1703

Гимназија Јован Јовановић Змај

Colegiul Național „Constantin Diaconovici Loga" din Timișoara

Co-funded by the Erasmus+ Programme of the European Union

Project title: **Computer supported Math teaching,** COMPMATH
Ref. No.: KA210-SCH-ABDA6A90
Action Type: KA210-SCH - Small-scale partnerships in school education

Author: Jeflea Ioana
School: National College "Constantin Diaconovici Loga", Timișoara

Applications of Equations in Solving Physics Problems

2022/2023

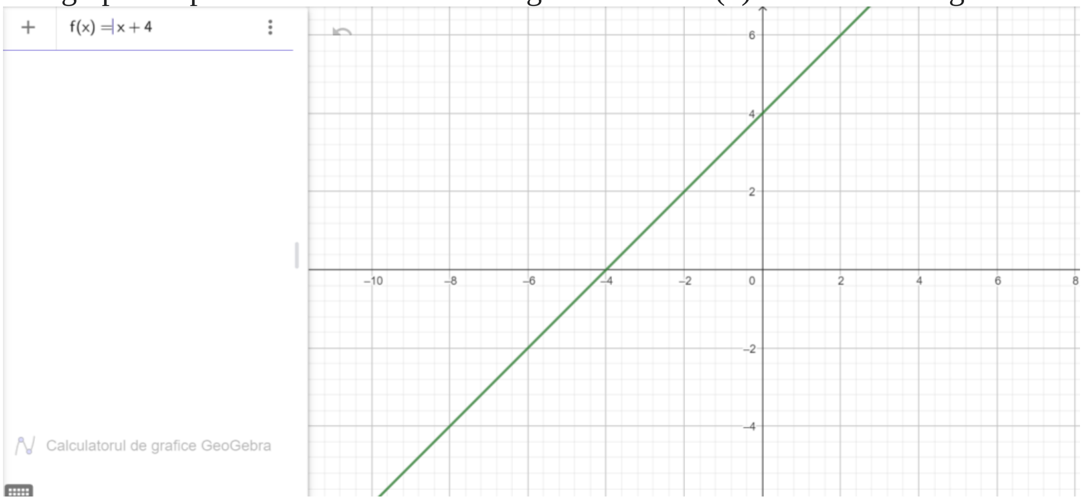
Table of contents

Aplications of equations in physics

1. **Theoretical notions**

1.1 First Degree Equation

The general form of a first degree equation is ax+b=0, x is the variable, and a and b are constants (a ≠ 0). The solution of the equation is $x = -\frac{b}{a}$.
The graphic representation of the first degree function f(x)=ax+b is a straight line.



1.2 Second Degree Equation

The general form of a second degree equation is: ax^2+bx+c=0.
where: x is the variable, and a, b, and c are constants (a ≠ 0). The constants a, b, and c are called:

- a, coefficient of the squared term
- b, coefficient of the linear term
- c, constant term or free term

Δ=b^2-4ac is called the discriminant of the equation.
The roots of the algebraic equation of degree two are expressed by the formula:

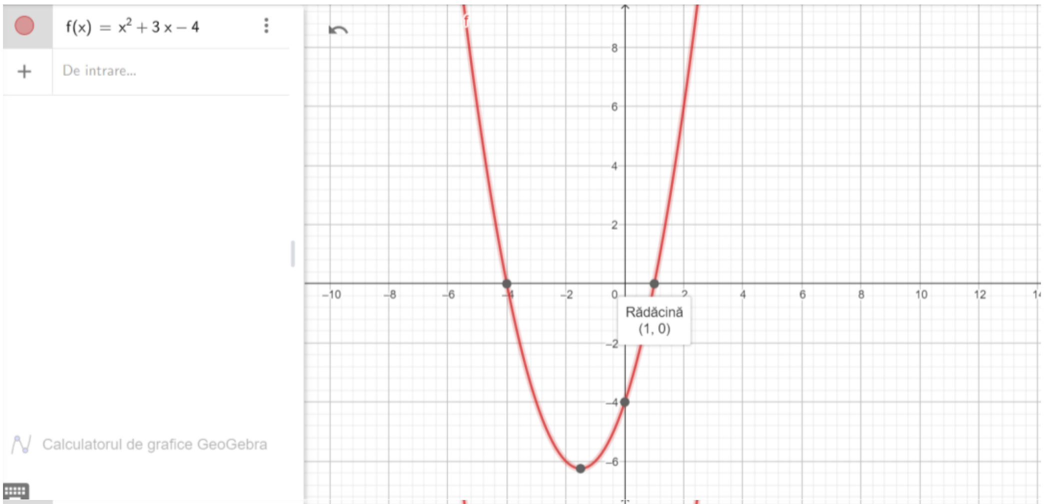
$$x_{1,2} = \frac{-b \pm \sqrt{\Delta}}{2a}$$

