



Ministry of Education and Science of Ukraine

ASTRONOMY

Curriculum for comprehensive schools

Grade 11

Standard level

Standard level programme
Grade 11
(1 hour per week; 35 hours in total)

The expected learning outcomes	Content of study material
Introduction. The discipline of astronomy. Its development and significance in society. A brief overview of the research objects in astronomy.	
<p><i>The knowledgeable component</i> Operates concepts and definitions: Astronomy; prominent astronomers (Ptolemy, Copernicus, Galileo, Kepler, Herschel, Gable, etc.); modern fields of astronomy. Explains the reasons for the emergence and development of astronomy; the relationship between astronomy and other sciences, the importance of astronomy in shaping the human worldview, the role of astronomy and astronautics Solving global problems of humankind. Examples of the history of development of astronomy in the world and in Ukraine, the relationship of astronomy with other sciences, the contribution of distinguished scientists of the world and Ukraine to astronomical science, objects of the Universe, use of astronomical knowledge in human life.</p> <p><i>The activity component</i> describes the main landmarks of the development of astronomy; Astronomy as an observational science, astronomical knowledge as a cultural factor; spatial and temporal scales in astronomy Formulates a definition of astronomy as a science.</p>	<p>Astronomy is the fundamental science that studies objects in the Universe and the Universe as a whole. Areas of astronomy. Relationship between astronomy and other sciences. History of development of astronomy. Pseudoscientific nature of astrology and its assumptions. Significance of astronomy in formation of human world outlook and culture. Objects of study and spatial and temporal scales in astronomy.</p> <p>Showcases. 1. Portraits of famous astronomers. 2. Portrayal of objects of study in astronomy.</p>
Section 1: The Celestial Sphere. The movement of the luminaries on the celestial sphere	
<p><i>The knowledgeable component</i> Operates concepts and definitions: celestial sphere, constellation, characteristic constellations of the starry sky, points and lines of the celestial sphere; ecliptic; celestial coordinates; horizontal parallax, units measurement of distances in astronomy; apparent and absolute magnitude of stars; local, standard and universal time; types of calendars; Kepler's laws. Names the number of constellations according to the modern division in the sky. Explains the causes of the visible movements of the luminaries in the celestial sphere, methods of determining distances to celestial bodies as well as their sizes and masses, the principle of determining Local time, calendar principles, systems of celestial coordinates, causes of solar and lunar eclipses. Examples of celestial luminaries, origin of constellation names, use of different types of calendars. The use of Kepler's laws in the world, the application of Kepler's laws</p> <p><i>The activity component</i> Shows the characteristic constellations in the starry sky, the brightest stars (Sirius, Arcturus, Vega, Capella, Rigel, etc.), the planets of the solar system visible to the naked eye. Describes the daily motion of the luminaries at different geographical latitudes.</p>	<p>Celestial luminaries and the celestial sphere. Constellation. Stellar magnitudes. Determination of distances to celestial bodies. Celestial coordinates. Types of calendars. Astronomy and determination of time. Visible movements of the Sun. Visible movements of the Moon and planets. Kepler's laws. Determining the masses and dimensions of celestial bodies.</p> <p>Showcases 1. Tellurium. 2. Globe of the starry sky.</p> <p>Practical exercise 1 (a) Work with a moving star map of the sky. Determining the positions of the luminaries on the celestial sphere by means of a starry sky map (star globe). b) Equatorial systems of celestial coordinates. Map of the starry sky. c) Study (observation)</p>

