



VISUAL TEACHING OF THE TOPIC "STRUCTURE OF CRYSTALLINE BODIES" WITH THE HELP OF THE MAPLE SOFTWARE PACKAGE

Turaeva Lolakhon Yuldashevna

Head teacher of physics at the "Temurbeklar maktabi" Tashkent military-academic lyceum

ANNOTATION

This article discusses the topic of the structure of crystalline bodies, which makes it difficult for readers to understand the clarity using the "Maple" software tool.

KEY WORDS: *kristall; monokristall; polikristall; building; cell; oscillation; centralized cubical; geksonal; centralized hexenal; spatial location.*

Annotatsiya: *Ushbu maqolada o'quvchilar tushunishida qiyinchilik tug'diradigan kristall jismlar tuzilishi haqidagi mavzuni Maple dasturiy vositasi yordamida ko'rgazmalilik asosida yoritilgan.*

Kalit so'zlar: *kristall; monokristall; polikristall; tuzilish; yacheyka;tebranish; markazlashgan kubik; geksonal; markazlashgan geksonal; fazoviy joylashuv.*

Аннотация: *В этой статье рассматривается тема структуры кристаллических тел, которая затрудняет понимание читателями с помощью программного инструмента "Maple", основанного на наглядности.*

Ключевые слова: *кристалл; монокристалл; поликристалл; строение; ячейка; колебания; централизованный; кубический; гексенал; централизованный гексенал; пространственное расположение.*

We all know very well that there is no left area where information communication technologies and software tools have not penetrated. Their opportunities have had time to make our lives easier, to create comfort, as well as to become an integral part of our lives. Even if we say that the organization of the educational process using the capabilities of Information Technology in the field of education, as in other areas, has already become a tradition in all educational institutions of our country, there will never be an exaggeration. Among them, the organization of physics classes in academic lyceums, like all subjects, with the help of a projector, an electronic board, computer gadgets, an internet network, virtual laboratories, hypermedia capabilities, as well as lesson presentations designed for each lesson and various developments obtained using a software tool, has become a requirement of the present day. Based on this, the science of physics presented difficulties in understanding and imagining¹.

Under the academic Lyceum curriculum, students of the 1st stage are taught information about the internal properties of substances in the spring, about the structures of Crystal bodies in the chapter on the structure of substances, as well as about the types of yacheyka. Several atoms or molecules of a substance that are located close together form a spatial pattern. This form is called yacheyka, and the types of yacheyka are much more diverse. For example, if the Centers of atoms or molecules are located at the edges of the Jub, he called it a cubic yacheyka, and if the hexagonal is located at the ends of the prism, he called it a hexonal yacheyka. Cubical and hexonal yachts are also in turn divided into types such as centered cubical or hexonal and collar centered cubical or hexonal. Beyond it are the types of oblique cuboid, hexonal, rhombahedral and hokoza, which the simple oral (oral) explanation does not pay much to readers. Showing crystals and yacheykas using modern programs without moving their generated spatial images away from the lesson, showing the subject in parallel as visual materials during the transition process, causes an increase in the effectiveness and productivity of the lesson².

¹ Tigai O.E. *Methods of application of information technologies in the teaching of physics in secondary special, vocational education (on the example of the electronic textbook in physics): Autoef. Dis.... kand. ped. sciences.* T.: TSPU, 2009. 24 p.

² V.F.Ochkov, K.A.Orlov. A.I. Tikhonov. Yu.V.Chudova. *Engineering calculations in Maple.*2020. 345 p



To this end, we can refer to the Maple software package, the possibility of which is extremely wide. We call the point at which the atom or molecule in the crystal cells is located nodes. Let's take the fact that only atoms are sitting in the node so that it is simpler and describe it as spherical. In the Maple package, the balloon is entered by the sphere command. For example, the `sphere(0,0,0,3,color=red)` order is entered to draw a sphere whose center is at the beginning of the coordinate, whose radius is equal to 3, and whose color is red. In order to vividly describe what shape the Yacheyka is in, the yacheyka knots should be cut out adjacent to the cuts. In the Maple package, cuts are entered by the line command. For example, line an incision with a brown color at the ends (-1,-2,-3) and (1,2,3) with a thickness of 3([-1,-2,-3], [1,2,3], color=brown, thickness=3) Command. With these two commands, we can get 3D-dimensional images of simple yacheykas and Crystal nodes. To do this, we will use the Cartesian coordinate system and it will be necessary to draw up an algorithm for entering the coordinates of the atom (sphere) at each node, as well as the coordinates of the intersections connecting the nodes. To distinguish between each other, it is better to number each line as and each sfwrani as. `Plots[display](l1,l2,l3,...,s1,s2, s3,...)`; we use the command. First of all, take a 3D – dimensional representation of the simplest yacheyka-centered cubic³.

