# Science
# Course of Study
# 2014

Wickliffe City School District
2221 Rockefeller Road
Wickliffe, Ohio 44092

February, 2014

**Wickliffe City Schools**
Kindergarten Science -Pacing Guide

| **Quarter 1** | |
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| Unit | Standards |
| Earth and Space Science (Yearlong)<br><br><br><br><br>Physical Science (October for 2 weeks) | Use scientific processes with appropriate laboratory safety techniques to understand Earth & Space:<br>- observe and ask questions about the natural environment<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br><br>K.ESS.1 Weather changes are long term and short term.<br>K.PS.1 Objects and materials can be sorted and described by their properties. |
| **Quarter 2** | |
| Unit | Standards |
| Life Science (November/December For 4 weeks) | Use scientific processes with appropriate laboratory safety techniques to understand Earth & Space:<br>- observe and ask questions about the natural environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>K.LS. Living things have physical traits and behaviors which influence their survival. |
| **Quarter 3** | |
| Unit | Standards |
| Earth and Space Science (January/February for 4 weeks)<br><br><br><br><br><br>Physical Science | Use scientific processes with appropriate laboratory safety techniques to understand Physical Science:<br>- observe and ask questions about the natural and physical environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>K.ESS.2 The moon, sun, and stars can be observed at different times of the day and night. |

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| (March for 4 weeks) | K.PS.2 Some objects and materials produce sound. |
| **Quarter 4** | |
| Unit | Standards |
| Life Science<br>March/April for 4 weeks) | Use scientific processes with appropriate laboratory safety techniques to understand Life Science:<br>- observe and ask questions about the natural environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>K.Ls.1 Living things are different from nonliving things. |

# Wickliffe City Schools

Grade 1 Science -Pacing Guide

**Quarter 1**

| Unit | Standards |
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| Life Science<br>September and October | 1.LS.1: Living things (animals) have basic needs which are met by obtaining materials from the physical enviro<br>1.LS.2: Living things (animals) survive only in environments that meet their needs.<br>Science Inquiry and Application:<br>• Observe and ask questions about the natural environment.<br>• Employ simple equipment and tools to gather data and extend the senses.<br>• Communicate about observations, investigations, and explanations.<br>• Review and ask questions about the observations and explanations of others. |

**Quarter 2**

| Unit | Standards |
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| Physical Science<br>November , December, and January | 1.PS.1: Properties of objects and materials can change.<br>1.PS.2: Objects can be moved in a variety of ways.<br>Science Inquiry and Application:<br>• Observe and ask questions about the natural environment.<br>• Plan and conduct simple investigations.<br>• Employ simple equipment and tools to gather data and extend the senses.<br>• Use appropriate mathematics with data to construct reasonable explanations.<br>• Communicate about observations, investigations, and explanations.<br>• Review and ask questions about the observations and explanations of others. |

**Quarter 3**

| Unit | Standards |
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| Life Science<br>February and March | Science Inquiry and Application:<br>• Observe and ask questions about the natural environment.<br>• Plan and conduct simple investigations.<br>• Employ simple equipment and tools to gather data and extend the senses.<br>• Use appropriate mathematics with data to construct reasonable explanations.<br>• Communicate about observations, investigations, and explanations; and<br>• Review and ask questions about the observations, and explanations of others.<br>1.LS.1 Living things have basic needs which are met by obtaining materials from the physical environment.<br><br>1.LS.2 Living things survive only in environments that meet their needs. |

| **Quarter 4** | |
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| Unit | Standards |
| Earth and Space Science<br>April and May | 1.ESS.1  The sun is the principal source of energy.<br>1.ESS.2  The physical properties of water can change.<br>Science Inquiry and Application:<br>• Observe and ask questions about the natural environment.<br>• Plan and conduct simple investigations.<br>• Employ simple equipment and tools to gather data and extend the senses.<br>• Communicate about observations, investigations, and explanations.<br>• Review and ask questions about the observations and explanations of others. |

