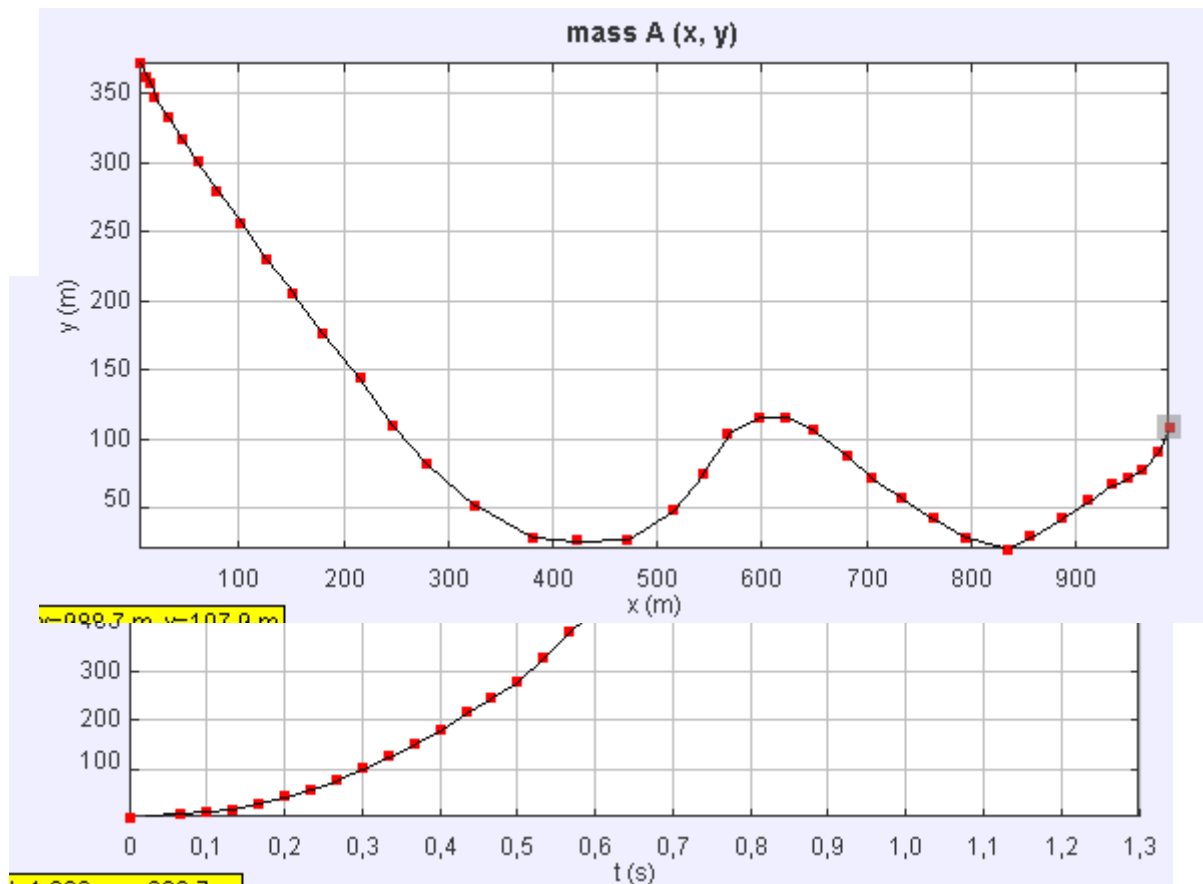
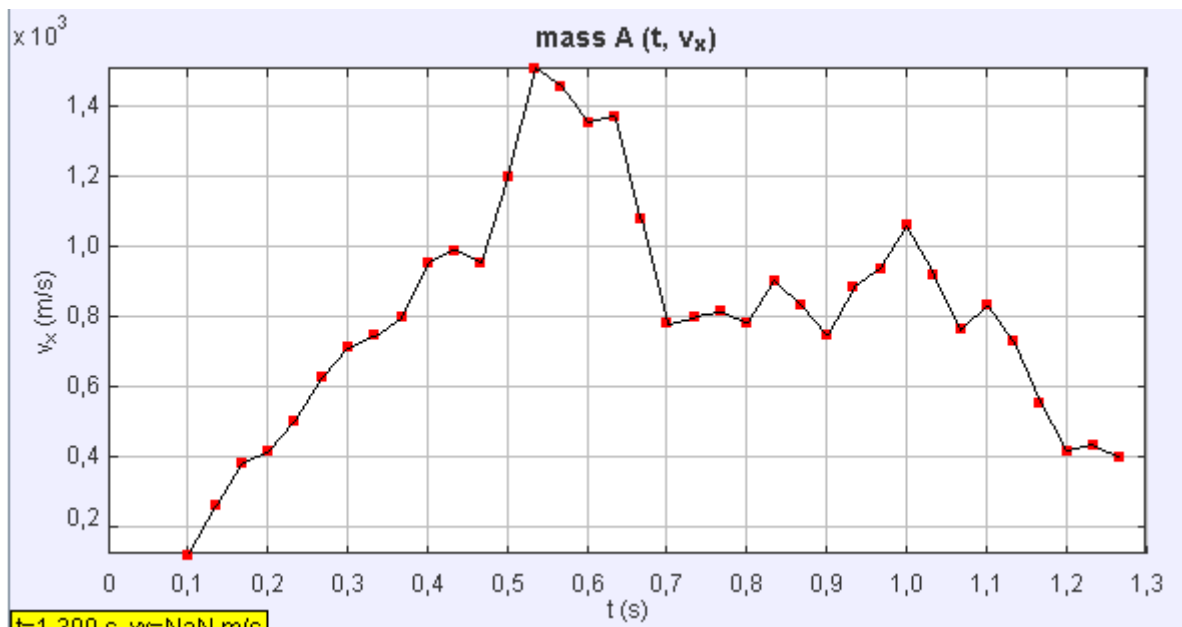