We all know well that there is no place where information communication technologies and software tools have not penetrated. Their capabilities have become an integral part of our life, facilitating our life, as well as creating comfort. Even if we say that the organization of the educational process using the capabilities of Information Technology in the field of education, as in other areas, has already become a tradition in all educational institutions of our country, there will never be an exaggeration. Among them, the organization of physics classes was established in academic lyceums, like all subjects, using a projector, an electronic board, computer gadgets, an internet network, virtual laboratories, hypermedia capabilities, as well as lesson presentations designed for each lesson and various developments obtained using a software tool. the demand of today. Based on this, the science of physics presents difficulties

> *with(plottools)* :

> $a := 4; R := a/5;$

$a := 4 \quad R := \frac{4}{5}$

> $l1 := \text{line}([-a/2, -a/2, -a/2], [-a/2, a/2, -a/2], \text{color} = \text{black}) :$

$l2 := \text{line}([-a/2, a/2, -a/2], [a/2, a/2, -a/2], \text{color} = \text{black}) :$

$l3 := \text{line}([a/2, a/2, -a/2], [a/2, -a/2, -a/2], \text{color} = \text{black}) : l4 := \text{line}([a/2, -a/2, -a/2], [-a/2, -a/2, -a/2], \text{color} = \text{black}) :$

$l5 := \text{line}([-a/2, -a/2, a/2], [-a/2, a/2, a/2], \text{color} = \text{black}) : l6 := \text{line}([-a/2, a/2, a/2], [a/2, a/2, a/2], \text{color} = \text{black}) :$

$l7 := \text{line}([a/2, a/2, a/2], [a/2, -a/2, a/2], \text{color} = \text{black}) : l8 := \text{line}([a/2, -a/2, a/2], [-a/2, -a/2, a/2], \text{color} = \text{black}) :$

$l9 := \text{line}([-a/2, -a/2, -a/2], [-a/2, -a/2, a/2], \text{color} = \text{black}) :$

$l10 := \text{line}([-a/2, a/2, -a/2], [-a/2, a/2, a/2], \text{color} = \text{black}) :$

$l11 := \text{line}([a/2, a/2, -a/2], [a/2, a/2, a/2], \text{color} = \text{black}) : l12 := \text{line}([a/2, -a/2, -a/2], [a/2, -a/2, a/2], \text{color} = \text{black}) :$

> $c1 := \text{sphere}([-a/2, -a/2, -a/2], R, \text{color} = \text{red}) : c2 := \text{sphere}([-a/2, a/2, -a/2], R, \text{color} = \text{red}) :$

$c3 := \text{sphere}([a/2, a/2, -a/2], R, \text{color} = \text{red}) : c4 := \text{sphere}([a/2, -a/2, -a/2], R, \text{color} = \text{red}) :$

$c5 := \text{sphere}([-a/2, -a/2, a/2], R, \text{color} = \text{red}) : c6 := \text{sphere}([-a/2, a/2, a/2], R, \text{color} = \text{red}) :$

$c7 := \text{sphere}([a/2, a/2, a/2], R, \text{color} = \text{red}) : c8 := \text{sphere}([a/2, -a/2, a/2], R, \text{color} = \text{red}) : c9 := \text{sphere}([0, 0, 0], R, \text{color} = \text{blue}) :$

³ V.F.Ochkov, K.A.Orlov. A.I. Tikhonov. Yu.V.Chudova. *Engineering calculations in Maple.2020.* 345 p

```
> plots[display](l1, l2, l3, l4, l5, l6, l7, l8, l9, l10, l11, l12, c1, c2, c3,  
c4, c5, c6, c7, c8, c9, scaling = constrained, axes = normal, style  
= wireframe, thickness = 3);
```

Then the computer program 1-a will give us the image in the picture. It was a 3D-dimensional image of a centered cubic yacht, depicting the atom at the edges of the cube in red, and the atom at the center in blue⁴.

