Integrated Physics and Chemistry

Subject: Science
Grade: 09
Num Expectations: 40
Num Breakouts: 211

(a) Introduction.

(1) Integrated Physics and Chemistry. In Integrated Physics and Chemistry, students conduct laboratory and field investigations, use engineering practices, use scientific practices during investigation, and make informed decisions using critical thinking and scientific problem solving. This course integrates the disciplines of physics and chemistry in the following topics: force, motion, energy, and matter. 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 currently 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 a tool 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 answer questions, 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 data-collecting probes, software applications, the internet, standard laboratory glassware, metric rulers, meter sticks, spring scales, multimeters, Gauss meters, wires, batteries, light bulbs, switches, magnets, electronic balances, mass sets, Celsius thermometers, hot plates, an adequate supply of consumable chemicals, lab notebooks or journals, timing devices, models, and diagrams;

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 labeled drawings and diagrams, graphic organizers, charts, tables, and graphs;

Breakouts

(i) organize quantitative data using labeled drawings and diagrams

(ii) organize quantitative data using graphic organizers

(iii) organize quantitative data using charts

(iv) organize quantitative data using tables

(v) organize quantitative data using graphs

(vi) organize qualitative data using labeled drawings and diagrams

(vii) organize qualitative data using graphic organizers

(viii) organize qualitative data using charts

(ix) organize qualitative data using tables

(x) organize qualitative data using graphs

(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 and consistent with scientific ideas, principles, and theories;

Breakouts

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

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

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

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

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

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

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

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

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

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

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

(xii) propose solutions supported by models and 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, 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 knows the relationship between force and motion in everyday life. The student is expected to:

(A) investigate, analyze, and model motion in terms of position, velocity, acceleration, and time using tables, graphs, and mathematical relationships;

Breakouts

(i) investigate motion in terms of position using tables

(ii) investigate motion in terms of position using graphs

(iii) investigate motion in terms of position using mathematical relationships

(iv) investigate motion in terms of velocity using tables

(v) investigate motion in terms of velocity using graphs

(vi) investigate motion in terms of velocity using mathematical relationships

(vii) investigate motion in terms of acceleration using tables

(viii) investigate motion in terms of acceleration using graphs

(ix) investigate motion in terms of acceleration using mathematical relationships

(x) investigate motion in terms of time using tables

(xi) investigate motion in terms of time using graphs

(xii) investigate motion in terms of time using mathematical relationships

(xiii) analyze motion in terms of position using tables

(xiv) analyze motion in terms of position using graphs

(xv) analyze motion in terms of position using mathematical relationships

(xvi) analyze motion in terms of velocity using tables

(xvii) analyze motion in terms of velocity using graphs

(xviii) analyze motion in terms of velocity using mathematical relationships

(xix) analyze motion in terms of acceleration using tables

(xx) analyze motion in terms of acceleration using graphs

(xxi) analyze motion in terms of acceleration using mathematical relationships

(xxii) analyze motion in terms of time using tables

(xxiii) analyze motion in terms of time using graphs

(xxiv) analyze motion in terms of time using mathematical relationships

(xxv) model motion in terms of position using tables

(xxvi) model motion in terms of position using graphs

(xxvii) model motion in terms of position using mathematical relationships

(xxviii) model motion in terms of velocity using tables

(xxix) model motion in terms of velocity using graphs

(xxx) model motion in terms of velocity using mathematical relationships

(xxxi) model motion in terms of acceleration using tables

(xxxii) model motion in terms of acceleration using graphs

(xxxiii) model motion in terms of acceleration using mathematical relationships

(xxxiv) model motion in terms of time using tables

(xxxv) model motion in terms of time using graphs

(xxxvi) model motion in terms of time using mathematical relationships

(B) analyze data to explain the relationship between mass and acceleration in terms of the net force on an object in one dimension using force diagrams, tables, and graphs;

Breakouts

(i) analyze data to explain the relationship between mass and acceleration in terms of the net force on an object in one dimension using force diagrams

(ii) analyze data to explain the relationship between mass and acceleration in terms of the net force on an object in one dimension using tables

(iii) analyze data to explain the relationship between mass and acceleration in terms of the net force on an object in one dimension using graphs

(C) apply the concepts of momentum and impulse to design, evaluate, and refine a device to minimize the net force on objects during collisions such as those that occur during vehicular accidents, sports activities, or the dropping of personal electronic devices;

Breakouts

(i) apply the concepts of momentum to design a device to minimize the net force on objects during collisions

(ii) apply the concepts of momentum to evaluate a device to minimize the net force on objects during collisions

