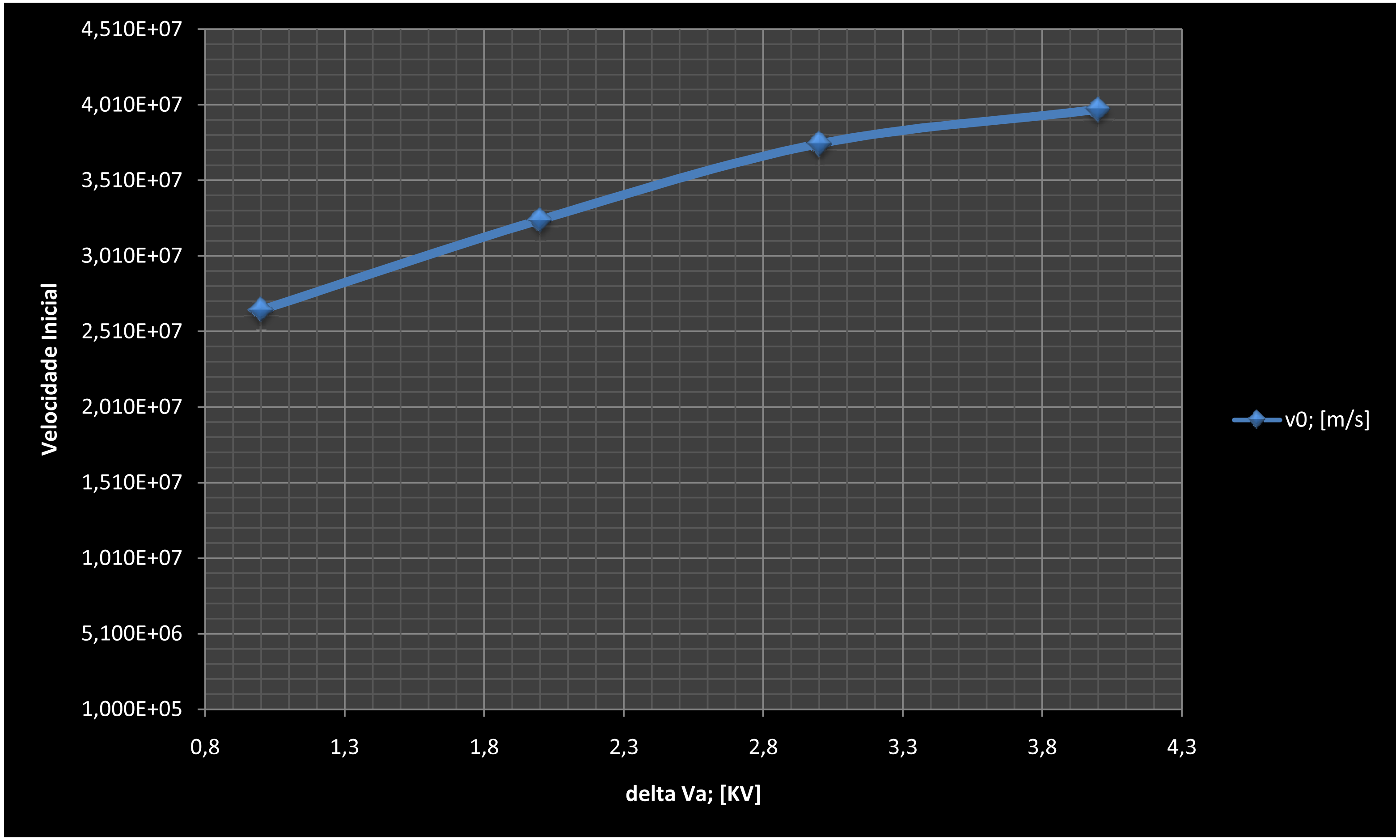
x = d; [m]	delta Va = 2; [KV]	delta Va = 3; [KV]	delta Va = 4; [KV]	delta Va = 4.5; [KV]
0,09	0,8	1,1	1,5	1,8
0,08	1	1,5	2	2,3
0,07	1,4	2	2,7	3,1
0,06	2,1	3,1	4,2	4,6
0,05	3,7	5,3	7,4	8,3
0,04	8,6	10,1		

delta Va; [kV]

