Astronomy

Subject: Science

Grade: 10

Num Expectations: 71

Num Breakouts: 307

(a) Introduction.

(1) Astronomy. In Astronomy, students focus on patterns, processes, and relationships among astronomical objects in our universe. Students acquire basic astronomical knowledge and supporting evidence about sun-Earth-Moon relationships, the solar system, the Milky Way, the size and scale of the universe, and the benefits and limitations of exploration. Students conduct laboratory and field investigations to support their developing conceptual framework of our place in space and time. By the end of Grade 12, students are expected to gain sufficient knowledge of the scientific and engineering practices across the disciplines of science to make informed decisions using critical thinking and scientific problem solving.

(2) Nature of science. Science, as defined by the National Academy of Sciences, is the "use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process." This vast body of changing and increasing knowledge is described by physical, mathematical, and conceptual models. Students should know that some questions are outside the realm of science because they deal with phenomena that are not scientifically testable.

(3) Scientific hypotheses and theories. Students are expected to know that:

(A) hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories; and

(B) scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well established and highly reliable explanations, but they may be subject to change as new areas of science and new technologies are developed.

(4) Scientific inquiry. Scientific inquiry is the planned and deliberate investigation of the natural world using scientific and engineering practices. Scientific methods of investigation are descriptive, comparative, or experimental. The method chosen should be appropriate to the question being asked. Student learning for different types of investigations include descriptive investigations, which involve collecting data and recording observations without making comparisons; comparative investigations, which involve collecting data with variables that are manipulated to compare results; and experimental investigations, which involve processes similar to comparative investigations but in which a control is identified.

(A) Scientific practices. Students should be able to ask questions, plan and conduct investigations to answer questions, and explain phenomena using appropriate tools and models.

(B) Engineering practices. Students should be able to identify problems and design solutions using appropriate tools and models.

(5) Science and social ethics. Scientific decision making is a way of answering questions about the natural world involving its own set of ethical standards about how the process of science should be carried out. Students should be able to distinguish between scientific decision-making methods (scientific methods) and ethical and social decisions that involve science (the application of scientific information).

(6) Science consists of recurring themes and making connections between overarching concepts. Recurring themes include systems, models, and patterns. All systems have basic properties that can be described in space, time, energy, and matter. Change and constancy occur in systems as patterns and can be observed, measured, and modeled. These patterns help to make predictions that can be scientifically tested, while models allow for boundary specification and provide tools for understanding the ideas presented. Students should analyze a system in terms of its components and how these components relate to each other, to the whole, and to the external environment.

(7) Statements containing the word "including" reference content that must be mastered, while those containing the phrase "such as" are intended as possible illustrative examples.

(b) Knowledge and Skills Statements

(1) Scientific and engineering practices. The student, for at least 40% of instructional time, asks questions, identifies problems, and plans and safely conducts classroom, laboratory, and field investigations to explain phenomena or design solutions using appropriate tools and models. The student is expected to:

(A) ask questions and define problems based on observations or information from text, phenomena, models, or investigations;

Breakouts

(i) ask questions based on observations or information from text, phenomena, models, or investigations

(ii) define problems based on observations or information from text, phenomena, models, or investigations

(B) apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems;

Breakouts

(i) apply scientific practices to plan descriptive investigations

(ii) apply scientific practices to plan comparative investigations

(iii) apply scientific practices to plan experimental investigations

(iv) apply scientific practices to conduct descriptive investigations

(v) apply scientific practices to conduct comparative investigations

(vi) apply scientific practices to conduct experimental investigations

(vii) use engineering practices to design solutions to problems

(C) use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards;

Breakouts

(i) use appropriate safety equipment during laboratory investigations as outlined in Texas Education Agency-approved safety standards

(ii) use appropriate safety equipment during classroom investigations as outlined in Texas Education Agency-approved safety standards

(iii) use appropriate safety equipment during field investigations as outlined in Texas Education Agency-approved safety standards