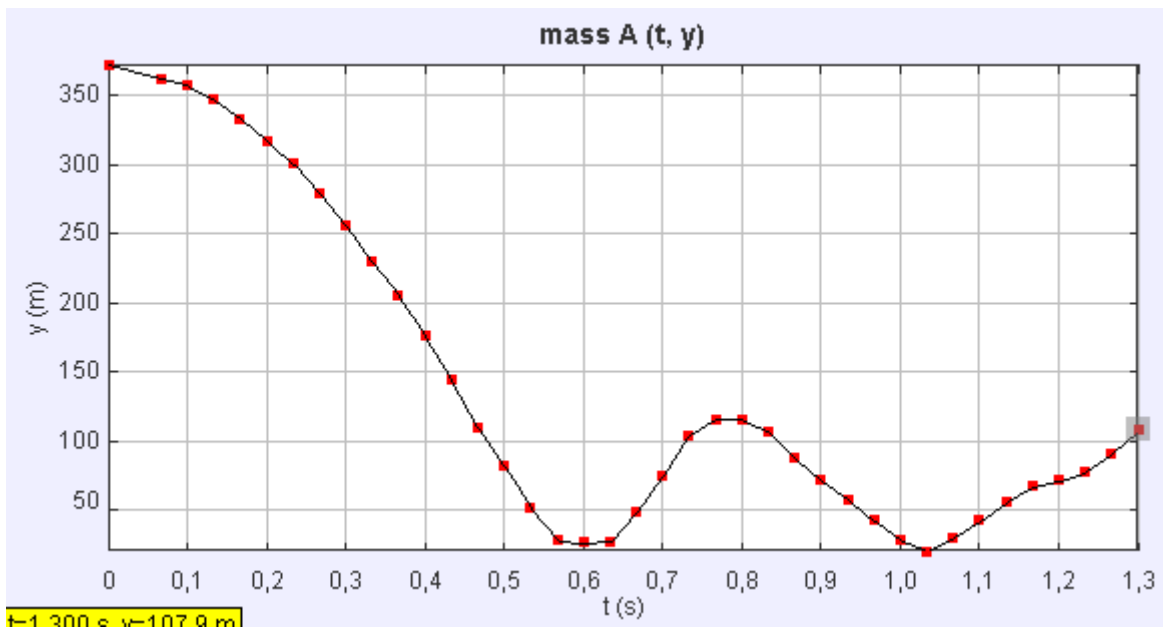


