

ISSN 2518-170X (Online),  
ISSN 2224-5278 (Print)

ҚАЗАҚСТАН РЕСПУБЛИКАСЫ  
ҰЛТТЫҚ ҒЫЛЫМ АКАДЕМИЯСЫНЫҢ  
Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

# Х А Б А Р Л А Р Ы

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## ИЗВЕСТИЯ

НАЦИОНАЛЬНОЙ АКАДЕМИИ НАУК  
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Казакский национальный исследовательский  
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## NEWS

OF THE ACADEMY OF SCIENCES  
OF THE REPUBLIC OF KAZAKHSTAN  
Kazakh national research technical university  
named after K. I. Satpayev

**SERIES  
OF GEOLOGY AND TECHNICAL SCIENCES**

**6 (438)**

**NOVEMBER – DECEMBER 2019**

THE JOURNAL WAS FOUNDED IN 1940

PUBLISHED 6 TIMES A YEAR

ALMATY, NAS RK

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*Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.*

*НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.*

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**ISSN 2518-170X (Online),**

**ISSN 2224-5278 (Print)**

Меншіктенуші: «Қазақстан Республикасының Ұлттық ғылым академиясы» РҚБ (Алматы қ.).

Қазақстан республикасының Мәдениет пен ақпарат министрлігінің Ақпарат және мұрағат комитетінде 30.04.2010 ж. берілген №10892-Ж мерзімдік басылым тіркеуіне қойылу туралы куәлік.

Мерзімділігі: жылына 6 рет.

Тиражы: 300 дана.

Редакцияның мекенжайы: 050010, Алматы қ., Шевченко көш., 28, 219 бөл., 220, тел.: 272-13-19, 272-13-18,  
<http://www.geolog-technical.kz/index.php/en/>

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Редакцияның Қазақстан, 050010, Алматы қ., Қабанбай батыра көш., 69а.

мекенжайы: Қ. И. Сәтбаев атындағы геология ғылымдар институты, 334 бөлме. Тел.: 291-59-38.

Типографияның мекенжайы: «Аруна» ЖК, Алматы қ., Муратбаева көш., 75.

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«Известия НАН РК. Серия геологии и технических наук».

**ISSN 2518-170X (Online),**

**ISSN 2224-5278 (Print)**

Собственник: Республиканское общественное объединение «Национальная академия наук Республики Казахстан (г. Алматы)

Свидетельство о постановке на учет периодического печатного издания в Комитете информации и архивов Министерства культуры и информации Республики Казахстан №10892-Ж, выданное 30.04.2010 г.

Периодичность: 6 раз в год

Тираж: 300 экземпляров

Адрес редакции: 050010, г. Алматы, ул. Шевченко, 28, ком. 219, 220, тел.: 272-13-19, 272-13-18,  
<http://nauka-nanrk.kz/geology-technical.kz>

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Адрес редакции: Казахстан, 050010, г. Алматы, ул. Кабанбай батыра, 69а.

Институт геологических наук им. К. И. Сатпаева, комната 334. Тел.: 291-59-38.

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**News of the National Academy of Sciences of the Republic of Kazakhstan. Series of geology and technology sciences.**

**ISSN 2518-170X (Online),**

**ISSN 2224-5278 (Print)**

Owner: RPA "National Academy of Sciences of the Republic of Kazakhstan" (Almaty)

The certificate of registration of a periodic printed publication in the Committee of information and archives of the Ministry of culture and information of the Republic of Kazakhstan N 10892-Ж, issued 30.04.2010

Periodicity: 6 times a year

Circulation: 300 copies

Editorial address: 28, Shevchenko str., of. 219, 220, Almaty, 050010, tel. 272-13-19, 272-13-18,  
<http://nauka-nanrk.kz/geology-technical.kz>

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Editorial address: Institute of Geological Sciences named after K.I. Satpayev  
69a, Kabanbai batyr str., of. 334, Almaty, 050010, Kazakhstan, tel.: 291-59-38.

