

The Gravitational field

The use of multimedia in teaching physics

The user's guide to the multimedia presentation

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The introduction

The multimedia presentation consists of one executable file. The application is multiplatform, in the Windows operation system run the *gpole_en.exe* file, in the Mac OS run the *gpole_en.hqx* file and in the Linux run the *gpole_en.swf* file. No installation is needed (except the Flash Player for the Linux operation system) so the program is ready for use just after the download. The part of the file's name after the underline indicates the language version. Separate texts of the presentation are available in Adobe PDF (*texty_en.pdf*). Everybody can download the latest version of all these files for free on the projects web site <http://www.gfxs.cz/gpole/>.

After running the *gpole_en.exe* file (or another above-mentioned *gpole_en.** files) a short intro appears (it can be skipped by clicking on the *Skip intro* button). Then the start page of the multimedia presentation The Gravitational field is displayed.

1. The basic layout

The presentation itself is wide-spread all over the screen's desktop which is divided into five parts:

- The top zone is composed by an illustrative picture and a gently animated heading *The Gravitational field: Physics in texts, simulations and physical problems*.
- The biggest part of the screen is occupied by a panel in which are the texts, simulations, physical problems and additional information loaded.
- A column in which the user chooses the themes and its chapters according to the systematically made tree type structure is situated in left side of the screen.
- One, two or three icons are displayed to the appropriate chapter just under this menu. After clicking them the text, the simulation or the physical problem is loaded into the main panel.
- Quick options could be found on the bottom strip of buttons (a few useful buttons for displaying information which are not directly connected with education). There are buttons to return to the start page, to show the list of used literature, the information about authors, brief and apposite help, background music controller and a button to quit the whole presentation. These buttons are also accessible from every place of the multimedia presentation.

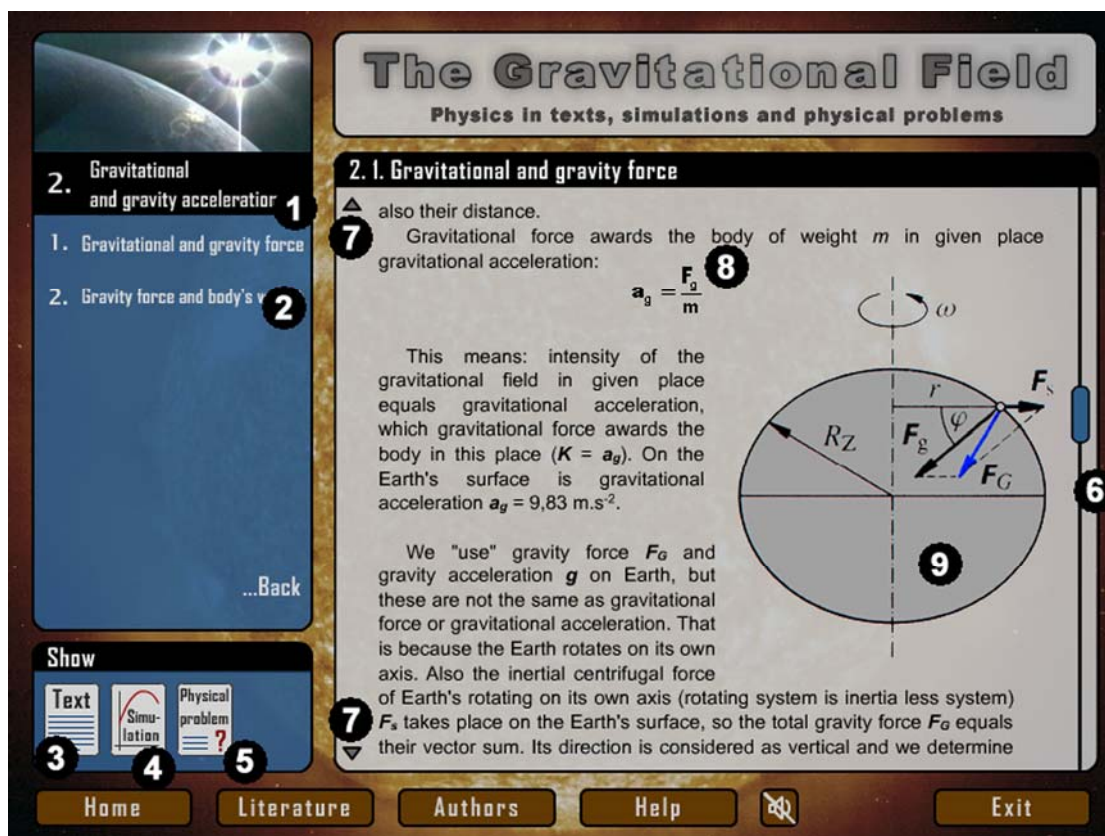


Picture 1.1 – Basic layout

1. the main menu with six themes
2. the frame designed for switching between the text, the simulation and the physical problem
3. the main information window
4. skips to the start page
5. shows the list of used literature
6. shows information about the authors
7. shows brief help
8. enables and disables sound
9. quits the whole multimedia presentation