If, in a similar way, several adjacent yachts are included in the program, then we have a 3D-dimensional image of the crystal structure (1-b, figure).

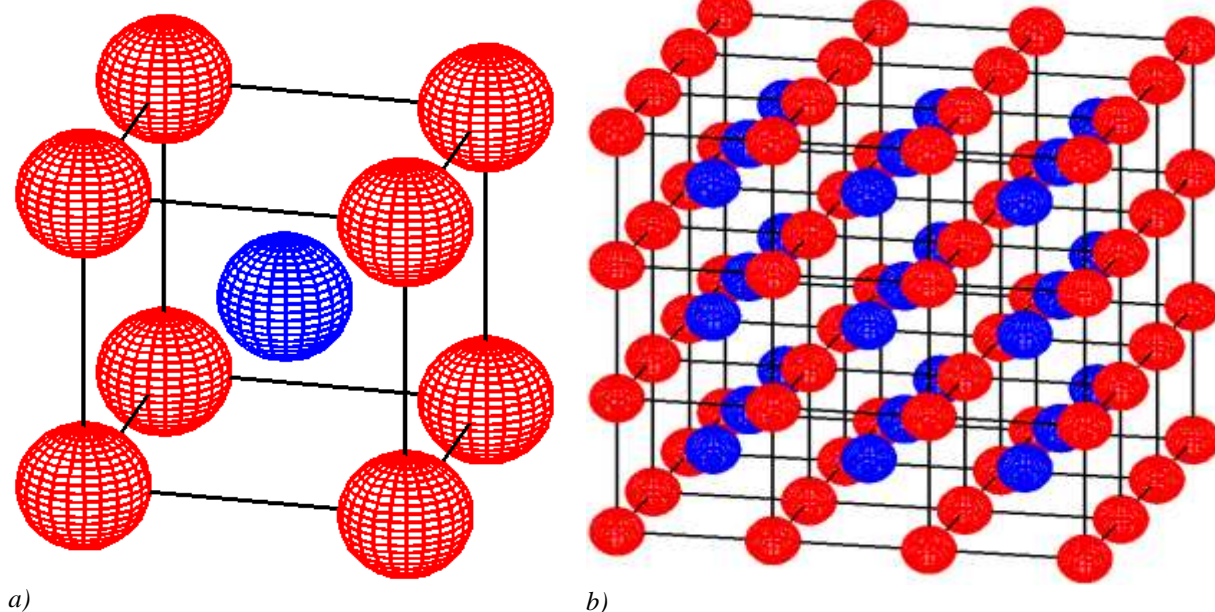


Figure -1

Now let's try to describe the slightly more complex appearance of the cubic yacheyka, that is, the cube with the sides centered. In this case, 8 atoms are located at the ends of the cube in one cell, and 6 atoms are located at the Centers of the cube's sides, for a total of 14 atoms forming a cell with one collar centered. Let ' make an algorithm to form that yacheyka.

```
> with(plottools) :  
> a := 4; R := a/5;  
a := 4  
R :=  $\frac{4}{5}$ 
```

⁴ Akhmedov Sh.B., Dusmuratov M.B. Physics (part 1). Textbook for students of academic lyceums. - Tashkent: Navruz, 2020. - 435 b.



```

> l1 := line([-a/2,-a/2,-a/2], [-a/2,a/2,-a/2], color = black) :
    l2 := line([-a/2,a/2,-a/2], [a/2,a/2,-a/2], color
    = black) :
    l3 := line([a/2,a/2,-a/2], [a/2,-a/2,-a/2], color = black) : l4
    := line([a/2,-a/2,-a/2], [-a/2,-a/2,-a/2], color = black) :
    l5 := line([-a/2,-a/2,a/2], [-a/2,a/2,a/2], color
    = black) : l6 := line([-a/2,a/2,a/2], [a/2,a/2,a/2], color
    = black) :
    l7 := line([a/2,a/2,a/2], [a/2,-a/2,a/2], color = black) : l8
    := line([a/2,-a/2,a/2], [-a/2,-a/2,a/2], color = black) :
    l9 := line([-a/2,-a/2,-a/2], [-a/2,-a/2,a/2], color
    = black) : l10 := line([-a/2,a/2,-a/2], [-a/2,a/2,a/2],
    color = black) : l11 := line([a/2,a/2,-a/2], [a/2,a/2,a/2],
    color = black) : l12 := line([a/2,-a/2,-a/2], [a/2,-a/2,a
    /2], color = black) :

> c1 := sphere([-a/2,-a/2,-a/2], R, color = red) : c2 := sphere([
    -a/2,a/2,-a/2], R, color = red) :
    c3 := sphere([a/2,a/2,-a/2], R, color = red) : c4 := sphere([a
    /2,-a/2,-a/2], R, color = red) :
    c5 := sphere([-a/2,-a/2,a/2], R, color = red) : c6 := sphere([
    -a/2,a/2,a/2], R, color = red) :
    c7 := sphere([a/2,a/2,a/2], R, color = red) : c8 := sphere([a
    /2,-a/2,a/2], R, color = red) :
    c9 := sphere([0,0,a/2], R, color = blue) : c10 := sphere([0,
    a/2,0], R, color = blue) :
    c11 := sphere([0,0,-a/2], R, color = blue) : c12 := sphere([0,
    -a/2,0], R, color = blue) : c13 := sphere([-a/2,0,0], R,
    color = blue) : c14 := sphere([a/2,0,0], R, color = blue) :

> plots[display](l1, l2, l3, l4, l5, l6, l7, l8, l9, l10, l11, l12, c1, c2, c3,
    c4, c5, c6, c7, c8, c9, c10, c11, c12, c13, c14, scaling
    = constrained, axes = normal, style = wireframe, thickness = 2);