Address of printing house: ST "Aruna", 75, Muratbayev str, Almaty

**NEWS**

OF THE NATIONAL ACADEMY OF SCIENCES OF THE REPUBLIC OF KAZAKHSTAN

**SERIES OF GEOLOGY AND TECHNICAL SCIENCES**

ISSN 2224-5278

Volume 6, Number 438 (2019), 208 – 214

<https://doi.org/10.32014/2019.2518-170X.172>

IRSTI 30.00.00

UDC 531.51

**K. A. Kabyzbekov<sup>1</sup>, Kh. K. Abdrakhmanova<sup>2</sup>, A. D. Dasibekov<sup>1</sup>,  
P. A. Saidakhmetov<sup>1</sup>, T. Sh. Makhanov<sup>1</sup>, B. Sh. Kedelbaev**

<sup>1</sup>M. Auezov South-Kazakhstan State University, Shymkent, Kazakhstan,

<sup>2</sup>South-Kazakhstan State Pedagogical University, Shymkent, Kazakhstan.

E-mail: kenkab@mail.ru, khadi\_kab@mail.ru, dasibekjv.azhibek@mail.ru,

timpf\_ukgu@mail.ru, tmakhanov@mail.ru b.sh.kedelbaev@mail.ru

## **THE MOTION WITH AIR DRAG OF A BODY LAUNCHED AT AN ANGLE ABOVE THE HORIZONTAL**

**Abstract.** The article offers calculations and visualization of motion of a body launched at an angle above the horizontal for two cases without air drag and with air drag by using the MATLAB software. It presents the motion trajectories of the body launched at an angle above the horizontal for two cases without air drag and with air drag at different values of air drag coefficient. The path of the body launched at a certain angle above the horizontal with no air drag is a parabola. In case of motion with air drag the path is not parabolic, i.e. not symmetric relative the vertical line drawn from the upper point of the trajectory, with less height and range. With the increase of air drag coefficient the maximum height reached by the body decreases. When the air drag coefficient increases from 0.1 up to 0.5 the maximum height reached by the body decreases approximately by 1.8 times. Students are offered to study this phenomenon by changing the air drag coefficient at various initial velocities and to analyze them. Results of this article are used at the practical classes on classical and theoretical mechanics and at the laboratory classes on the discipline "Modeling the physical phenomena".

**Key words:** motion, at an angle above the horizontal, initial height, initial velocity, path, parabola, medium drag coefficient.

**Introduction.** Nowadays all educational institutions of Kazakhstan are provided with computer hardware and software, interactive boards and internet. Almost all teachers have completed language and computer courses for professional development. Hence the educational institutions have all conditions for using computer training programs and models for performing computer laboratory works. In recent years the new computer system of carrying out mathematical calculations MATLAB is being widely used in many universities and engineering institutions throughout the world [1-7]. Unfortunately, the numerical calculations carried out by students are often done by means of the calculator. Modern computers are frequently used only for presentation of the work. Actually students should be able not only to solve these or other engineering problems, but also do it by using modern methods, that is, using personal computers.

Students of the physics specialties 5B060400 and 5B011000 successfully master the discipline "Computer modeling of physical phenomena" which is the logical continuation of the disciplines "Information technologies in teaching physics" and "Use of electronic textbooks in teaching physics". The aim of this discipline is to study and learn the program language of the MATLAB system, acquaintance with its huge opportunities for modeling and visualization of physical processes.

In our early works [8-25] we used the MATLAB system for modeling and visualization of physical processes related with mechanics, molecular physics, and electromagnetism and quantum physics. This software has enabled us to solve ordinary differential equations (ODE), visualize equipotential lines of charged conductors' system, describe the motion of charged particles in electric, magnetic and gravitational fields and etc.

The present article is devoted to calculation and visualization of motion of the body launched at an angle above the horizontal for two cases without air drag and with air drag by using the MATLAB software.

