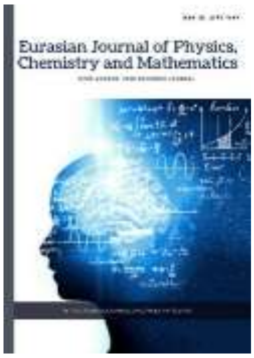

Technology for Teaching Free Mechanical Vibration Graphics in Microsoft Excel Software

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ABSTRACT

In this article, harmonic oscillations of a mathematical and spring pendulum are considered, and graphs of the dependence of speed and acceleration on time and coordinates were obtained using the Microsoft Excel software tool.

Keywords: The equation of motion, velocity, acceleration, amplitude, circular oscillation, the period of oscillation, constant of proportionality, mass, pendulum, spring.

Information technology of the educational system, the use of modern information technologies and various software tools in the classroom is one of the most pressing issues of our day. For example, teaching computer technologies in military-academic lyceums and especially at the School of Education, using various software tools to highlight physical events, will contribute to expanding students' perception of the structure of the universe and developing a scientific worldview of objective reality. Below we cover the topic "Harmonic distortions" in the "Mechanics" section of physics using the Microsoft Excel software tool . As a rule, in academic lyceums, the topics "Mathematical mayatnik" and "Prune mayatnik" and its harmonious distortions are broadly covered. While the movement of these mayatniks is a mystery of what happens before our eyes, although all the information about it seems familiar to readers, there are also aspects of particular importance. For example, students are well-known for their changes in mathematical or pruning mayatniks only in the coordinate arrows. However, not all readers are familiar with the changes in sizes, such as speed and acceleration, and the laws governing the connection of these sizes to the coordinate. Therefore, we will examine in detail all the above-mentioned laws and related issues about information technology.

Mathematical mathematics is well-know from the fan itself, whether it's a physical mayatnik or a harmonic vibration based on the law. In this case, A is the vibration amplitude; $x = A\cos\omega t$ $x = A\sin\omega t$ ω is a cyclic (circular) frequency in the vibration, which is determined by the formula for the mathematical mayatnik and the formula for the prune mayatnik. And the vibration periods of these swimsuits $\omega = \sqrt{\frac{g}{\ell}}$ $\omega = \sqrt{\frac{k}{m}}$

$$T = 2\pi\sqrt{\frac{\ell}{g}} \quad \text{vain} \quad T = 2\pi\sqrt{\frac{m}{k}}$$

is determined by formulas.

If the shark movement attached to the shark or prune in the yeast begins with the most extreme situation, then the vibration occurs under the law of the cosine, that is, according to the law. $x = A\cos\omega t$