```

Then we need a computer program 2-a, forming an image in the picture. It was a 3D-dimensional representation of a cubic yacheyka centered on the sides, with 8 atoms on the cube edges depicted in red, and 6 atoms centered on the sides in blue. If in a similar way we expand the algorithm in the program and insert several adjacent yacheys into the program by also giving the program the coordinates of the atoms in the nodes, then we have a 3D-dimensional image of a cubic yachecal crystal structure with the sides centered (2-b, figure)

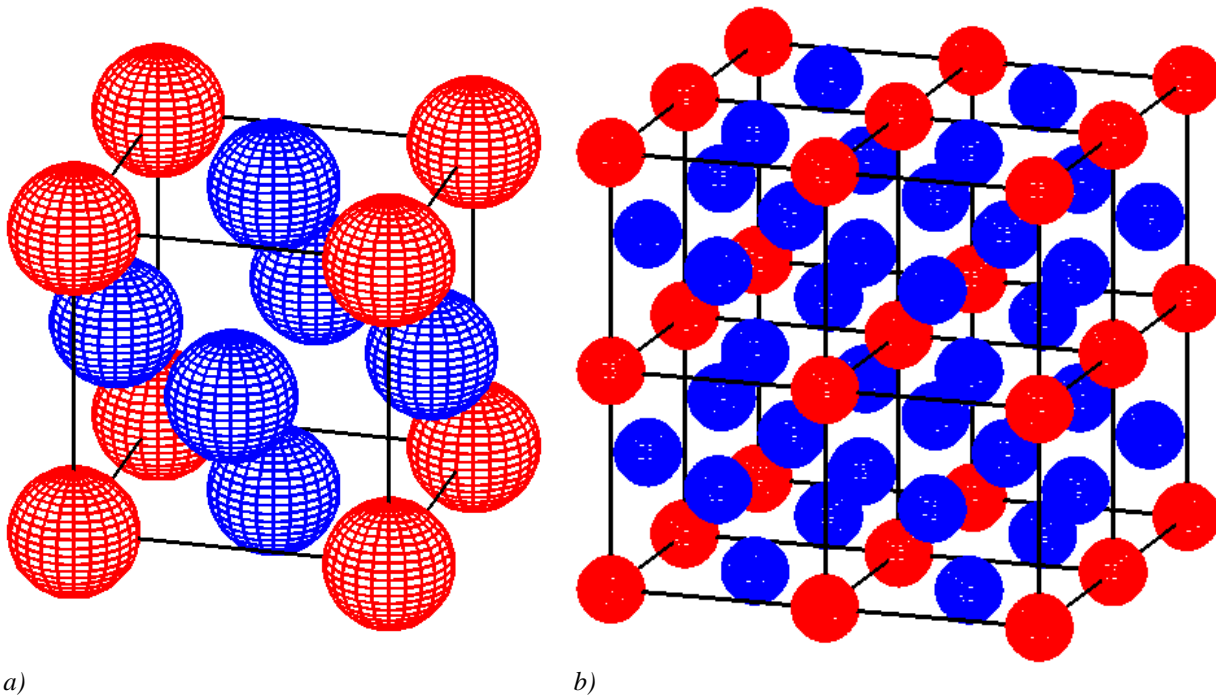


Figure -2

Another ken scattered pattern of Crystal yachts is the hexonal (6 – sided) yacheyka. In this case, 6 atoms will be located at the top and bottom ends of the 6-angle prism. There will be 1 additional atom located in the center of the prism or in the center of the 3 side oils of the prism, depending on whether it is a hexonal cachexa centered beyond it or the sides centered. Let's try to depict the atoms at the ends of the prism in red, and the atom at the center in blue. Let's build an algorithm for this centralized hexonal yacht.

> with(*plottools*) :

> $a := 4$; $R := a/3$; $H := 2*a$;

$a := 4$

$R := \frac{4}{3}$

$H := 8$

```
> l1 := line([a, 0, -H/2], [a/2, -sqrt(3)/2*a, -H/2], color = black) :
    l2 := line([a/2, -sqrt(3)/2*a, -H/2], [-a/2, -sqrt(3)/2
    *a, -H/2], color = black) :    l3 := line([-a/2, -sqrt(3)/2
    *a, -H/2], [-a, 0, -H/2], color = black) :    l4 := line([-a, 0,
    -H/2], [-a/2, sqrt(3)/2*a, -H/2], color = black) :    l5
    := line([-a/2, sqrt(3)/2*a, -H/2], [a/2, sqrt(3)/2*a, -H/2],
    color = black) :    l6 := line([a/2, sqrt(3)/2*a, -H/2],
    [a, 0, -H/2], color = black) :    l7 := line([a, 0, H/2], [a/2,
    -sqrt(3)/2*a, H/2], color = black) :    l8 := line([a/2,
    -sqrt(3)/2*a, H/2], [-a/2, -sqrt(3)/2*a, H/2], color = black)
    :    l9 := line([-a/2, -sqrt(3)/2*a, H/2], [-a, 0, H/2], color
    = black) :
```

l10 := line([-a, 0, H/2], [-a/2, sqrt(3)/2*a, H/2], color = black)

l11 := line([-a/2, sqrt(3)/2*a, H/2], [a/2, sqrt(3)/2*a, H/2], color = black) :