**Formulation of the problem 1.** Let's consider the movement of the body thrown with initial velocity of  $v_0$  at an angle  $\alpha$  to the horizon in the assumption that the air drag is proportional to squared velocity. In a vector form the equation of motion is given as

$$m\ddot{\vec{r}} = -\gamma\vec{v}|\vec{v}| - m\vec{g},$$

where  $\vec{r}$  is the position vector of the moving body,  $\vec{v}$  is the body's velocity,  $\gamma$  is the drag coefficient,  $m\vec{g}$  is the gravity force,  $m$  is the mass of the body and  $\vec{g}$  is the acceleration due to gravity.

The specific feature of this problem is in ending of the body's motion at an unknown time, when the body falls on the ground.

If to denote  $k=\gamma/m$ , then we have a system of equations for  $x$ - and  $y$ - components of the motion, to which it is necessary to add initial conditions:  $x(0)=0$ ,  $y(0)=h$  ( $h$  is an initial height),  $\dot{x}(0)=v_0 \cos \alpha$ ,  $\dot{y}(0)=v_0 \sin \alpha$ .

Let us have the following denotations:

$$y(1) = x, \quad y(2) = \dot{x}, \quad y(3) = y, \quad y(4) = \dot{y}.$$

Then the corresponding system of ordinary differential equations (ODE) of the first order for  $x$ - and  $y$ -components of the motion is given as

$$\begin{aligned} \dot{y}(1) &= y(2) \\ \dot{y}(2) &= -k \cdot y(2) \cdot \sqrt{(y(2))^2 + (y(4))^2} \\ \dot{y}(3) &= y(4) \\ \dot{y}(4) &= -k \cdot y(4) \cdot \sqrt{(y(2))^2 + (y(4))^2} - g \end{aligned}$$

**Methods and results.** To obtain the solution of this problem we introduce the function "bodyangle.m" for calculation of the right side of the system of ODE.

Listing of the function Movifricion.m.

```
function F=Movifricion(x,y)
```

```
k=0.01;
```

```
g=9.81;
```

```
F=[y(2); -k.*y(2).*sqrt(y(2).^2+y(4).^2);...
```

```
y(4); -k.*y(4).*sqrt(y(2).^2+y(4).^2)-g];
```

The algorithm of the solution ex14\_1.m of our boundary-value problem can be as the following:

```
>> % motion of the body launched at an angle to the horizon
```

```
>> alph=pi/4; % the angle of launch
```

```
>> k=0;
```

```
>>v0=1; % initial velocity
```

```
>>h=0; % initial height
```

```
>>tmax=0.2; % time interval
```

```
>>Y0=[0; v0.*cos(alph); h; v0.*sin(alph)]; % vector of initial conditions
```

```
>> [T,Y]=ode45(@Movifricion,[0 tmax],Y0);% approximate solution
```

```
>>plot(Y(:,1),Y(:,3), 'LineWidth',2); % the graph of the curve x(t), y(t)
```

```
>>axis equal;
```

```
>>grid on
```

The result is presented in the figure 1.

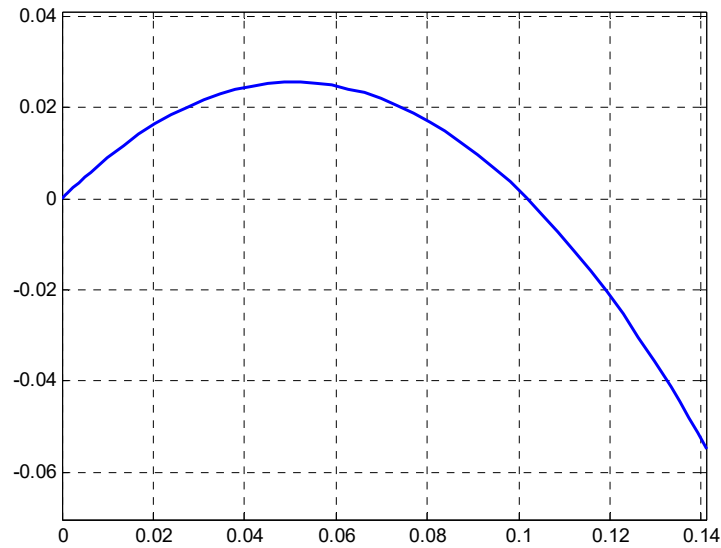


Figure 1 – The path of body’s motion without air drag ( $k=0$ ) at initial conditions  $\alpha=\pi/4$  – launch angle,  $v_0=1$  – initial velocity,  $h=0$  – initial height