(iv) use appropriate safety practices during laboratory investigations as outlined in Texas Education Agency-approved safety standards

(v) use appropriate safety practices during classroom investigations as outlined in Texas Education Agency-approved safety standards

(vi) use appropriate safety practices during field investigations as outlined in Texas Education Agency-approved safety standards

(D) use appropriate tools such as gnomons; sundials; Planisphere; star charts; globe of the Earth; diffraction gratings; spectroscopes; color filters; lenses of multiple focal lengths; concave, plane, and convex mirrors; binoculars; telescopes; celestial sphere; online astronomical databases; and online access to observatories;

Breakouts

(i) use appropriate tools

(E) collect quantitative data using the International System of Units (SI) and qualitative data as evidence;

Breakouts

(i) collect quantitative data using the International System of Units (SI)

(ii) collect qualitative data as evidence

(F) organize quantitative and qualitative data using graphs, charts, spreadsheets, and computer software;

Breakouts

(i) organize quantitative data using graphs

(ii) organize quantitative data using charts

(iii) organize quantitative data using spreadsheets

(iv) organize quantitative data using computer software

(v) organize qualitative data using graphs

(vi) organize qualitative data using charts

(vii) organize qualitative data using spreadsheets

(viii) organize qualitative data using computer software

(G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and

Breakouts

(i) develop models to represent phenomena, systems, processes, or solutions to engineering problems

(ii) use models to represent phenomena, systems, processes, or solutions to engineering problems

(H) distinguish between scientific hypotheses, theories, and laws.

Breakouts

(i) distinguish between scientific hypotheses, theories, and laws

(2) Scientific and engineering practices. The student analyzes and interprets data to derive meaning, identify features and patterns, and discover relationships or correlations to develop evidence-based arguments or evaluate designs. The student is expected to:

(A) identify advantages and limitations of models such as their size, scale, properties, and materials;

Breakouts

(i) identify advantages of models

(ii) identify limitations of models

(B) analyze data by identifying significant statistical features, patterns, sources of error, and limitations;

Breakouts

(i) analyze data by identifying significant statistical features

(ii) analyze data by identifying patterns

(iii) analyze data by identifying sources of error

(iv) analyze data by identifying limitations

(C) use mathematical calculations to assess quantitative relationships in data;

and Breakouts

(i) use mathematical calculations to assess quantitative relationships in data

(D) evaluate experimental and engineering designs.

Breakouts

(i) evaluate experimental designs

(ii) evaluate engineering designs

(3) Scientific and engineering practices. The student develops evidence-based explanations and communicates findings, conclusions, and proposed solutions. The student is expected to:

(A) develop explanations and propose solutions supported by data and models consistent with scientific ideas, principles, and theories;

Breakouts

(i) develop explanations supported by data consistent with scientific ideas

(ii) develop explanations supported by data consistent with scientific principles

(iii) develop explanations supported by data consistent with scientific theories

(iv) develop explanations supported by models consistent with scientific ideas

(v) develop explanations supported by models consistent with scientific principles

(vi) develop explanations supported by models consistent with scientific theories

(vii) propose solutions supported by data consistent with scientific ideas

(viii) propose solutions supported by data consistent with scientific principles

(ix) propose solutions supported by data consistent with scientific theories

(x) propose solutions supported by models consistent with scientific ideas

(xi) propose solutions supported by models consistent with scientific principles

(xii) propose solutions supported by models consistent with scientific theories

(B) communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and

Breakouts

(i) communicate explanations individually in a variety of settings

(ii) communicate explanations individually in a variety of formats

(iii) communicate explanations collaboratively in a variety of settings

(iv) communicate explanations collaboratively in a variety of formats

(v) communicate solutions individually in a variety of settings

(vi) communicate solutions individually in a variety of formats

(vii) communicate solutions collaboratively in a variety of settings

(viii) communicate solutions collaboratively in a variety of formats

(C) engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

Breakouts

(i) engage respectfully in scientific argumentation using applied scientific explanations