(iii) apply the concepts of momentum to refine a device to minimize the net force on objects during collisions

(iv) apply the concepts impulse to design a device to minimize the net force on objects during collisions

(v) apply the concepts of impulse to evaluate a device to minimize the net force on objects during collisions

(vi) apply the concepts of impulse to refine a device to minimize the net force on objects during collisions

(D) describe the nature of the four fundamental forces: gravitation; electromagnetic; the strong and weak nuclear forces, including fission and fusion; and mass-energy equivalency; and

Breakouts

(i) describe the nature of the four fundamental forces: gravitation

(ii) describe the nature of the four fundamental forces: electromagnetic

(iii) describe the nature of the four fundamental forces: the strong and weak nuclear forces, including fission

(iv) describe the nature of the four fundamental forces: the strong and weak nuclear forces, including fusion

(v) describe mass-energy equivalency

(E) construct and communicate an explanation based on evidence for how changes in mass, charge, and distance affect the strength of gravitational and electrical forces between two objects.

Breakouts

(i) construct an explanation based on evidence for how changes in mass affect the strength of gravitational forces between two objects

(ii) construct an explanation based on evidence for how changes in charge affect the strength of gravitational forces between two objects

(iii) construct an explanation based on evidence for how changes in distance affect the strength of gravitational forces between two objects

(iv) construct an explanation based on evidence for how changes in mass affect the strength of electrical forces between two objects

(v) construct an explanation based on evidence for how changes in charge affect the strength of electrical forces between two objects

(vi) construct an explanation based on evidence for how changes in distance affect the strength of electrical forces between two objects

(vii) communicate an explanation based on evidence for how changes in mass affect the strength of gravitational forces between two objects

(viii) communicate an explanation based on evidence for how changes in charge affect the strength of gravitational forces between two objects

(ix) communicate an explanation based on evidence for how changes in distance affect the strength of gravitational forces between two objects

(x) communicate an explanation based on evidence for how changes in mass affect the strength of electrical forces between two objects

(xi) communicate an explanation based on evidence for how changes in charge affect the strength of electrical forces between two objects

(xii) communicate an explanation based on evidence for how changes in distance affect the strength of electrical forces between two objects

(6) Science concepts. The student knows the impact of energy transfer and energy conservation in everyday life. The student is expected to:

(A) design and construct series and parallel circuits that model real-world circuits such as in-home wiring, automobile wiring, and simple electrical devices to evaluate the transfer of electrical energy;

Breakouts

(i) design series circuits that model real-world circuits

(ii) design parallel circuits that model real-world circuits

(iii) construct series circuits that model real-world circuits

(iv) construct parallel circuits that model real-world circuits

(B) design, evaluate, and refine a device that generates electrical energy through the interaction of electric charges and magnetic fields;

Breakouts

(i) design a device that generates electrical energy through the interaction of electric charges and magnetic fields

(ii) evaluate a device that generates electrical energy through the interaction of electric charges and magnetic fields

(iii) refine a device that generates electrical energy through the interaction of electric charges and magnetic fields

(C) plan and conduct an investigation to provide evidence that energy is conserved within a closed system;

Breakouts

(i) plan an investigation to provide evidence that energy is conserved within a closed system

(ii) conduct an investigation to provide evidence that energy is conserved within a closed system

(D) investigate and demonstrate the movement of thermal energy through solids, liquids, and gases by convection, conduction, and radiation such as weather, living, and mechanical systems;

Breakouts

(i) investigate the movement of thermal energy through solids by conduction

(ii) investigate the movement of thermal energy through liquids by convection

(iii) investigate the movement of thermal energy through liquids by conduction

(iv) investigate the movement of thermal energy through gases by convection

(v) investigate the movement of thermal energy by radiation

(vi) demonstrate the movement of thermal energy through solids by conduction

(vii) demonstrate the movement of thermal energy through liquids by convection

(viii) demonstrate the movement of thermal energy through liquids by conduction

(ix) demonstrate the movement of thermal energy through gases by convection

(x) demonstrate the movement of thermal energy by radiation

(E) plan and conduct an investigation to evaluate the transfer of energy or information through different materials by different types of waves such as wireless signals, ultraviolet radiation, and microwaves;

Breakouts

(i) plan an investigation to evaluate the transfer of energy or information through different materials by different types of waves

(ii) conduct an investigation to evaluate the transfer of energy or information through different materials by different types of waves

(F) construct and communicate an evidence-based explanation for how wave interference, reflection, and refraction are used in technology such as medicine, communication, and scientific research; and

Breakouts

(i) construct an evidence-based explanation for how wave interference [is] used in technology

(ii) construct an evidence-based explanation for how reflection [is] used in technology

(iii) construct an evidence-based explanation for how refraction [is] used in technology

(iv) communicate an evidence-based explanation for how wave interference [is] used in technology

(v) communicate an evidence-based explanation for how reflection [is] used in technology

(vi) communicate an evidence-based explanation for how refraction [is] used in technology

(G) evaluate evidence from multiple sources to critique the advantages and disadvantages of various renewable and nonrenewable energy sources and their impact on society and the environment.