# Wickliffe City Schools

Grade 2 Science -Pacing Guide

| **Quarter 1** | |
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| Unit | Standards |
| Earth & Space | Use scientific processes with appropriate laboratory safety techniques to understand Earth & Space:<br>- observe and ask questions about the natural environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br><br>2.ES.1 The atmosphere is made of air |
| **Quarter 2** | |
| Unit | Standards |
| Earth & Space | Use scientific processes with appropriate laboratory safety techniques to understand Earth & Space:<br>- observe and ask questions about the natural environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>2.ES.2 Water is present in the air & Long and short term changes due to changes in energy |
| **Quarter 3** | |
| Unit | Standards |
| Physical Science | Use scientific processes with appropriate laboratory safety techniques to understand Physical Science:<br>- observe and ask questions about the natural and physical environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>2.PS.1 Forces change the motion of an object |

| **Quarter 4** | |
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| Unit | Standards |
| Life Science<br><br><br><br><br><br><br><br><br>Life Science | Use scientific processes with appropriate laboratory safety techniques to understand Life Science:<br>- observe and ask questions about the natural environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>2.LS.1 Living things cause changes on earth & Some kinds of individuals that once lived on the Earth have completely disappeared, although they were something like others that are alive today<br>Use scientific processes with appropriate laboratory safety techniques to understand Life Science:<br>- observe and ask questions about the natural environment<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>2.LS.2 Living things cause changes on Earth |

# Wickliffe City Schools

Grade 3 Science – Pacing Guide

| **Quarter 1** | |
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| Unit | Standards |
| Earth and Space Science | Use scientific processes with appropriate laboratory safety techniques to understand Earth & Space:<br>- observe and ask questions about the natural environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>3.ESS.1 Earth's nonliving resources have specific properties. |
| **Quarter 2** | |
| Unit | Standards |
| Physical Science | Use scientific processes with appropriate laboratory safety techniques to understand Physical Science:<br>- observe and ask questions about the natural environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>3.PS.1 All objects and substances in the natural world are composed of matter.<br>3.PS.2 Matter exists in different states, each of which has different properties. |
| **Quarter 3** | |
| Unit | Standards |
| Earth and Space Science | Use scientific processes with appropriate laboratory safety techniques to understand Earth and Space Science:<br>- observe and ask questions about the natural and physical environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>3.ESS.2 Earth's resources can be used for energy. |

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| | 3.ESS.3 Some of Earth's resources are limited. |
| **Quarter 4** | |
| Unit | Standards |
| Life Science | Use scientific processes with appropriate laboratory safety techniques to understand Life Science:<br>- observe and ask questions about the natural environment<br>- plan and conduct simple investigations<br>- employ simple equipment and tools to gather data and extend the senses<br>- use appropriate mathematics with data to construct reasonable explanations<br>- communicate about observations, investigations, and explanations<br>- review and ask questions about the observations and explanations of others<br>3.LS.1 Offspring resemble their parents and each other.<br>3.LS.2 Indivuals of the same kind differ in their traits and sometimes the differences give individuals an advantage in surviving and reproducing.<br>3.LS.3 Plants and animals have life cycle that part of their adaptations for survival in their natural environments. |

**Wickliffe City Schools**
Grade 4 Science – Pacing Guide

| **Quarter 1** | |
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| Unit | Standards |
| Scientific Method (2 weeks)<br>Earth and Space Science<br>1) Land forms (2 ½ weeks) | Science Inquiry and Application<br>Students will become proficient in the use of the scientific process, with laboratory safety techniques, to constr<br>their knowledge and understanding in all Science content.<br>-Observe and ask questions about the natural environment;<br>-Plan and conduct simple investigations;<br>-Employ simple equipment and tools to gather data and extend the senses;<br>-Use appropriate mathematics with data to construct reasonable explanations;<br>-Communicate about observations, investigations and explanations and<br>-Review and ask questions about the observations and explanations of others.<br><br>4.ESS.1: Earth's surface has specific characteristics and landforms that can be identified. |
| **Quarter 2** | |
| Unit | Standards |
| Earth and Space Science<br><br>1) Erosion and deposition ( 3 ½ weeks)<br><br>Weathering (1 week) | Students will become proficient in the use of the scientific process, with laboratory safety techniques, to constr<br>their knowledge and understanding in Earth and Space Science.<br>-Observe and ask questions about the natural environment;<br>-Plan and conduct simple investigations;<br>-Employ simple equipment and tools to gather data and extend the senses;<br>-Use appropriate mathematics with data to construct reasonable explanations;<br>-Communicate about observations, investigations and explanations and<br>-Review and ask questions about the observations and explanations of others.<br><br>4.ESS.3 The surface of Earth changes due to erosion and deposition.<br><br>4.ESS.2 The surface of Earth changes due to weathering |
| **Quarter 3** | |
| Unit | Standards |
| Earth's Living History<br>1) Fossil Record (1 ½ weeks) | Students will become proficient in the use of the scientific process, with laboratory safety techniques, to constr<br>their knowledge and understanding in Earth and Space Science.<br>-Observe and ask questions about the natural environment; |

