VRIJE ASO.SCHOOL

Let's go for a ride! The physics of roller-coasters

Creating a scale model and performing measurements on the model

Given:

m = 24,02 g

$Y_{beginning}$ = 1,02 m

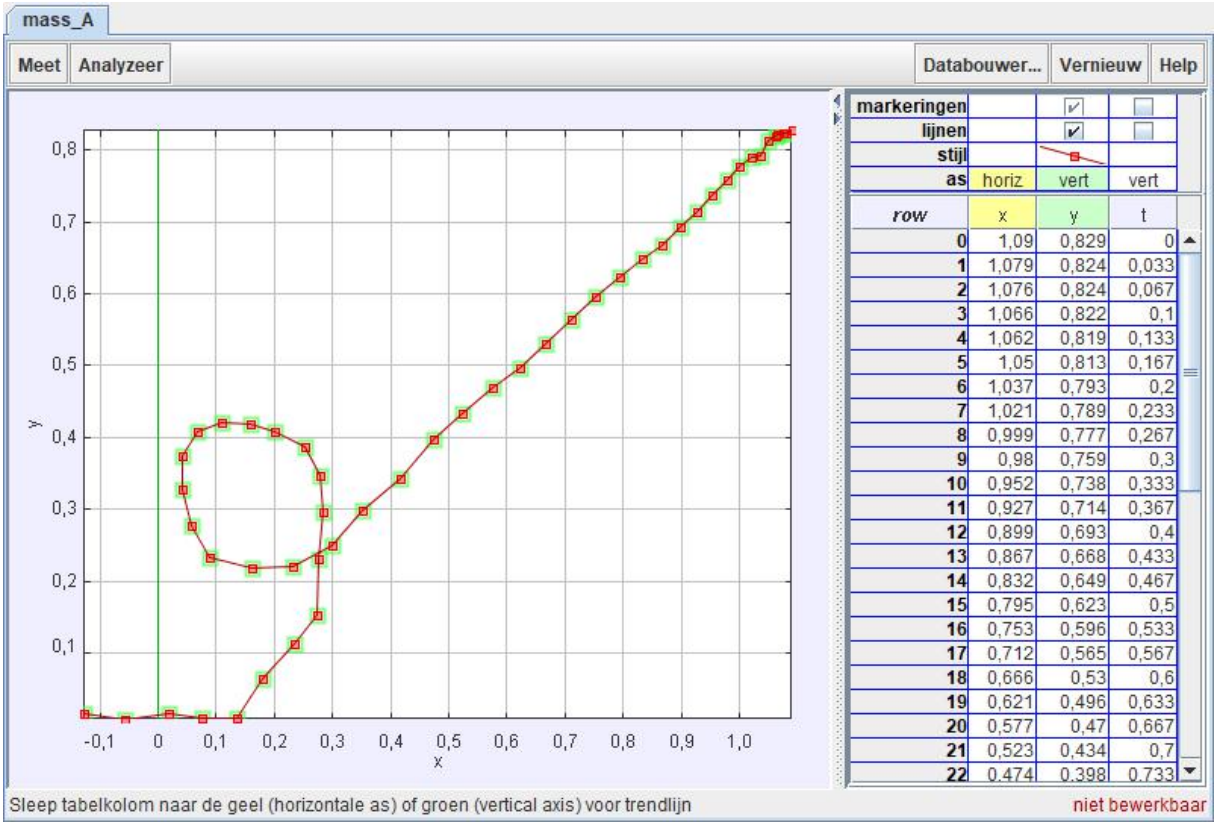
$Y_{top\ looping}$ = 0,55 m

$Y_{bottom\ looping}$ = 0,20 m

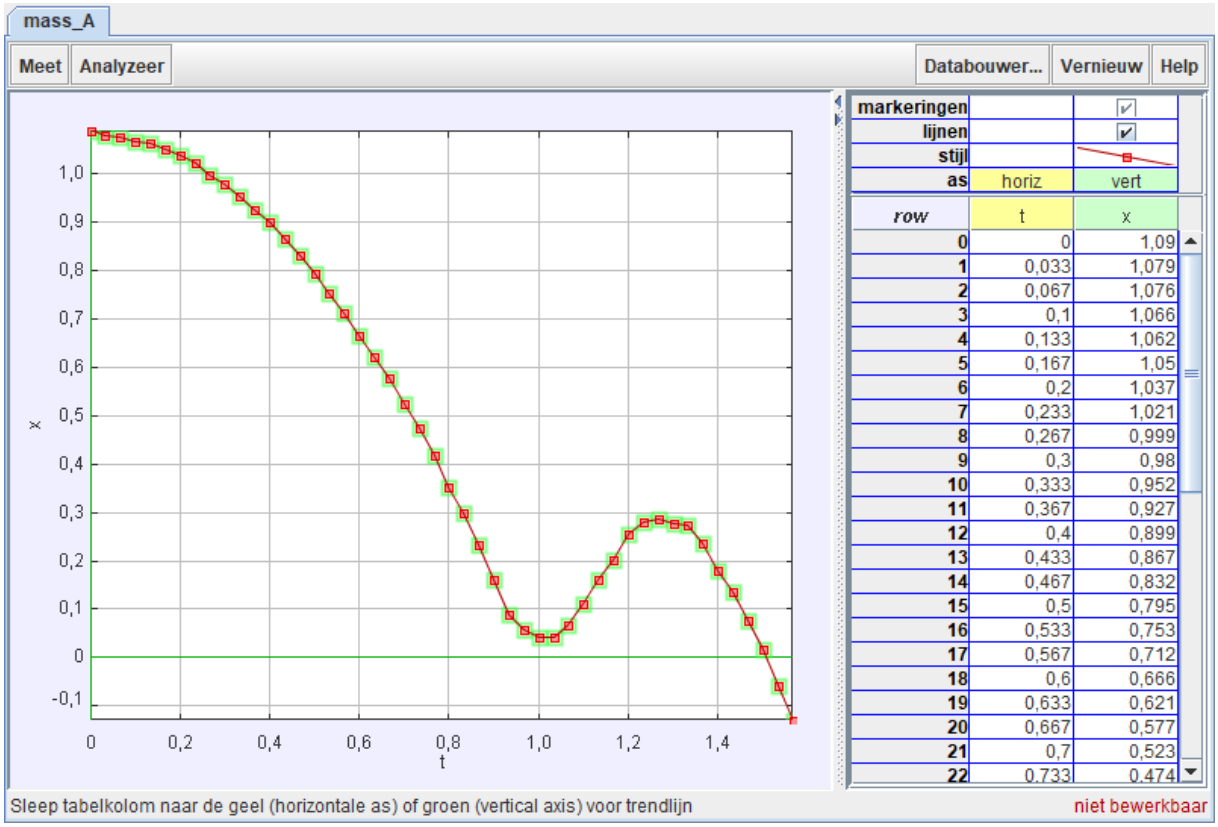