Breakouts

(i) evaluate evidence from multiple sources to critique the advantages of various renewable energy sources

(ii) evaluate evidence from multiple sources to critique the advantages of various nonrenewable energy sources

(iii) evaluate evidence from multiple sources to critique the disadvantages of various renewable energy sources

(iv) evaluate evidence from multiple sources to critique the disadvantages of various nonrenewable energy sources

(v) evaluate evidence from multiple sources to critique the impact [of renewable energy sources] on society

(vi) evaluate evidence from multiple sources to critique the impact [of nonrenewable energy sources] on society

(vii) evaluate evidence from multiple sources to critique the impact [of renewable energy sources] on the environment

(viii) evaluate evidence from multiple sources to critique the impact [of nonrenewable energy sources] on the environment

(7) Science concepts. The student knows that relationships exist between the structure and properties of matter. The student is expected to:

(A) model basic atomic structure and relate an element's atomic structure to its bonding, reactivity, and placement on the Periodic Table;

Breakouts

(i) model basic atomic structure

(ii) relate an element's atomic structure to its bonding

(iii) relate an element's atomic structure to its reactivity

(iv) relate an element's atomic structure to its placement on the Periodic Table

(B) use patterns within the Periodic Table to predict the relative physical and chemical properties of elements;

Breakouts

(i) use patterns within the Periodic Table to predict the relative physical properties of elements

(ii) use patterns within the Periodic Table to predict the relative chemical properties of elements

(C) explain how physical and chemical properties of substances are related to their usage in everyday life such as in sunscreen, cookware, industrial applications, and fuels;

Breakouts

(i) explain how physical properties of substances are related to their usage in everyday life

(ii) explain how chemical properties of substances are related to their usage in everyday life

(D) explain how electrons can transition from a high energy level to a low energy state, emitting photons at different frequencies for different energy transitions;

Breakouts

(i) explain how electrons can transition from a high energy level to a low energy state, emitting photons at different frequencies for different energy transitions

(E) explain how atomic energy levels and emission spectra present evidence for the wave particle duality; and

Breakouts

(i) explain how atomic energy levels present evidence for the wave particle duality

(ii) explain how atomic emission spectra present evidence for the wave particle duality

(F) plan and conduct an investigation to provide evidence that the rate of reaction or dissolving is affected by multiple factors such as particle size, stirring, temperature, and concentration.

Breakouts

(i) plan an investigation to provide evidence that the rate of reaction or dissolving is affected by multiple factors

(ii) conduct an investigation to provide evidence that the rate of reaction or dissolving is affected by multiple factors

(8) Science concepts. The student knows that changes in matter affect everyday life. The student is expected to:

(A) investigate how changes in properties are indicative of chemical reactions such as hydrochloric acid with a metal, oxidation of metal, combustion, and neutralizing an acid with a base;

Breakouts

(i) investigate how changes in properties are indicative of chemical reactions

(B) develop and use models to balance chemical equations and support the claim that atoms, and therefore mass, are conserved during a chemical reaction;

Breakouts

(i) develop models to balance chemical equations

(ii) develop models to support the claim that atoms, and therefore mass, are conserved during a chemical reaction

(iii) use models to balance chemical equations

(iv) use models to support the claim that atoms, and therefore mass, are conserved during a chemical reaction

(C) research and communicate the uses, advantages, and disadvantages of nuclear reactions in current technologies; and

Breakouts

(i) research the uses of nuclear reactions in current technologies

(ii) research the advantages of nuclear reactions in current technologies

(iii) research the disadvantages of nuclear reactions in current technologies

(iv) communicate the uses of nuclear reactions in current technologies

(v) communicate the advantages of nuclear reactions in current technologies

(vi) communicate the disadvantages of nuclear reactions in current technologies

(D) construct and communicate an evidence-based explanation of the environmental impact of the end-products of chemical reactions such as those that may result in degradation of water, soil, air quality, and global climate change.

Breakouts

(i) construct an evidence-based explanation of the environmental impact of the end-products of chemical reactions

(ii) communicate an evidence-based explanation of the environmental impact of the end- products of chemical reactions