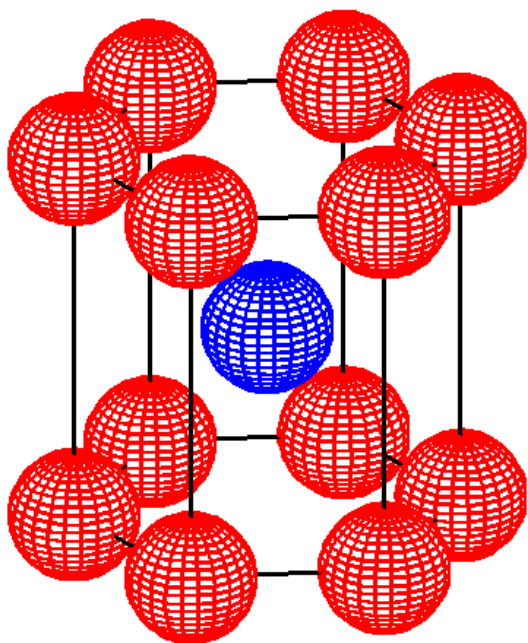

```

l12 := line([a/2, sqrt(3)/2*a, H/2], [a, 0, H/2], color = black) :
    l13 := line([a, 0, -H/2], [a, 0, H/2], color = black) :
        l14 := line([a/2, -sqrt(3)/2*a, -H/2], [a/2,
            -sqrt(3)/2*a, H/2], color = black) :
l15 := line([-a/2, -sqrt(3)/2*a, -H/2], [-a/2, -sqrt(3)/2*a, H
    /2], color = black) :    l16 := line([-a, 0, -H/2], [-a, 0, H
    /2], color = black) :    l17 := line([-a/2, sqrt(3)/2*a, -H
    /2], [-a/2, sqrt(3)/2*a, H/2], color = black) :    l18
    := line([a/2, sqrt(3)/2*a, -H/2], [a/2, sqrt(3)/2*a, H/2],
    color = black) :

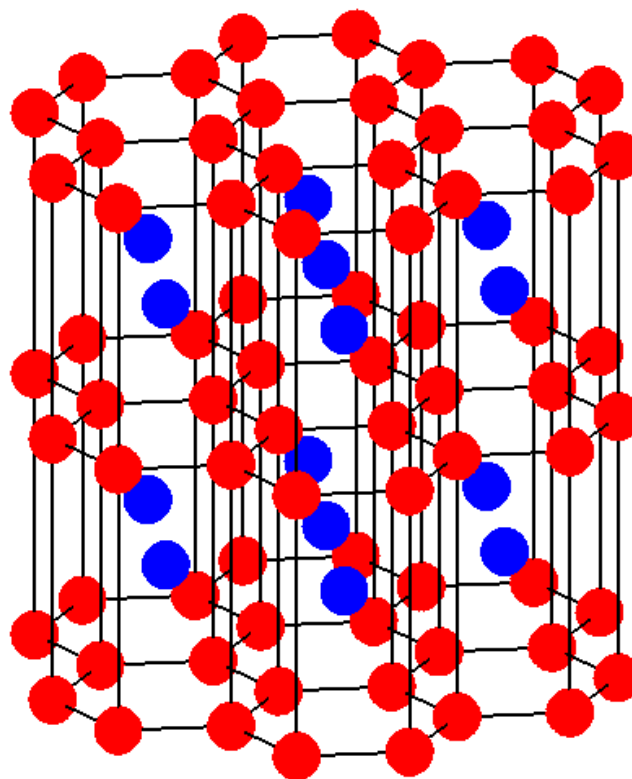
> c1 := sphere([a, 0, -H/2], R, color = red) :          c2
    := sphere([a/2, -sqrt(3)/2*a, -H/2], R, color = red) :
c3 := sphere([-a/2, -sqrt(3)/2*a, -H/2], R, color = red) :    c4
    := sphere([-a, 0, -H/2], R, color = red) :
c5 := sphere([-a/2, sqrt(3)/2*a, -H/2], R, color = red) :
    c6 := sphere([a/2, sqrt(3)/2*a, -H/2], R, color = red) :
c7 := sphere([a, 0, H/2], R, color = red) :          c8
    := sphere([a/2, -sqrt(3)/2*a, H/2], R, color = red) :
c9 := sphere([-a/2, -sqrt(3)/2*a, H/2], R, color = red) :    c10
    := sphere([-a, 0, H/2], R, color = red) :
c11 := sphere([-a/2, sqrt(3)/2*a, H/2], R, color = red) :    c12
    := sphere([a/2, sqrt(3)/2*a, H/2], R, color = red) :    c13
    := sphere([0, 0, 0], R, color = blue) :
    
```

```

plots[display](l1, l2, l3, l4, l5, l6, l7, l8, l9, l10, l11, l12, l13, l14, l15,
    l16, l17, l18, c1, c2, c3, c4, c5, c6, c7, c8, c9, c10, c11, c12, c13,
    scaling = constrained, axes = normal, style = wireframe,
    thickness = 2);
    
```



a)



b)

Figure -3



Then we need a computer program 3-a, forming an image in the picture. If, in a similar way, we construct an algorithm by expanding the algorithm in the program and inserting the coordinates of several adjacent yacheykas into the program as well, then we have a 3D-dimensional image of the hexonal yacheykali crystal structure, the sides of which are centered (3-b, figure)

We can construct an algorithm using the Maple-12 software package to capture a 3D-dimensional representation of a cubic yacht whose sides are centered in a similar way to the surface.

> with(plottools) :

> a := 4; R := a/3; H := 2 * a;