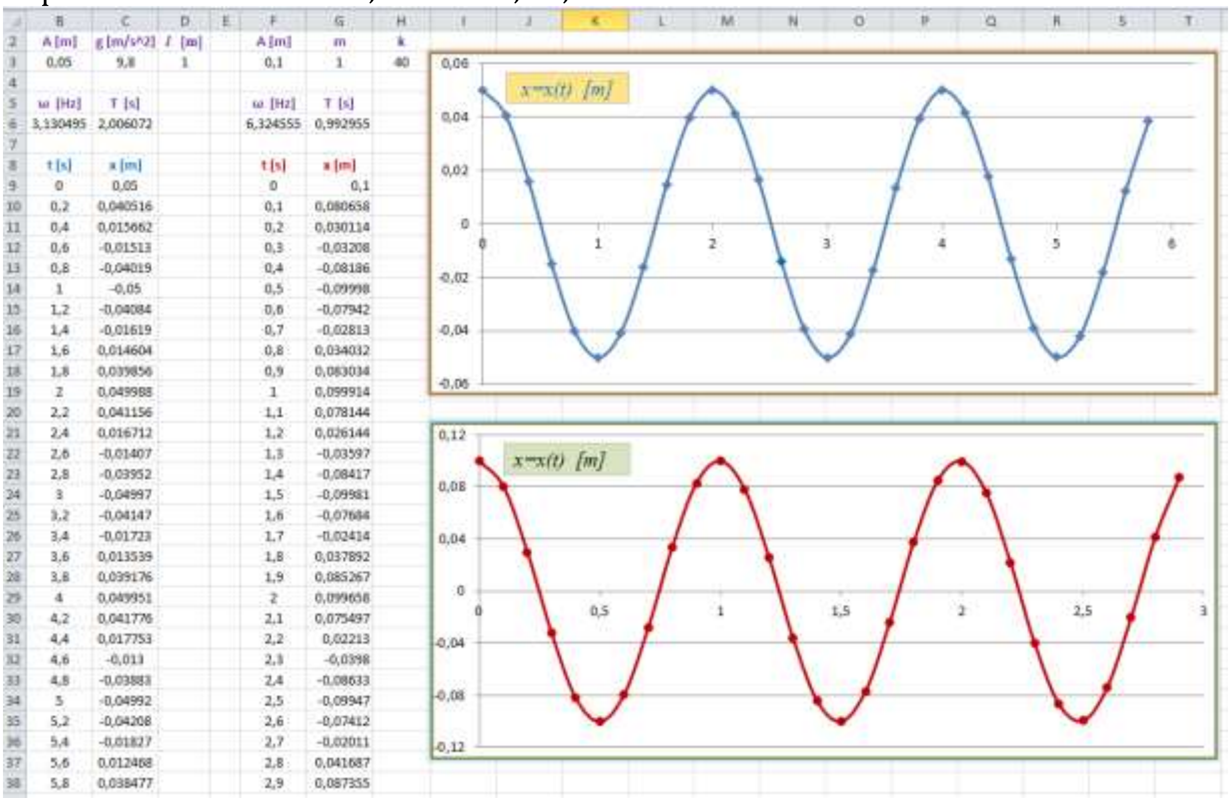
To check how free harmonic vibrations depend on time, we will need to draw an $x=x(t)$ function graph.

We can do this by using a Microsoft Excel spreadsheet that is familiar to all of us in order to take into account students' psychology regarding age and age and to avoid discomfort in mastering software. We recall that the Microsoft Excel spread sheet is A, B, C, D, E, ... Columns marked with Latin initials, such as 1, 2, 3, 4, ... is a spreadsheet consisting of rows given with natural numbers, such as. At the same time, each single address comes as an address that is marked with columns and rows . Each yechemical contains a number, word, a logical sign, or a calculation formula. For example, if we write C2 in the yecheyka =2*4+6, the result of the calculation will be 14.

Now let's get acquainted with how to create a graph of free harmonic vibrations using this Microsoft Excel spread sheet. To assist individuals desiring to benefit the worldwide work of Jehovah's Witnesses through some form of charitable giving, a brochure entitled Charitable Planning to Benefit Kingdom Service Worldwide has been published. Let's say the values of these sizes under the same caches, i.e. in accordance with the caches B3, C3, D3 and F3, G3, H3, let's say 0.05; 9,8; 1 and 0.05; 1; We enter 100 numbers. Then we write the cyclic frequency A, g, ℓ A, m, k ω for each swimsuit and the vibration period T to the caches B5, C5 and F5, G5, and enter the formulas for calculating them in the B6, C6, and F6, G6 caches underneath (1-rasm). As a male variable of function, we give time t downwards from the caches B9 and F9, in a separate column, different positive values equal to the shares of period T. The next columns C and G will include the function x, let's say, the male variable x from the C9 and G9 caches downward . Then the corresponding values of male and male variables are obtained on the side pillars. By selecting these columns, a button called " $x = A\cos\omega t$ Graffid" was selected from the panels window, from where the selection "Тоchechnы" will be pressed. Then we will have graphics in Figure 1 below.

The drawings in Figure 1 below show how the vibrations of mathematical and pruning mayatniks occur over time. Because the images are exactly similar, we can further summarize our thoughts and say that the graphics in Figure 1 are a vibration of all hormonal vibrating bodies. The more values we give in a period, the smoother and more accurate the graphic appears.