2. The theme's content

Each theme contains several chapters. In case that displayed text is larger than the frame, you can move with the text by handling the scroll bar on the right side. This situation is indicated by a small triangle on the left side of the text frame. To scroll two lines you can use the cursor keys, to move to the next page use the Page Up and Page Down keys.



Picture 2.1 – The theme's content

1. shows the introduction to current theme
2. switching between the chapters, the *Back* button returns the user to the start page
3. shows the text of the current chapter
4. shows the simulation to the current chapter
5. shows the physical problem to the current chapter
6. the scroll bar to scroll the text
7. small triangles indicates, that you can scroll the text
8. the text of the chapter is supplemented with physical formulas, the chapter's heading is displayed in the black headline
9. the text of the chapter is also supplemented with images

3. The physical problem

At the first time only the assignment of the problem is displayed. If the user is interested in the solution including the whole progress, he can click the *Show solution* button. The solution can be hidid again by the *Hide solution* button.

The problem with hidden solution:



Picture 3.1 – Physical problem with hidden solution

1. the physical problem's assignment
2. the button to show the problem's solution

The problem with displayed solution:

The screenshot shows a software interface titled "The Gravitational Field" with the subtitle "Physics in texts, simulations and physical problems". The main content area displays a physics problem and its solution. The problem asks for the gravity force's value on the equator and poles for a 10 kg body. The solution includes formulas for centripetal force, gravitational force, and their sum, with numerical calculations for both cases. The interface also features a sidebar with navigation options, a "Show" section with icons for Text, Simulation, and Physical problem, and a bottom navigation bar with buttons for Home, Literature, Authors, Help, and Exit.

The Gravitational Field
Physics in texts, simulations and physical problems

2. Gravitational and gravity acceleration

1. Gravitational and gravity force
2. Gravity force and body's weight

...Back

Show

Text Simulation Physical problem ?

2. 1. Gravitational and gravity force

What is the gravity force's value, which affects a body of 10 kg weight

a) on the equator? **1**
b) on the poles?

Hide solution **2**

$m = 10 \text{ kg}; F_G = ?$

$r = R_z \cdot \cos \alpha$

$\omega = \frac{2 \cdot \pi}{T} = \frac{2 \cdot \pi}{86400} \text{ s}^{-1} = 7,3 \cdot 10^{-5} \text{ s}^{-1}$

$F_s = \frac{m \cdot v^2}{R_z} = \frac{m \cdot \omega^2 \cdot r^2}{R_z} = m \cdot \omega^2 \cdot R_z \cdot \cos^2 \alpha$

$F_g = \kappa \cdot \frac{m \cdot M_z}{R_z^2} = 6,67 \cdot 10^{-11} \cdot \frac{10 \cdot 6 \cdot 10^{24}}{(6,38 \cdot 10^6)^2} \text{ N} = 98,3 \text{ N}$

$F_G = F_g + F_s$ **3**

a) $\alpha = 0^\circ$
 $\cos \alpha = 0$
 $F_s = 10 \cdot (7,3 \cdot 10^{-5})^2 \cdot 6,38 \cdot 10^6 \cdot 1 \text{ N} = 0,034 \text{ N}$
 $F_G = 98,3 - 0,034 \text{ N} \doteq 97,9 \text{ N}$

b) $\alpha = 90^\circ$
 $\cos \alpha = 1$
 $F_s = 0 \text{ N}$
 $F_G = 98,3 \text{ N}$

The gravity force's value on the equator is 97,9 N and on the poles it is 98,3 N.