a := 4

R := $\frac{4}{3}$

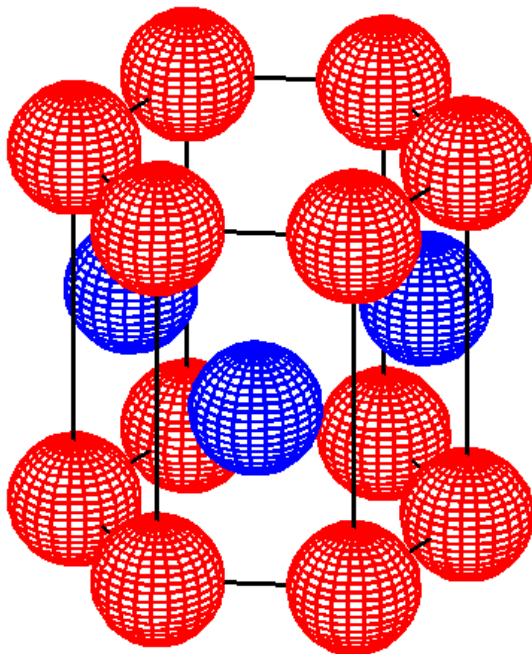
H := 8

```
> l1 := line([a, 0, -H/2], [a/2, -sqrt(3)/2*a, -H/2], color = black) :
    l2 := line([a/2, -sqrt(3)/2*a, -H/2], [-a/2, -sqrt(3)/2
    * a, -H/2], color = black) :    l3 := line([-a/2, -sqrt(3)/2
    * a, -H/2], [-a, 0, -H/2], color = black) :    l4 := line([-a, 0,
    -H/2], [-a/2, sqrt(3)/2*a, -H/2], color = black) :    l5
    := line([-a/2, sqrt(3)/2*a, -H/2], [a/2, sqrt(3)/2*a, -H/2],
    color = black) :    l6 := line([a/2, sqrt(3)/2*a, -H/2],
    [a, 0, -H/2], color = black) :    l7 := line([a, 0, H/2], [a/2,
    -sqrt(3)/2*a, H/2], color = black) :    l8 := line([a/2,
    -sqrt(3)/2*a, H/2], [-a/2, -sqrt(3)/2*a, H/2], color = black)
    :    l9 := line([-a/2, -sqrt(3)/2*a, H/2], [-a, 0, H/2],
    color = black) :    l10 := line([-a, 0, H/2], [-a/2, sqrt(3)
    /2*a, H/2], color = black) :    l11 := line([-a/2,
    sqrt(3)/2*a, H/2], [a/2, sqrt(3)/2*a, H/2], color = black) :
    l12 := line([a/2, sqrt(3)/2*a, H/2], [a, 0, H/2],
    color = black) :    l13 := line([a, 0, -H/2], [a, 0, H/2],
    color = black) :    l14 := line([a/2, -sqrt(3)/2*a, -H/2], [a/2
    -sqrt(3)/2*a, H/2], color = black) :    l15 := line([-a/2,
    -sqrt(3)/2*a, -H/2], [-a/2, -sqrt(3)/2*a, H/2], color
    = black) :    l16 := line([-a, 0, -H/2], [-a, 0, H/2], color