(ii) engage respectfully in scientific argumentation using empirical evidence

(4) Scientific and engineering practices. The student knows the contributions of scientists and recognizes the importance of scientific research and innovation on society. The student is expected to:

(A) analyze, evaluate, and critique scientific explanations and solutions by using empirical evidence, logical reasoning, and experimental and observational testing, so as to encourage critical thinking by the student;

Breakouts

(i) analyze scientific explanations and solutions by using empirical evidence so as to encourage critical thinking by the student

(ii) analyze scientific explanations and solutions by using logical reasoning so as to encourage critical thinking by the student

(iii) analyze scientific explanations and solutions by using experimental testing so as to encourage critical thinking by the student

(iv) analyze scientific explanations and solutions by using observational testing so as to encourage critical thinking by the student

(v) evaluate scientific explanations and solutions by using empirical evidence so as to encourage critical thinking by the student

(vi) evaluate scientific explanations and solutions by using logical reasoning so as to encourage critical thinking by the student

(vii) evaluate scientific explanations and solutions by using experimental testing so as to encourage critical thinking by the student

(viii) evaluate scientific explanations and solutions by using observational testing so as to encourage critical thinking by the student

(ix) critique scientific explanations and solutions by using empirical evidence so as to encourage critical thinking by the student

(x) critique scientific explanations and solutions by using logical reasoning so as to encourage critical thinking by the student

(xi) critique scientific explanations and solutions by using experimental testing so as to encourage critical thinking by the student

(xii) critique scientific explanations and solutions by using observational testing so as to encourage critical thinking by the student

(B) relate the impact of past and current research on scientific thought and society, including research methodology, cost-benefit analysis, and contributions of diverse scientists as related to the content; and

Breakouts

(i) relate the impact of past research on scientific thought, including research methodology

(ii) relate the impact of past research on scientific thought, including cost-benefit analysis

(iii) relate the impact of past research on scientific thought, including contributions of diverse scientists as related to the content

(iv) relate the impact of past research on society, including research methodology

(v) relate the impact of past research on society, including cost-benefit analysis

(vi) relate the impact of past research on society, including contributions of diverse scientists as related to the content

(vii) relate the impact of current research on scientific thought, including research methodology

(viii) relate the impact of current research on scientific thought, including cost-benefit analysis

(ix) relate the impact of current research on scientific thought, including contributions of diverse scientists as related to the content

(x) relate the impact of current research on society, including research methodology

(xi) relate the impact of current research on society, including cost-benefit analysis

(xii) relate the impact of current research on society, including contributions of diverse scientists as related to the content

(C) research and explore resources such as museums, planetariums, observatories, libraries, professional organizations, private companies, online platforms, and mentors employed in a science, technology, engineering, and mathematics (STEM) field in order to investigate STEM careers.

Breakouts

(i) research STEM careers

(ii) explore resources in order to investigate STEM careers

(5) Science concepts. The student understands how astronomy influenced and advanced civilizations. The student is expected to:

(A) evaluate and communicate how ancient civilizations developed models of the universe using astronomical structures, instruments, and tools such as the astrolabe, gnomons, and charts and how those models influenced society, time keeping, and navigation;

Breakouts

(i) evaluate how ancient civilizations developed models of the universe using astronomical structures

(ii) evaluate how ancient civilizations developed models of the universe using astronomical instruments

(iii) evaluate how ancient civilizations developed models of the universe using astronomical tools

(iv) communicate how ancient civilizations developed models of the universe using astronomical structures

(v) communicate how ancient civilizations developed models of the universe using astronomical instruments

(vi) communicate how ancient civilizations developed models of the universe using astronomical tools