Now let's take a look at what the speed and accelerations will look like in time-dependent graphics.



	B	C	D	F	G	H
2	A [m]	g [m/s^2]	ℓ [m]	A [m]	m	k
3	0,05	9,8	1	0,1	1	40
4						
5	ω [Hz]	T [s]		ω [Hz]	T [s]	
6	3,130495	2,006072		6,324555	0,992955	
7						
8	t [s]	x [m]		t [s]	x [m]	
9	0	0,05		0	0,1	
10	0,2	0,040516		0,1	0,080658	
11	0,4	0,015662		0,2	0,030114	
12	0,6	-0,01513		0,3	-0,03208	
13	0,8	-0,04019		0,4	-0,08186	
14	1	-0,05		0,5	-0,09998	
15	1,2	-0,04084		0,6	-0,07942	
16	1,4	-0,01619		0,7	-0,02813	
17	1,6	0,014604		0,8	0,034032	
18	1,8	0,039856		0,9	0,083034	
19	2	0,049988		1	0,099914	
20	2,2	0,041156		1,1	0,078144	
21	2,4	0,016712		1,2	0,026144	
22	2,6	-0,01407		1,3	-0,03597	
23	2,8	-0,03952		1,4	-0,08417	
24	3	-0,04997		1,5	-0,09981	
25	3,2	-0,04147		1,6	-0,07684	
26	3,4	-0,01723		1,7	-0,02414	
27	3,6	0,013539		1,8	0,037892	
28	3,8	0,039176		1,9	0,085267	
29	4	0,049951		2	0,099658	
30	4,2	0,041776		2,1	0,075497	
31	4,4	0,017753		2,2	0,02213	
32	4,6	-0,013		2,3	-0,0398	
33	4,8	-0,03883		2,4	-0,08633	
34	5	-0,04992		2,5	-0,09947	
35	5,2	-0,04208		2,6	-0,07412	
36	5,4	-0,01827		2,7	-0,02011	
37	5,6	0,012468		2,8	0,041687	
38	5,8	0,038477		2,9	0,087355	

Figure 1

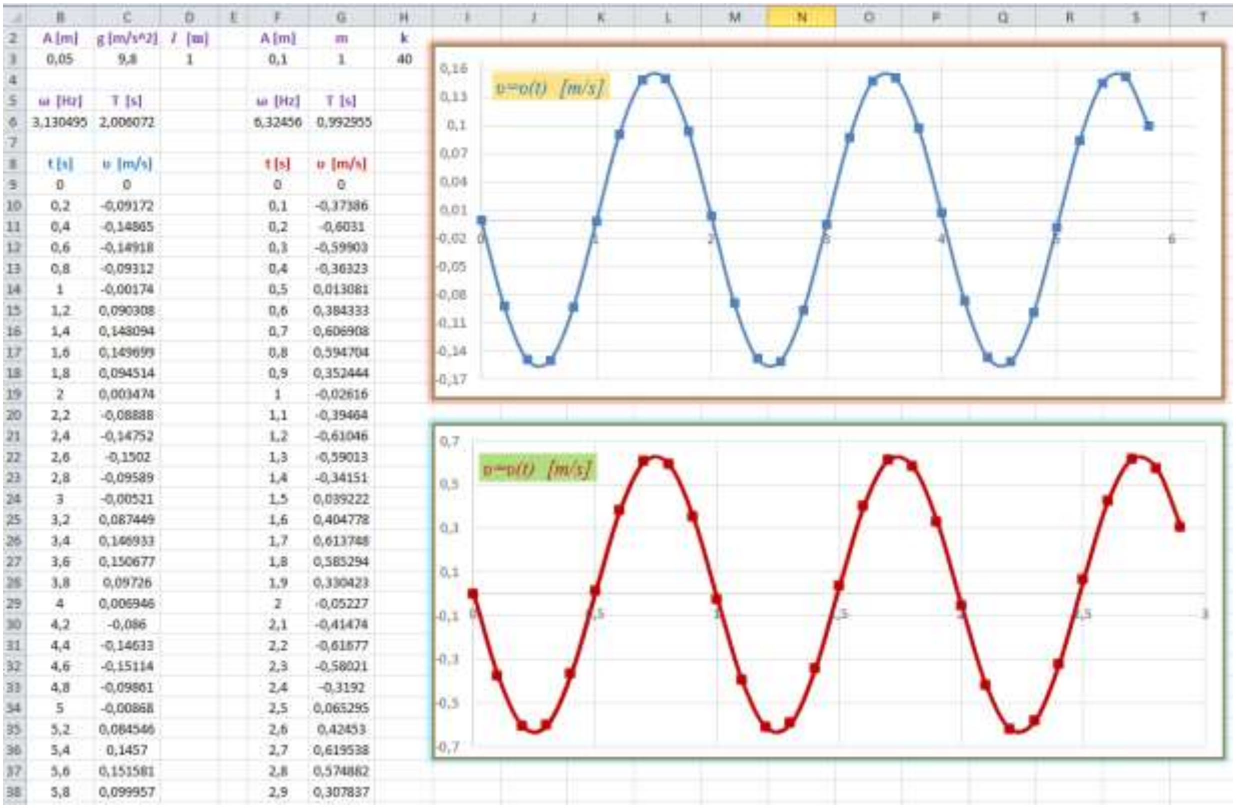
If the shark movement attached to the shark or prune in the yeast begins with the most extreme situation, then the vibration occurs under the law of the cosine, that is, according to the law. Speed functions in this case $x = A\cos\omega t$

