Enclosure 2
Scenario of main lesson

Theme: The contribution of Nicholas Copernicus' observations to the reform of calendar .

General aim: Get to know Copernicus experiment observation results and their consequences

Operational aims: Student:

- understand the concepts: geocentric and heliocentric systems, ecliptic, celestial equator, the equinox, gnomon, calendar, „white nights”,
- understand what is the rotation of the Earth,
- understand what is the progressive movement (circulation) of the Earth,
- can explain the apparent movement of the Sun,
- knows who they were: Aristotle, Aristarchus, Ptolemy and Copernicus,
- knows how to exploit the Earth's motion around the Sun for investigation the phenomenon of actual equinox.

Educational tools:

- Instruments for demonstration:
  progressive and rotary motion (lamp, globe) and the apparent movement of the Sun (plasticine with a match - gnomon, a piece of paper, pencil an electrical circuit with the diode on a mobile stand - in short called "gnomon with a lamp),
- card (or foliogram) with chart presenting the experiment,
- blackboard.

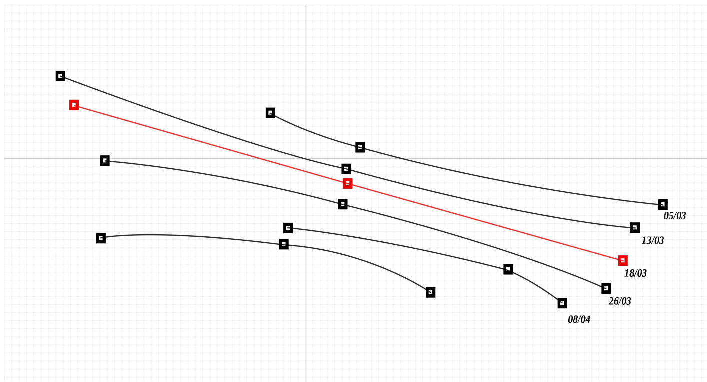
<u>Methods:</u> experiments, talks, discussion,.

<u>Forms</u>: collective, individual.

Teacher’s activities	Student’s activities
1. Introduction	
Organisation of lesson: welcome, checking of presence	
Communication of theme of the lesson	Writing the theme of the lesson: „The contribution of Nicholaus Copernicus to the reform of calendar.”.
Question 1: Could you remind: who was Nicolaus Copernicus? **Question 2:** Could you remind: what astronomical instruments were used by Nicolaus Copernicus for his observations?	**Answer:** Polish astronomer, physician, and a canon and lawyer, who, referring to some ideas from antiquity proposed and described the heliocentric system of the Universe. **Answer** Astrolabe, quadrant, triquetrum and astronomical table
2. Explication of lesson	
I. Elements of history	
- Geocentric system **Question3**: What was characterized geocentric system?	**Answer:** In the center of such a system is the Earth and other planets, Moon and Sun (on the third orbit) revolve around her.
• Aristotle (384 -322 BC on) placed the Earth in the center of the Universe; • Ptolemy (ca. 100 - 170 of n. e.) In 140, the n.e. described a system in which Earth was in the middle, and the planets circled	Students write a short note: Eg. : Geocentric system: a) Aristotle (384 -322 BC on) b) Ptolemy (c. 100 - 170 of n. e.)

around: Moon and Sun in third place. All these astronomical objects rotated in circular orbits.	
- heliocentric system **Question 4**: What was characterized heliocentric system?	**Answer:** In the center of this system is the Sun, and other planets, Earth and Moon (on the third orbit) revolve around him.
• Aristarchus (320 - 230 of BC.) Around 280 BC He and other thinkers have put the Sun in the middle of the world; • Nicolaus Copernicus (1473 - 1543) In his work, , "On the Revolutions of Heavenly Spheres ..." issued in 1543 He describes the motion of the Earth and other planets around the Sun in which the planets around the Sun and the Moon around the Earth rotate in circular orbits.	Students write a short note: Eg.2: Heliocentric system: a) Aristarchus (320 - 230 of BC), b) Copernicus (1473 - 1543).
- calendars **Question 5:** What according to you is meant by the calendar? The original name comes from the accounting books moneylender - the first day of the month - time to pay debts.	**Answer:** General calculations of days in a large time intervals.
Question 6: What kind od calendars do you know?	**Answer:** Gregorian and Julian calendars.
Roman Calendar The oldest known „the year of Romulus", repeatedly reformed. **Julian Calendar** A major reform of the Roman calendar was carried out in the time of Julius Caesar and in 46 BC the calendar as proposed by Sosigenesa – was introduced. Every four years was a leap year, ain this way year have been prelongated by one day - an average year of calendar was 365.25 days. **Gregorian Calendar** It turned out that the Julian calendar is not accurate (too long) and reformed back in 1582 year, as proposed by Luigi Lilio. To shorten the average year of the new calendar, leap years were introduced, but only those which are divisible by four, but if the year is divisible by one hundred is not a leap year (unless it is divisible by 400).	Students are writing the short note:. E.g. 3: Calendars: a) Julian – introduced in times of the Julius Caesar in 46 BC; the average year of the calendar counted 365.25 days, b) Gregorian – introduced in times of the Pope - Great Gregor in 1582 r.; leap years were implemented, but only the ones which are divisible by four, however, if the year is divisible by one hundred is not a leap year (unless it is divisible by 400).
Question 7: Where known, and as observed differences in time?	
II. Elements of geography	
- experiments with globe and a lamp	
• *rotational motion of the Earth - an explanation of days and nights;* **Question 8:** What are the lengths of day and night on the whole Planet?	Two students carry out the experiment, while others observe. All reflect on the question.
Overview of the length of day and night, when the Earth not revolves around the Sun , but rotates around an axis perpendicular to the line connecting it with the Sun;	**Answer**: In this case on whole Panet, day and night are equally long, as in any village the Sun each day is plotting on the sky exactly the same circle

