Newton Index

Newton: A Newtonian motion simulator
v1.0 for Windows 3.1
© 1993 by Paul Keet

Newton is shareware. Please send in a registration fee of $10, this will allow me to make more and better programs. My address is:

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Thank you for you support.

Introduction to Newton

Newton provides a user-friendly system for simulating the motion of masses (referred to in this program as bodies) in space.

Using functions described in this help document, the user may easily create and modify the starting positions and velocities of bodies in space and allow the user to easily change characteristics like mass and radius.

The user is provided with an information bar at the top of the screen indicating the position of the mouse, the position and velocity of an object and the scale of grid used in the simulation. The simulation may be navigated by using the right-hand mouse button or by using the keypad.

Collisions between bodies are indicate by the sound of an explosion and the halting of the simulation. Bodies are also given a minimum pixel size on screen of a three pixel radius -- given the real proportions of bodies like the earth and the moon relative to the space they inhabit most objects would otherwise simply disappear on screen.

The purpose of Newton is to encourage the user to explore the orbits of objects in space. The best way to explore is simply to play around with various menu commands until you can create and modify your own systems.

Please submit all comments to the author at the address in the comments section.

See also:

Newton's Laws

Editing a Body

You must first select a body by double-clicking on a body or by choosing a body through the 'Edit Body...' menu command (found under the 'Body' heading). Creating a new body will also call up the edit dialog.

You can change the name of the body by clicking in the name field, typing in the new name and selecting the 'Okay' button. You can change the mass of the body either by using the scroll bar or by typing in the new mass in the mass field.

All other characteristics of the body can be changed by selecting the appropriate button. See also:

Editing Color
Editing Radius and Density
Editing Position
Editing Velocity

Editing Color

After selecting a body to edit, you can change the color of the body disc and the trail left by the body. The number of colors available is dependent on the way you have windows configured.

Colors can be quickly selected by choosing from the basic colors or by clicking at a point on the color map. Exact colors can be specified either through setting the Red, Green and Blue (RGB) values or by adjusting Hue, Saturation and Luminosity (HSL).

See also:

Editing a Body
Selecting a Body

Edit Position

The position of a selected body can be change in one of two ways:

1) Select the body and choose Position in either the edit dialog or by using the menu command. Enter the distance and direction of the body from the central body directly into the dialog.

2) Simply drag the body using the mouse. This only works if the body being moved is other than the central body.

See also:

Editing a Body
Selecting a Body

Editing Radius and Density

After selecting a body to edit, you can change the radius and the density simultaneously with this dialog. This dialog is not only useful in changing the size of the selected body, it also demonstrates the relationship between radius (which also suggests volume) and density (which depends on volume).

The following formulae describe the relationships used in the dialog:

$$\text{Density} = \frac{1}{\text{Volume}} = \frac{1}{4/3 \times Pi \times Radius^3}$$

You can adjust the radius or density either through using the scroll bars or by entering a value in the appropriate field. If you type in a new value for the radius, you can see what the resulting density is by using the ">" button. Likewise you can use the "<" button to convert density into radius.

See also:

Editing a Body
Selecting a Body

Editing Velocity

You can edit velocity in two basic ways:

1) Type in the velocity by selecting the body and choosing 'Velocity.'

2) Select the body. A red or a green spline will appear attached to the body. Adjust the velocity by grabbing the bulb on the end of the spline and moving it. The length and direction of the spline will correspond to the velocity and direction of the body.

   The velocity of the object is shown on the information bar at the top of the screen.

   A red spline indicates the use of a logarithmic scale for selecting velocity. Use the logarithmic scale to set the approximate velocity. A green spline indicates a linear scale. Use the linear scale to accurately set the velocity after using the logarithmic scale. You can switch between logarithmic and linear scales by pressing '**F2**' or by selecting the scale under the Options menu.

   This method will not work if the body selected is the central body.

See also:

Editing a Body
Selecting a Body

File Menu Commands

The following file commands are available:

New	Delete the current system.
Open	Opens a previously save system. The system, the <u>options</u> and the <u>time step</u> will be loaded.
Save	Saves a system. If it is a new system, you will be prompted for a file name. This function will save all the options currently set in Newton.
Save As	Saves a system as a different file.
Exit	Quits Newton.