$R_{looping}$ = 0,35 m

Ghraps

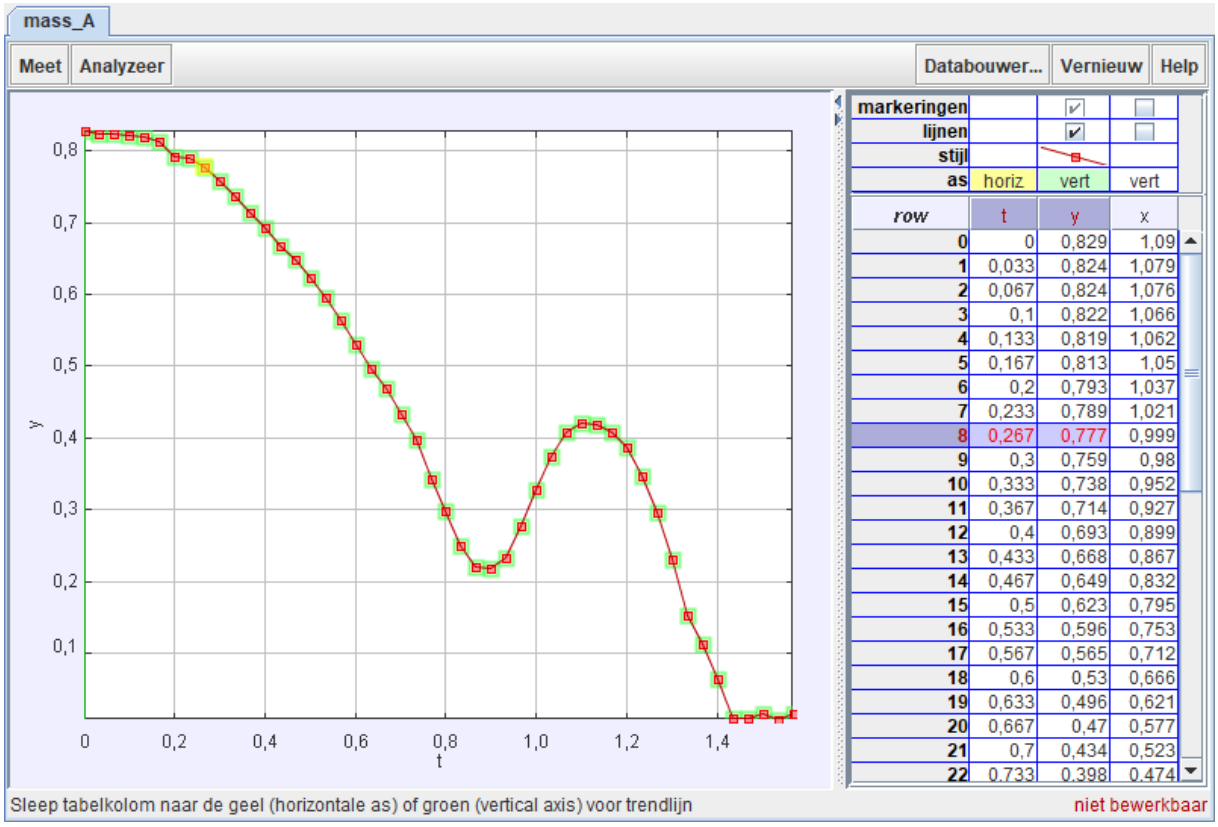
y(x)



(x(t))



y(t) → E_{pot} (J/kg) (at the beginning, in the middle and at the end)