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| 2) Organism effects on habitat (3 weeks) | -Plan and conduct simple investigations;<br>-Employ simple equipment and tools to gather data and extend the senses;<br>-Use appropriate mathematics with data to construct reasonable explanations;<br>-Communicate about observations, investigations and explanations and<br>-Review and ask questions about the observations and explanations of others.<br><br>4.LS.2 Fossils can be compared to one another and to present day organisms according to their similarities and differences.<br><br>4.LS.1 Changes in an organism's environment are sometimes beneficial to its survival and sometimes harmful. |
| **Quarter 4** | |
| Unit | Standards |
| Physical Science<br>1) Conservation of matter (1 week)<br>2) Electricity and circuits (3 ½ weeks) | Students will become proficient in the use of the scientific process, with laboratory safety techniques, to constr their knowledge and understanding in Physical Science.<br>-Observe and ask questions about the natural environment;<br>-Plan and conduct simple investigations;<br>-Employ simple equipment and tools to gather data and extend the senses;<br>-Use appropriate mathematics with data to construct reasonable explanations;<br>-Communicate about observations, investigations and explanations and<br>-Review and ask questions about the observations and explanations of others.<br><br>4.PS.1 The total amount of matter is conserved when it undergoes a change.<br><br>4.PS.2 Energy can be transferred from one form to another or can be transferred from one location to another. |

# Wickliffe City Schools

Grade 5 Science - Pacing Guide

| **Quarter 1 & 2** | |
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| Unit | Standards |
| Unit 1: Getting Ready for Science<br><br>August – September<br>4 weeks | Science Inquiry and Application:<br>Use scientific processes with appropriate laboratory safety techniques to understand science skills/process<br>• Identify questions that can be answered through scientific investigations<br>• Design and conduct a scientific investigation<br>• Use appropriate mathematics, tools and techniques to gather data and information<br>• Analyze and interpret data<br>• Develop descriptions, models, explanations and predictions<br>• Think critically and logically to connect evidence and explanations<br>• Recognize and analyze alternative explanations and predications<br>• Communicate scientific procedures and explanations |
| Unit 2: Life Science<br><br>September – December<br>8 weeks | • 5.LS.1: Organisms perform a variety of roles in an ecosystem.<br>• 5.LS.2: All of the processes that take place within ecosystems require energy.<br><br>Use scientific processes with appropriate laboratory safety techniques to understand life science.<br>• Identify questions that can be answered through scientific investigations<br>• Analyze and interpret data<br>• Develop descriptions, models, explanations and predictions<br>• Think critically and logically to connect evidence and explanations<br>• Recognize and analyze alternative explanations and predications<br>• Communicate scientific procedures and explanations |
| **Quarter 3 & 4** | |
| Unit | Standards |
| Unit 3: Earth and Space Science | • 5.ESS.1: The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the s system has unique characteristics.<br>• 5.ESS.2: The sun is one of many stars that exists in the universe.<br>• 5.ESS.3: Most of the cycles and patterns of motion between the Earth and the sun are predictable. |

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| January<br>3 weeks | Use scientific processes with appropriate laboratory safety techniques to understand Earth and Space Scie<br>• Analyze and interpret data<br>• Develop descriptions, models, explanations and predictions<br>• Think critically and logically to connect evidence and explanations<br>• Recognize and analyze alternative explanations and predications<br>• Communicate scientific procedures and explanations |
| Unit 4: Physical Science<br>February - March<br>8 weeks | • 5.PS.1: The amount of change in movement of an object is based on the mass of the object and the amount of force exerted.<br>• 5.PS.2: Light and sound are forms of energy that behave in predictable ways.<br><br>Use scientific processes with appropriate laboratory safety techniques to understand Physical Science.<br>• Identify questions that can be answered through scientific investigations<br>• Design and conduct a scientific investigation<br>• Use appropriate mathematics, tools and techniques to gather data and information<br>• Analyze and interpret data<br>• Develop descriptions, models, explanations and predictions<br>• Think critically and logically to connect evidence and explanations<br>• Recognize and analyze alternative explanations and predications<br>• Communicate scientific procedures and explanations |
| Standardized Test Review<br>April<br>3-4 weeks | • OAA Preparation and Review |
| Unit 5: Earth and Space Science<br>May – June<br>4-5 weeks | • 5.ESS.1: The solar system includes the sun and all celestial bodies that orbit the sun. Each planet in the s has unique characteristics.<br>• 5.ESS.2: The sun is one of many stars that exists in the universe.<br>• 5.ESS.3: Most of the cycles and patterns of motion between the Earth and the sun are predictable.<br><br>Use scientific processes with appropriate laboratory safety techniques to understand Earth and Space Scie<br>• Develop descriptions, models, explanations and predictions<br>• Think critically and logically to connect evidence and explanations<br>• Recognize and analyze alternative explanations and predications<br>• Communicate scientific procedures and explanations |

