The original course of Astronomy for the Physics and Mathematics Lyceum

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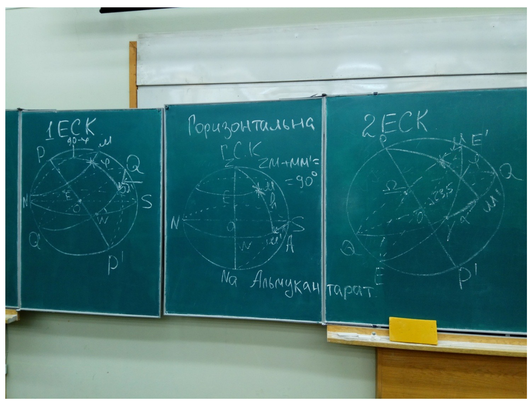
Abstract: Despite the dependence and vulnerability of our civilization from outer space, astronomy is not teach as a compulsory subject in every country. And even centers for extracurricular education not pay enough attention for Astronomy. Perhaps it is the reason that we have a small number of professional astronomers, although interest in astronomy as a science is consistently great. There are very few countries in which astronomy is taught, as a compulsory course. In some countries, astronomy appears nowhere in the curriculum. In Ukraine the “average” situation is that astronomy is taught once a week at grade level 11. But there are exceptions. In one of the best physics and mathematics schools in Ukraine (UPML of Taras Shevchenko National University), the subject of astronomy is taught for 2.5 years with one lesson per week. The program include a unit of astronomy at grade level 9-11. It gives pupils deep and fundamental knowledge of the subject and also prepares children for competitions of different levels. This course of astronomy includes such thematic blocks: the basic concept of astronomy; information about the celestial sphere and coordinate systems; constellations; time measurement and calendars; information about the Solar System; the foundations of celestial mechanics; stars; the structure of the galaxy; extragalactic astronomy and cosmology. In this course there is still something to work on, namely on motivation of students for which astronomy is perceived far from the realities of life. It is also necessary ensure full compliance of equipment to the given course. Classes are conducted once in a week, that's why in order to achieve a high level of mastering knowledge, we need to improve teaching methodology. But still the powerful course of astronomy for our students thanks my efforts, the efforts of my colleague and administration of lyceum successfully works and develops.

Training takes place in the large classrooms

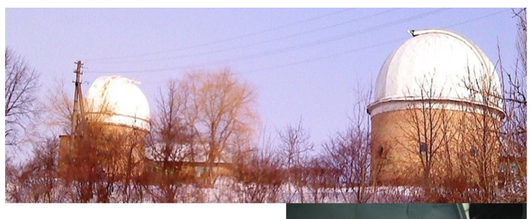


Lyceum cooperates with the Astronomical Observatory of Taras Shevchenko National University

The most active students have the opportunity to deepen their knowledge of the practical course of astronomy at the observation station

The station of Astronomical Observatory of Taras Shevchenko National University “Lisnyky”(MPC code 585) and the dome of the telescope AZT-14

Telescope AZT-14 (D = 0.48 m, F = 7.7 m) with the spectrograph ASP-9



Telescope AZT-8 (D = 0.7 m, F = 2.8 m)

Thematic planning of astronomy lessons for students of 9th-11 th grades in 2016-2017 academic year