For determination of motion duration it is necessary to select the value of  $t_{max}$ . Also it is necessary to determine approximately the maximum height and the range. The ODE solver of MATLAB gives an opportunity to determine the moments of occurring of the events corresponding to some special solutions and reactions to them. For this aim a special function-event processor is used. During solution MATLAB recognizes events and calls the user’s processor.

The format of the function of event processor must be as following:

`[value, isterminal, direction] = eventsfun(t, y)`

Function has to return three vectors -value, isterminal, direction- of identical length in which the  $i$ -th component corresponds to equalizing to zero of some expression depending on  $t$  and  $y(k)$  components of a vector-function of ODE system solution (arguments  $t, y$  functions - events). Components of these vectors have the following meanings:

value(i) is the expression made of an argument  $t$  and the  $y(k)$  components of a vector function  $y$  which in a solver will be checked on equality to zero;

isterminal(i) = 1 if an integration of the ODE system has to be stopped at reaching the condition - value (i) = 0, or = 0 if it isn't required to stop calculations;

direction(i) = 0 if it is necessary "to catch" all zeros of the expression - value (i), + 1 when passing through zero the expression - value (i) increases, and – 1 when passing through zero the expression - value(i) decreases.

Then the descriptor of this function should be transferred to a solver, having specified it in structure of parameters - options - of the function- odeset (see above) as the value of the parameter - Events.

`options=odeset('Events', eventsfun)`

After that a solver should be called with 5 exit parameters

`[T,Y,TE,YE,IE] = solver(odefun, tspan, y0, options)`

Problem 2. Let's return to the problem 1 in which we we considered the motion of the body thrown at an angle to the horizon. Let's create the bodyanglek.m function of a right side of the system of equations having additional parameter  $k$  – the medium drag coefficient.

Listing function bodyanglek.m.

```
function F=bodyanglek(x,y,k)
g=9.81;
F=[y(2); -k.*y(2).*sqrt(y(2).^2+y(4).^2);...
y(4); -k.*y(4).*sqrt(y(2).^2+y(4).^2)-g];
```

If the function -processor of an event - Events is used, then it also has to have this additional argument.



```

function [value,isterminal,direction] = ex8eventsk(t,y,k)
% Determine the time when the height
% is equal to 0 during the body's falling and to end calculations, also
% determine the time of body's reaching the maximum height (without stopping calculations),
% when the y-component of the velocity is equal to 0
value = [y(3), y(4)]; % determine zeros for y(3) and y(4)
isterminal = [1,0]; % stop calculations at y(3)=0
direction = [-1,0]; % function y(3) decreases, for y(4) it makes no difference
When calling the solver we also should give it an additional argument. Then the algorithm of the
solution ex16_1.m of our boundary- value problem will be as following
% motion of the body launched at an angle to the horizon ex16_1.m
>>alph=pi/4; % the launch angle
>>v0=10; % initial velocity
>>Y0=[0; v0.*cos(alph); 0; v0.*sin(alph)]; % vector of initial conditions
>>ak=[0.1 0.2 0.3 0.5]; % medium drag coefficients
>>opts = odeset('Events',@ex8eventsk,'Refine',16); % parameters
>>newplot; hold on;
>>for i=1:4
>> [t,Y,te,ye,ie] = ode45(@bodyanglek,[0 Inf],Y0,opts,ak(i)); % solution
>>plot(Y(:,1),Y(:,3), 'LineWidth',2); % path graph
>>end
>>grid on; hold off;
The result is presented in the figure 2.