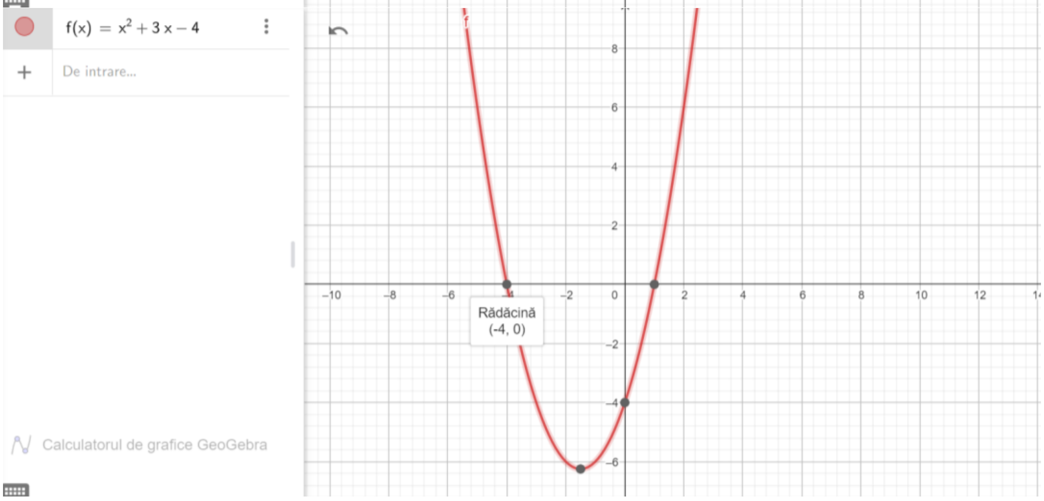
The following cases can be encountered:
• Δ>0, the equation has two distinct real solutions $x_1 \neq x_2$
• Δ=0, the equation has two identical real solutions $x_1 = x_2$
•Δ<0, the equation has no real solutions.
The graphic representation of the second degree function $f(x) = ax^2 + bx + c$ is a parabola.

1.3 Example of Solving a Second Degree Equation

$x^2 + 3x - 4 = 0$
$a = 1$
$b = 3$

$c = -4$
$\Delta = b^2 - 4ac, \Delta = 9 + 16 = 25$
$$x_{1,2} = \frac{-b \pm \sqrt{\Delta}}{2a}$$
$$x_{1,2} = \frac{-3 \pm 5}{2}$$
$x_1 = 1$ *is the first root of the equation*
$x_2 = -4$ *is the second root of the equation*





2. Applications of equations in physics. Solving motion problems.

2.1. Uniformly Variable Rectilinear Motion

Uniformly Variable Rectilinear Motion is the motion of a body on a rectilinear path with constant acceleration.

The law of uniformly variable rectilinear motion is $x = x_0 + v_0 t + \frac{1}{2} a t^2$ where the physical quantities are as follows:

x_0 - initial coordinate
v_0 - initial velocity
a - acceleration
t – time

Example 1:

Two bodies start from the same point in the same direction with initial speeds $v_{01} = 6\frac{m}{s}$ and $v_{02} = 2\frac{m}{s}$ and accelerations $a_1 = 2\frac{m}{s^2}$ and $a_2 = 4\frac{m}{s^2}$. Body 2 starts at an interval τ=21s later than body 1. Find out after how much time and at what distance the bodies will meet.