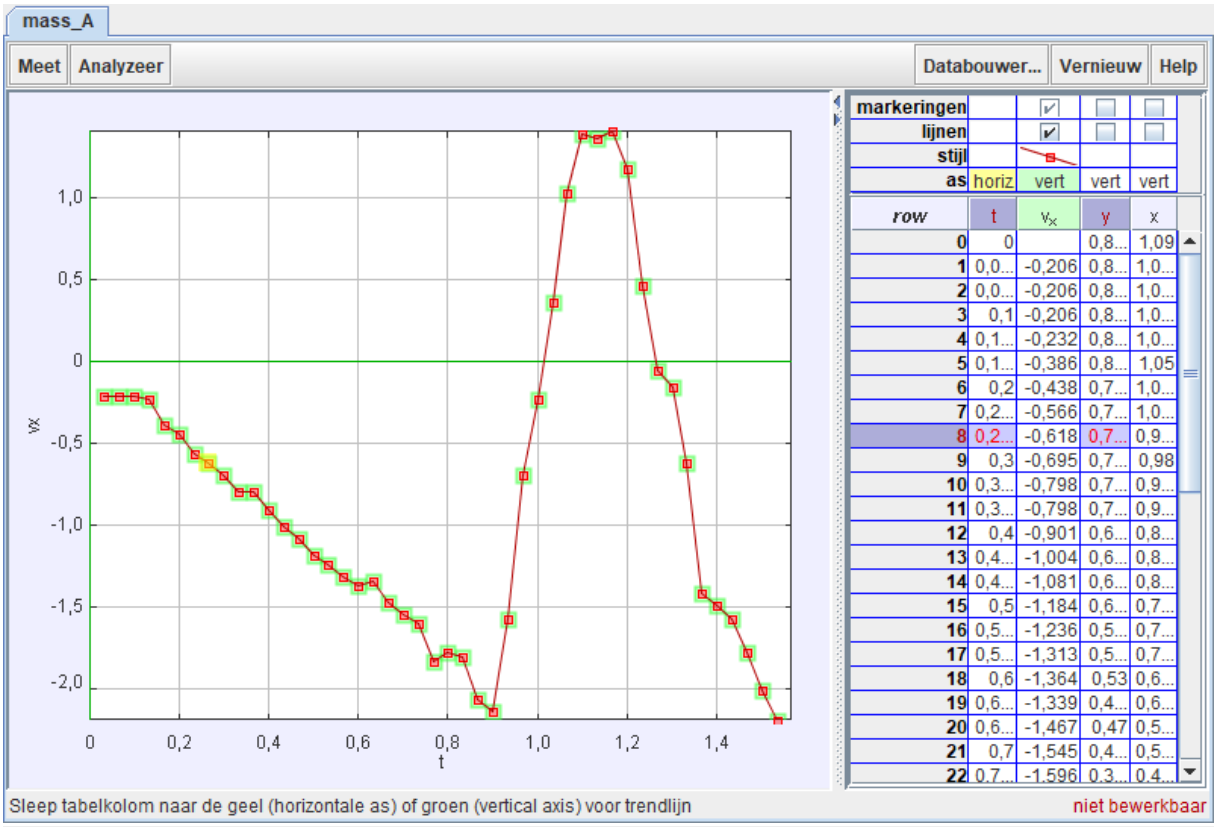
$v_x(t)$

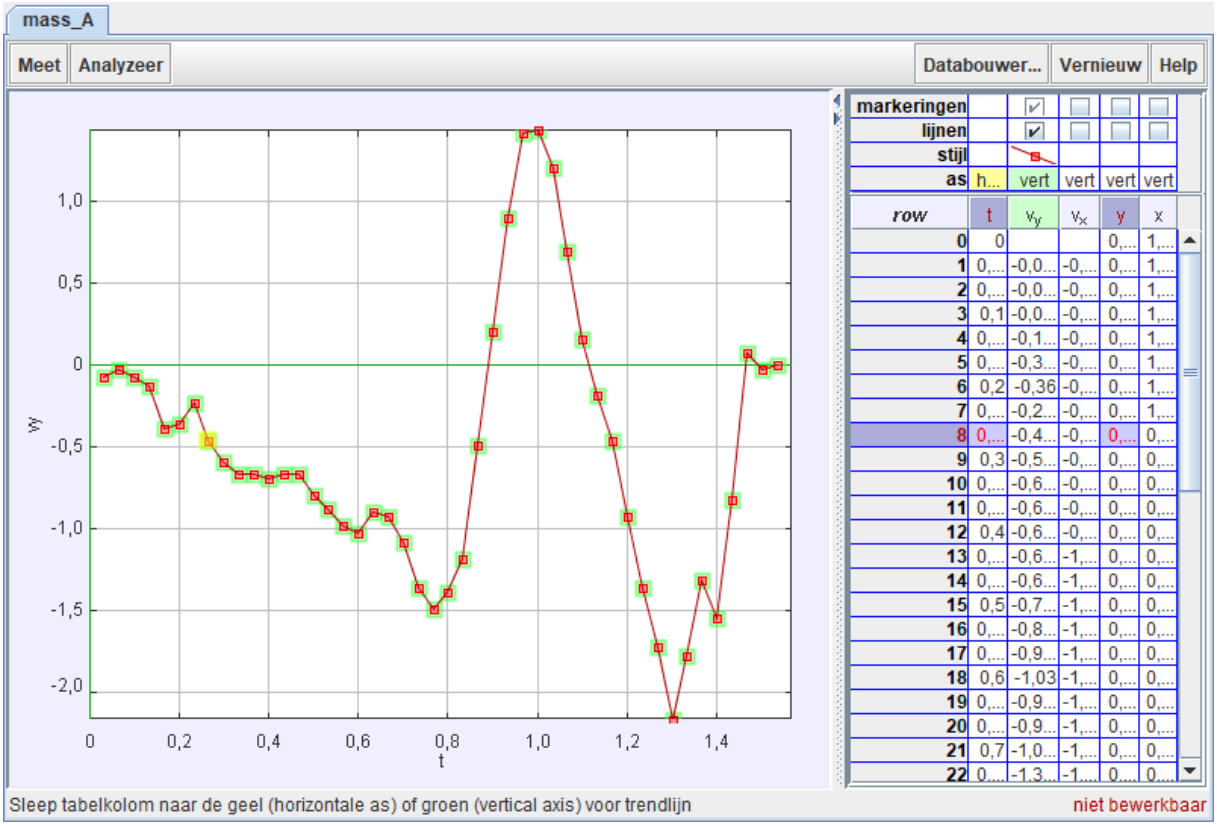
$v_y(t)$

$v = \sqrt{vx2 + vy2}$

➔ E_{kin} (J/kg)

(at the beginning, in the middle and at the end)





Calculations:

$V_{beginning}$ (t = 0.033)= $\sqrt{-0.102^2 + (-5.11 * 10-^2)^2}$ = 0.1140842233 m/s
V_{middle} (t = 0.733)= $\sqrt{(-1.612)^2 + (-1.228)^2}$ = 2.026457007 m/s
V_{end}(t = 1.533)= $\sqrt{(-1.331)^2 + 0^2}$ = 1.331 m/s

The velocity increases until the looping, during the looping it decreases.

a_x(t)

a_y(t)

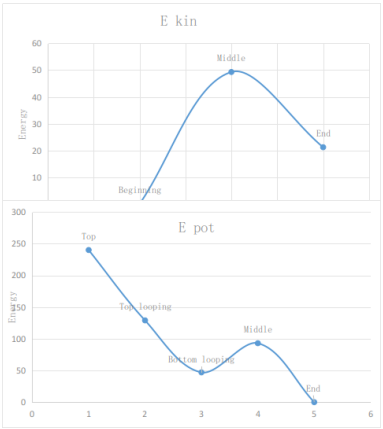
a = $\sqrt{ax2 + ay2}$

$ax_{beginning}$ (t = 0.067)= $\sqrt{(-2.851)^2 + (-2.851)^2}$ = 4.031922866 m/s²
ax_{middle} (t = 0.733)= $\sqrt{(-1.535)^2 + (-1.755)^2}$ = 2.33157672 m/s²

ax_{end}(t = 1.500)= $\sqrt{(10.97)^2 + 1.535^2}$ = 11.07687343 m/s²

E_{kin}= (m*v²) /2

$E_{kin\ beginning}$ = (24.02 * (0.1140842233)²) /2 = 0,1563126722 J
$E_{kin\ middle}$ = (24.02 * (2.026457007)²) /2 = 49,3194013 J
$E_{kin\ end}$ = (24.02 * (1.331)²) /2 = 21,27644761 J



Epot= m*g*h