```

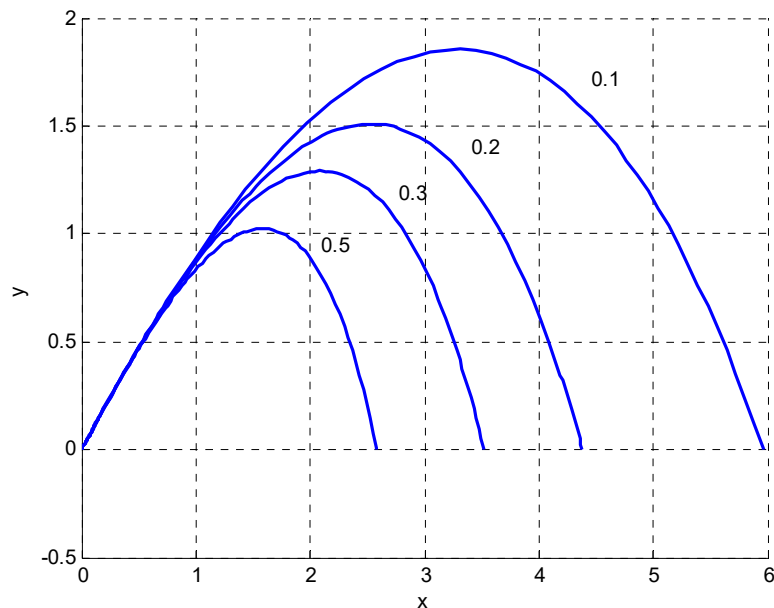


Figure 2 – A trajectory of motion of a body launched at an angle to the horizon at various values of the medium drag coefficient

Students are offered to study this phenomenon by changing the initial conditions (the launch angle, initial velocities and heights) and at various values of the medium drag coefficient and to analyze them.

**Conclusion.** The article considers calculations and visualization of motion of a body launched at an angle above the horizontal without air drag and with air drag by using the MATLAB software. It presents the motion trajectories of the body launched at an angle above the horizontal at different values of air drag coefficient. The path of the body launched at a certain angle above the horizontal with no air drag is a parabola. In case of motion with air drag the path is not parabolic, i.e. not symmetric relative the vertical line drawn from the upper point of the trajectory, with less height and range. With the increase of air drag

coefficient the maximum height reached by the body decreases. When the air drag coefficient increases from 0.1 up to 0.5 the maximum height reached by the body decreases approximately by 1.8 times. Students are offered to study this phenomenon by changing the air drag coefficient at various initial velocities and to analyze them. Results of this article are used at the practical classes on classical and theoretical mechanics and at the laboratory classes on the discipline "Modeling the physical phenomena".

**К. А. Қабылбеков<sup>1</sup>, Х. К. Абдрахманова<sup>2</sup>, А. Д. Дасибеков<sup>1</sup>,  
П. А. Саидахметов<sup>1</sup>, Т. Ш. Маханов<sup>1</sup>, Б. Ш. Кеделбаев**

<sup>1</sup>М. Әуезов атындағы Оңтүстік Қазақстан мемлекеттік университеті, Шымкент, Қазақстан,  
<sup>2</sup>Оңтүстік Қазақстан мемлекеттік педагогикалық университеті, Шымкент, Қазақстан

**МАТЛАВ ЖҮЙЕСІНДЕ  
«КӨКЖИЕККЕ БҰРЫШ ЖАСАП ЛАҚТЫРЫЛҒАН  
ДЕНЕНІҢ КЕДЕРГІМЕН ҚОЗҒАЛЫСЫН ЗЕРТТЕУ»**

**Аннотация.** Көкжиекке бұрыш жасап лақтырылған дененің ортаның кедергісі жоқ және кедергісі болған жағдайларындағы қозғалысын есептеу мен бейнелеу ұсынылады. Көкжиекке бұрышпен лақтырылған дененің ортаның кедергісі жоқ және кедергісінің коэффициенттері әртүрлі болған жағдайларындағы қозғалысының траекторияларың графиктері келтірілген.

Ортаның кедергісін есепке алмаған жағдайда дене парабола бойында қозғалады, ал орта кедергісі есепке алынған жағдайда оның траекториясы параболадан ауытқиды және ең жоғарғы биктіктегі нүктеден жүргізілген верикалға салыстырғанда симметриялы болмайды.

