



0 Modellus: the concept and uses

Write a mathematical model... and then visualise and explore it!

1

Modellus 4, A Visual Introduction for Teachers

Modellus - C:\Modellus4\examples\circle with trig function.modellus

Home Independent Variable Model Parameters Initial Conditions Table Graph Objects Notes

Particle Vector Pen Text Level Indicator Analog Variable Image Geometric Object Origin Measure Coordinates Measure Distance Copy Image Clipboard

Animation Objects

Mathematical Model

```

angle = omega * t
x = R * cos( angle )
y = R * sin( angle )
R = 100
omega = 60

```

Write a model, using functions, differential equations or iterations...

Graph

Visualize one or more quantities on a graph and, or, on a table

Table

t	angle	x	y
10.00	600.00	-50.00	-86.60
10.10	606.00	-40.67	-91.35
10.20	612.00	-30.90	-95.11
10.30	618.00	-20.79	-97.81
10.40	624.00	-10.45	-99.45
10.50	630.00	-4.29E-14	-100.00
10.60	636.00	10.45	-99.45
10.70	642.00	20.79	-97.81
10.80	648.00	30.90	-95.11
10.90	654.00	40.67	-91.35
11.00	660.00	50.00	-86.60
11.10	666.00	58.78	-80.90
11.20	672.00	66.91	-74.31
11.30	678.00	74.31	-66.91
11.40	684.00	80.90	-58.78
11.50	690.00	86.60	-50.00
11.60	696.00	91.35	-40.67
11.70	702.00	95.11	-30.90
11.80	708.00	97.81	-20.79
11.90	714.00	99.45	-10.45
12.00	720.00	100.00	-4.90E-14
12.10	726.00	99.45	10.45
12.20	732.00	97.81	20.79
12.30	738.00	95.11	30.90
12.40	744.00	91.35	40.67
12.50	750.00	86.60	50.00
12.60	756.00	80.90	58.78
12.70	762.00	74.31	66.91
12.80	768.00	66.91	74.31
12.90	774.00	58.78	80.90
13.00	780.00	50.00	86.60

Make an animation using the model...

$x = 50.00$

$y = 86.60$

Notes

t = 13.00 Min: 0.00 Max: 30.00



1 A first look of the interface

Learn how things are labelled and what they do

The screenshot shows the Modellus software interface with the following components and labels:

- Ribbon:** A top toolbar with icons for Particle, Vector, Pen, Text, Level Indicator, Analog, Variable, Image, Geometric Object, Origin, Measure Coordinates, Measure Distance, and Copy Image Clipboard.
- Mathematical Model:** A window on the left side.
- Graph:** A window in the center showing a coordinate system with axes ranging from -80.00 to 80.00.
- Table:** A window on the right showing a table with a header 't' and a value '0.00'.
- Workspace:** The central area where the model is built.
- Start / Pause:** A green play button icon.
- Step Backward / Step Forward:** Two arrow icons for navigation.
- Notes Window:** A window at the bottom left for taking notes.
- Independent Variable:** A slider control for adjusting the independent variable.
- Replay:** A circular arrow icon for replaying the simulation.
- Reset:** A square icon for resetting the simulation.
- Hide / Show Case Boxes:** A window management icon.
- Minimize All Windows:** A window management icon.
- Hide / Show Ribbon:** A window management icon.



2 See it in action: a simple example with functions (a model of projectile motion)

What you will get on this example that illustrates how to make a model of a projectile motion... (click on the image to see the movie)

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Mathematical Model

$$x = 50 \times t$$
$$y = 50 \times t + \frac{1}{2} \times (-10) \times t^2$$

Table

t	x
6.50	325.00
6.60	330.00
6.70	335.00
6.80	340.00
6.90	345.00
7.00	350.00
7.10	355.00
7.20	360.00
7.30	365.00
7.40	370.00
7.50	375.00
7.60	380.00
7.70	385.00
7.80	390.00
7.90	395.00
8.00	400.00



2a See it in action: a simple example with functions (a model of projectile motion)

Write the model on the Mathematical Model Window...

The screenshot shows the Modellus software interface. The title bar reads "Modellus - New Document". The menu bar includes "Home", "Independent Variable", "Model", "Parameters", "Initial Conditions", and "Table". The "Model" tab is active, showing a toolbar with icons for "Copy Image", "Interpret", "Power" (x^n), "Square Root" (\sqrt{x}), "PI" (π), "e", "Delta" (Δx), and "Rat Ch" ($\frac{d}{d}$). Below the toolbar, the "Mathematical Model" window contains the following equations:

$$x = 50 \times t$$
$$y = 50 \times t + \frac{1}{2} \times (-10) \times t^2$$

To the right of the Mathematical Model window is a "Graph" window, which is currently empty.

Use either the * key or the SPACE BAR to get the multiplication sign

To make an exponent, either click on the exponent icon or press ^

Keys Backspace and Delete can be used to correct mistakes

Shortcuts for Copy, Cut, Paste and Undo are the usual ones (Ctrl C; Ctrl X; Ctrl V; Ctrl Z), on the Mathematical Model Window and on the Notes Window



2b See it in action: a simple example with functions (a model of projectile motion)

Create a particle to see the motion of the projectile...

The screenshot shows the Modellus software interface. The title bar reads "Modellus - New Document". The ribbon includes tabs for Home, Independent Variable, Model, Parameters, Initial Conditions, Table, and Graph. The ribbon contains icons for Particle, Vector, Pen, Text, Level Indicator, Analog, Variable, and Image. The "Mathematical Model" window displays the following equations:

$$x = 50 \times t$$
$$y = 50 \times t + \frac{1}{2} \times (-10) \times t^2$$

The "Graph" window shows a coordinate system with a horizontal axis labeled with -80.00 and -40.00. A yellow callout box points to the "Particle" icon on the ribbon and contains the text:

To create an object on the workspace, use the Right Button or Click on an object on the Ribbon

A context menu is shown below the callout, listing the following options:

- Add Particle
- Add Vector
- Add Pen
- Add Text
- Add Level Indicator
- Add Analog
- Add Variable



2C See it in action: a simple example with functions (a model of projectile motion)

Once the particle is created, select its coordinates...