    = black) :    l17 := line([-a/2, sqrt(3)/2*a, -H/2], [-a
    /2, sqrt(3)/2*a, H/2], color = black) :    l18 := line([a
    /2, sqrt(3)/2*a, -H/2], [a/2, sqrt(3)/2*a, H/2], color = black)
    :
```

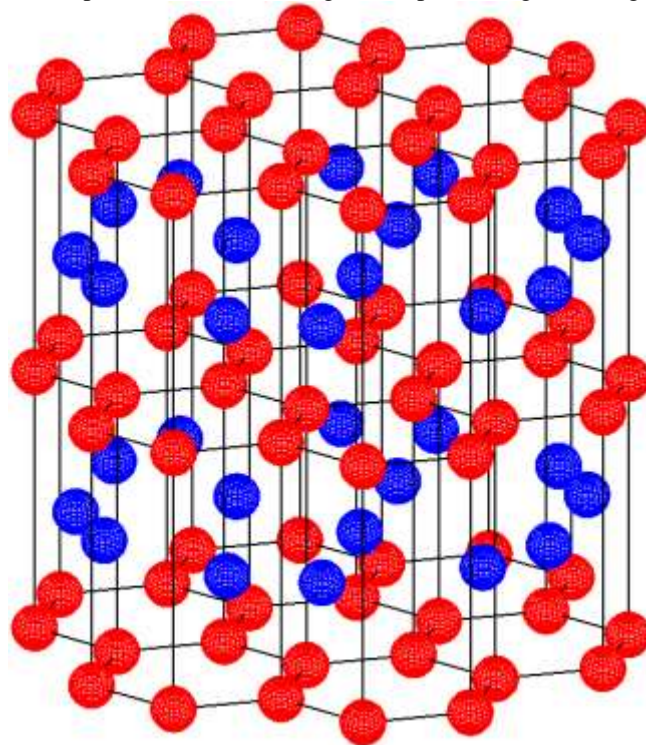
```
> c1 := sphere([a, 0, -H/2], R, color = red) :    c2
    := sphere([a/2, -sqrt(3)/2*a, -H/2], R, color = red) :
    c3 := sphere([-a/2, -sqrt(3)/2*a, -H/2], R, color = red) :    c4
    := sphere([-a, 0, -H/2], R, color = red) :
    c5 := sphere([-a/2, sqrt(3)/2*a, -H/2], R, color = red) :    c6
    := sphere([a/2, sqrt(3)/2*a, -H/2], R, color = red) :
    c7 := sphere([a, 0, H/2], R, color = red) :    c8
    := sphere([a/2, -sqrt(3)/2*a, H/2], R, color = red) :
    c9 := sphere([-a/2, -sqrt(3)/2*a, H/2], R, color = red) :    c10
    := sphere([-a, 0, H/2], R, color = red) :
    c11 := sphere([-a/2, sqrt(3)/2*a, H/2], R, color = red) :    c12
    := sphere([a/2, sqrt(3)/2*a, H/2], R, color = red) :    c13
    := sphere([3/4*a, sqrt(3)/4*a, 0], R, color = blue) :    c14
    := sphere([-3/4*a, sqrt(3)/4*a, 0], R, color = blue) :    c15
    := sphere([0, -sqrt(3)/2*a, 0], R, color = blue) :
```

```
> plots[display](l1, l2, l3, l4, l5, l6, l7, l8, l9, l10, l11, l12, l13, l14, l15,  
l16, l17, l18, c1, c2, c3, c4, c5, c6, c7, c8, c9, c10, c11, c12, c13,  
c14, c15, scaling = constrained, axes = normal, style  
= wireframe, thickness = 2);
```