Solution) We choose the origin of time at the moment when the first body starts. The laws of motion for the two bodies will be:

$x_1 = v_{01}t + \frac{1}{2}a_1t^2$ for the first body

$x_2 = v_{02}(t-\tau) + \frac{1}{2}a_2(t-\tau)^2$ for the second body

The condition for the meeting is $x_1 = x_2$. At the time of the meeting, the bodies are in the same point, at the same distance from the origin.

$$v_{01}t + \frac{1}{2}a_1t^2 = v_{02}(t-\tau) + \frac{1}{2}a_2(t-\tau)^2$$

$$x_1 = t^2 + 6t$$

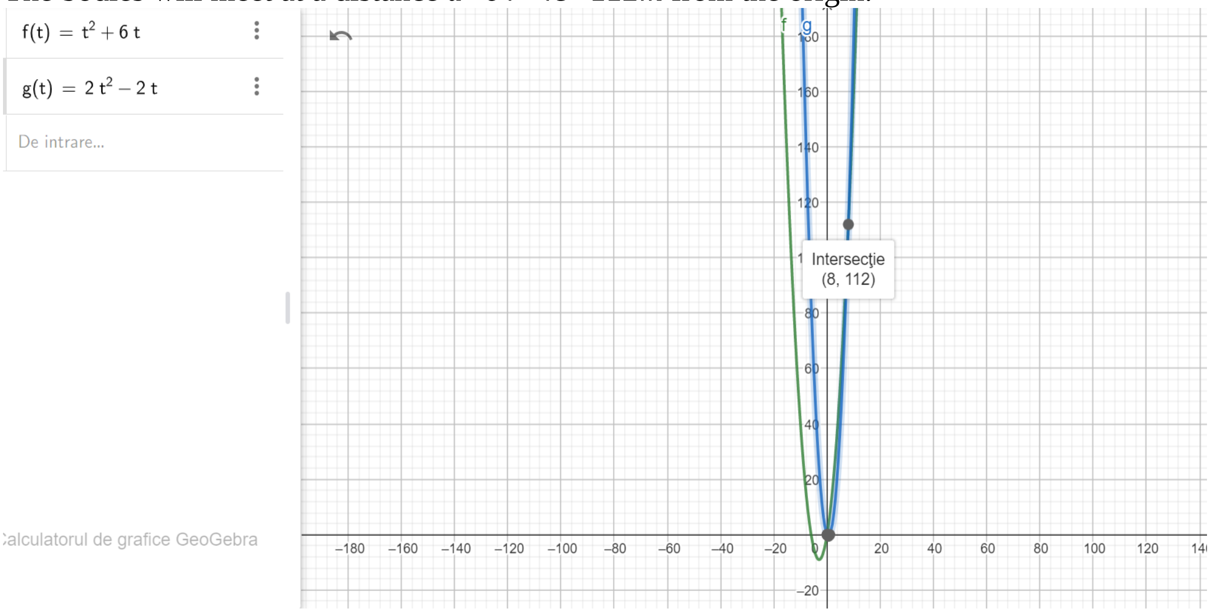
$$x_2 = 2t^2 - 2t$$

$$6t + \frac{1}{2}2t^2 = 2(t-1) + \frac{1}{2}4(t-1)^2$$

$$t^2 + 6t = 2t^2 - 2t <=> t(t-8) = 0$$

The solutions are $t_1 = 0s\ and\ t_2 = 8s$.

The bodies will meet at a distance *d=64+48=112m* from the origin.



Example 2:

Two vehicles move along the Ox axis according to the laws of motion $x_1 = t^2 - 10t + 8$ și $x_2 = -3t^2 + 4t$+2, where x is expressed in meters and t in seconds. Find the moments of time at which the vehicles meet.