<p>Describes qualitatively a scale of stellar magnitudes. Observes changes in the starry sky during the year, the Moon, the planets of the solar system; Uses a moving map of the starry sky, star atlases. Orientates on the ground by the Sun and Polaris.</p>	<p>of the visible starry sky.</p>
<p>Section 2: Methods and tools of astronomical research</p>	
<p><i>The knowledgeable component</i> Operates on concepts and definitions: telescope; ranges of the electromagnetic spectrum; radiation receiver; optical telescope; radio telescope; space telescope; astronomical observatory; neutrino and gravitational astronomy. Names the radiation ranges of celestial bodies, telescopes and radiation receivers for different ranges of the electromagnetic spectrum. detectors of neutrino and gravitational waves, leading astronomical observatories of Ukraine and the world. Explains the influence of the atmosphere on astronomical observations, the principle of the optical telescope, differences between optical telescopes and radio telescopes, peculiarities of registration of radiation of celestial bodies. Gives examples of transparency windows for the electromagnetic spectrum in the Earth's atmosphere, methods of astronomical research, receivers. The radiation of celestial bodies, ground-based and space-based telescopes and their applications to different radiation ranges.</p> <p><i>The activity component</i> Describes the application of technological advances in telescope building.</p>	<p>Radiation from celestial bodies. Methods of astronomical research (observations). Principle of operation and structure of optical and Radio telescope, neutrino and gravitational wave detectors. Receivers of radiation. The use in telescope building of advances in engineering and technology. Modern ground-based and space-based telescopes. Astronomical observatories.</p> <p>Showcases An optical telescope (photos of modern ground-based and space-based telescopes). 2. Pictures of neutrino telescopes. 3. Photographs of gravitational wave detectors for gravitational waves (LIGO and LISA). 4. Schemes of modern optical and radio telescopes, neutrino telescopes, gravitational wave detectors. Photos of astronomical observatories (among them - Ukrainian).</p>
<p>Section 3. Our planetary system</p>	
<p><i>A knowledgeable component</i> Operates concepts and definitions: Earth-group planets, giant planets, dwarf planets, small bodies of the solar system; asteroid danger to the Earth Names the planets of the solar system and their order with respect to the Sun, types of small bodies in the solar system, stages of formation of the solar system. Explains the causes of the greenhouse effect, the occurrence of tides, the nature of the asteroidal danger to the Earth. Gives examples of famous comets and meteor showers, exploration of bodies of the solar system using spacecrafts.</p> <p><i>The activity component</i> Describes the structure of the solar system, the nature of the planets and small bodies of the solar system, hypotheses and theories Formation of the solar system. Describes the Earth as a planet of the Solar System.</p>	<p>The Earth and the Moon. Earth group planets: Mercury, Venus, Mars and its satellites Giant planets: Jupiter, Saturn, Uranus, Neptune and their satellites. Dwarf planets. Kuiper belt, Oort cloud. Small solar system bodies - asteroids, comets, meteoroids. Exploration of bodies of the solar system with the help of spacecraft. Hypotheses and theories of solar system formation.</p> <p>Showcases 1. Diagram of the solar system. 2. Pictures of planets, their satellites, small bodies of the solar system.</p>
<p>Section 4. The Sun is the nearest star</p>	
<p><i>The knowledgeable component</i> Operates concepts and definitions: The main formations in the Sun's atmosphere (spots, flares, spicules, protuberances, coronal holes, etc.). Names the main physical properties of the Sun. Explains the structure of the Sun, the physical mechanism for generating the Sun's energy.</p>	<p>The physical properties of the Sun. The structure of the Sun and its energy sources. Registration of solar neutrinos. Manifestations of solar activity and their impact on the Earth.</p> <p>Showcases.</p>