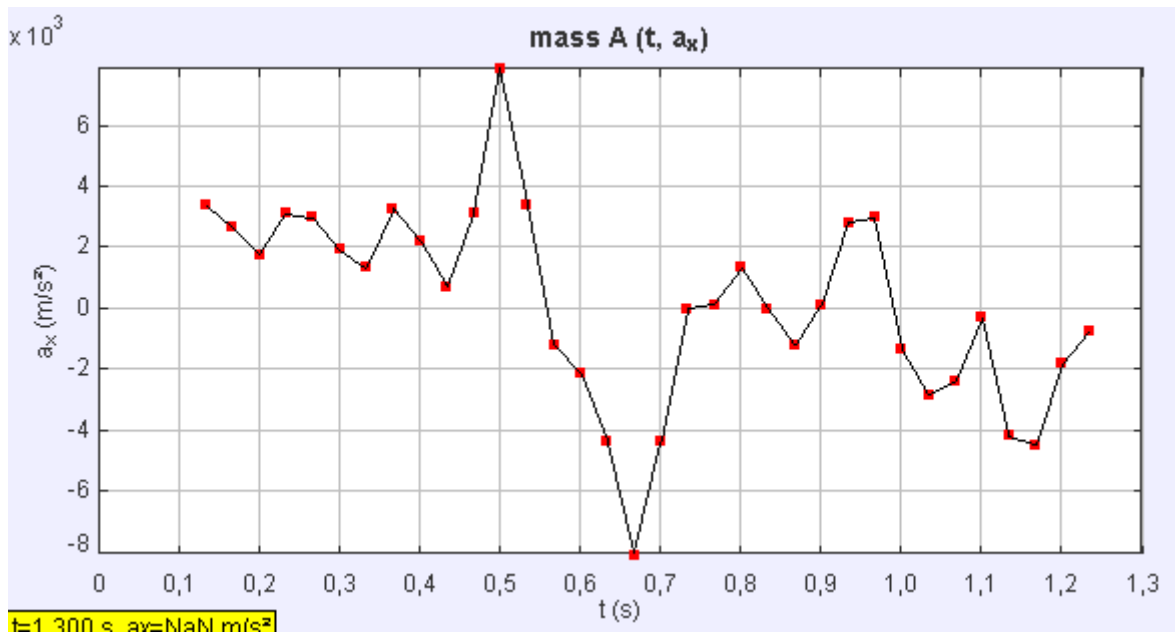
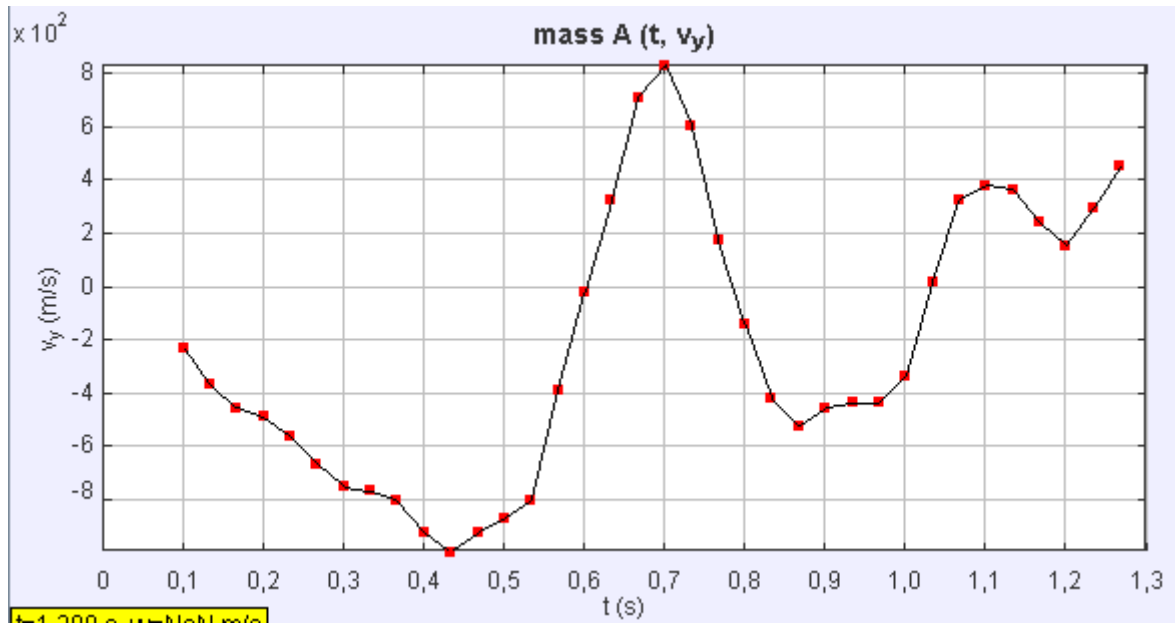