(vii) evaluate how those models [of the universe] influenced society

(viii) evaluate how those models [of the universe] influenced time keeping

(ix) evaluate how those models [of the universe] influenced navigation

(x) communicate how those models [of the universe] influenced society

(xi) communicate how those models [of the universe] influenced time keeping

(xii) communicate how those models [of the universe] influenced navigation

(B) research and evaluate the contributions of scientists, including Ptolemy, Copernicus, Tycho Brahe, Kepler, Galileo, and Newton, as astronomy progressed from a geocentric model to a heliocentric model; and

Breakouts

(i) research the contributions of scientists, including Ptolemy as astronomy progressed from a geocentric model to a heliocentric model

(ii) research the contributions of scientists, including Copernicus, as astronomy progressed from a geocentric model to a heliocentric model

(iii) research the contributions of scientists, including Tycho Brahe, as astronomy progressed from a geocentric model to a heliocentric model

(iv) research the contributions of scientists, including Kepler, as astronomy progressed from a geocentric model to a heliocentric model

(v) research the contributions of scientists, including Galileo, as astronomy progressed from a geocentric model to a heliocentric model

(vi) research the contributions of scientists, including Newton, as astronomy progressed from a geocentric model to a heliocentric model

(vii) evaluate the contributions of scientists, including Ptolemy, as astronomy progressed from a geocentric model to a heliocentric model

(viii) evaluate the contributions of scientists, including Copernicus, as astronomy progressed from a geocentric model to a heliocentric model

(ix) evaluate the contributions of scientists, including Tycho Brahe, as astronomy progressed from a geocentric model to a heliocentric model

(x) evaluate the contributions of scientists, including Kepler, as astronomy progressed from a geocentric model to a heliocentric model

(xi) evaluate the contributions of scientists, including Galileo, as astronomy progressed from a geocentric model to a heliocentric model

(xii) evaluate the contributions of scientists, including Newton, as astronomy progressed from a geocentric model to a heliocentric model

(C) describe and explain the historical origins of the perceived patterns of constellations and the role of constellations in ancient and modern navigation.

Breakouts

(i) describe the historical origins of the perceived patterns of constellations

(ii) explain the historical origins of the perceived patterns of constellations

(iii) describe the role of constellations in ancient navigation

(iv) describe the role of constellations in modern navigation

(v) explain the role of constellations in ancient navigation

(vi) explain the role of constellations in modern navigation

(6) Science concepts. The student conducts and explains astronomical observations made from the point of reference of Earth. The student is expected to:

(A) observe, record, and analyze the apparent movement of the Sun, Moon, and stars and predict sunrise and sunset;

Breakouts

(i) observe the apparent movement of the Sun

(ii) record the apparent movement of the Sun

(iii) analyze the apparent movement of the Sun

(iv) observe the apparent movement of the Moon

(v) record the apparent movement of the Moon

(vi) analyze the apparent movement of the Moon

(vii) observe the apparent movement of the stars

(viii) record the apparent movement of the stars

(ix) analyze the apparent movement of the stars

(x) predict sunrise

(xi) predict sunset

(B) observe the movement of planets throughout the year and measure how their positions change relative to the constellations;

Breakouts

(i) observe the movement of planets throughout the year

(ii) measure how [the planets'] positions change relative to the constellations

(C) identify constellations such as Ursa Major, Ursa Minor, Orion, Cassiopeia, and constellations along the ecliptic and describe their importance; and

Breakouts

(i) identify constellations along the ecliptic

(ii) describe the importance [of the constellations along the ecliptic]

(D) understand the difference between astronomy and astrology, the reasons for their historical conflation, and their eventual separation.