<p>Gives examples of the impact of solar activity on the Earth's biosphere.</p> <p><i>The activity component</i> Describes the physical conditions on the Sun, sources of solar energy, features of solar neutrino recording, manifestations of solar activity and its cyclicity. Describes "calm" and "active" Sun. Observes safety rules during telescopic observations of the Sun.</p>	<ol style="list-style-type: none"> 1. Photographs of the Sun in different wavelength ranges. 2. Photographs of active formations on the Sun's disk. 3. Graphs of Wolf numbers. <p>Practical work No. 2</p> <ol style="list-style-type: none"> a) Visual telescopic observations of the Sun. b) Determination of the diameter of the Sun using a camera obscura. c) Determination of the height (culmination) of the Sun using a gnomon.
<p>Section 5. Stars. Evolution of the stars</p>	
<p><i>A knowledgeable component</i> Operates the concepts and definitions: star; types of stars; spectral classification of stars; Hertzsprung-Russell diagram, white dwarf, new star, supernova; neutron star; black hole, exoplanet. Identifies methods for determining distances to stars, the main physical characteristics of stars, the main stages of evolution, and methods for discovering and investigating exoplanets. Explains the difference between types of stars, the relationship between the colour of a star and its temperature. Provides examples of stars of different types and spectral classes, planetary systems of other stars.</p> <p><i>The active component.</i> Describes the spectral classification of stars, the evolution of stars (including the Sun), and types of exoplanets. Characterizes the Sun as a star.</p>	<p>Stars and their classification. Ordinary stars. Double stars. Physically variable stars. Planetary systems of other stars. Evolution of stars. White dwarfs. Neutron stars. Black holes.</p> <p>Showcases.</p> <ol style="list-style-type: none"> 1. Comparison of the sizes of different types of stars. 2. Diagrams of stellar evolution. 3. Scheme of spectral classes of stars. 1. 4. Comparison of sizes, densities and composition of different types of exoplanets.
<p>Section 6. Our Galaxy</p>	
<p><i>A knowledgeable component</i> Operates the concepts and definitions: Milky Way Galaxy; star cluster; star association; nebula; interstellar medium. Names the components of the structure of the Galaxy. Explains the reason for the existence of the Milky Way in the Earth's starry sky. Gives examples of star clusters, nebulae.</p> <p><i>The activity component.</i> Describes the place of the Solar System in the Galaxy.</p>	<p>The Milky Way. Structure of the Galaxy. The place of the Solar System in the Galaxy. Star clusters and associations. Nebula. Subsystems of the Galaxy and its spiral structure. Supermassive black hole in the centre of the Galaxy.</p> <p>Showcases</p> <ol style="list-style-type: none"> 1. Photographs of star clusters and nebulae. <p>Diagram of the structure of the Galaxy</p>
<p>Section 7. Structure and Evolution of the Universe</p>	
<p><i>The knowledgeable component</i> Operates on concepts and definitions: types of galaxies; classification of galaxies; active galactic nuclei; Hubble's law; red shift; cosmology; large-scale structure of the universe; relic radiation; dark matter; dark energy. Names bright galaxies in the Earth's sky, types of galaxies. Provides examples of observational evidence to support the Big Bang theory.</p> <p><i>The activity component.</i></p>	<p>The world of galaxies. The active galactic nuclei. Observational bases of cosmology. History of the development of ideas about the universe. Origin and the origin and evolution of the Universe.</p> <p>Showcases</p> <ol style="list-style-type: none"> 1. Photographs of different types of galaxies. 1. 2. Pictures of the large-scale

<p>Describes the Gubble classification of galaxies, the large-scale structure of the universe and accepted models of its origin and evolution, the nature of galaxy nuclei activity, observational manifestations of the expansion of the universe, the nature of relict radiation.</p> <p>Describes the nature of galaxies and quasars.</p>	<p>structure of the Universe.</p>
<p>Section 8. Life in the Universe</p>	
<p><i>The knowledgeable component</i></p> <p>Operates the concepts and definitions: anthropic principle; quantum birth of the universe, multiverse. Explains the essence of the anthropic principle. Provides examples of scientific hypotheses about the origin of life on Earth, the search for life on other planets in the solar system, international scientific projects to search for life in the universe.</p> <p><i>The activity component</i></p> <p>Describes the likelihood of life on other planets. Characterizes the relationship between basic fundamental constants and life, the hypothesis of the existence of other universes.</p> <p>Life in the Universe.</p> <p>Draws a conclusion about the uniqueness of our Universe.</p>	<p>Man in the Universe. The anthropic principle. Probability of life on other planets. Drake equation. Search for life outside the Earth. The question of the existence of other universes. Multiverse.</p> <p>Demonstrations .</p> <ol style="list-style-type: none"> 1. depiction of Earthmen's messages to representatives of extraterrestrial civilizations (radio messages, Voyagers space probes). 2. Pictures of telescopes and equipment designed to search for extraterrestrial life.