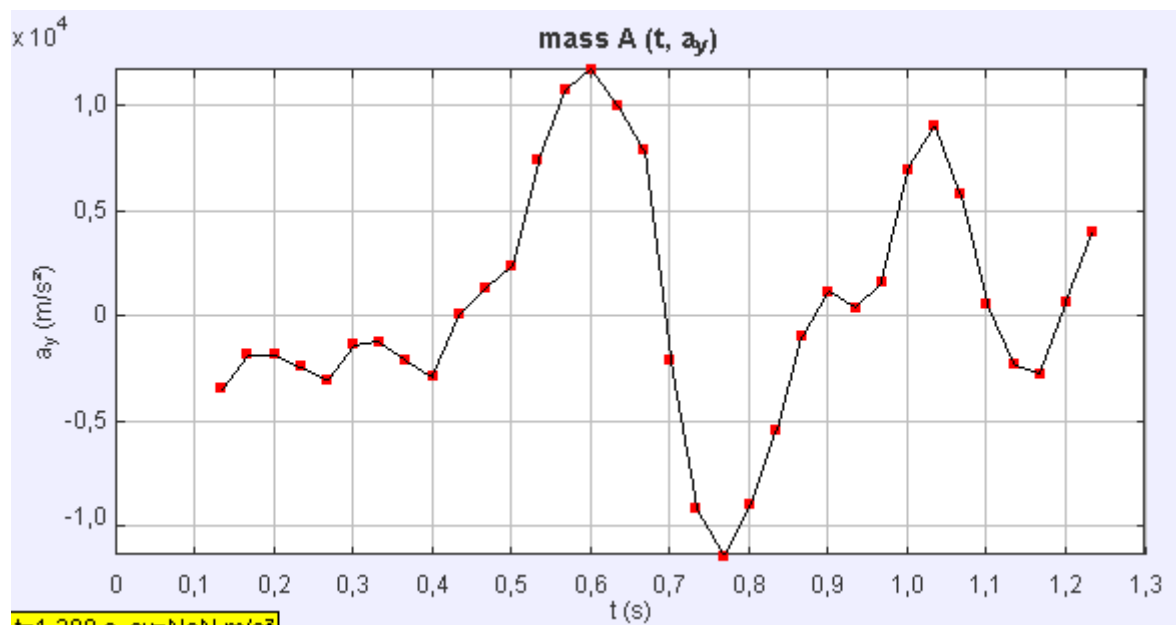
Let's go for a ride! The physics of roller-coasters  
 Creating a scale model and performing measurements on the model  
**Pulsar (BE) vs. Divertical (IT)**