The screenshot shows the Modellus software interface. The title bar reads "Modellus - C:\Principia\A visual introduction ... Java\models\3 projectile.modellus". The interface has several tabs: Home, Independent Variable, Model, Parameters, Initial Conditions, Table, Graph, and Objects. The "Parameters" tab is active, showing a "Particle2" object. The "Coordinates" section has "Horizontal:" and "Vertical:" dropdown menus. The "Horizontal:" menu is set to "x" and the "Vertical:" menu is set to "y". A yellow oval highlights these two dropdown menus. Below the "Coordinates" section, there are checkboxes for "Value", "Variable Name", and "Trajectory", and a "Values" section. The "Mathematical Model" window is open, showing the equations: $x = 50 \times t$ and $y = 50 \times t + \frac{1}{2} \times (-10) \times t^2$. A yellow oval highlights the "Particle2" object in the "Appearance" section. A yellow callout box contains the text: "Click on the Particle to see its properties..." and "Use the Horizontal and Vertical variable boxes to select x and y as coordinates for the particle". A yellow oval highlights a small red square icon representing the particle in the "Graph" window.

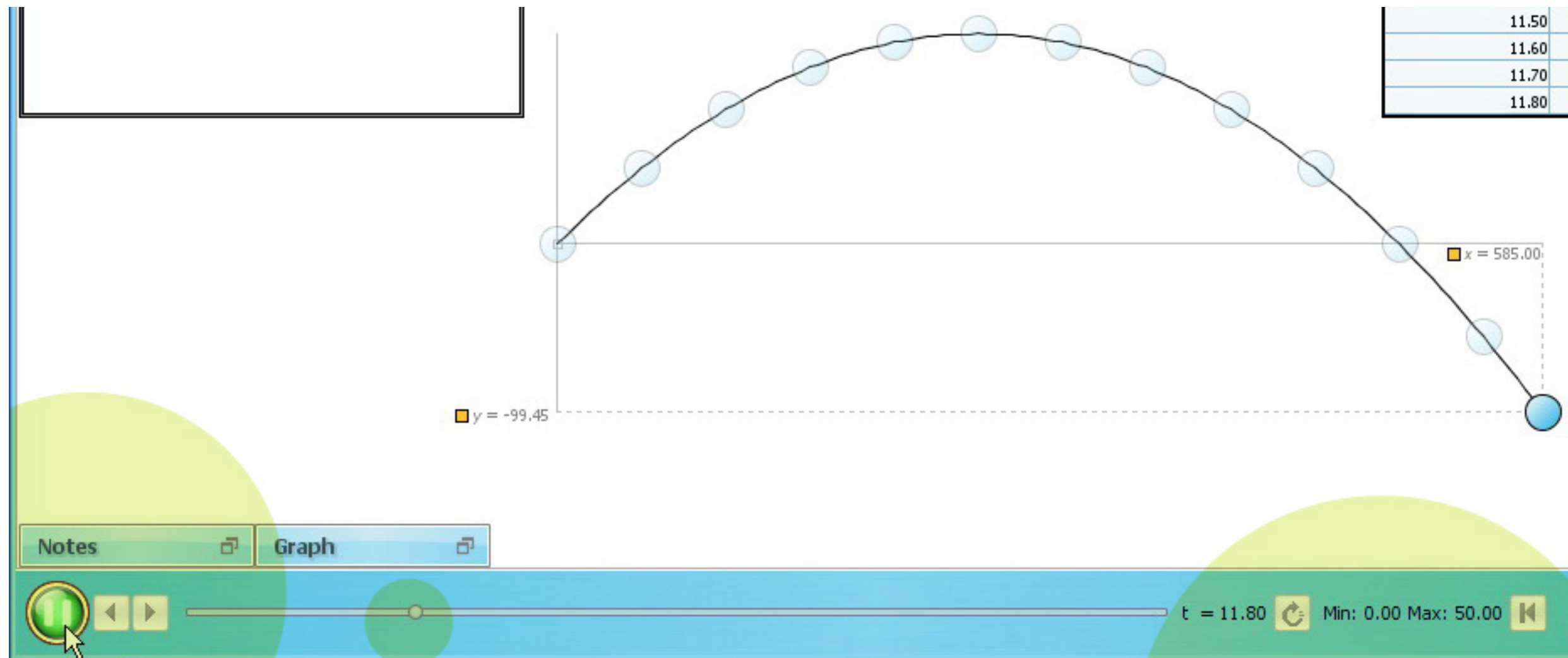
Click on the Particle to see its properties...

Use the Horizontal and Vertical variable boxes to select x and y as coordinates for the particle



2d See it in action: a simple example with functions (a model of projectile motion)

Run the model...



Run the Model...

The Run button is also the Pause button...

The current value of the independent variable is shown as a small ball alongside an horizontal line...