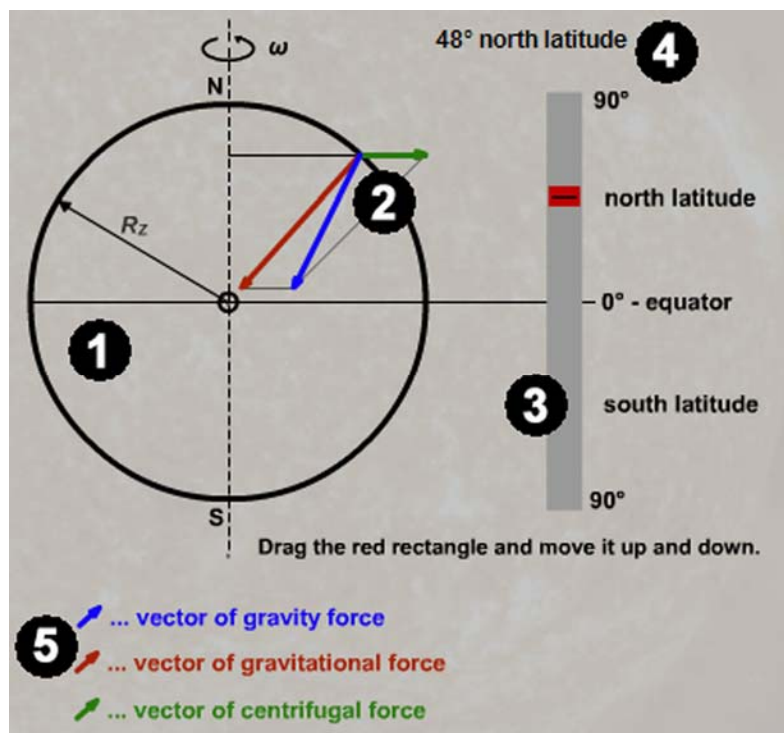
Home Literature Authors Help Exit

Picture 3.2 – Physical problem with displayed solution

1. the physical problem's assignment
2. the button to hide the problem's solution
3. the whole solution of the problem including the progress and the answer

4. The simulation of the relationship between the gravitational and the gravity force

The simulation clearly shows that the gravity force is the vector sum of the gravitational and the centrifugal force. The change of the gravity force's size during the transformation from the equator to the pole is noticeable too. The latitude can be changed by handling the red oblong by mouse. It can be also changed by using the cursor keys. Current latitude is displayed in the top right corner.

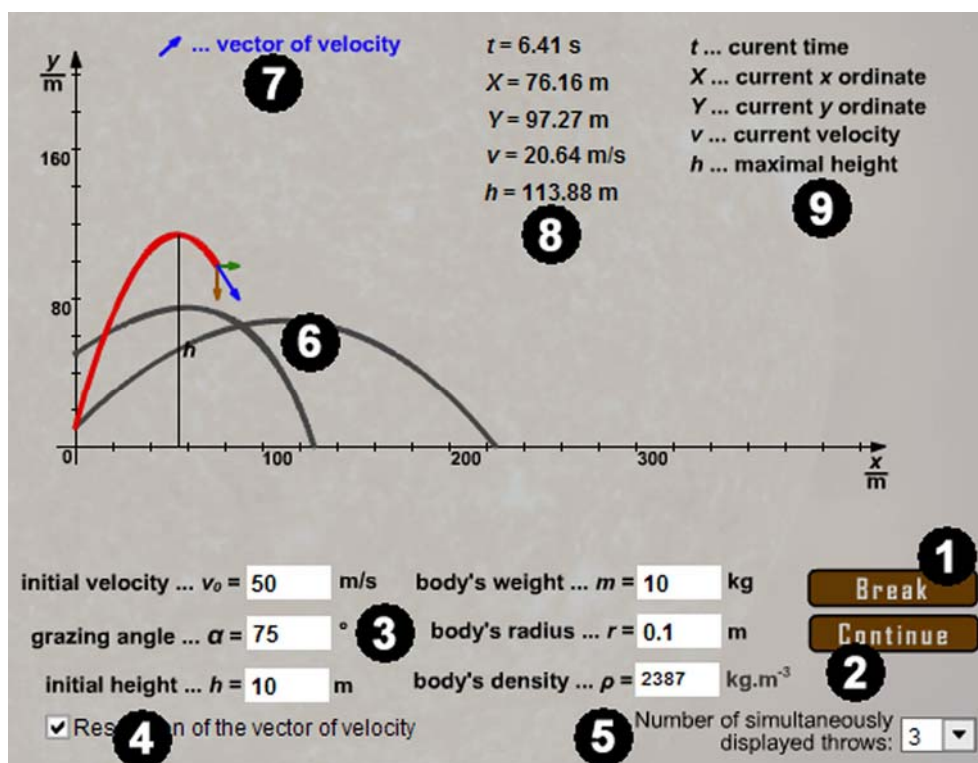


Picture 4.1 – The simulation of the relationship between the gravitational and the gravity force