Belgian graphics:





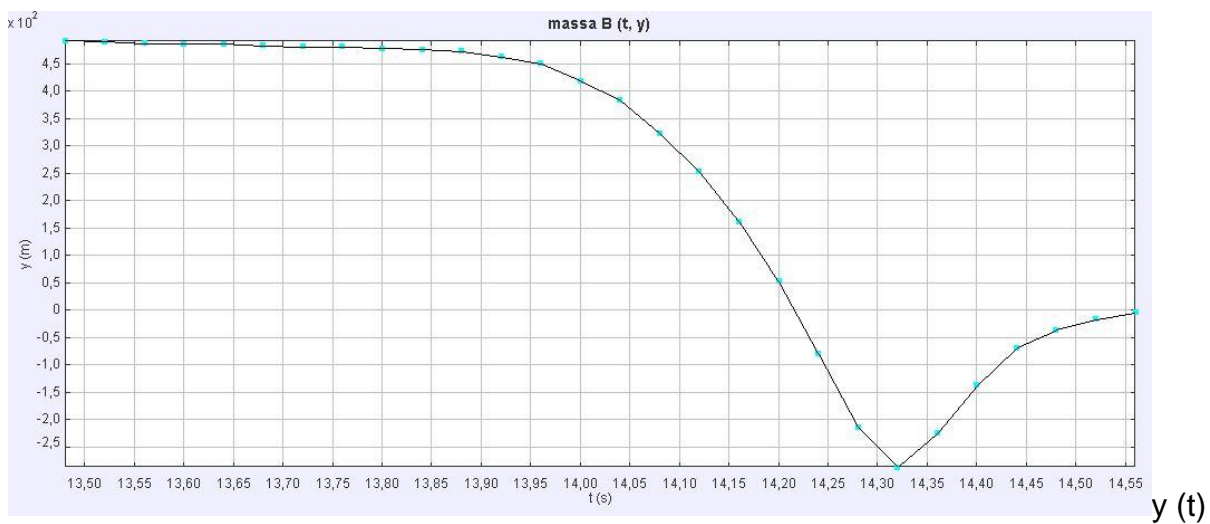
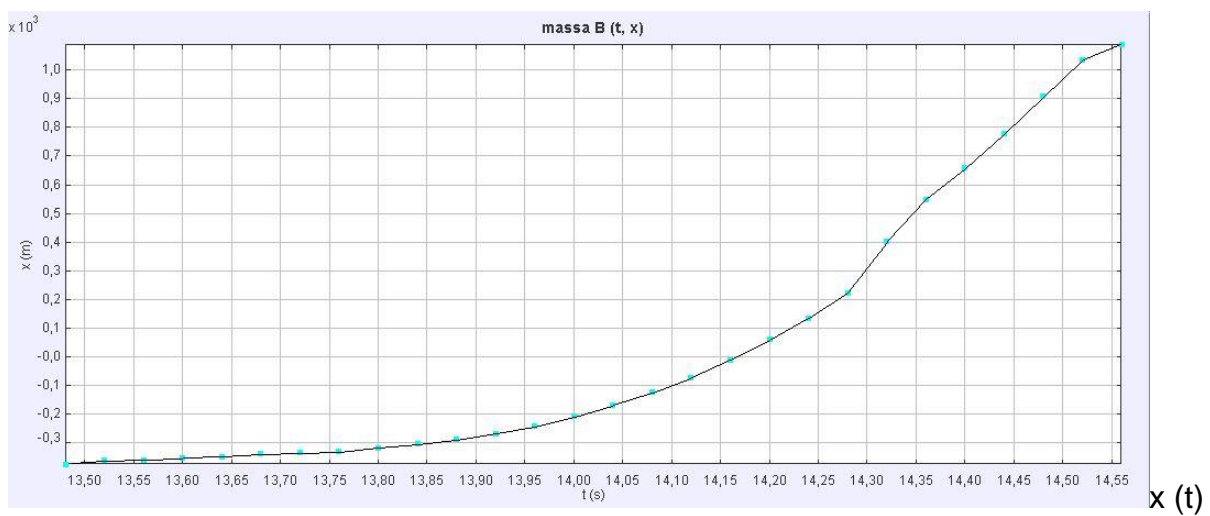
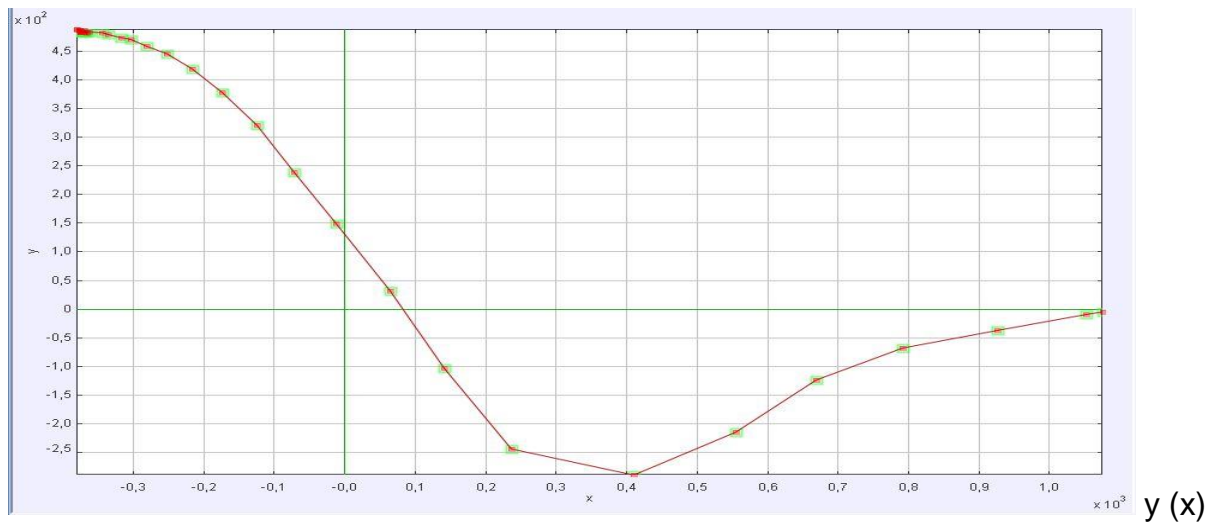