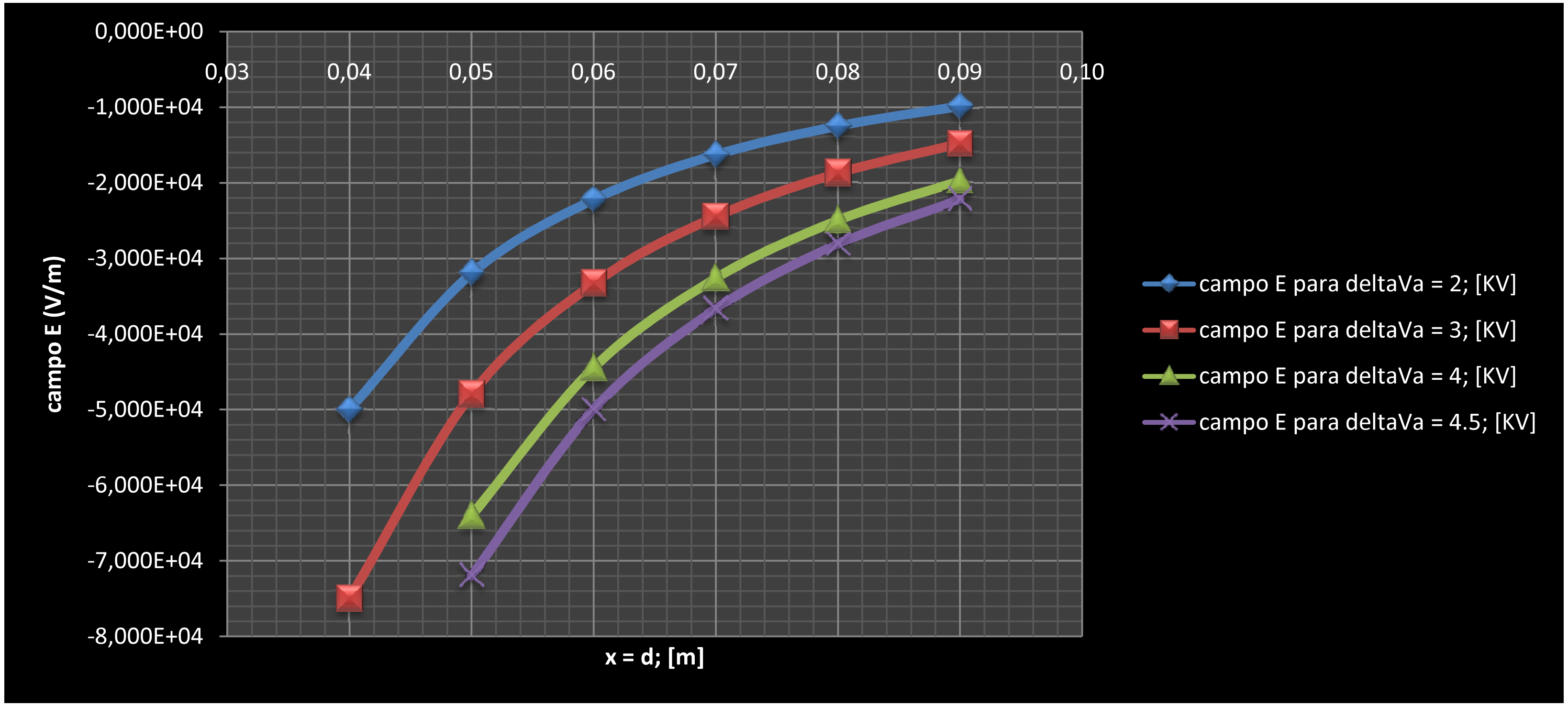


	2,00E+03	3,00E+03	4,00E+03	4,50E+03
	delta Va = 2; [KV]	delta Va = 3; [KV]	delta Va = 4; [KV]	delta Va = 4.5; [KV]
v0; [m/s]	2,652E+07	3,248E+07	3,751E+07	3,978E+07