Breakouts

(i) understand the difference between astronomy and astrology

(ii) understand the reasons for their historical conflation

(iii) understand [the] eventual separation [of astronomy and astrology]

(7) Science concepts. The student knows our relative place in the solar system. The student is expected to:

(A) demonstrate the use of units of measurement in astronomy, including astronomical units and light years, minutes, and seconds;

Breakouts

(i) demonstrate the use of units of measurement in astronomy, including astronomical units

(ii) demonstrate the use of units of measurement in astronomy, including light years

(iii) demonstrate the use of units of measurement in astronomy, including minutes

(iv) demonstrate the use of units of measurement in astronomy, including seconds

(B) model the scale, size, and distances of the Sun, Earth, and Moon system and identify the limitations of physical models; and

Breakouts

(i) model the scale of the Sun, Earth, and Moon system

(ii) model the size of the Sun, Earth, and Moon system

(iii) model the distances of the Sun, Earth, and Moon system

(iv) identify the limitations of physical models [of the Sun, Earth, and Moon system]

(C) model the scale, sizes, and distances of the Sun and the planets in our solar system and identify the limitations of physical models.

Breakouts

(i) model the scale of the Sun and the planets in our solar system

(ii) model the sizes of the Sun and the planets in our solar system

(iii) model the distances of the Sun and the planets in our solar system

(iv) identify the limitations of physical models [of the Sun, Earth, and Moon system]

(8) Science concepts. The student observes and models the interactions within the Sun, Earth, and Moon system. The student is expected to:

(A) model how the orbit and relative position of the Moon cause lunar phases and predict the timing of moonrise and moonset during each phase;

Breakouts

(i) model how the orbit of the Moon cause[s] lunar phases

(ii) model how the relative position of the Moon cause[s] lunar phases

(iii) predict the timing of moonrise during each [lunar] phase

(iv) predict the timing of moonset during each [lunar] phase

(B) model how the orbit and relative position of the Moon cause lunar and solar eclipses; and Breakouts

(i) model how the relative position of the Moon cause[s] lunar eclipses

(ii) model how the relative position of the Moon cause[s] solar eclipses

(iii) model how the orbit of the Moon cause[s] lunar eclipses

(iv) model how the orbit of the Moon cause[s] solar eclipses

(C) examine and investigate the dynamics of tides using the Sun, Earth, and Moon model.

Breakouts

(i) examine the dynamics of tides using the Sun, Earth, and Moon model

(ii) investigate the dynamics of tides using the Sun, Earth, and Moon model

(9) Science concepts. The student models the cause of planetary seasons. The student is expected to:

(A) examine the relationship of a planet's axial tilt to its potential seasons;

Breakouts

(i) examine the relationship of a planet's axial tilt to its potential seasons

(B) predict how changing latitudinal position affects the length of day and night throughout a planet's orbital year;

Breakouts

(i) predict how changing latitudinal position affects the length of day and night throughout a planet's orbital year

(C) investigate the relationship between a planet's axial tilt, angle of incidence of sunlight, and concentration of solar energy; and

Breakouts

(i) investigate the relationship between a planet's axial tilt, angle of incidence of sunlight, and concentration of solar energy

(D) explain the significance of Earth's solstices and equinoxes.

Breakouts

(i) explain the significance of Earth's solstices

(ii) explain the significance of Earth's equinoxes

(10) Science concepts. The student knows how astronomical tools collect and record information about celestial objects. The student is expected to:

(A) investigate the use of black body radiation curves and emission, absorption, and continuous spectra in the identification and classification of celestial objects;

Breakouts

(i) investigate the use of black body radiation curves in the identification of celestial objects

(ii) investigate the use of black body radiation curves in the classification of celestial objects

(iii) investigate the use of emission spectra in the identification of celestial objects

(iv) investigate the use of absorption spectra in the identification of celestial objects

(v) investigate the use of continuous spectra in the identification of celestial objects

(vi) investigate the use of emission spectra in the classification of celestial objects

(vii) investigate the use of absorption spectra in the classification of celestial objects

(viii) investigate the use of continuous spectra in the classification of celestial objects

(B) calculate the relative light-gathering power of different-sized telescopes to compare telescopes for different applications;

Breakouts

(i) calculate the relative light-gathering power of different-sized telescopes to compare telescopes for different applications

(C) analyze the importance and limitations of optical, infrared, and radio telescopes, gravitational wave detectors, and other ground-based technology; and

Breakouts

(i) analyze the importance of optical telescopes

(ii) analyze the importance of infrared telescopes

(iii) analyze the importance of radio telescopes

(iv) analyze the importance of gravitational wave detectors

(v) analyze the importance of other ground-based technology

(vi) analyze the limitations of optical telescopes

(vii) analyze the limitations of infrared telescopes

(viii) analyze the limitations of radio telescopes

(ix) analyze the limitations of gravitational wave detectors

(x) analyze the limitations of other ground-based technology

(D) analyze the importance and limitations of space telescopes in the collection of astronomical data across the electromagnetic spectrum.