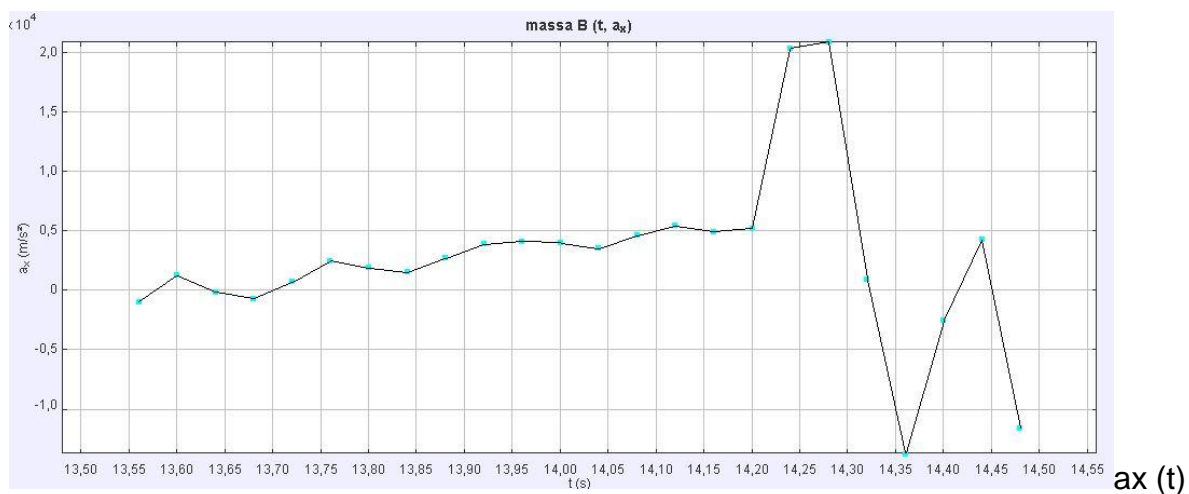
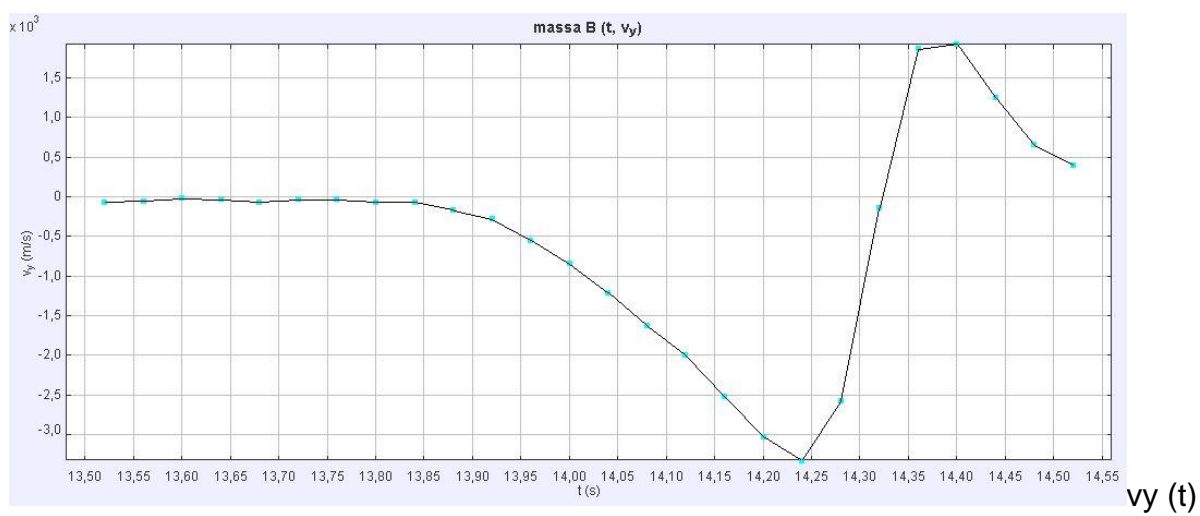
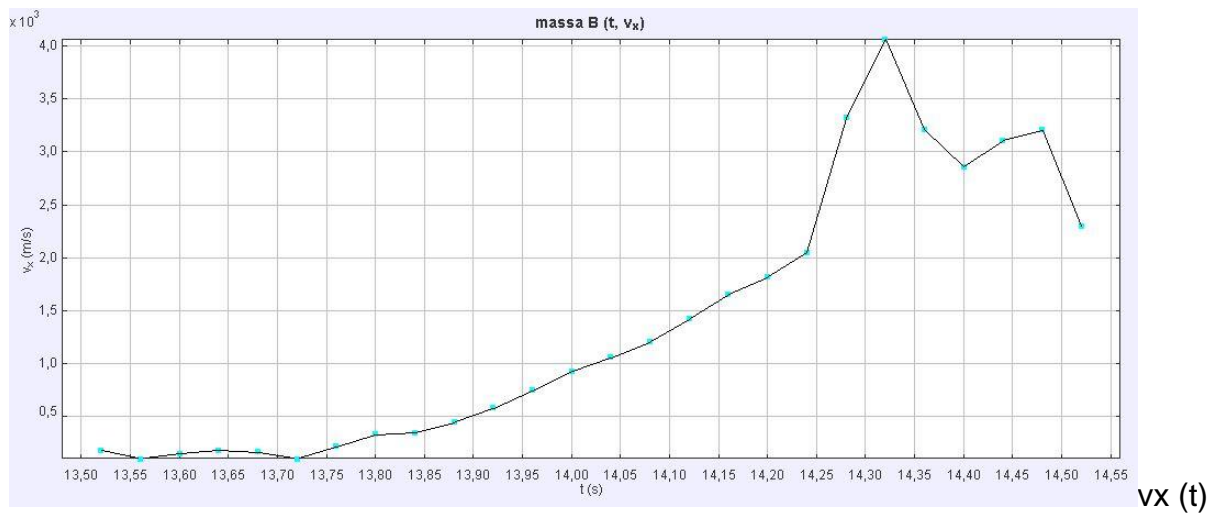