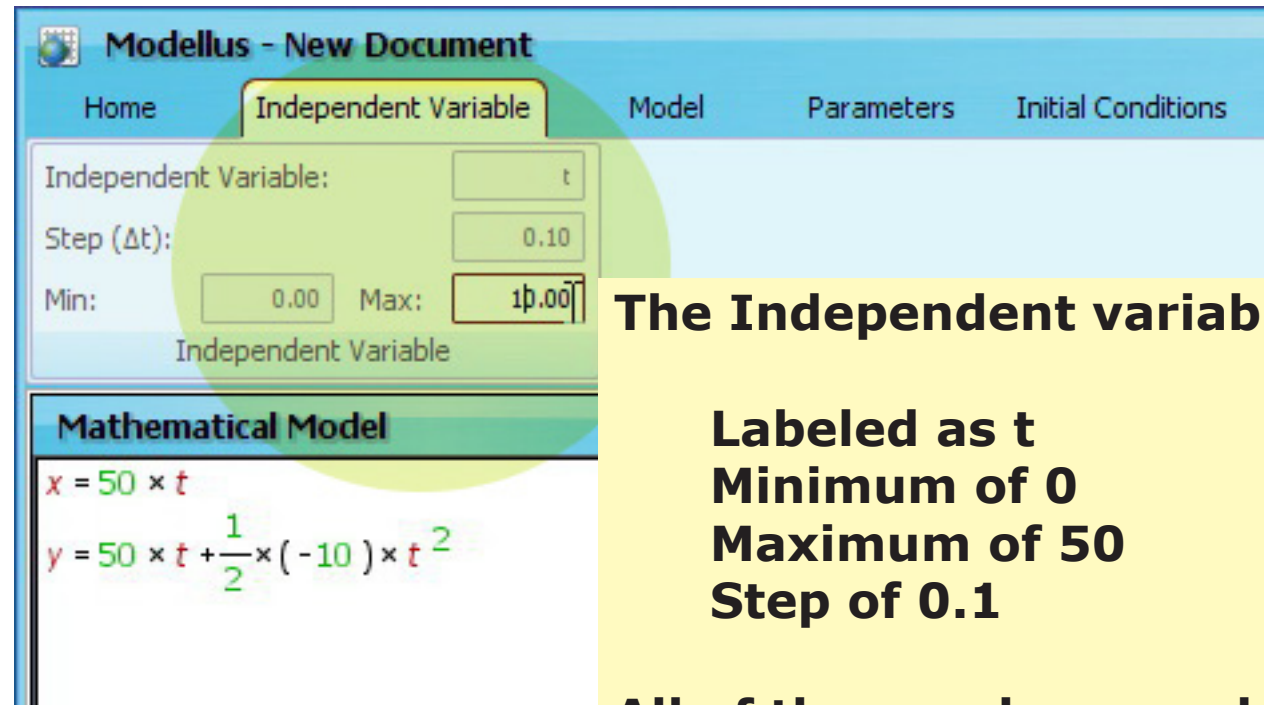
The current value of the independent variable is also shown as a number...

... as well as the Minimum and Maximum values.



2e See it in action: a simple example with functions (a model of projectile motion)

The Maximum value of the independent variable t is too big... but can be changed!



The Independent variable has the following default values:

Labeled as t
Minimum of 0
Maximum of 50
Step of 0.1

All of these values can be changed on the Independent Variable Ribbon

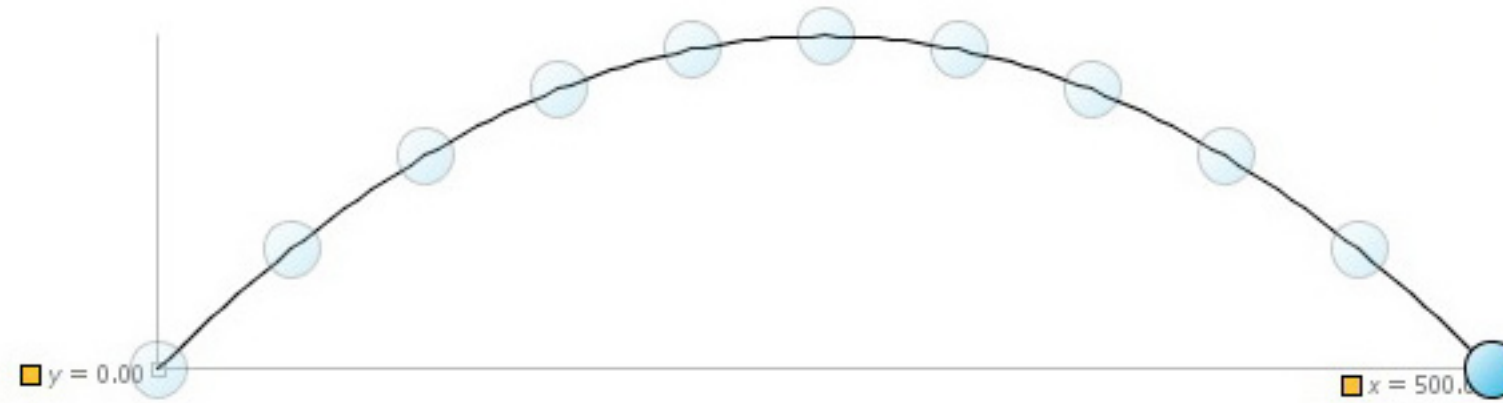
Define a domain $[0, 10]$ for t : Minimum value is 0, Maximum is 10 units

Don't forget to reset the Model, if necessary, using the Reset button 



2f See it in action: a simple example with functions (a model of projectile motion)

Play it again...



Run the model again... to check if the domain is correct

With a domain $[0, 10]$ for t , the projectile fly until the same height of the launching point...



2g See it in action: a simple example with functions (a model of projectile motion)

Place a Pen on the Workspace to make a graph of the vertical coordinate y...

The screenshot shows the Modellus software interface. The 'Table' ribbon is active, showing various options for drawing objects. The 'Pen' option is checked, and the 'Points' option is unchecked. The 'Horizontal' scale is set to 10.00 and the 'Vertical' scale is set to 1.00. The 'Mathematical Model' window displays the equations for projectile motion:

$$x = 50 \times t$$
$$y = 50 \times t + \frac{1}{2} \times (-10) \times t^2$$

The graph shows a parabolic trajectory of a projectile starting at the origin (0,0) and ending at (10,0). A red box highlights the 'Pen' icon on the workspace ribbon.

To place a Pen, use the right button or click on the icon on the Workspace Ribbon

Select the properties for the Pen on the Ribbon

The Horizontal scale was changed to 1 unit = 10 pixels because the default value (1 unit = 1 pixel) was too small...

The Pen can draw points or lines, just select or unselect the Points check-box



2h See it in action: a simple example with functions (a model of projectile motion)

And the complete model is...