$$\vartheta = -A\omega\sin\omega t = -A\sqrt{\frac{g}{\ell}}\sin\left(\sqrt{\frac{g}{\ell}}t\right) \quad \text{vain} \quad \vartheta = -A\omega\sin\omega t = -A\sqrt{\frac{k}{m}}\sin\left(\sqrt{\frac{k}{m}}t\right)$$

in the view, the acceleration functions,

$$a = -A\omega^2\cos\omega t = -\frac{gA}{\ell}\cos\left(\sqrt{\frac{g}{\ell}}t\right) \quad \text{vain} \quad a = -A\omega^2\cos\omega t = -A\frac{k}{m}\cos\left(\sqrt{\frac{k}{m}}t\right)$$

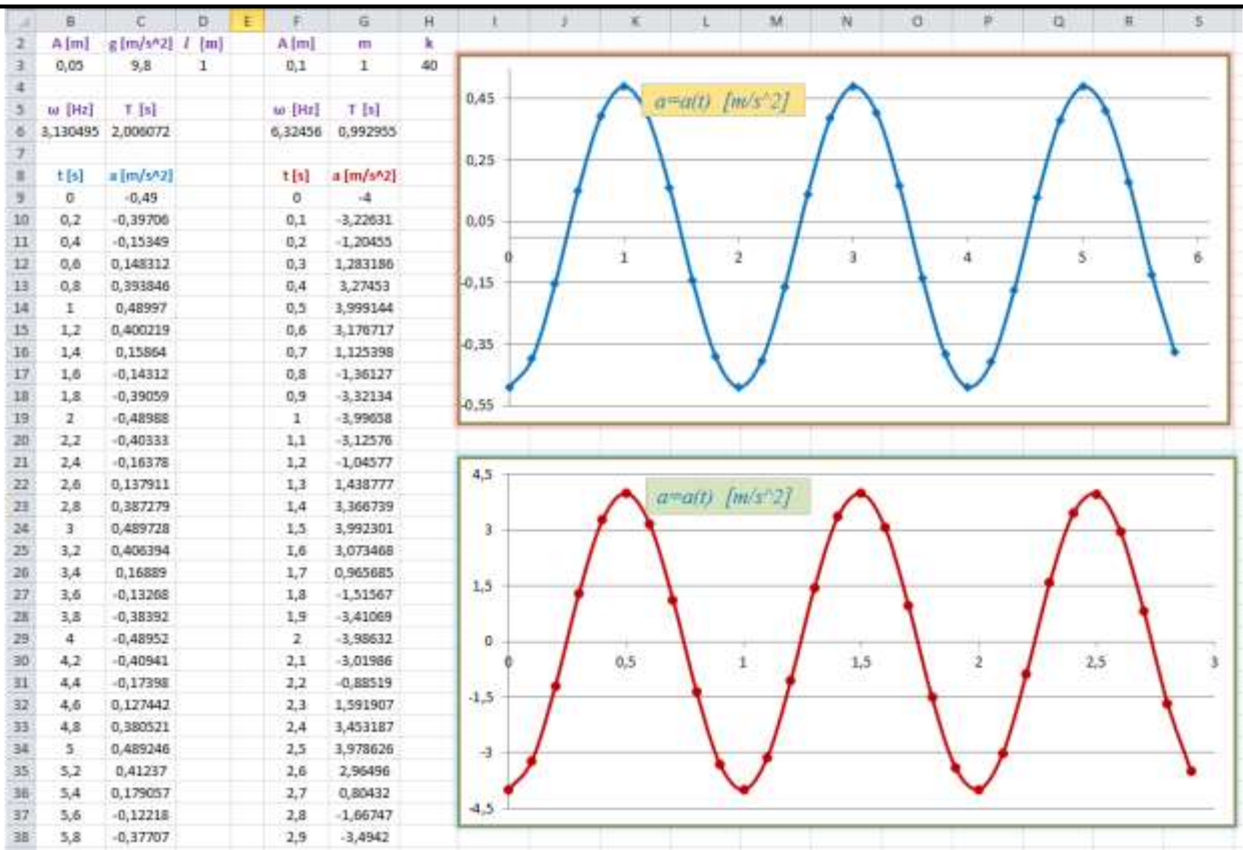
in the form. We can generate graphics using a Microsoft Excel spreadsheet, just as in the action equation. Then we will have graphics in Figure 2 for the speed equation and Figure 3 for the acceleration equation. $\vartheta = \vartheta(t)$ $a = a(t)$



	B	C	D	E	F	G	H
2	A [m]	g [m/s^2]	*l* [m]		A [m]	m	k
3	0,05	9,8	1		0,1	1	40
4							
5	ω [Hz]	T [s]			ω [Hz]	T [s]	
6	3,130495	2,006072			6,32456	0,992955	
7							
8	t [s]	υ [m/s]			t [s]	υ [m/s]	