Breakouts

(i) analyze the importance of space telescopes in the collection of astronomical data across the electromagnetic spectrum

(ii) analyze the limitations of space telescopes in the collection of astronomical data across the electromagnetic spectrum

(11) Science concepts. The student uses models to explain the formation, development, organization, and significance of solar system bodies. The student is expected to:

(A) relate Newton's law of universal gravitation and Kepler's laws of planetary motion to the formation and motion of the planets and their satellites;

Breakouts

(i) relate Newton's law of universal gravitation to the formation of the planets

(ii) relate Newton's law of universal gravitation to the motion of the planets

(iii) relate Newton's law of universal gravitation to the formation of the [planets'] satellites

(iv) relate Newton's law of universal gravitation to the motion of the [planets'] satellites

(v) relate Kepler's laws of planetary motion to the formation of the planets

(vi) relate Kepler's laws of planetary motion to the motion of the planets

(vii) relate Kepler's laws of planetary motion to the formation of the [planets'] satellites

(viii) relate Kepler's laws of planetary motion to the motion of the [planets'] satellites

(B) explore and communicate the origins and significance of planets, planetary rings, satellites, asteroids, comets, Oort cloud, and Kuiper belt objects;

Breakouts

(i) explore the origins of planets

(ii) explore the origins of planetary rings

(iii) explore the origins of satellites

(iv) explore the origins of asteroids

(v) explore the origins of comets

(vi) explore the origins of Oort cloud objects

(vii) explore the origins of Kuiper belt objects

(viii) explore the significance of planets

(ix) explore the significance of planetary rings

(x) explore the significance of satellites

(xi) explore the significance of asteroids

(xii) explore the significance of comets

(xiii) explore the significance of Oort cloud objects

(xiv) explore the significance of Kuiper belt objects

(xv) communicate the origins of planets

(xvi) communicate the origins of planetary rings

(xvii) communicate the origins of satellites

(xviii) communicate the origins of asteroids

(xix) communicate the origins of comets

(xx) communicate the origins of Oort cloud objects

(xxi) communicate the origins of Kuiper belt objects

(xxii) communicate the significance of planets

(xxiii) communicate the significance of planetary rings

(xxiv) communicate the significance of satellites

(xxv) communicate the significance of asteroids

(xxvi) communicate the significance of comets

(xxvii) communicate the significance of Oort cloud objects (xxviii) communicate the significance of Kuiper belt objects

(C) compare the planets in terms of orbit, size, composition, rotation, atmosphere, natural satellites, magnetic fields, and geological activity; and

Breakouts

(i) compare the planets in terms of orbit

(ii) compare the planets in terms of size

(iii) compare the planets in terms of composition

(iv) compare the planets in terms of rotation

(v) compare the planets in terms of atmosphere

(vi) compare the planets in terms of natural satellites

(vii) compare the planets in terms of magnetic fields

(viii) compare the planets in terms of geological activity

(D) compare the factors essential to life on Earth such as temperature, water, gases, and gravitational and magnetic fields to conditions on other planets and their satellites.