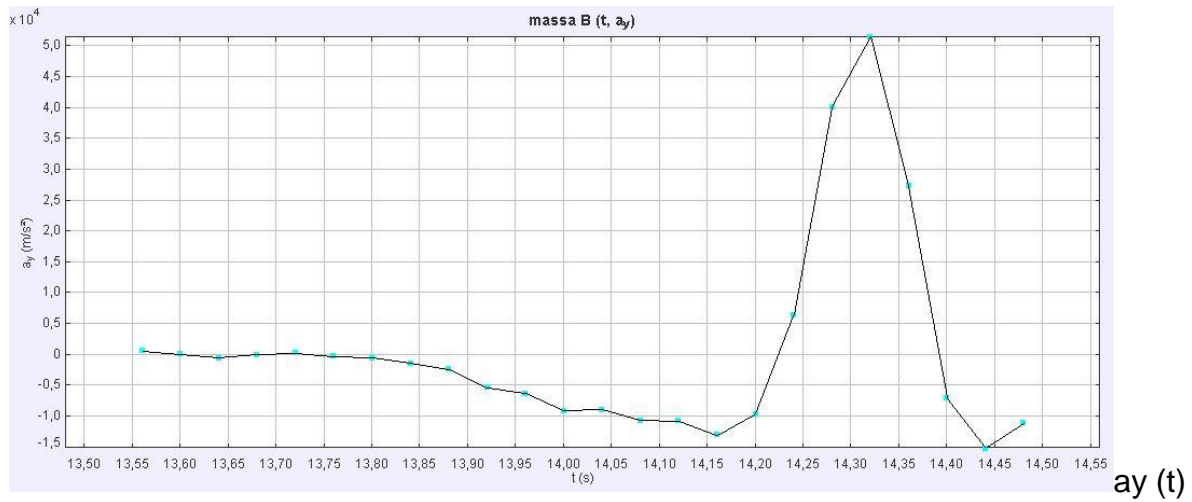
<b>t(s)</b>	0,0	0,2	0,6	1,1	1,2
<b>x</b>	$3,35 \cdot 10^{-2}$	0,124	0,899	1,729	1,852
<b>y</b>	0,666	0,553	$3,272 \cdot 10^{-2}$	$8,172 \cdot 10^{-2}$	0,142
<b>v<sub>x</sub></b>	/	0,937	2,697	1,274	0,879
<b>v<sub>y</sub></b>	/	-1,123	0,540	0,694	0,483
<b>a<sub>x</sub></b>	/	3,368	-11,13	-2,596	/
<b>a<sub>y</sub></b>	/	-4,420	19,23	0,264	/

Italian graphics:

Let's go for a ride







<b>t (s)</b>	0,0 (start)	0,2	0,4	0,6	0,75 (end fall)
<b>x (m)</b>	0	0,05	0,1	0,4	0,6
<b>y (m)</b>	0,6	0,55	0,5	0,2	0
<b>V<sub>x</sub> (m/s)</b>	0	0,1	0,5	1,25	3,2
<b>v<sub>y</sub> (m/s)</b>	0	-0,05	-0,25	-2,0	0
<b>a<sub>x</sub> (m/s<sup>2</sup>)</b>	0	0,1	0,4	0,5	2,0
<b>a<sub>y</sub> (m/s<sup>2</sup>)</b>	0	0	-0,45	-1,1	0