№ Lesson	Themes of lessons
	Thematic planning of astronomy lessons for students of 9th grades
	Theme 1 «Introduction to Astronomy»
1	Astronomy as a science. Stages of development of astronomical science.
2	Creators of astronomical science. Astronomy in Ukraine.
3	Astronomical observatories and their equipment. Astronomical climate.
4	Telescopes: basic telescope systems, optical characteristics of telescopes.
5	Advantages and disadvantages of the various systems of telescopes. Types of optical aberrations.
6	Angular and linear dimensions of objects.
7	Tasks solutions.
8	Parallaxes. The units of distance in astronomy and the connection between them.
9	Determination of distances by means of parallaxes.
10	Elementary concepts of the brightness and luminosity of stars, the basis of their measurement.
11	Stellar magnitudes and their connection to illumination and luminosity. The Pogson formula.
12	Tasks solutions. Independent work.
	Theme 2 «Celestial sphere »
13	Not Cartesian coordinate systems: polar, cylindrical and spherical coordinate system.
14	Formulas of spherical trigonometry.
15	Tasks solutions.
16	Celestial sphere. Points and lines on the celestial sphere.
17	Coordinate systems on the celestial sphere. Parallactic triangles.
18	The connection between the celestial coordinate systems.
19	Tasks solutions.
20	The diurnal motion of the celestial sphere at different latitudes. The upper and lower culmination of the celestial bodies.
21	Visible and invisible celestial bodies for a given area.
22	Movement of the Sun, Moon and the planets by the celestial sphere. Ecliptic.
23	Phenomena that change the coordinates of the celestial bodies: atmospheric refraction, light aberration, precession, nutation.
24	Constellations. A view of the stellar sky in different seasons.
25	The most known objects in the constellations.
26	Orientation with the help of the Sun and stars.
27	A moving map of the starry sky.
28	Practical work №1 «Working with a moving map of the starry sky."
	Theme 3 «Time measurement»
29	Time and methods of its calculation. Time scales of measurement.
30	Units of time: sidereal day, the real and the mean solar day, the equation of time.
31	Time measurement systems: local, global, belt, ephemeris and summer time.
32	Tropical year.
33	Calendar.
34	Tasks solutions.
	Thematic planning of astronomy lessons for students of 10th grades
	Theme 4 «Solar System»
1	Solar System. Models of the formation of the Solar System.
2	The Sun. General characteristics.
3	Solar-terrestrial connections.
4	Practical work №2 «The study of Solar activity.»
5	Planets of the terrestrial group.
6	The giant planets.
7	Small bodies of the Solar System: dwarf planets and asteroids.
8	Small bodies of the Solar System: comets and small meteor particles.
9	Space debris. Independent work.
	Theme 5 «Celestial mechanics»
11	Fundamentals of celestial mechanics. The movement of the two bodies under the action of its own force of gravity.
12	The laws of conservation of momentum and energy.
13	Tasks solutions.
14	Generalized Kepler laws.
15	Tasks solutions. Independent work.
16	Practical work «Determination of the masses of bodies with the help of III Kepler law.»
17	Many-body problem. Libration points.
18	Libration, precession, nutation.
19	Practical work №3 «Investigation of precession and nutation phenomena using a homemade top.»
20	Test work.
	Theme 6 «Stars»
21	Stars. Star formation. Fragmentation. Jeans Size.
22	The model of an absolutely black body and the laws of its radiation.
23	Tasks solutions.
24	Spectrum, the formation of spectral lines. Fundamentals of the spectral classification of stars.
25	Dependence of the colour of the star on temperature. Classes of luminosity of stars.
26	Practical work №4 «Spectral classification of stars»
27	Stationary stars. Conditions for stationarity of stars. The Hertzsprung-Russell diagram.
28	Double and non-stationary stars.
29	Determination of the basic parameters of eclipsing binary system.
30	Cepheids and throbbing stars.
31	Practical work №5 «Study of variable stars»
32	The final stages of the evolution of stars. White dwarfs, neutron stars, black holes.
33	Test work.
	Thematic planning of astronomy lessons for students of 11th grades
	Theme 7 «Structure of the Galaxy»
1	Star Clusters and Associations
2	Nebulae and interstellar medium. Types of nebulae.
3	Formation of nebular lines.
4	Planetary systems of other stars. Exoplanets.
5	Methods for detection of exoplanets.
6	Practical work №6 «Exoplanet research.»
7	Structure of the Milky Way.
8	Practical work №7«Determination of the age of the spherical cluster and the distance to it.»
	Theme 8 «Extragalactic astronomy and cosmology»
9	Classification of galaxies. Galaxies that are not subject to classification.
10	Practical work №8 « Classification of galaxies »
11	Hubble's law. The relativistic Hubble law.
12	Active nuclei of galaxies and manifestations of activity of extragalactic objects.
13	Supermassive black holes and black holes of intermediate masses.
14	The Big Bang Theory and the large-scale structure of the Universe. Relic radiation.
15	**Modern problems of astrophysics. Independent work.**

Building of of the Ukrainian Physics and Mathematics Lyceum of Taras Shevchenko National University

History and modernity of UPML

The lyceum was established in 1963 and was known as the Republican Specialized Physics and Mathematics Boarding School until 1992. In total 5,324 students graduated from UPML by 2013. Many of the alumni are winners of National Ukrainian and International Science Olympiads: only between 1963 and 2005 as many as 65 UPML students were awarded medals at International Olympiads in Physics (IPhO), Mathematics (IMO), Chemistry (IChO) and Informatics (IOI), 148 – at all-Soviet Olympiads, 696 – at Ukrainian National Olympiads.

The lyceum is currently publicly funded in its entirety and suffers from regular budget shortfalls. Nevertheless, tuition, board and lodging are free of charge for all admitted students.

In 2007 UPML became the first Ukrainian school with its name visible from outer space.

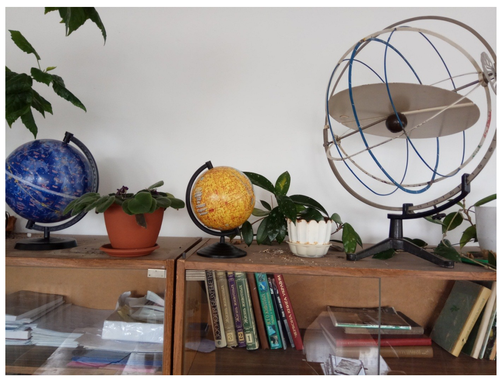
Students of the lyceum study from 8th through 11th grades. Due to the organizational affiliation students of the graduating class (11th grade) have the right to be admitted to engineering and natural sciences departments of Taras Shevchenko National University of Kyiv through a preferential admission process.

A growing number of the lyceum alumni continue their studies overseas: in the United States, Canada, Europe and Asia. Many alumni work in the IT industry and build their careers in the R&D sector.

The educational process in the Lyceum is provided by two departments (Physics and Astronomy, Mathematics) and six methodological associations: teachers of Informatics; Chemistry, Biology and Geography; Foreign language; Social and humanitarian subjects; Physical culture and also Educators. The system of the organization of the educational process is also important: in the classrooms, an average of 20 students, in the lessons of individual subjects there is a division into subgroups; In the second half of the day there is an extensive system of elective classes.

Students have the opportunity to make astronomical observations in the Lyceum

At elective classes, students prepare for competitions of different levels and deepen their knowledge on selected questions of astronomy



Lyceum cooperates with the Kiev Planetarium