LOCALLY DEVELOPED COURSE OUTLINE

Astronomy (2022)15-3
Astronomy (2022)25-3
Astronomy (2022)35-3

Submitted By:

The Calgary School Division

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Course Basic Information

Outline Number	Hours	Start Date	End Date	Development Type	Proposal Type	Grades
15-3	62.50	09/01/2022	08/31/2026	Developed	Authorization	G10
25-3	62.50	09/01/2022	08/31/2026	Developed	Authorization	G10
35-3	62.50	09/01/2022	08/31/2026	Developed	Authorization	G10

Course Description

While inundated with space and astronomy in modern media, many students remain unaware that the sky is constantly changing above them. Using a variety of astronomical tools; telescopes, binoculars, lenses, and signing out the Star Lab, students in the Astronomy sequence will experience first-hand observations that foster foundational understandings, including:

- An appreciation for the vastness of space;
- Knowledge of the position and motion of celestial objects;
- The ability to explain nucleosynthesis and stellar evolution;
- Knowledge of historical models of astronomy, cosmology and astrophysics;
- Competency in basic astrophotography; and
- Knowledge of space exploration and flight dynamics.

Field experiences will offer practical application to observe and document the various objects visible in the day and night skies. Students will further use their field experience observations to develop and reinforce the learning outcomes within this course sequence. While field experiences and observations are part of the course, they are dependent upon the teacher and school's ability to offer them and the student's ability to participate. Alternative methods for field experiences and gathering observations may be considered (i.e. Remote observations online).

Required Equipment: Star Lab; Telescopes; Binoculars and lenses

Course Prerequisites

15: none

25: level 15 or Science 10

35: level 25 or Science 20 or Physics 20

Sequence Introduction (formerly: Philosophy)

In Astronomy 15-25-35, students will analyze, assess, and refine connections among celestial observations, human exploration, creativity, innovation and technological advancements. By embracing historical human curiosity pertaining to the sky above, students can further critically examine their perspective within the solar system and universe. Moreover, throughout the course sequence, students will enhance their scientific literacy and numeracy by applying active observation and documentation skills (such as diagrams, sketches, field notes) of various celestial bodies visible in the daytime and nighttime skies.

The Astronomy course sequence promotes the development of engaged thinkers and ethical citizens by allowing students to strive for personal excellence in their high school learning journey, using astronomy to enhance scientific literacy and numeracy. Further, the combination of classroom and evening field experiences enables students to solve complex problems; to think critically; to apply multiple literacies in reading, writing, and mathematics; to demonstrate communication skills; and to collaborate with others in the application of knowledge and skills in studying the celestial sphere

Student Need (formerly: Rationale)

Astronomy 15-25-35 prepares students to become active participants in Canadian society through exploring countless connections among the historical knowledge of stars, human exploration, and technological advancements that improve our understanding of the planet, solar system, and universe. Students will enhance their propensity to become ethically engaged citizens by appreciating their place within the solar system and universe; and recognizing the interconnectedness of social, economic, and environmental endeavours associated with space exploration.

Scope and Sequence (formerly: Learner Outcomes)

This course is intended to support students in developing a robust understanding of their place in the universe. This is achieved by combining aspects of the Sciences and the Social Sciences in order to offer an engaging and challenging opportunity to students. As the course progresses, students will engage in aspects of history, physics and other areas of study to better understand the complex and interdisciplinary nature of Astronomy.

Guiding Questions (formerly: General Outcomes

1 Examine the size, scale and vastness of space through daytime and nighttime observations

2 Compare and contrast daytime and nighttime skies through first-hand observations and astrophotography

3 Understand the stellar processes of star formation and evolution

4 Examine observations and data from a variety of astronomical tools to understand the composition, movement and interactions among the Earth, solar system, and stellar bodies

5 Compare and contrast historical models of the local solar system, galaxy and universe and describe the scientific validity behind each model

6 Analyze the links among the development of past and present technology; the advancement of scientific knowledge in the context of space exploration; and the common, practical applications of space exploration

7 Explore the advancements and applications of Einstein's Theories of Special and General Relativity

8 Examine the features involved in flight dynamics

Learning Outcomes (formerly: Specific Outcomes)

1 Examine the size, scale and vastness of space through daytime and nighttime observations	**15-3 25-3 35-3**
1.1 Explain how "seeing" conditions and differing atmospheric effects impact sky transparency	X
1.2 Design a 3-dimensional, theoretical scale model of the solar system relative to both size and distance	X
1.3 Articulate positions and relative motions of moons, planets, asteroids, and comets by interpreting solar system and sky	X
1.4 Interpret planetary and satellite elliptical paths as they orbit in the same approximate plane	X
1.5 Explain planetary and satellite motions to daytime and nighttime observations to approximately predict when a planet will be in opposition to Earth for optimal observation	X
1.6 Determine distance of nearby stars by interpreting tabular data of nearby stars to define a light year and apply observations	X