**Belgian calculations:**

$$E_{\text{pot}} = m \cdot g \cdot h$$

$$E_{\text{pot beginning}} = 1 \cdot 9,81 \cdot 0,5535 = 5,429 \text{ J}$$

$$E_{\text{pot middle}} = 1 \cdot 9,81 \cdot 3,272 = 32,098 \text{ J}$$

$$E_{\text{pot end}} = 1 \cdot 9,81 \cdot 8,172 \cdot 10^{-2} = 0,8017 \text{ J}$$

$$v_{\text{beginning}} (t = 0,2) = \sqrt{0,937^2 * (-1,123)^2} = 1,052 \text{ m/s}$$

$$v_{\text{middle}} (t = 0,6) = \sqrt{2,697^2 * 0,540^2} = 1,456 \text{ m/s} \quad v_{\text{end}} (t = 1,1) = \sqrt{1,274^2 * 0,694^2} = 0,884 \text{ m/s}$$

$$a_{\text{beginning}} (t = 0,2) = \sqrt{3,368^2 * (-4,420)^2} = 14,89 \text{ m/s}^2$$

$$a_{\text{middle}} (t = 0,6) = \sqrt{(-11,13)^2 * 19,23^2} = 214,0 \text{ m/s}^2$$

$$a_{\text{end}} (t = 1,1) = \sqrt{(-2,596)^2 * 0,264^2} = 0,6853 \text{ m/s}^2$$

$$E_{\text{kin}} = (m \cdot v^2) / 2$$

$$E_{\text{kin beginning}} = (1 \cdot 1,052^2) / 2 = 0,5535 \text{ J}$$

$$E_{\text{kin middle}} = (1 \cdot 1,456^2) / 2 = 1,060 \text{ J}$$

$$E_{\text{kin end}} = (1 \cdot 0,884^2) / 2 = 0,3907 \text{ J}$$

$$E_{\text{mech}} = E_{\text{kin}} + E_{\text{pot}}$$

$$E_{\text{mech beginning}} = 0,5535 + 5,429 = 5,9825 \text{ J}$$

$$E_{\text{mech middle}} = 1,060 + 0,3210 = 1,3810 \text{ J}$$

$$E_{\text{mech end}} = 0,3907 + 0,8017 = 1,1924 \text{ J}$$

**Problems**

We had a hard time to make our scale model. We had at first some problems because we hadn't enough sticks to make our construction. We could fix this problem but our coaster wasn't so stable. We ended with a scalemodel that was useable for our calculations so we were very happy. We struggled a lot with Tracker (the programm we used) and with our calculation, but we made it!

We can conclude that the  $E_{\text{mech}}$  is shrinking because the energy goes away in a form of air movements.



## Italian Calculations

$$E_{\text{pot}} = m \cdot g \cdot h$$

$$E_{\text{pot beginning}} = 9,81 \cdot 0,60 = 5,886 \text{ J/kg}$$

$$E_{\text{pot middle}} = 9,81 \cdot 0,30 = 2,943 \text{ J/kg}$$

$$E_{\text{pot end}} = 0 \text{ J}$$

$$v_{\text{beginning}} (t = 0,2) = \sqrt{0,1^2 + (-0,05)^2} = 0,11 \text{ m/s}$$

$$v_{\text{middle}} (t = 0,6) = \sqrt{1,25^2 + (-2,0)^2} = 2,35 \text{ m/s} \quad v_{\text{end}} (t = 0,75) = \sqrt{3,2^2 + 0^2} = 3,2 \text{ m/s}$$

$$a_{\text{beginning}} (t = 0,2) = \sqrt{0^2 + 0,1^2} = 0,1 \text{ m/s}^2$$

$$a_{\text{middle}} (t = 0,6) = \sqrt{0,5^2 + (-0,45)^2} = 0,67 \text{ m/s}^2$$

$$a_{\text{end}} (t = 1,1) = \sqrt{2,0^2 + 0^2} = 2,0 \text{ m/s}^2$$

$$E_{\text{kin}} = (m \cdot v^2) / 2$$

$$E_{\text{kin beginning}} = (0,1^2) / 2 = 0,005 \text{ J/kg}$$

$$E_{\text{kin middle}} = (2,35^2) / 2 = 2,76 \text{ J/kg}$$

$$E_{\text{kin end}} = (3,2^2) / 2 = 5,12 \text{ J/kg}$$

$$E_{\text{mech}} = E_{\text{kin}} + E_{\text{pot}}$$

$$E_{\text{mech beginning}} = 5,886 + 0,005 = 5,891 \text{ J/kg}$$

$$E_{\text{mech middle}} = 2,943 + 2,76 = 5,793 \text{ J/kg}$$

$$E_{\text{mech end}} = 0 + 5,12 = 5,12 \text{ J/kg}$$

## Problems

We haven't had any particular problem, nor with Tracker, nor with the model.