Breakouts

(i) compare the factors essential to life on Earth to conditions on other planets

(ii) compare the factors essential to life on Earth to conditions on [other planet's] satellites

(12) Science concepts. The student knows that our Sun serves as a model for stellar activity. The student is expected to:

(A) identify the approximate mass, size, motion, temperature, structure, and composition of the Sun;

Breakouts

(i) identify the approximate mass of the Sun

(ii) identify the approximate size of the Sun

(iii) identify the approximate motion of the Sun

(iv) identify the approximate temperature of the Sun

(v) identify the approximate structure of the Sun

(vi) identify the approximate composition of the Sun

(B) distinguish between nuclear fusion and nuclear fission and identify the source of energy within the Sun as nuclear fusion of hydrogen to helium;

Breakouts

(i) distinguish between nuclear fusion and nuclear fission

(ii) identify the source of energy within the Sun as nuclear fusion of hydrogen to helium

(C) describe the eleven-year solar cycle and the significance of sunspots;

and Breakouts

(i) describe the eleven-year solar cycle

(ii) describe the significance of sunspots

(D) analyze the origins and effects of space weather, including the solar wind, coronal mass ejections, prominences, flares, and sunspots.

Breakouts

(i) analyze the origins of space weather, including the solar wind

(ii) analyze the effects of space weather, including the solar wind

(iii) analyze the origins of space weather, including the coronal mass ejections

(iv) analyze the effects of space weather, including the coronal mass ejections

(v) analyze the origins of space weather, including the prominences

(vi) analyze the effects of space weather, including prominences

(vii) analyze the origins of space weather, including flares

(viii) analyze the effects of space weather, including flares

(ix) analyze the origins of space weather, including sunspots

(x) analyze the effects of space weather, including sunspots

(13) Science concepts. The student understands the characteristics and life cycle of stars. The student is expected to:

(A) identify the characteristics of main sequence stars, including surface temperature, age, relative size, and composition;

Breakouts

(i) identify the characteristics of main sequence stars, including surface temperature

(ii) identify the characteristics of main sequence stars, including age

(iii) identify the characteristics of main sequence stars, including relative size

(iv) identify the characteristics of main sequence stars, including composition

(B) describe and communicate star formation from nebulae to protostars to the development of main sequence stars;

Breakouts

(i) describe star formation from nebulae to protostars to the development of main sequence stars

(ii) communicate star formation from nebulae to protostars to the development of main sequence stars

(C) evaluate the relationship between mass and fusion on stellar evolution;

Breakouts

(i) evaluate the relationship between mass and fusion on stellar evolution

(D) compare how the mass of a main sequence star will determine its end state as a white dwarf, neutron star, or black hole;

Breakouts

(i) compare how the mass of a main sequence star will determine its end state as a white dwarf, neutron star, or black hole

(E) describe the use of spectroscopy in obtaining physical data on celestial objects such as temperature, chemical composition, and relative motion;

Breakouts

(i) describe the use of spectroscopy in obtaining physical data on celestial objects

(F) use the Hertzsprung-Russell diagram to classify stars and plot and examine the life cycle of stars from birth to death;

Breakouts

(i) use the Hertzsprung-Russell diagram to classify stars

(ii) use the Hertzsprung-Russell diagram to plot the life cycle of stars from birth to death

(iii) use the Hertzsprung-Russell diagram to examine the life cycle of stars from birth to death

(G) illustrate how astronomers use geometric parallax to determine stellar distances and intrinsic luminosities; and

Breakouts

(i) illustrate how astronomers use geometric parallax to determine stellar distances

(ii) illustrate how astronomers use geometric parallax to determine intrinsic luminosities

(H) describe how stellar distances are determined by comparing apparent brightness and intrinsic luminosity when using spectroscopic parallax and the Leavitt relation for variable stars.