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Mathematical Model

$$x = 50 \times t$$

$$y = 50 \times t + \frac{1}{2} \times (-10) \times t^2$$

Table

t	y
6.90	106.95
7.00	105.00
7.10	102.95
7.20	100.80
7.30	98.55
7.40	96.20
7.50	93.75
7.60	91.20
7.70	88.55
7.80	85.80
7.90	82.95
8.00	80.00
8.10	76.95
8.20	73.80
8.30	70.55
8.40	67.20
8.50	63.75
8.60	60.20
8.70	56.55
8.80	52.80
8.90	48.95
9.00	45.00
9.10	40.95
9.20	36.80
9.30	32.55
9.40	28.20
9.50	23.75
9.60	19.20
9.70	14.55
9.80	9.80
9.90	4.95
10.00	0.00

The trajectory is parabolic, as well as the function y... but these are two completely different parabolas!

The values on the table can be scrolled and shown with the scroll bar...

The Graph Window is minimized, as well as the Notes Window

Minimized Windows can be shown with a double click or a click on their top-right icon

Notes Graph

t = 10.00 Min: 0.00 Max: 10.00



2i See it in action: a simple example with functions (a model of projectile motion)

And now a complete movie on how to make the model...

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Modellus - New Document

Home Independent Variable Model Parameters Initial Conditions Table Graph **Objects** Notes

Particle Vector Pen Text Level Indicator Analog Variable Image Geometric Object Origin Measure Coordinates Measure Distance Copy Image Clipboard

Animation Objects

Mathematical Model

$$x = 50 \times t$$

$$y = 50 \times t + \frac{1}{2} \times [-10] \times t^2$$

Table

t	y
7.80	398.80
7.90	396.80
8.00	408.80
8.10	406.80
8.20	418.80
8.30	416.80
8.40	428.80
8.50	426.80
8.60	438.80
8.70	436.80
8.80	448.80
8.90	446.80
9.00	458.80
9.10	456.80
9.20	468.80
9.30	466.80

Notes Graph

Min: 0.00 Max: 10.00 t = 9.30



3 A more complex example with functions (exploring parameters)

Particle launched vertically, with different accelerations: what you will get...

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Mathematical Model

$$y = \frac{1}{2} \times a \times t^2 + v_0 y + y_0$$

$v_0 y = 50$
 $y_0 = 0$

Graph

Table

t	y
15.00	187.50
15.10	184.98
15.20	182.40
15.30	179.77
15.40	177.10
15.50	174.38
15.60	171.60
15.70	168.77
15.80	165.90
15.90	162.98
16.00	160.00
16.10	156.98
16.20	153.90
16.30	150.77
16.40	147.60
16.50	144.38

Notes

t = 16.50 Min: 0.00 Max: 20.00



3a A more complex example with functions (exploring parameters)

Create the mathematical model...

Modellus - C:\Principia\A visual introduction ... Java\4\modelo exemplo.n

Home Independent Variable Model Parameters Initial Conditions

Particle1

Horizontal: 30.00 Vertical: y

Coordinates: 30.00 y

Colour: Blue

Scale, 1unit = 1.00 1.00

Appearance

Mathematical Model

$$y = \frac{1}{2} \times a_y \times t^2 + v_{0y} \times t + y_0$$
$$v_{0y} = 50$$
$$y_0 = 0$$

Write the Mathematical Model...

The independent variable is the time t ...

This model is a function y that represents the vertical coordinate of a particle launched vertically with a certain initial velocity v_{0y}

Initial velocity and initial coordinate are given on the Mathematical Model Window

a_y is a free parameter...



3b A more complex example with functions (exploring parameters)

Give different values for the free parameter...

The screenshot shows the Modellus software interface. The title bar reads "Modellus - C:\Principia\A visual introduction ... Java\4\modelo exemplo.". The ribbon at the top has tabs for "Home", "Independent Variable", "Model", "Parameters", and "Initial Conditions". The "Parameters" tab is active, showing a table of parameters:

Parameter	Value
a_y	-5.00
	-10.00
	-15.00
	0.00
	0.00
	0.00

Below the ribbon, the "Mathematical Model" section displays the following equations:

$$y = \frac{1}{2} \times a_y \times t^2 + v_{0y} \times t + y_0$$
$$v_{0y} = 50$$
$$y_0 = 0$$

a_y is a free parameter...

On the Parameters Ribbon, give three different values for the free parameter...