Solution) The condition for the meeting is $x_1 = x_2$

$$t^2 - 10t + 8 = -3t^2 + 4t + 2$$

$$4t^2 - 14t + 6 = 0$$

$$2t^2 - 7t + 3 = 0$$

$$a = 2$$

$$b = -7$$

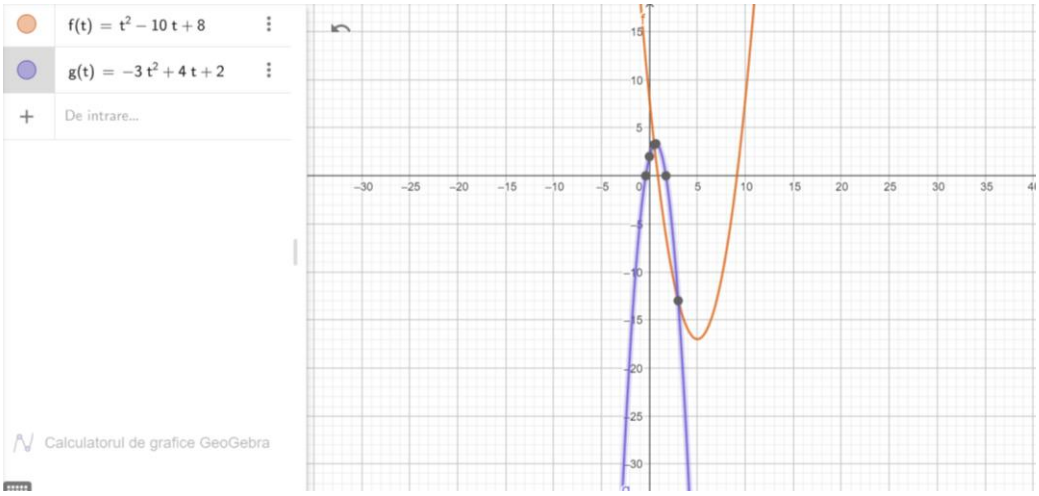
$c = 3$

$\Delta = \frac{-b\pm\sqrt{\Delta}}{2a}$, Δ=25

$t_{1,2} = \frac{7\pm5}{4}$

$t_1 = \frac{7-5}{4} = \frac{2}{4} = \frac{1}{2} = 0{,}5s$ first moment of time when they meet

$t_2 = \frac{7+5}{4} = \frac{12}{4} = 3s$ second moment of time when they meet



The vehicles meet twice, because the second vehicle stops.

2.2 Uniform Rectilinear Motion

Mişcarea rectilinie uniformă este mişcarea unui corp pe o traiectorie rectilinie cu viteză constantă.

The law of uniform rectilinear motion is: $x = x_0 + vt$ where the physical quantities are as follows:

x_0 - coordonata inițială

x – coordonata finală

v-viteza

t -timpul

Example 3:

Two vehicles move according to the laws of motion $x_1 = 1 + 2t\ (m/s)$ and $x_2 = 5 - t\left(\frac{m}{s}\right)$. Determine the location and time of the vehicles meeting.

Solution) The condition for the meeting is $x_1 = x_2$

$1 + 2t = 5 - t$

$3t = 4$

$t = \frac{4}{3}s$

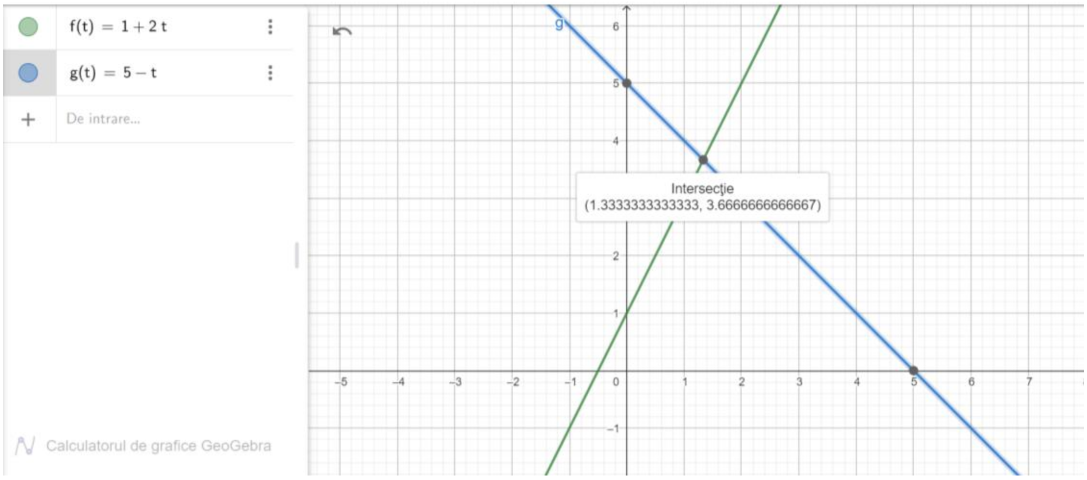
$t = 1,(3)s$

$x = 5 - \frac{4}{3}$

$x = \frac{11}{3}m$

$x = 3,(6)m$

The vehicles meet after $t = 1,(3)s$ at a distance $x = 3,(6)m$ from the origin.



References

[1] Anatolie Hristev, Vasile Fălie, Dumitru Manda :” Fizică- Manual pentru clasa a IX-a”, EDP 1981
[2] Cătălin Eugen Năchilă, Viorel Popescu, Petre Năchilă, Marta Popescu:” Exerciții și probleme de matematică-fizică pentru gimnaziu”, Editura ProGnosis, București 2001
[3] https://www.geogebra.org/