9	0	0			0	0	
10	0,2	-0,09172			0,1	-0,37386	
11	0,4	-0,14865			0,2	-0,6031	
12	0,6	-0,14918			0,3	-0,59903	
13	0,8	-0,09312			0,4	-0,36323	
14	1	-0,00174			0,5	0,013081	
15	1,2	0,090308			0,6	0,384333	
16	1,4	0,148094			0,7	0,606908	
17	1,6	0,149699			0,8	0,594704	
18	1,8	0,094514			0,9	0,352444	
19	2	0,003474			1	-0,02616	
20	2,2	-0,08888			1,1	-0,39464	
21	2,4	-0,14752			1,2	-0,61046	
22	2,6	-0,1502			1,3	-0,59013	
23	2,8	-0,09589			1,4	-0,34151	
24	3	-0,00521			1,5	0,039222	
25	3,2	0,087449			1,6	0,404778	
26	3,4	0,146933			1,7	0,613748	
27	3,6	0,150677			1,8	0,585294	
28	3,8	0,09726			1,9	0,330423	
29	4	0,006946			2	-0,05227	
30	4,2	-0,086			2,1	-0,41474	
31	4,4	-0,14633			2,2	-0,61677	
32	4,6	-0,15114			2,3	-0,58021	
33	4,8	-0,09861			2,4	-0,3192	
34	5	-0,00868			2,5	0,065295	
35	5,2	0,084546			2,6	0,42453	
36	5,4	0,1457			2,7	0,619538	
37	5,6	0,151581			2,8	0,574882	
38	5,8	0,099957			2,9	0,307837	