Overview of the length of day and night, when the Earth not revolves around the Sun, but rotates around an axis inclined to the line connecting it to the sun at about 66.50 degrees.	**Answer:** In any place the Sun each day plots on the sky exactly the same circle, but for example, to the north of the tropic of Cancer lit areas occupy more than half the length of the given parallel and consequently on that parallel we can see the Sun for more than half a day. Days are longer than the nights farther to north, and even appear so.called „white nights" and vice versa, shorter, when we descend to the south. It is always so.
• *Circulation (progressive) motion of the Earth around the Sun* - an explanation of the seasons; **Question 9:** How do the light areas of the Earth changes?	Two students are carry out the experiment, while others observe. All reflect on the question.
Discussion of the emergence of the various lights of the Earth, when the Earth revolves around the Sun, but not ratate (spinning);	.**Answer:** Within one circulation of the Earth around the Sun, any place on Earth is illuminated once the market by 0.5 times. Lighting that changes smoothly.
Discussion of the emergence of the various lights of the Earth and, consequently, the seasons, when the Earth revolves around the Sun, and rotates about an axis inclined to the line connecting it to the sun at about 66.50 degrees.	**Answer:** Within one circulation of the Earth around the Sun, any place on Earth is lit, but lengths of day and night are changing and thus to cause the appearance of the seasons.
Please make a brief note on inversion and progressive movement (circulation).	Students draw up a note - record the effects of rotational and advancing (circulation motions of the Earth as: Eg 4: The effects of motion of the Earth and the inclination to the ecliptic plane: a) rotational - day and night, b) circulating (progressive) - the time of the year- seasons.
Question10: What differences in time referred to different calendars have been observed?	
At the Council of Nicaea in 325 day of Easter on the Sunday after the spring full moon was established, so after the spring equinox.. Equinox is a special time in which the ecliptic - the path of the Sun crosses the celestial equator - the plane of Earth's equator. During the year, this phenomenon occurs twice. When?	**Answer:** About 21st of March and 23rd of September.
From around the thirteenth century the differences between the actual seasons, and seasons resulting from the Julian calendar century were marked ,and therefore, intended to improve the current calendar - but there still was not a good idea how to do this. During the **Luteran Council** (1513 - 1517), in the time of Pope Leo X, work on calendar reform were intensified. It turns out that in this work Copernicus also participated. His work on the calendar began in 1515 and ended in mid-1516. We know that based on the letter of 4 June 1516 by Paul from the Middelburg (Bishop, who asked Copernicus in 1513 to work on the calendar) to Pope Leo X. The results of his observations, he has also placed at work "On the Revolutions of Heavenly Spheres ..."	

-experiments with gnomon and lamp	
It turns out that after submitting their results to Paul of Middelburg Copernicus continued his studies in Olsztyn. As the administrator of the castle in Olsztyn, he left the so-called astronomical table showing the apparent motion of the Sun on the sky.	
The apparent motion of the Sun Using "gnomon with a lamp the teacher draws on the card: 1) points left after shadow when the sun (light) is set at the equinox, defines directions of the world: east - west, north - south. Draw the line (should be straight line). 2) points left after the shadow when it is winter, so the Sun rises in the southeast, and set in the southwest. Draw the line (should be hyperbole). 3) points left after the shade when it is summer, so the sun rises in the northeast, and it is in the northwest. Draw the line (should be hyperbole bent the other way). **Important**: During experiment gnomon should be in the same place, but the card (or stand) can be moved.	Students in groups approach the table with a completed experiment. They are Watching the experiment.
III Experimental resulds	
Students are presenting the results of experiments that we conducted at the school (hrough the presentation of the obtained charts).	After wathing the results they drawn up a note, for example: *The apparent motion of the sun in the sky* a) straight line (red line) is representing a movement of the Sun, when the ecliptic equator coincides with the celestian equator - the equinox, the Sun "rises in the east" and "sets in the west" b) the hyperbolas (black lines) are representing a movement of the Sun, when the ecliptic crosses the celestial equator and: • Winter - the Sun "rises in the southeast" and "sets in the southwest, • Summer:- the Sun "rises in the northeast" and "sets s in the northwest" c) the complete graph is looking as follows:  Students should remember that the similar graph they already saw.

• Discussion **Question 11:** What similarities and what differences do you see in comparison with the original graph made by Copernicus?	**Answer:** The graph obtained as the result of experiment, which was carried out at school is very similar to the Copernicus graph. However, students will read a different date for Spring equinox - March 18 and inexact graph of the hyperbola from April 8. They communicate the cause of the errors (the diameter of the point is about 5cm, not precise method of „dropping points” in a coordinate system, measurements with the use of measuring tape, etc).
3. Summary	
Nicolaus Copernicus, knowing that within a year the Sun twice intersects the plane of the celestial equator (equinox) could calculate: 1) if the date of obeyed calendar is shifted to the date of the astronomical equinox - a discrepancy was about 10 days, 2) how long is the year of actual movement of the Earth around the Sun – and from these to conclude that the the difference is about 11 minutes/year at that time.	