# Wickliffe City Schools

Grade 7 Science - Pacing Guide

| **Quarter 1** | |
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| Unit | Standards |
| Introduction (Aug.-June)<br>Ch 1, Ch 2<br><br>Conservation of Mass and Energy (Sept.-Oct)<br>Ch 9, Ch 10 | Students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas (Throughout the year)<br>• Identify questions and concepts that guide scientific investigations;<br>• Design and conduct scientific investigations;<br>• Use technology and mathematics to improve investigations and communications;<br>• Formulate and revise explanations and models using logic and evidence (critical thinking);<br>• Recognize and analyze explanations and models; and<br>• Communicate and support a scientific argument.<br>PS.1-The properties of matter are determined by the arrangement of atoms |
| **Quarter 2** | |
| Unit | Standards |
| Conservation of Mass and Energy (Nov.-Jan.)<br>Ch 5, Ch 6, Ch 8 | PS.2-Energy can be transformed from one form to another or can be transferred from one location to another, but is never lost<br><br>PS.3-Energy can be transformed or transferred through a variety of ways |
| **Quarter 3** | |
| Unit | Standards |
| Cycles of Matter and Flow of Energy (Jan.-March.)<br>Ch 3, Ch 4<br>Cycles and Patterns of Earth and Moon (March)<br>Ch 13 | LS.1-Matter is transferred continuously between one organism to another and between organisms and their physical environments<br>LS.2-In any particular biome, the number, growth and survival of organisms and populations depend on biotic and abiotic factors<br>ES.3-The atmosphere has different properties at different elevation and contains a mixture of gases that cycle through the lithosphere, biosphere, hydrosphere and atmosphere |
| **Quarter 4** | |

| Unit | Standards |
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| Cycles and Patterns of Earth and Moon<br>(April-June)<br>Ch 12 (sect. 1-4)<br>Ch 12 (sect. 5)<br>Ch 15 | ES.1-Hydrologic cycle illustrates changing states of water as it moves through lithosphere, biosphere, hydrosphere, and atmosphere<br>ES.2-Thermal energy transfers in the ocean and the atmosphere contribute to the formation of currents, which influence global climate patterns<br>ES.4-The relative patterns of motion and positions of the Earth, moon, and sun causes solar and lunar eclipses, tides, and phases of the moon |

# Wickliffe City Schools

## 9th Grade Physical Science - Pacing Guide

| Quarter 1 | |
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| **Unit** | **Standards** |
| Beginning of the year Procedures and Activities (2 weeks) | Introduce Physical Science students to the procedures and standards of a high school science course. |
| Unit 1- Introduction to Physical Science (3 weeks) | Physical science introduces students to key concepts and theories that provide a foundation for further study in other sciences and advanced science disciplines. Physical science comprises the systematic study of the physical world as it relates to fundamental concepts about matter, energy and motion. A unified understanding of phenomena in physical, living, Earth and space systems is the culmination of all previously learned concepts related to chemistry, physics, and Earth and space science, along with historical perspective and mathematical reasoning.<br><br>Science Inquiry and Application<br>During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:<br>• Identify questions and concepts that guide scientific investigations;<br>• Design and conduct scientific investigations;<br>• Use technology and mathematics to improve investigations and communications;<br>• Formulate and revise explanations and models using logic and evidence (critical thinking);<br>• Recognize and analyze explanations and models; and<br>• Communicate and support a scientific argument. |
| Unit 2- Study of Matter (4 weeks) | Classification of Matter<br>Matter can be classified in broad categories such as homogeneous and heterogeneous or classified according to its composition or by its chemical (reactivity) and physical properties (e.g., color solubility, odor, hardness, density, melting point and boiling point, viscosity and malleability). Solutions are homogenous mixtures of a solute dissolved in a solvent. The amount of a solid solute that can dissolve in a solvent generally increases as the temperature increases since the particles have more kinetic energy to overcome the attractive forces between them. Water is often used as a solvent since so many substances will dissolve in water. Physical properties can be used to separate the substances in mixtures, including solutions. |