Ортаның кедергі коэффициенті 0.1 ден 0.5-ке дейін өскен сайын дененің көтерілу биктігі 1.8 есе төмендейді.

Студенттерге өз бетінше қозғалыстың бастапқы жылдамдығы мен бастапқы биіктігі және лақтыру бұрышы мен кедергі коэффициентінің әр түрлі мәндерінде тәжірибелер жасау және нәтижелерін талдау ұсынылады.

Тәжірибелер нәтижелері классикалық, теориялық механика және «Физикалық процестерді есептеу мен бейнелеу» пәндерін меігеруде қолданылады

**Түйін сөздер:** қозғалыс, көкжиекке бұрыш жасап лақтырылған, бастапқы жылдамдық, бастапқы биіктік, лақтыру бұрышы, траектория, парабола, ортаның кедергі коэффициенті.

**К. А. Қабылбеков<sup>1</sup>, Х. К. Абдрахманова<sup>2</sup>, А. Д. Дасибеков<sup>1</sup>,  
П. А. Саидахметов<sup>1</sup>, Т. Ш. Маханов<sup>1</sup>, Б. Ш. Кеделбаев**

<sup>1</sup>Южно-Казахстанский государственный университет им. М. Ауэзова, Шымкент, Казахстан  
<sup>2</sup>Южно-Казахстанский государственный педагогический университет, Шымкент, Казахстан

**«ИССЛЕДОВАНИЕ ДВИЖЕНИЯ ТЕЛА С ТРЕНИЕМ,  
БРОШЕННОГО ПОД УГЛОМ К ГОРИЗОНТУ»  
В СИСТЕМЕ МАТЛАВ**

**Аннотация.** Предлагается программа расчета и визуализации движения тела, брошенного под углом к горизонту без учета и с учетом сопротивления среды. Представлены траектории движения тела, брошенного под углом к горизонту без учета и с учетом сопротивления среды при различных значения коэффициента сопротивления среды. Траекторией движения тела, брошенного под углом к горизонту без учета сопротивления среды является парабола и с учетом сопротивления среды траектория отличается и не симметрична относительно вертикали проведенной от верхней точки координаты. С увеличением коэффициента сопротивления среды понижается высота подъема тела; увеличение коэффициента сопротивления от 0.1 до 0.5 понижает высоту подъема тела примерно в 1.8 раза. Студентам предлагается самостоятельно поэкспериментировать, изменяя коэффициент сопротивления среды при различных начальных скоростях и их проанализировать. Результаты экспериментов используются при изучении и освоении классической, теоретической механики и дисциплины «Расчет и визуализация физических процессов».

**Ключевые слова:** движение, под углом к горизонту, начальная высота, начальная скорость, угол броска, траектория, парабола, коэффициент сопротивления среды.

**Information about authors:**

Kabylbekov K. A., cand. ph-math. sc., associate professor of the chair of Physics, M. Auezov South-Kazakhstan State University, Shymkent, Kazakhstan; kenkab@mail.ru; <https://orcid.org/0000-0001-8347-4153>

Abdrakhmanova Kh. K., cand. chem. sc., associate professor of the chair of Physics, South-Kazakhstan State Pedagogical University, Shymkent, Kazakhstan; khadi\_kab@mail.ru; <https://orcid.org/0000-0002-6110-970X>

Dasibekov A. D., doc. eng. sc., professor of the chair of Mechanics, M. Auezov South-Kazakhstan State University, Shymkent, Kazakhstan; dasibekov.azhibek@mail.ru; <https://orcid.org/0000-0002-7148-5506>

Saidakhmetov P. A., cand. phys.-math. sciences, associate professor of the department "Physics" of M. Auezov SKSU, Shymkent, Kazakhstan; timpf\_ukgu@mail.ru; <https://orcid.org/0000-0002-9146-047X>

Makhanov T. Sh., cand. ped. sc., associate professor of the chair of "Professional education", M. Auezov South-Kazakhstan State University, Shymkent, Kazakhstan; tmakhanov@mail.ru; <https://orcid.org/0000-0003-0880-0224>