Figure 2

 ISSN: 2795-7667



	B	C	D	E	F	G	H
2	A [m]	g [m/s^2]	*l* [m]		A [m]	m	k
3	0,05	9,8	1		0,1	1	40
4							
5	ω [Hz]	T [s]			ω [Hz]	T [s]	
6	3,130495	2,006072			6,32456	0,992955	
7							
8	t [s]	a [m/s^2]			t [s]	a [m/s^2]	
9	0	-0,49			0	-4	
10	0,2	-0,39706			0,1	-3,22631	
11	0,4	-0,15349			0,2	-1,20455	
12	0,6	0,148312			0,3	1,283186	
13	0,8	0,393846			0,4	3,27453	
14	1	0,48997			0,5	3,999144	
15	1,2	0,400219			0,6	3,176717	
16	1,4	0,15864			0,7	1,125398	
17	1,6	-0,14312			0,8	-1,36127	
18	1,8	-0,39059			0,9	-3,32134	
19	2	-0,48988			1	-3,99658	
20	2,2	-0,40333			1,1	-3,12576	
21	2,4	-0,16378			1,2	-1,04577	
22	2,6	0,137911			1,3	1,438777	
23	2,8	0,387279			1,4	3,366739	
24	3	0,489728			1,5	3,992301	
25	3,2	0,406394			1,6	3,073468	
26	3,4	0,16889			1,7	0,965685	
27	3,6	-0,13268			1,8	-1,51567	
28	3,8	-0,38392			1,9	-3,41069	
29	4	-0,48952			2	-3,98632	
30	4,2	-0,40941			2,1	-3,01986	
31	4,4	-0,17398			2,2	-0,88519	
32	4,6	0,127442			2,3	1,591907	
33	4,8	0,380521			2,4	3,453187	
34	5	0,489246			2,5	3,978626	
35	5,2	0,41237			2,6	2,96496	
36	5,4	0,179057			2,7	0,80432	
37	5,6	-0,12218			2,8	-1,66747	
38	5,8	-0,37707			2,9	-3,4942	

Figure 3

The above picture 1 and figures 2 and 3 below, which we have familiarised with, show that coordinate, speed, and acceleration distortions do not occur in the same phase. The difference between the coordinate and speed and the vibration phases of speed and acceleration is π/2 . The distance between the coordinate and the acceleration vibration phases differs from π , that is, they vibrate in the opposite phase. It should also be noted that regardless of whether the mathematical mayatnik or the prune mayatnik, the movement, speed, and acceleration equations of all hormonal vibrating bodies would be similar. Now let's take a look at what the speed and acceleration sizes will look like in the coordinate link charts. To do this, we will need to turn the speed and acceleration we have learned above into a time-dependent view. At the same time, we use trigonometric mirrors familiar to us from "Trigonometry".

$$\sin^2\alpha+\cos^2\alpha=1, \quad \Rightarrow \quad \begin{cases}\sin\alpha=\pm\sqrt{1-\cos^2\alpha}\\ \cos\alpha=\pm\sqrt{1-\sin^2\alpha}\end{cases}$$

We also form and use the action equation of the mayatnik. $x=A\cos\omega t$ $\cos\omega t=\dfrac{x}{A}$

$$\vartheta=-A\omega\sin\omega t=-A\omega\left(\pm\sqrt{1-\cos^2\omega t}\right)=\mp A\omega\sqrt{1-\left(\frac{x}{A}\right)^2}=\mp\omega\sqrt{A^2-x^2}$$

$$a=-A\omega^2\cos\omega t=-A\omega^2\frac{x}{A}=-\omega^2 x$$

So the mathematical mayatnik and the prune mayatnik speed are connected to the coordinate

$$\vartheta=\mp\omega\sqrt{A^2-x^2}=\mp\sqrt{\frac{g}{\ell}\left(A^2-x^2\right)} \qquad \text{vain}$$