$E_{pot\ beginning}$ (0.067) = 24.02 * 9.81 * 1.02 = 240,348924 J
$E_{pot\ top\ looping}$ = 24.02 *9.81 * 0.55 = 129,59991 J
$E_{pot\ bottom\ looping}$ = 24.02 * 9.81 * 0.20 = 47,12724 J
$E_{pot\ middle}$ (0.733) =24.02 * 9.81 * 0.398 = 93,7832076 J
$E_{pot\ end}$ (1.500) = 24.02 * 9.81 * 0 = 0

Emech= Ekin + Epot

$E_{mech\ beginning}$ = 0.1563126722 + 240,348924 = 240,5052367 J
$E_{mech\ middle}$ = 49.3194013 + 93.7832076 = 143,1026089 J
$E_{mech\ end}$ = 21,28+0 = 21,28 J

Problems scalemodel:

We needed a heavier ball because it needed to make a looping and our looping was big. With a heavier ball, the potential gravitation energy was bigger and that results in a higher velocity. At first it just fell, but with the heavier ball the problem was solved.

Table with energy

	E_{kin}	E_{pot}	E_{mech}
Beginning	0,16 J	240,35 J	240,51 J
Middle	49,32 J	93,78 J	143,10 J
End	21,28 J	0 J	21,28 J
Average	23,58 J	111,38 J	134,96 J

Mechanic energy change

The mechanic energy decreases because the ball loses energy because there's friction.