Kedelbaev B. Sh., <https://orcid.org/0000-0001-7158-1488>

**REFERENCES**

- [1] Porsev S.V. Computer simulation of physical processes in the package MATLAB. M.: Hot Line-Telecom, 2003. 592 p.
- [2] Kotkin G.A., Cherkassky V.S. Computer modeling of physical processes using MATLAB: Tutorial / Novosibirsk University.
- [3] Lurie M.S., Lurie O.M. Application of the MATLAB program in the study of course of electrical engineering. For students of all specialties and forms of educatio. Krasnoyarsk: SibSTU, 2006. 208 p.
- [4] Potemkin V. System of engineering and scientific calculations MATLAB 5.x (in 2 volumes). M.: Dialog-MIFI, 1999.
- [5] Averyanov G.P., Budkin, Dmitrieva V.V. Design automation. Computer workshop. Part 1. Solving problems of Electrophysics in MATLAB: tutorial. M.: MEPhI, 2009. 111 p.
- [6] Dyakonov V.P. MATLAB. Complete tutorial. M.: DMK Press, 2012. 768 p.
- [7] Ryndin E.A., Lysenko I.E. Solving problems of mathematical physics in MATLAB. Taganrog: TRTU, 2005. 62 p.
- [8] Kabylbekov K.A., Abdrakhmanova Kh.K., Abekova J., Abdraimov R.T., Ualikhanova B.S. Calculation and visualization of a system-an electron in a deep square potential well, with use of the software package of MATLAB // Proceeding of the III International Scientific and Practical Conference «Topical researches of the World Science» (June 28, 2017, Dubai, UAE). July 2017. Vol. I, N 7(23). P. 7-13.
- [9] Kabylbekov K., Saidullaeva N., Spabekova R., Omashova G, Tagaev N., Bitemirova A., Berdieva M. Model of a blank form for computer laboratory work on research of the speed selector // Journal of Theoretical and Applied Information Technology 15th July 2017. Vol. 95, N 13. P. 2999-3009. c 2005 – ongoing JATIT & LLS. Indexada en Scopus.
- [10] Kabylbekov K.A., Omashova G., Spabekova R., Saidullaeva N., Saidakhmetov P., Junusbekova S. Management and organization of computer laboratory work in physics education // Espacios. Año 2017. Vol. 38, N 45. Pág. 35. Indexada en Scopus.
- [11] Kabylbekov K., Omashova G., Spabekova R., Saidullaeva N., Saidakhmetov P., Junusbekova S. Management and organization of computer laboratory work in physics education // Espacios. Año 2017. Vol. 38, N 45. Pág. 35. Indexada en Scopus, Google Schollar.
- [12] Kabylbekov K.A., Ashirbaev Kh.A., Arysbaeva A.S., Jumagaliyeva A.M. Model of the form of the organization of computer laboratory work in the study of physical phenomena // Modern high technologies. M., 2015. N 4. P. 40-43.
- [13] Kabylbekov K.A., Madiyarov N.K., Saidakhmetov P.A. Independent design of research tasks of computer laboratory works on thermodynamics // Proceedings of the IX International Scientific and Methodological Conference. Teaching natural sciences (biology, physics, chemistry) mathematics and computer science. Tomsk, 2016. P. 93-99.
- [14] Kabylbekov K.A., Omashova G.Sh., Spabekova R.S., Saidakhmetov P.A., Serikbaeva G.S., Aktureeva G. Organization of computer laboratory works on study the turn-on and turn-off current of the power supply by using MATLAB software package // Proceedings of the National academy of sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2017. N 3. P. 139-146. <https://doi.org/10.32014/2018.2518-1726>
- [15] Kabylbekov K.A., Omashova G.Sh., Spabekova R.S., Saidakhmetov P.A., Serikbaeva G.S., Aktureeva G. Organization of computer labs for the study of velocity and height distribution of molecules from the Earth's surface by using MATLAB software package // Herald of RK NAS. Almaty, 2017. N 3. P. 111-119. <https://doi.org/10.32014/2018.2518-1467>