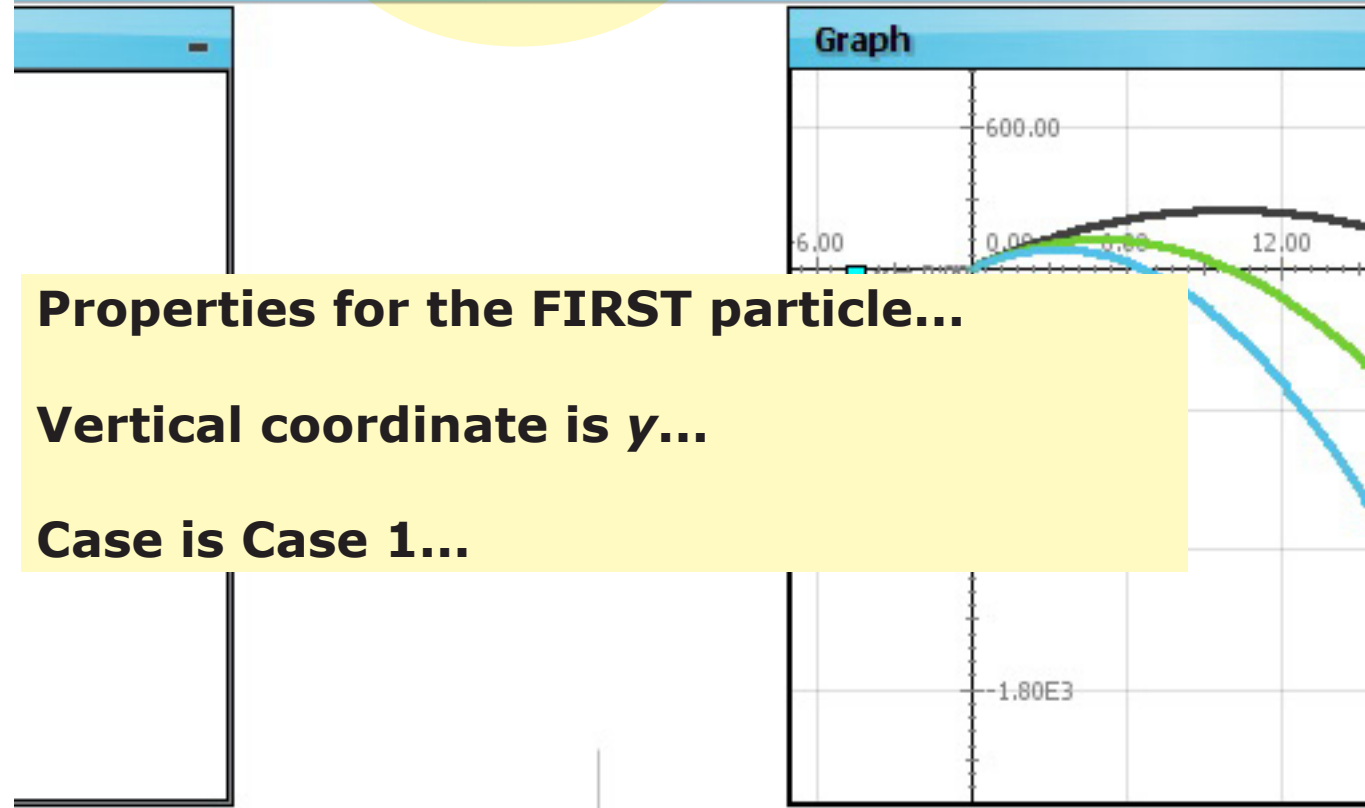


3C A more complex example with functions (exploring parameters)

Create three particles and attribute properties for the first particle...

introduction ... Java\4\modelo exemplo.modellus

Model	Parameters	Initial Conditions	Table	Graph	Objects
	Horizontal: 30.00	Vertical: y	<input checked="" type="checkbox"/> Value	<input checked="" type="checkbox"/> Axes	<input checked="" type="checkbox"/> Leave a mark e
			<input checked="" type="checkbox"/> Variable Name	<input checked="" type="checkbox"/> Projection Lines	<input type="checkbox"/> Case1
	le, 1unit = 1.00	1.00	<input checked="" type="checkbox"/> Trajectory	<input type="checkbox"/> Name	<input type="checkbox"/> Auto-Scale



Properties for the FIRST particle...
Vertical coordinate is y...
Case is Case 1...



3d A more complex example with functions (exploring parameters)

Attribute properties for the second particle...

introduction ... Java\4\modelo exemplo.modellus

Model	Parameters	Initial Conditions	Table	Graph	Objects
	Horizontal: 30.00	Vertical: y	<input checked="" type="checkbox"/> Value	<input checked="" type="checkbox"/> Axes	<input checked="" type="checkbox"/> Leave a mark e
	Unit: 1.00	1.00	<input checked="" type="checkbox"/> Variable Name	<input checked="" type="checkbox"/> Projection Lines	<input checked="" type="checkbox"/> Case2
			<input checked="" type="checkbox"/> Trajectory	<input type="checkbox"/> Name	<input type="checkbox"/> Auto-Scale

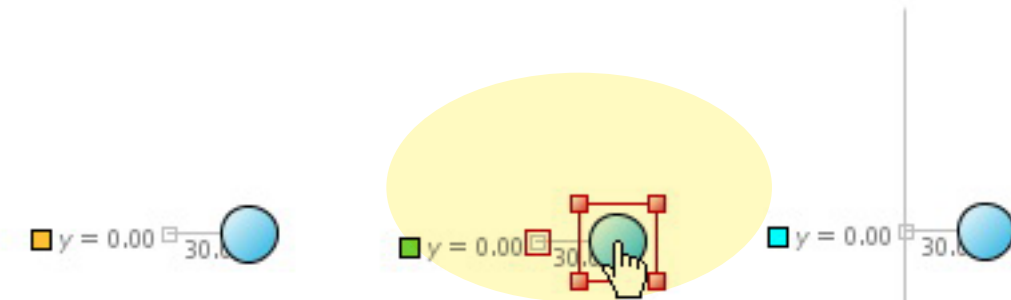
Graph

600.00

-1.20E3

-1.80E3

Properties for the SECOND particle...
Vertical coordinate is y...
Case is Case 2...





3e A more complex example with functions (exploring parameters)

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Attribute properties for the third particle...

introduction ... Java\4\modelo exemplo.modellus

Model	Parameters	Initial Conditions	Table	Graph	Objects
	Horizontal: 30.00	Vertical: y	<input checked="" type="checkbox"/> Value	<input checked="" type="checkbox"/> Axes	<input checked="" type="checkbox"/> Leave a mark e
	Unit: 1.00	1.00	<input checked="" type="checkbox"/> Variable Name	<input checked="" type="checkbox"/> Projection Lines	<input checked="" type="checkbox"/> Case3
			<input checked="" type="checkbox"/> Trajectory	<input type="checkbox"/> Name	<input type="checkbox"/> Auto-Scale

Graph

600.00

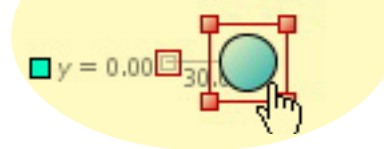
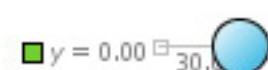
-1.20E3

-1.80E3

Properties for the THIRD particle...

Vertical coordinate is y...

Case is Case 3...





3f A more complex example with functions (exploring parameters)

Select what to display on the graph window...

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The screenshot shows the Modellus software interface. The top menu bar includes Home, Independent Variable, Model, Parameters, Initial Conditions, Table, Graph, Objects, and Notes. The Graph window is active, showing a grid with three curves: a black curve, a green curve, and a blue curve. The horizontal axis is labeled 't' and the vertical axis is labeled 'y'. The Graph window also shows a tooltip for a point on the blue curve at (3.97, -354.04). The Mathematical Model window shows the equation $y = \frac{1}{2} \times ay \times t^2 + v0y \times t + y0$ and the initial conditions $v0y = 50$ and $y0 = 0$.