2 Compare and contrast daytime and nighttime skies through first-hand observations and astrophotography	**15-3 25-3 35-3**
2.1 Apply the scientific method in using terms and skills of amateur astronomers when observing daytime and nighttime skies	X
2.2 Apply the implications of nighttime observations through the physiological basis of sight	X
2.3 Articulate positions and motions of moons, planets and asteroids based on daytime and nighttime observations	X
2.4 Analyze the movement of celestial bodies using units of time	X
2.5 Analyze stellar brightness through nighttime sky surveys	X
2.6 Identify the meridian line and zenith point using naked eye nighttime sky surveys	X

2.7 Identify the approximate locations and/or times for sunrise, sunset and noon at various times using the naked eye, sextant and telescopic sky surveys	X
2.8 Construct sky maps using naked eye sky surveys of the nighttime sky applied to the rotation about Polaris and the North Celestial Pole	X
2.9 Confirm the tilt of the Earth's spin axis through both observations and hypothesizing how the changing geometry of the spin and the orbit of the Earth changes perspective of the Sun at current latitude of observation	X
2.10 Analyze how the geometry of the sun, Earth and moon change as the moon orbits the Earth by interpreting telescopic and binocular observations of Earth's moon through its successive phases	X
2.11 Articulate the geometry of the moon's orbits about Jupiter by interpreting telescopic and binocular observations of Jupiter's moons	X
2.12 Describe planets in the solar system including Venus, Jupiter and Saturn through naked eye and larger aperture telescopic observations	X
2.13 Explain the complex effects of light pollution on astronomical observations by comparing current designs aimed at minimizing pollution effects and preserving dark sky regions	X
2.14 Explain the basic terms and perform skills with equipment used for single long exposure wide field astrophotography and/or processing to facilitate an understanding of stellar bodies	X
2.15 Apply the basic terms and skills used for stacked multiple exposure planetary astrophotography and/or processing to facilitate an understanding of planetary bodies such as the rings of Saturn	X
2.16 Demonstrate the functionality of German Equatorial mounts through use of geocentric coordinates	X
2.17 Apply the basic terms and skills for stacked long exposure deep sky astrophotography and/or processing to facilitate an understanding of stellar bodies	X

3 Understand the stellar processes of star formation and evolution	15-3	25-3	35-3
3.1 Project the sun's actual image, size, location, and any visible sunspots on a piece of paper	X		
3.2 Interpret the impact of the sun's magnetic field on the Earth	X		
3.3 Interpret solar time using sundial observations of analemma in relation to local time and Earth’s spin axis and relative velocity as Earth orbits the sun	X		
3.4 Apply sundial observation to analemma to correction of solar time to local time to interpretation of Earth's spin axis and relative velocity as the planet orbits the sun	X		
3.5 Demonstrate the daily path of the sun through the sky	X		
3.6 Classify stars and trace lifespans on the Hertzsprung-Russel Diagram by interpreting life cycles, classes and compositions of stars	X		
3.7 Interpret qualitatively, the composition, mass, temperature and velocity of stars in relation to the Hertzsprung-Russel Diagram using spectroscopy	X		
3.8 Interpret phases of the stellar process of nuclear star formation based on initial gas cloud, mass influence on final state of the star, force of gravity, circular motion	X		
3.9 Describe primary chemical processes including the proton-proton (PP) chain and Carbon-Nitrogen-Oxygen (CNO) cycle		X	
3.10 Explain nucleosynthetic processes related to stellar formation and the Big Bang		X	
3.11 Explain key chemical compounds within the field of astrochemistry		X	
3.12 Classify deep sky objects within their lifetime of stellar evolution		X	
3.13 Differentiate observable stellar bodies in the northern and southern hemisphere to qualitatively explain the existence of deep sky objects existence of deep sky objects		X	
3.14 Explain nuclear processes, including the production of neutrinos through radioactive decay		X	

3.15 Describe, quantitatively, binding energy, binding energy per nucleon and transmutation of isotopes throughout the chart of nuclides.		X	
3.16 Explain the role of hydrostatic equilibrium within stellar evolution		X	