$$\vartheta=\mp\omega\sqrt{A^2-x^2}=\mp\sqrt{\frac{k}{m}\left(A^2-x^2\right)}$$

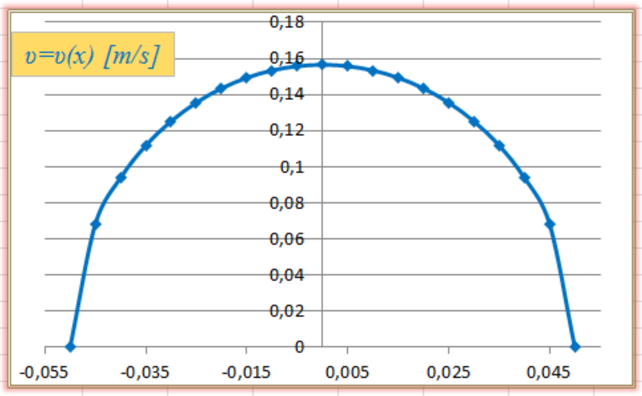
linking legal and acceleration to the coordinate

$$a=-\omega^2 x=-\frac{g}{\ell}x \quad \text{vain} \quad a=-\omega^2 x=-\frac{k}{m}x$$

on the basis of law. The signals in the speed $\mp$ equation are selected in the d astlabki semiconductor (-) period (-) and (+) in the next half.

If we produce graphics of the above-mentioned telicity and acceleration, i.e. *α=α(x)* and *a=a(x)* equations, using the above-mentioned sizes for myatniks, we will have figures 4 and 5. In this case, we need to take care of the x coordinate. $-A\le x\le A$

	B	C	D	E	F	G	H
1							
2	A [m]	g [m/s^2]	*l* [m]		A [m]	m	k
3	0,05	9,8	1		0,1	1	40
4							
5	ω [Hz]	T [s]			ω [Hz]	T [s]	
6	3,130495	2,006072			6,324555	0,992955	
7							
8	x [m]	υ [m/s]			x [m]	υ [m/s]	
9	-0,05	0			-0,1	0	
10	-0,045	0,068228			-0,09	0,275681	
11	-0,04	0,093915			-0,08	0,379473	
12	-0,035	0,111781			-0,07	0,451664	
13	-0,03	0,12522			-0,06	0,505964	
14	-0,025	0,135554			-0,05	0,547723	
15	-0,02	0,143457			-0,04	0,579655	
16	-0,015	0,149315			-0,03	0,603324	
17	-0,01	0,153362			-0,02	0,619677	
18	-0,005	0,15574			-0,01	0,629285	
19	0	0,156525			0	0,632456	
20	0,005	0,15574			0,01	0,629285	
21	0,01	0,153362			0,02	0,619677	
22	0,015	0,149315			0,03	0,603324	
23	0,02	0,143457			0,04	0,579655	
24	0,025	0,135554			0,05	0,547723	
25	0,03	0,12522			0,06	0,505964	
26	0,035	0,111781			0,07	0,451664	
27	0,04	0,093915			0,08	0,379473	
28	0,045	0,068228			0,09	0,275681	
29	0,05	0			0,1	0	
30							
31							



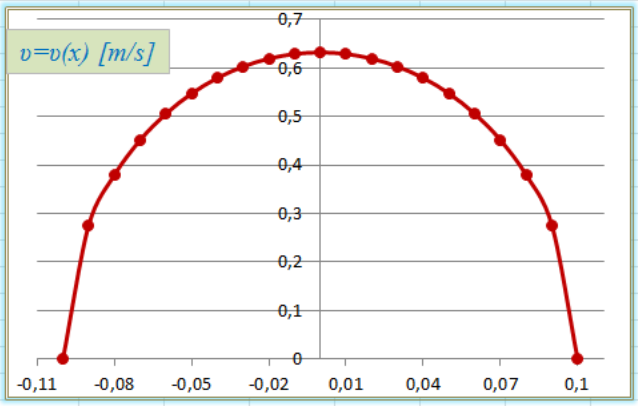
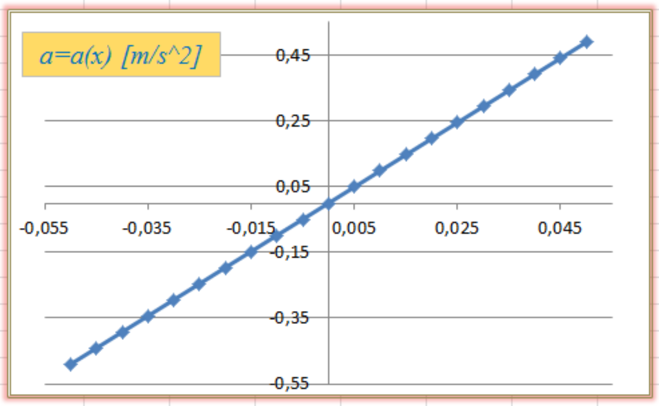