[16] Kabyzbekov K.A., Ashirbayev H.A., Abdrakhmanova Kh.K., Dzhumagalieva A.I., Kydyrbekova J.B. Organization of laboratory work on study of electric and magnetic fields by using MATLAB software package // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2017. Vol. 3(313). P. 206-212. <https://doi.org/10.32014/2018.2518-1726>

[17] Kabyzbekov K.A., Spabekova R.S., Omashova G.Sh., Abzhapparov A.A., Polatbek A., Serkebayeva S.G. The use of the software package MATLAB for solving problems on bifurcated electrical circuits // Herald of NAS RK. Almaty, 2017. N 4. P. 101-108. <https://doi.org/10.32014/2018.2518-1467>

[18] Kabyzbekov K.A., Ashirbaev H.A., Abdrakhmanova Kh.K., Dzhumagalieva A.I., Kadyrbekova J.B. Organization of the performance of the laboratory work "Modeling the electric field of a system consisting of a dielectric square and a long charged conductor" by using MATLAB software package // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. Almaty, 2017. N 4. P. 252-259. <https://doi.org/10.32014/2018.2518-1726>

[19] Kabyzbekov K.A., Abdrakhmanova Kh.K., Ermakhanov M.N., Urmashov B.A., Jarakanbayev E.T. Calculation and visualization of a body motion in a gravitational field // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2018. Vol. 4, N 430. P. 87-98. <https://doi.org/10.32014/2018.2518-170X.28>

[20] Kabyzbekov K.A., Abdrakhmanova Kh.K., Omashova G.Sh., Lakhanova K.M., Abekova Zh.A. Organization of computer laboratory work "Calculation and visualization of small forced oscillations" // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2018. Vol. 4, N 430. P. 145-155. <https://doi.org/10.32014/2018.2518-170X.28>

[21] Kabyzbekov K.A., Abdrakhmanova Kh.K., Omashova G.Sh., Kedelbaev B., Abekova Zh.A. Calculation and visualization of electric field of a space – charged sphere // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2018. Vol. 5, N 431. P. 201-209. <https://doi.org/10.32014/2018.2518-170X.28>

[22] Kabyzbekov K.A., Abdrakhmanova Kh.K., Saidakhmetov P.A., Sultanbek T.S., Kedelbaev B.Sh. Calculation and visualization of isotopes separation process using MATLAB program // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2018. Vol. 5, N 431. P. 218-225. <https://doi.org/10.32014/2018.2518-170X.28>

[23] Kabyzbekov K.A., Abdrakhmanova Kh.K., Saidakhmetov P.A., Musaev J.M., Issayev Ye.B., Ashirbaev Kh.A. Calculation and visualization of a body motion under the gravity force and the opposing drag // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2018. Vol. 6, N 432. P. 85-95. <https://doi.org/10.32014/2018.2518-170X.28>

[24] Kabyzbekov K.A., Abdrakhmanova Kh.K., Saidakhmetov P.A., Kedelbaev B.Sh., Abdraimov R.T., Ualikhanova B.S. Calculation and visualization of the field of a coaxial cable carrying steady current // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2018. Vol. 6, N 432. P. 55-65. <https://doi.org/10.32014/2018.2518-170X.28>

[25] Kabyzbekov K.A., Dasibekov A.D., Abdrakhmanova Kh.K., Saidakhmetov P.A., Issayev E.B., Urmashov B.A. Calculation and visualization of oscillating systems // News of the National academy of sciences of the Republic of Kazakhstan. Series of geology and technical sciences. 2018. Vol. 6, N 432. P. 110-120. <https://doi.org/10.32014/2018.2518-170X.28>

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**ISSN 2518-170X (Online), ISSN 2224-5278 (Print)**

<http://www.geolog-technical.kz/index.php/en/>

*Верстка Д. Н. Калкабековой*

Подписано в печать 15.11.2019.

Формат 70x881/8. Бумага офсетная. Печать – ризограф.

19,7 п.л. Тираж 300. Заказ 6.