Click on the Graph Window...

Select y for the vertical axis in the first three boxes...

Select Case 1 for the FIRST value of y

Select Case 2 for the SECOND value of y

Select Case 3 for the THIRD value of y



3g A more complex example with functions (exploring parameters)

Change the upper limit for the independent variable...

The screenshot shows the Modellus software interface. The title bar reads "Modellus - C:\Principia\A visual introduction ... Java\4\modelo exemplo". The ribbon menu includes "Home", "Independent Variable", "Model", "Parameters", and "Initial Conditions". The "Independent Variable" ribbon is active, showing the following settings: "Independent Variable:" set to "t", "Step (Δt):" set to "0.10", "Min:" set to "0.00", and "Max:" set to "20.00". Below the ribbon is the "Mathematical Model" section, which contains the following equations:
$$y = \frac{1}{2} \times ay \times t^2 + v0y \times t + y0$$
$$v0y = 50$$
$$y0 = 0$$

Click on the Independent Variable Ribbon...

Change the Max value for t : 20 units is a good value...



3h A more complex example with functions (exploring parameters)

See it all, as an image...

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The screenshot displays the Modellus software interface with the following components:

- Mathematical Model:**
$$y = \frac{1}{2} \times ay \times t^2 + v0y \times t + y0$$
$$v0y = 50$$
$$y0 = 0$$
- Graph:** A plot showing three trajectories (black, green, and blue) over time. The x-axis represents time (t) and the y-axis represents vertical position (y). Key points are labeled: $t = 9.90$, $t = 19.80$, $y = -970.20$, and $y = -1.95E3$.
- Table:** A data table with columns for time (t) and vertical position (y).

t	y
18.40	73.60
18.50	69.38
18.60	65.10
18.70	60.77
18.80	56.40
18.90	51.97
19.00	47.50
19.10	42.98
19.20	38.40
19.30	33.77
19.40	29.10
19.50	24.38
19.60	19.60
19.70	14.77
19.80	9.90
19.90	4.97
- Simulation Area:** A vertical axis with a series of blue circles representing the position of an object at discrete time intervals. The current position is labeled $y = 9.90$ at $t = 30.00$.
- Notes:** A text area at the bottom left for user notes.
- Timeline:** A control bar at the bottom showing the current time $t = 19.80$ and a range from $\text{Min: } 0.00$ to $\text{Max: } 20.00$.



3g A more complex example with functions (exploring parameters)

See it all, as a movie...

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Mathematical Model

$$y = \frac{1}{2} \times ay \times t^2 + v0y \times t + y0$$

$v0y = 50$
 $y0 = 0$

Graph

t	y
19.10	42.98
19.20	38.40
19.30	33.77
19.40	29.10
19.50	24.38
19.60	19.60
19.70	14.77
19.80	9.90
19.90	4.97
20.00	0.00
20.10	-5.02
20.20	-10.10
20.30	-15.23
20.40	-20.40
20.50	-25.62
20.60	-30.90

Table

t	y
19.10	42.98
19.20	38.40
19.30	33.77
19.40	29.10
19.50	24.38
19.60	19.60
19.70	14.77
19.80	9.90
19.90	4.97
20.00	0.00
20.10	-5.02
20.20	-10.10
20.30	-15.23
20.40	-20.40
20.50	-25.62
20.60	-30.90

Notes

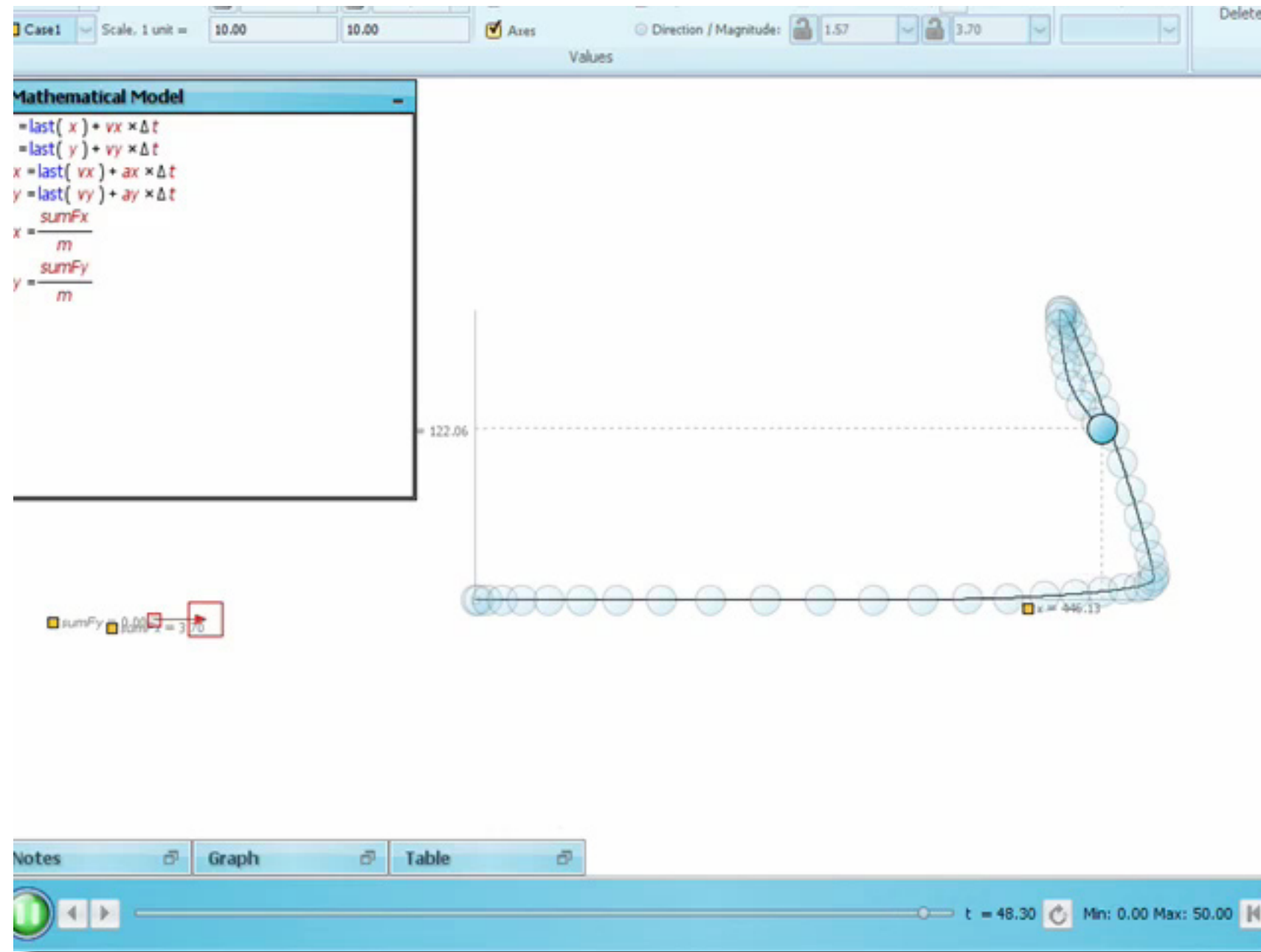
Timeline: t = 20.00, Min: 0.00, Max: 20.00