1. the cross-section of the Earth
2. the gravity force equals the vector sum of the gravitational and the centrifugal force
3. the latitude's scale
4. current latitude
5. the legend to the vectors

5. The simulations of the throws

The multimedia presentation contains simulations of five types of throws: the free fall, the vertical throw upwards, the horizontal throw, the oblique throw upwards and the oblique throw upwards with indispensable air resistance. The curve of the body's movement is painted in real time after running the throw's simulation. All information about the body's movement is displayed in top right part of the screen. We are going to show you the way to control these simulations only on the most complicated throw, the others are controlled in the same way and they have only fewer input boxes. The user will be warned if he gives wrong input parameters. The simulations do not start until accepted parameters have been given.

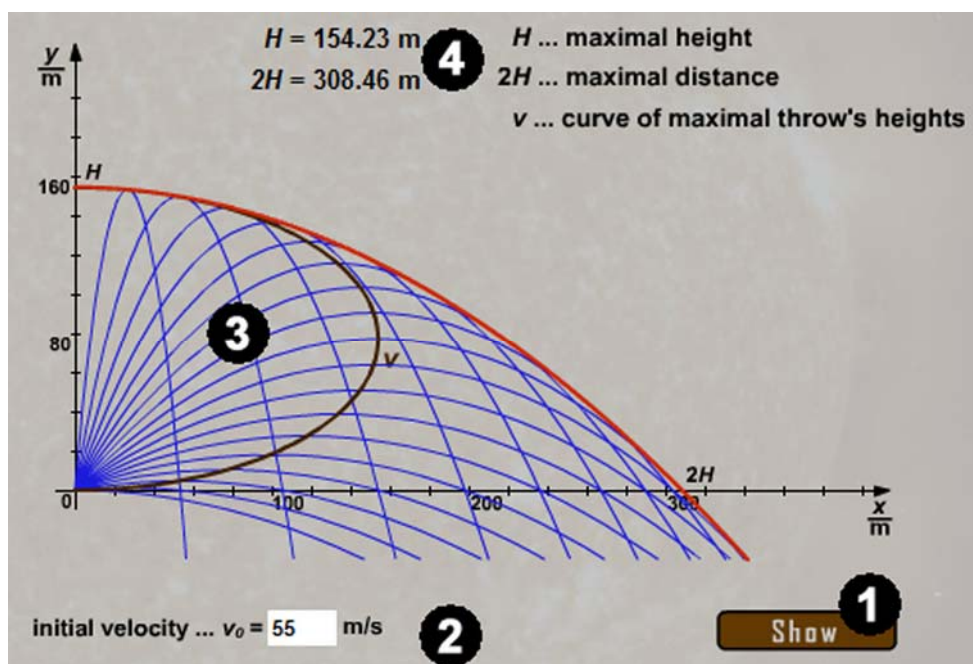


Picture 5.1 – The simulations of the oblique throw upwards with indispensable air resistance

1. the *Throw – Break* button: runs throws, if the throws is running it interrupts it
2. the *Pause – Continue* button: pauses the throw, runs the paused throw
3. the input boxes for the input magnitudes
4. switch on/off the velocity vector's resolution
5. the count of simultaneously displayed throws
6. the throws' trajectories
7. the legend to the vector
8. the information about the time, the body's velocity and current position
9. the glossary to the magnitudes

6. The simulation of the security parabola

This simulation allows you to see the security parabola for given velocity after clicking the *Show* button. The security parabola – the red curve – defines an area where it is possible to hit a given point with constant initial velocity with the oblique throw upwards only by changing the grazing angle.