See also

<u>Options</u>
<u>Time step</u>

Moving Around

Centering the Screen around a Body:

Initialize	This function will centre the screen around the most massive body at an appropriate scale.
Centre on a Body	This function allows the user to select a body and centre the screen around that body.
Re-Centre on a Body	This function will centre the screen around a body previously chosen using the Centre function. You may also use the 'Home' key to activate this function.

Zooming In and Out:

To **zoom in** on the centre of the screen, select the '+' key.

To **zoom out** from the centre of the screen select the '-' key.

You may navigate around the screen by using the mouse or by using the numeric keypad on the keyboard.

Navigating with a Mouse:

Move the mouse to the location on the screen you would like to make the new centre of the screen. Click the right mouse button. The position of the mouse appears in the upper left-hand corner of the information bar.

Although this method of moving around the screen might take some getting used to, it is by far the easiest method of navigating.

Navigating with the Keypad:

 You may use the keypad (with NumLock selected) to move around the screen

Other keyboard commands:

F1   Calls up this help document.
F2   Switches between linear and logarithmic <u>velocity scales</u>.
Home   Centres screen on the body selected for that purpose.
Esc   Redraws the screen with no body outlines left at the start.

Newton's Laws

Newton developed three laws (more correctly theories) of motion:

1) Every body continues in its state of rest, or in uniform motion in a right line unless it is compelled to change that state by forces impressed upon it.

2) The change of motion is proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.

3) To every action there is always opposed an equal reaction; or, the mutual actions of two bodies upon each other are always directed to contrary parts.

To completely understand the motion of massive bodies through space it is also necessary to understand *Newton's law of gravitation*:

F stands for force (mass x acceleration)

G stands for the universal gravitational constant (= 7.67 x 10-11 N.m2/kg2)

M & **m** denote masses

r denotes the distance between the two masses

The Newton program follows this formula. For a full discussion of the motion of bodies through space, look up these topics in any basic physics textbook.

Options

The following options are available for Newton under the 'Options' menu:

Trail	Causes moving bodies to leave trails.
Relative Coordinates	Keeps the central body fixed on the view screen.
Polar Coordinates	Selecting this option will switch the coordinate system from a rectangular (Cartesian) to an polar (Angular) system.
Grid	Plots a conveniently scaled grid on the view screen with the central body as its origin.
Linear Vel Scale	Sets the <u>velocity</u> spline to use a linear scale.
Logarithmic Vel Scale	Sets the <u>velocity</u> spline to use a logarithmic scale.
Screen Font	Saves a system as a different file.

Option settings are saved when Newton systems are saved and loaded when Newton systems are loaded.

See also:

<u>File Menu Commands</u>
<u>Time step</u>

Selecting a Body

You can select a body for editing by either clicking on the body or by using the 'Select Body' command under the 'Body' menu.

See also:

Time

Learning to use the **Time step** command is extremely important to your use of Newton.

Newton simulates the motion of bodies by projecting the velocity and acceleration at an instant and calculating the new position and velocity a certain amount of time after the instant. The discrete unit of time between one unit and the next is called, in Newton, a **Time step**.

Naturally the larger the time step (measured in seconds) between calculations the faster the whole simulation will go. However, if the Time step is too great inaccuracies will arise in the simulation causing jagged motion or unnaturally wobbly orbits. If you are experiencing problems in the simulation (jagged/wobbly motion or no motion) play around with the Time step.

The following commands are available under the Time step menu:

Fixed	Simulate motion in fixed Time step intervals. With this option selected motion will appear natural.
Optimized	Adjusts the Time step to maintain the accuracy of the simulation. With this option selected bodies won't appear to change speed naturally; however the simulation will be accurate under a wider set of circumstances.
Change Settings	Selecting this command will cause a dialog box to appear. You may then select a new Time step in seconds either by using the scroll bar or by typing in a value.

See also:
File Menu Commands
Options