4 Examine observations and data from a variety of astronomical tools to understand the composition, movement and interactions among the Earth, solar system, and stellar bodies	**15-3**	**25-3**	**35-3**
4.1 Design, construct, and apply knowledge of simple refracting telescope to focal length	X		
4.2 Design, construct, and apply knowledge of a variety of sundials to geometric method of laying out sundial	X		
4.3 Apply aperture regarding stellar brightness, focal length and magnification to celestial telescopic observations	X		
4.4 Evaluate technologies to identify extra-solar planets	X		
4.5 Compare and contrast telescopic constellation observation and naked eye constellation observation	X		
4.6 Interpret data gathered by modern terrestrial and space telescopes in Radio, Microwave, Infrared, Visible, Ultraviolet, X-Ray and Gamma			X
4.7 Apply the phenomena of reflection, refraction, diffraction, interference and polarization in the design and limitations of current telescopes and data interpretation			X
4.8 Explore technological implementation that reduces/limits the interference of terrestrial observations			X
4.9 Explore technological implementation that allows the quantitative analysis of stellar bodies through temperature and brightness in the context of the Stefan Boltzmann Law			X
4.10 Explore technological implementation that allows the quantitative analysis of stellar bodies through the distance modulus			X
4.11 Explain how the use of interferometry enables measurements of gravitational waves and characteristics of massive stellar bodies			X

5 Compare and contrast historical models of the local solar system, galaxy and universe and describe the scientific validity behind each model	**15-3 25-3 35-3**
5.1 Compare and contrast the evidenced used for early models and contrast with a Newtonian model	X
5.2 Compare and contrast the evidence used for early models and with the Keplerian model	X
5.3 Explain, qualitatively, how Kepler's laws and uniform circular motion were used in the development of Newton's Law of Universal Gravitation	X
5.4 Demonstrate applications of Newton's law of universal gravitation and Kepler's laws in the context of orbital dynamics for stellar bodies	X
5.5 Articulate the parameters of an orbit	X
5.6 Explain how general relativity improved on Newton's Law of Gravitation	X
5.7 Contrast current models resulting from contributions by modern astrophysicists	X
5.8 Examine the functionality of Hubble's Law	X

6 Analyze the links among the development of past and present technology; the advancement of scientific knowledge in the context of space exploration; and the common, practical applications of space exploration	**15-3 25-3 35-3**
6.1 Investigate fundamental questions related to exploration motives	X
6.2 Articulate the conditions necessary for intelligent life to exist	X
6.3 Explain the historical significance of origins of space exploration and the value of scientific knowledge advancements as a function of spin off technology	X
6.4 Investigate the challenges involved with collaborating, planning, engineering, operating and executing space exploration missions	X

7 Explore the advancements and applications of Einstein's Theories of Special and General Relativity	**15-3 25-3 35-3**
7.1 Evaluate the Michelson Morley Experiment and results by interpreting data and relevant applications	X
7.2 Demonstrate, quantitatively and qualitatively, time dilation, length contraction, and Einstein's postulates	X
7.3 Analyze, quantitatively, simple systems for reference frames within the context of special relativity	X
7.4 Validate the Theory of General Relativity by applying data from gravitational waves	X
7.5 Explain the interaction of stellar bodies not detectable with EMR by using gravitational waves	X
7.6 Compare the scientific validity of the Big Bang, Big Freeze, and Big Crunch models	X
7.7 Explain the characteristics of black holes - singularities, event horizon, accretion disc, spaghettification, effects on time - due to strong gravitational fields	X
7.8 Apply the phenomenon of gravitational lensing to astronomical observations	X

8 Examine the features involved in flight dynamics	**15-3 25-3 35-3**
8.1 Analyze orbital dynamics for natural and artificial satellites by applying Newton's law of universal gravitation and Kepler's laws	X
8.2 Explain, qualitatively, the Rocket Equation	X
8.3 Compare and contrast the evolution of space exploration propulsion systems	X
8.4 Evaluate aerodynamic design considerations for a variety of atmospheric entries and exits	X

Facilities or Equipment

Facility

· No required facilities

Facilities:

Equipment

- Star Lab
- Telescopes
- Binoculars and lenses

Learning and Teaching Resources

No required resources

Sensitive or Controversial Content

No sensitive or controversial content.

Issue Management Strategy

Health and Safety

No directly related health and safety

Risk Management Strategy

Statement of Overlap with Existing Programs

Provincial Courses with Overlap and/or Similar

Science 30

Identified Overlap/Similarity

Unit C, General Outcome 2. Science 30 focuses on understanding EMS spectrum and its applications in space exploration

Reasoning as to Why LDC is Necessary

Most of this curriculum provides a general introduction to EMS use in space exploration. The Astronomy courses will dig deeper in the various ways that these ideas can be used to refine observations and explore the nature of the celestial bodies. Science 30 examines the impact of refraction on observations, while the Astronomy LDC will look at ways to overcomes these distortions as well as examine it under Snell's law and the Thin Lens equations.

Provincial Courses with Overlap and/or Similar

Physics 20

Identified Overlap/Similarity

Unit C, General Outcome 1

Reasoning as to Why LDC is Necessary

The Physics 20 course looks at orbit through a mathematical analysis, while Astronomy will focus on a deep qualitative understanding that focuses on application and interpretation.

Student Assessment

No identified student assessment.

Course Approval Implementation and Evaluation

No specific processes.