Breakouts

(i) describe how stellar distances are determined by comparing apparent brightness and intrinsic luminosity when using spectroscopic parallax

(ii) describe how stellar distances are determined by comparing apparent brightness and intrinsic luminosity when using the Leavitt relation for variable stars

(14) Science concepts. The student knows the structure of the universe and our relative place in it. The student is expected to:

(A) illustrate the structure and components of our Milky Way galaxy and model the size, location, and movement of our solar system within it;

Breakouts

(i) illustrate the structure of our Milky Way galaxy

(ii) illustrate the components of our Milky Way galaxy

(iii) model the size of our solar system within [the Milky Way]

(iv) model the location of our solar system within [the Milky Way]

(v) model the movement of our solar system within [the Milky Way]

(B) compare spiral, elliptical, irregular, dwarf, and active

galaxies; Breakouts

(i) compare spiral, elliptical, irregular, dwarf, and active galaxies

(C) develop and use models to explain how galactic evolution occurs through mergers and collisions;

Breakouts

(i) develop models to explain how galactic evolution occurs through mergers

(ii) develop models to explain how galactic evolution occurs through collisions

(iii) use models to explain how galactic evolution occurs through mergers

(iv) use models to explain how galactic evolution occurs through collisions

(D) describe the Local Group and its relation to larger-scale structures in the

universe; and Breakouts

(i) describe the Local Group

(ii) describe [the Local Group's] relation to larger-scale structures in the universe

(E) evaluate the indirect evidence for the existence of dark matter.

Breakouts

(i) evaluate the indirect evidence for the existence of dark matter

(15) Science concepts. The student knows the scientific theories of cosmology. The student is expected to:

(A) describe and evaluate the historical development of evidence supporting the Big Bang Theory;

Breakouts

(i) describe the Big Bang Theory

(ii) evaluate the historical development of evidence supporting the Big Bang Theory

(B) evaluate the limits of observational astronomy methods used to formulate the distance ladder;

Breakouts

(i) evaluate the limits of observational astronomy methods used to formulate the distance ladder

(C) evaluate the indirect evidence for the existence of dark energy;

Breakouts

(i) evaluate the indirect evidence for the existence of dark energy

(D) describe the current scientific understanding of the evolution of the universe, including estimates for the age of the universe; and

Breakouts

(i) describe the current scientific understanding of the evolution of the universe, including estimates for the age of the universe

(E) describe current scientific hypotheses about the fate of the universe, including open and closed universes.

Breakouts

(i) describe current scientific hypotheses about the fate of the universe, including open universes

(ii) describe current scientific hypotheses about the fate of the universe, including closed universes

(16) Science concepts. The student understands the benefits and challenges of expanding our knowledge of the universe. The student is expected to:

(A) describe and communicate the historical development of human space flight and its challenges;

Breakouts

(i) describe the historical development of human space flight

(ii) describe the challenges [of human space flight]

(iii) communicate the historical development of human space flight

(iv) communicate the challenges [of human space flight]

(B) describe and communicate the uses and challenges of robotic space flight;

Breakouts

(i) describe the uses of robotic space flight

(ii) describe the challenges of robotic space flight

(iii) communicate the uses of robotic space flight

(iv) communicate the challenges of robotic space flight

(C) evaluate the evidence of the existence of habitable zones and potentially habitable planetary bodies in extrasolar planetary systems;

Breakouts

(i) evaluate the evidence of the existence of habitable zones in extrasolar planetary systems

(ii) evaluate the evidence of the existence of potentially habitable planetary bodies in extrasolar planetary systems

(D) evaluate the impact on astronomy from light pollution, radio interference, and space debris;

Breakouts

(i) evaluate the impact on astronomy from light pollution

(ii) evaluate the impact on astronomy from radio interference

(iii) evaluate the impact on astronomy from space debris

(E) examine and describe current developments and discoveries in astronomy; and Breakouts

(i) examine current developments in astronomy

(ii) examine current discoveries in astronomy

(iii) describe current developments in astronomy

(iv) describe current discoveries in astronomy

(F) explore and explain careers that involve astronomy, space exploration, and the technologies developed through them.

Breakouts

(i) explore careers that involve astronomy

(ii) explore careers that involve space exploration

(iii) explore careers that involve the technologies developed through them

(iv) explain careers that involve astronomy

(v) explain careers that involve space exploration

(vi) explain careers that involve the technologies developed through them