4 Exploring inertia with iterations

See a movie of what you will get...

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4a Exploring inertia with iterations

Creating the model...

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Particle Vector Pen Text Level Indicator Animation

Mathematical Model

$$x = \text{last}(x) + vx \times \Delta t$$
$$y = \text{last}(y) + vy \times \Delta t$$
$$vx = \text{last}(vx) + ax \times \Delta t$$
$$vy = \text{last}(vy) + ay \times \Delta t$$
$$ax = \frac{\text{sumFx}}{m}$$
$$ay = \frac{\text{sumFy}}{m}$$



4b Exploring inertia with iterations

Setting the scene... but there is a problem with the scale for the vector sum of the forces!

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The screenshot shows a software interface for a physics simulation. At the top, there are tabs for Home, Independent Variable, Model, Parameters, Initial Conditions, Table, Graph, Objects, Notes, and Animate. Below these are various control panels for a vector object, including color, coordinates, and scale settings.

The **Mathematical Model** panel contains the following equations:

$$\begin{aligned}
 x &= \text{last}(x) + vx \times \Delta t \\
 y &= \text{last}(y) + vy \times \Delta t \\
 vx &= \text{last}(vx) + ax \times \Delta t \\
 vy &= \text{last}(vy) + ay \times \Delta t \\
 ax &= \frac{\text{sum}Fx}{m} \\
 ay &= \frac{\text{sum}Fy}{m}
 \end{aligned}$$

The **Graph** panel shows a plot of position versus time. The x-axis ranges from -80.00 to 80.00, and the y-axis ranges from -80.00 to 80.00. A curve is plotted, and a point is labeled with $x = 54.14$ and $t = 6.30$.

The **Table** panel displays a data table with two columns, t and x . The data points are as follows:

t	x
4.00	209.4
4.90	207.4
5.00	203.5
5.10	199.5
5.20	193.4
5.30	186.4
5.40	178.2
5.50	168.7
5.60	158.1
5.70	146.2
5.80	133.1
5.90	119.0
6.00	103.9
6.10	87.7
6.20	71.1
6.30	54.1

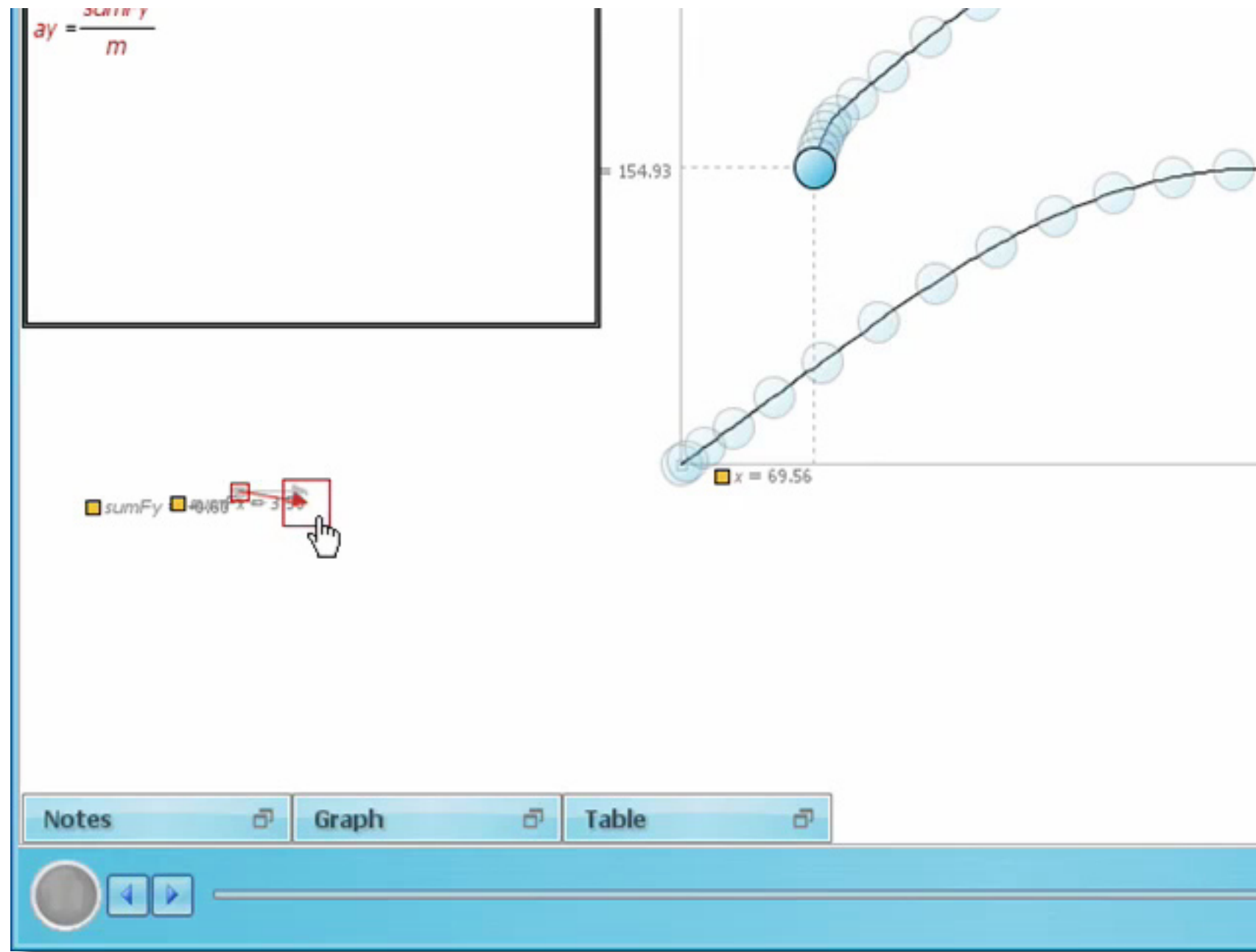
At the bottom left, there are labels for $\text{sum}Fy = 100.00$ and $\text{sum}Fx = -40.00$. The **Notes** panel is empty. The bottom status bar shows a play button, a slider, and the current time $t = 6.30$ with a range from Min: 0.00 to Max: 50.00.