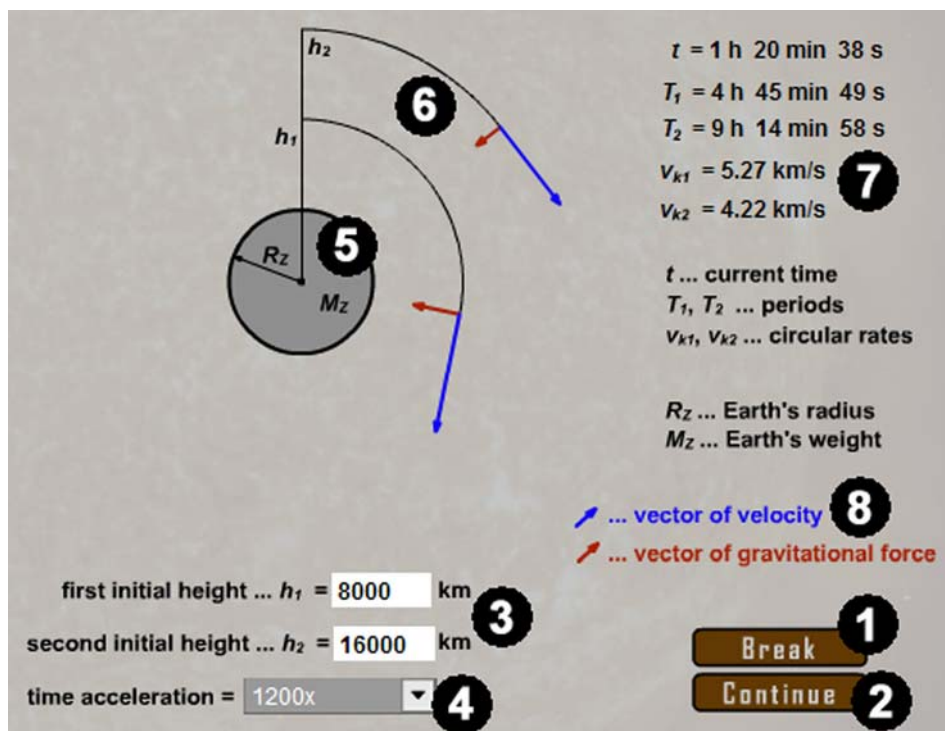


Picture 6.1 – The simulation of the security parabola

1. the *Show* button
2. the input box for the initial velocity
3. the security parabola
4. the information about maximal height and distance of the throw

7. The simulation of the circular rate

This simulation allows the user to observe two bodies which are moving around the Earth on two differently big circular trajectories (orbits). It is noticeable that the closer to the Earth the body is, the faster its movement is. Except of inserting the bodies heights the user can specify the time acceleration (from 10× to 1200×).

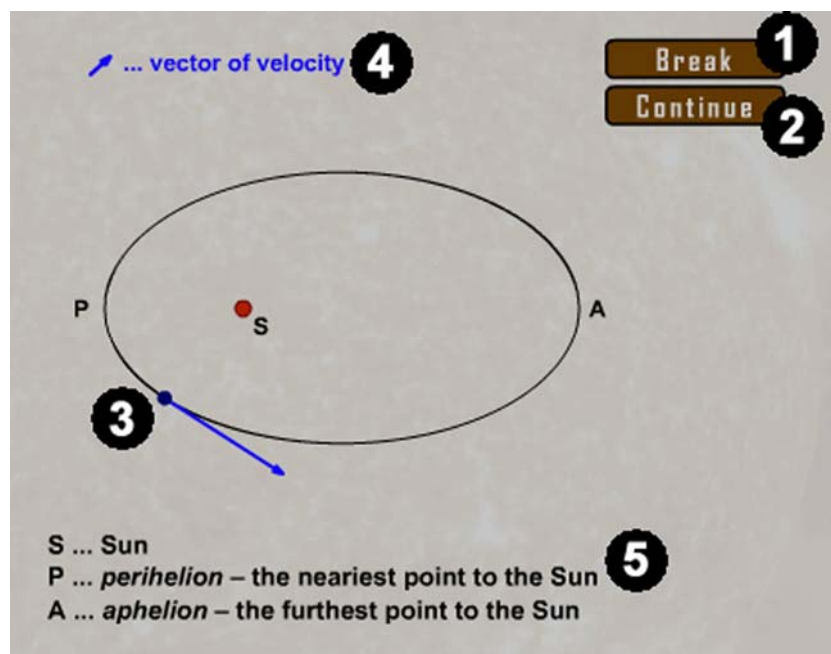


Picture 7.1 – The simulation of the circular rate

1. the *Start – Break* button: runs the circulation, if the circulation is running, it interrupts it
2. the *Pause – Continue* button: pauses the circulation, runs the paused circulation
3. the input boxes for two heights (the orbits' radiuses)
4. the time acceleration controller
5. the Earth
6. the orbits in h_1 and h_2 heights
7. the information about the time, the velocities and the periods of both bodies
8. the legend to the vectors

8. The simulation of the second Kepler's law

This simulation shows the movement of a body on an elliptic trajectory around the Sun. It shows that the body's velocity is bigger in perihelion than in aphelion.



Picture 8.1 – The simulation of the second Kepler's law

1. the *Start – Break* button: runs the circulation, if the circulation is running, it interrupts it
2. the *Pause – Continue* button: pauses the circulation, runs the paused circulation
3. the body on an elliptic trajectory with the velocity vector
4. the legend to the vector
5. the meaning of the points