Then we need a computer program 4-a, forming an image in the picture. We can also easily generate 3D-dimensional images of Crystal pangaras with centered hexonal cells, such as those performed above, using the Maple Package (4-b, figure).



a)



b)

Figure-4

Of course, our first goal is not to teach programming to students of academic lyceums during the lesson, but to teach topics related to physics. But it is better to use the various developments obtained using various software tools and packages in parallel during the coverage of the topic on physics in order to increase the sensitivity, attractiveness of the subject and make the most of the time. This leads to an increase in skills and competencies that students can understand and master, and to be able to bring the phenomena and processes surrounding the topic to the fore.

Thus, in addition to the fact that teaching students with the help of modern software tools, a topic related to the structure of Crystal bodies has the advantages listed above, it makes students interested in working with programs, creating an opportunity for them to work on their own. It can also be explained in this topic by the teacher that due to the presence of forces of attraction and push between molecules and atoms, the atoms and molecules in the yacheyka nodes, without standing hardened, oscillate around this node, and when this oscillatory movement intensifies, they gradually begin to turn into liquids. This allows students' knowledge to be formed in detail, in depth.

REFERENCES

1. Tigai O.E. *Methods of application of information technologies in the teaching of physics in secondary special, vocational education (on the example of the electronic textbook in physics): Autoef. Dis.... kand. ped. sciences.* T.: TSPU, 2009. 24 p.
2. Gomulina N.N. *Application of new information and telecommunications technologies in school physical and astronomical education. Kand.Ped.Sciences...Disses.* - Moscow, 2003. - P. 11 - 19.
3. Koptev, A. A. Pasko, A. A. Baranov. *Maple in engineering calculations.* Tambov State Technical University. - Tambov.: 2003. -63 p
4. V.F.Ochkov, K.A.Orlov. A.I. Tikhonov. Yu.V.Chudova. *Engineering calculations in Maple.*2020. 345 p
5. V.Z.Aladev. *Basics of programming in Maple.* - Tallinn. 2006, 301 p.
6. Akhmedov Sh.B., Dusmuratov M.B. *Physics (part 1). Textbook for students of academic lyceums.* - Tashkent: Navruz, 2020. – 435 b.
7. Dusmuratov M.B. *The study and demonstration of equipotential surfaces under the Maple program//pedagogical education.* - Tashkent, 2012. –№5. B. 60–66.
8. A.Primkulova, R.Turgunbaev, G.Eshchanova, Sh.Ismailov. *Methods for solving mathematical problems in Maple (methodical guide).* Tashkent Pedagogical University named after Nizami. Tashkent.:2009. -116 b.
9. *Physics 10th grade: textbook.n.Sh.Turdiyev et al.* - T.: Publishing house " Niso polygraph", 2017, -192 P.