4C Exploring inertia with iterations

Changing the scale for the sumF vector makes it more easy to control velocity...

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5 Chemical equilibrium with differential equations

The model. The graph shows how the system reacts to change in the concentration of a reactant

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Mathematical Model

$$\frac{dA}{dt} = -v1 + v2$$
$$\frac{dB}{dt} = v1 - v2$$
$$v1 = k1 \times A$$
$$v2 = k2 \times B$$

Graph

The graph plots concentration (y-axis, -0.50 to 3.00) against time (x-axis, 8.00 to 32.00). A red curve represents concentration A, which starts at 2.00, drops to a minimum of approximately 0.50 at t = 8.00, and then rises to a new equilibrium value of 0.88. A blue curve represents concentration B, which starts at 0.00, rises to a peak of approximately 1.50 at t = 8.00, and then settles at a new equilibrium value of 2.33. A vertical dashed line is drawn at t = 28.30, indicating the time of the concentration change.

Table

t	A
26.80	0.87
26.90	0.87
27.00	0.87
27.10	0.87
27.20	0.87
27.30	0.87
27.40	0.87
27.50	0.87
27.60	0.87
27.70	0.87
27.80	0.87
27.90	0.87
28.00	0.87
28.10	0.87
28.20	0.87
28.30	0.88

Visual Model

The visual model shows two connected tanks. The left tank has a blue liquid level at A = 0.88. The right tank has a red liquid level at B = 2.33. Sliders for parameters k1 = 0.64 and k2 = 0.24 are shown below the tanks.



5a Chemical equilibrium with differential equations

Creating the model...

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The screenshot shows the Modellus software interface. The title bar reads "Modellus - New Document". The menu bar includes "Home", "Independent Variable", "Model", "Parameters", "Initial Conditions", and "Ta". The "Model" menu is open, showing options: "Copy Image", "Interpret", "Power" (x^n), "Square Root" (\sqrt{x}), "PI" (π), "e", and "Delta" (Δx). Below the menu is a "Mathematical Model" window containing the following equations:

$$\frac{dA}{dt} = -v1 + v2$$
$$\frac{dB}{dt} = v1 - v2$$
$$v1 = k1 \times A$$
$$v2 = k2 \times B$$

A yellow circle highlights a mouse cursor pointing at the bottom right corner of the "Mathematical Model" window.



5b Chemical equilibrium with differential equations

Creating controls for initial values and for parameters... and giving values for them

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Independent Variable Model Parameters Initial Conditions Table Graph Objects Notes

Pen Text Level Indicator Analog Variable Image Geometric Object Origin Measure Coordinates Measure Distance Copy Image Clipboard

Animation Objects

Model

Graph

t	A
0.00	1

A = 1.15

B = 0.42

k1 = 0.46

k2 = 0.73



5C Chemical equilibrium with differential equations

Running the model and changing values interactively...

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Modellus 4, A Visual Introduction for Teachers

The screenshot shows the Modellus software interface with the following components:

- Mathematical Model:**
$$\frac{dA}{dt} = -v1 + v2$$
$$\frac{dB}{dt} = v1 - v2$$
$$v1 = k1 \times A$$
$$v2 = k2 \times B$$
- Graph:** A plot showing the concentration of A (blue line) and B (red line) over time. The x-axis represents time (t) from 0 to 50, and the y-axis represents concentration from 0.00 to 1.50. The graph shows a step-like behavior where the concentrations change abruptly at certain time intervals.
- Table:** A data table with columns for time (t) and concentration (A). The data points are as follows:

t	A
48.50	0.79
48.60	0.79
48.70	0.79
48.80	0.79
48.90	0.79
49.00	0.79
49.10	0.79
49.20	0.79
49.30	0.79
49.40	0.79
49.50	0.79
49.60	0.79
49.70	0.79
49.80	0.79
49.90	0.79
50.00	0.79
- Visual Representation:** Four diagrams of a two-compartment system. The top-left diagram shows A = 0.7 and B = 0.0. The top-right diagram shows A = 0.51 and B = 0.0. The bottom-left diagram shows A = 0.46 and B = 0.0. The bottom-right diagram shows A = 0.72 and B = 0.0.
- Notes:** A text area at the bottom left for user notes.
- Timeline:** A slider at the bottom right showing the current time t = 50.00, with a range from Min: 0.00 to Max: 50.00.