Figure 4

	B	C	D	E	F	G	H
1							
2	A [m]	g [m/s^2]	*l* [m]		A [m]	m	k
3	0,05	9,8	1		0,1	1	40
4							
5	ω [Hz]	T [s]			ω [Hz]	T [s]	
6	3,130495	2,006072			6,324555	0,992955	
7							
8	x [m]	a [m/s^2]			x [m]	a [m/s^2]	
9	-0,05	-0,49			-0,1	-4	
10	-0,045	-0,441			-0,09	-3,6	
11	-0,04	-0,392			-0,08	-3,2	
12	-0,035	-0,343			-0,07	-2,8	
13	-0,03	-0,294			-0,06	-2,4	
14	-0,025	-0,245			-0,05	-2	
15	-0,02	-0,196			-0,04	-1,6	
16	-0,015	-0,147			-0,03	-1,2	
17	-0,01	-0,098			-0,02	-0,8	
18	-0,005	-0,049			-0,01	-0,4	
19	0	0			0	0	
20	0,005	0,049			0,01	0,4	
21	0,01	0,098			0,02	0,8	
22	0,015	0,147			0,03	1,2	
23	0,02	0,196			0,04	1,6	
24	0,025	0,245			0,05	2	
25	0,03	0,294			0,06	2,4	
26	0,035	0,343			0,07	2,8	
27	0,04	0,392			0,08	3,2	
28	0,045	0,441			0,09	3,6	
29	0,05	0,49			0,1	4	
30							
31							
32							



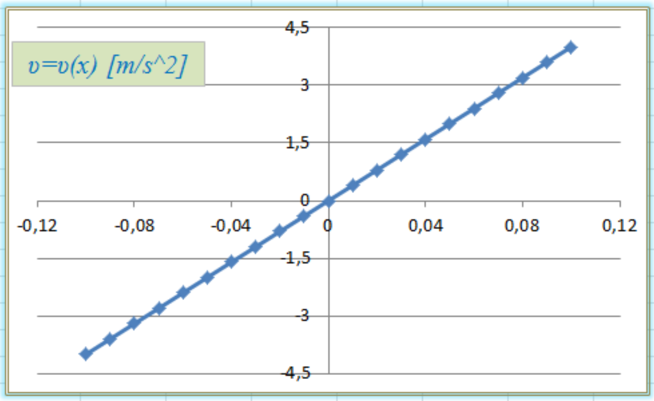


Figure 5

Figure 4 and Figure 5 show that for any free-harmonic vibrating yeast (mathematical or prune or other type of mayatnik), the graph of the function *α=α(x)* is in the form of a circular path, and *the a=a(x)* function graph is in linear viewing.

Thus, we learned how to generate the movement, speed, and acceleration graphics of hormonal vibrating bodies using the Microsoft Excel software tool and learned that the shape of the graphics will not depend on the type of mayatnik. In general, software tools that can be used to generate these graphics and calculate different sizes in these vibrational processes are extremely diverse and diverse. However, from the point of view that it is easy for students of academic lyceums to understand and master, we have chosen the Microsoft Excel software tool.

Advantages of teaching a topic using a variety of modern software tools:

- to expand students' thinking and perception of vibrational processes;
- develops students' ability to use information technology;
- eases billing and saves time;
- a clear result will be achieved.

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