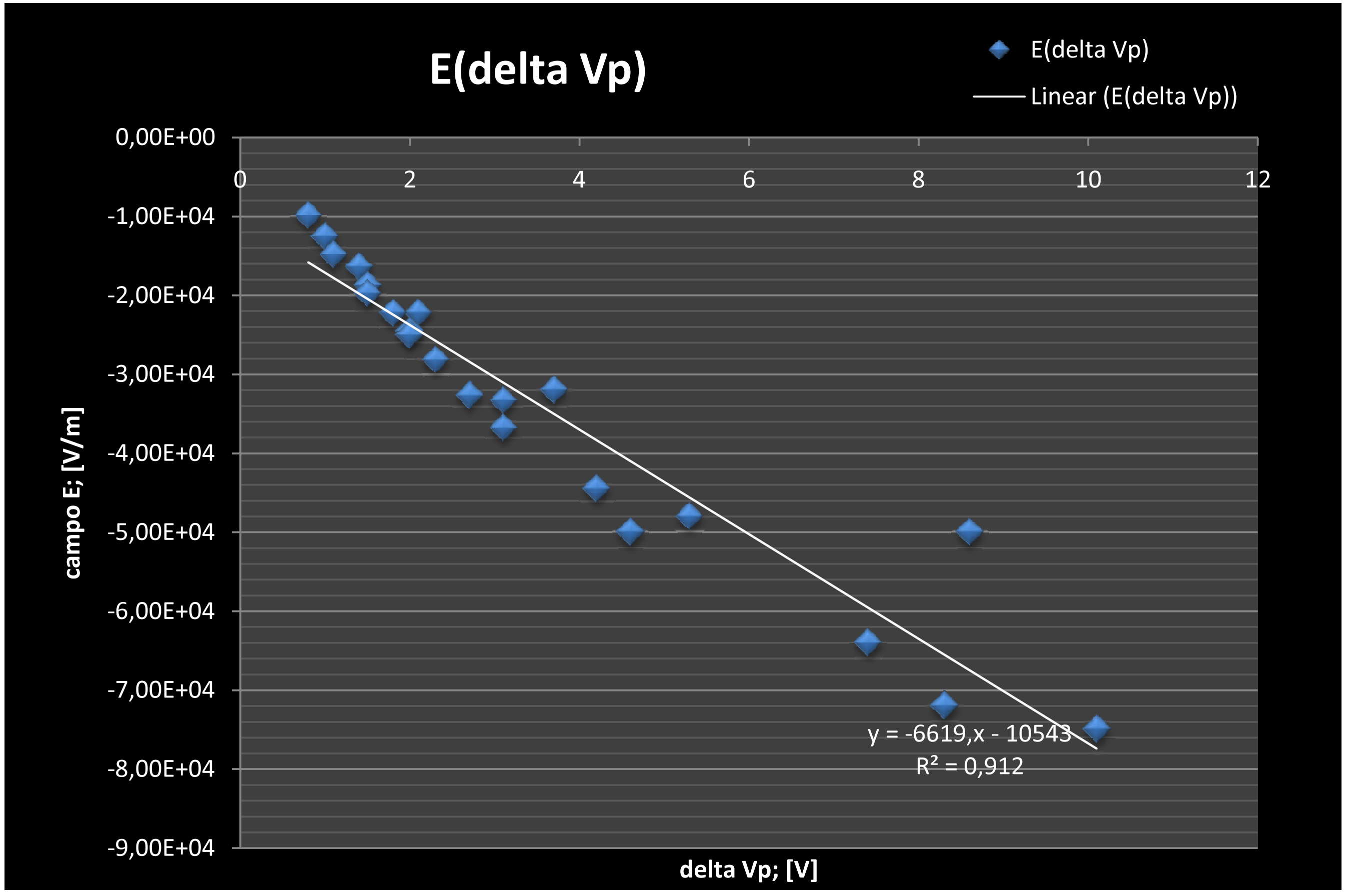
delta Va; [kV]



campo E (V/m)	y=0,01; [m]			
	campo E para deltaVa = 2; [KV]	campo E para deltaVa = 3; [KV]	campo E para deltaVa = 4; [KV]	campo E para deltaVa = 4.5; [KV]
9,00E-02	-9,877E+03	-1,481E+04	-1,975E+04	-2,222E+04
8,00E-02	-1,250E+04	-1,875E+04	-2,500E+04	-2,813E+04
7,00E-02	-1,633E+04	-2,449E+04	-3,265E+04	-3,673E+04
6,00E-02	-2,222E+04	-3,333E+04	-4,444E+04	-5,000E+04
5,00E-02	-3,200E+04	-4,800E+04	-6,400E+04	-7,200E+04
4,00E-02	-5,000E+04	-7,500E+04		
x; [m]				



	E(delta Vp)
0,8	-9,88E+03
1	-1,25E+04
1,4	-1,63E+04
2,1	-2,22E+04
3,7	-3,20E+04
8,6	-5,00E+04
1,1	-1,48E+04
1,5	-1,88E+04
2	-2,45E+04
3,1	-3,33E+04
5,3	-4,80E+04
10,1	-7,50E+04
1,5	-1,98E+04
2	-2,50E+04
2,7	-3,27E+04
4,2	-4,44E+04
7,4	-6,40E+04
1,8	-2,22E+04
2,3	-2,81E+04
3,1	-3,67E+04
4,6	-5,00E+04
8,3	-7,20E+04



delta Vp
(eixo xx)