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| | Phase changes can be represented by graphing the temperature of a sample vs. the time it has been heated. Investigations must include collecting data during heating, cooling and solid-liquid-solid phase changes. At times, the temperature will change steadily, indicating a change in the motion of the particles and the kinetic energy of the substance. However, during a phase change, the temperature of a substance does not change, indicating there is no change in kinetic energy. Since the substance continues to gain or lose energy during phase changes, these changes in energy are potential and indicates a change in the position of the particles. When heating a substance, a phase change will occur when the kinetic energy of the particles is great enough to overcome the attractive forces between the particles; the substance then melts or boils. Conversely, when cooling a substance, a phase change will occur when the kinetic energy of the particles is no longer great enough to overcome the attractive forces between the particles; the substance then condenses or freezes. Phase changes are examples of changes that can occur when energy is absorbed from the surroundings (endothermic) or released into the surroundings (exothermic).<br>When thermal energy is added to a solid, liquid or gas, most substances increase in volume because the increased kinetic energy of the particles causes an increased distance between the particles. This results in a change in density of the material. Generally, solids have greater density than liquids, which have greater density than gases due to the spacing between the particles. The density of a substance can be calculated from the slope of a mass vs. volume graph. Differences in densities can be determined by interpreting mass vs. volume graphs of the substances. |
| **Quarter 2** | |
| **Unit** | **Standards** |
| Unit 2- Study of Matter (9 weeks) | Atoms<br>All atoms of a particular element have the same atomic number; an element may have different isotopes with different mass numbers. Atoms may gain or lose electrons to become anions or cations. Atomic number, mass number, charge and identity of the element can be determined from the numbers of protons, neutrons and electrons. Each element has a unique atomic spectrum that can be observed and used to identify an element. Atomic mass and explanations about how atomic spectra are produced are addressed in the chemistry syllabus.<br><br>Periodic Trends of the Elements<br>Content from the middle school level, specifically the properties of metals and nonmetals and their positions on the periodic table, is further expanded in this course. When elements are listed in order of increasing atomic number, the same sequence of properties appears over and over again; this is the periodic law. The periodic table is arranged so that elements with similar chemical and physical properties are in the same group or family. Metalloids are elements that have some |

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| | properties of metals and some properties of nonmetals. Metals, nonmetals, metalloids, periods and groups or families including the alkali metals, alkaline earth metals, halogens and noble gases can be identified by their position on the periodic table. Elements in Groups 1, 2 and 17 have characteristic ionic charges that will be used in this course to predict the formulas of compounds. Other trends in the periodic table (e.g., atomic radius, electronegativity, ionization energies) are found in the chemistry syllabus.<br><br>Bonding and Compounds<br>Middle school content included compounds are composed of atoms of two or more elements joined together chemically. In this course, the chemical joining of atoms is studied in more detail. Atoms may be bonded together by losing, gaining or sharing electrons to form molecules or three-dimensional lattices. An ionic bond involves the attraction of two oppositely charged ions, typically a metal cation and a nonmetal anion formed by transferring electrons between the atoms. An ion attracts oppositely charged ions from every direction, resulting in the formation of a three-dimensional lattice. Covalent bonds result from the sharing of electrons between two atoms, usually nonmetals. Covalent bonding can result in the formation of structures ranging from small individual molecules to three-dimensional lattices (e.g., diamond). The bonds in most compounds fall on a continuum between the two extreme models of bonding: ionic and covalent.<br>Using the periodic table to determine ionic charge, formulas of ionic compounds containing elements from groups 1, 2, 17, hydrogen and oxygen can be predicted. Given a chemical formula, a compound can be named using conventional systems that include Greek prefixes where appropriate. Prefixes will be limited to represent values from one to 10. Given the name of an ionic or covalent substance, formulas can be written. Naming organic molecules is beyond this grade level and is reserved for an advanced chemistry course. Prediction of bond types from electronegativity values, polar covalent bonds, writing formulas and naming compounds that contain polyatomic ions or transition metals will be addressed in the chemistry syllabus.<br><br>Reactions of Matter<br>In middle school, the law of conservation of matter was expanded to chemical reactions, noting that the number and type of atoms and the total mass are the same before and after the reaction. In this course, conservation of matter is expressed by writing balanced chemical equations. At this level, reactants and products can be identified from an equation and simple equations can be written and balanced given either the formulas of the reactants and products or a word description of the reaction. Stoichiometric relationships beyond the coefficients in a balanced equation and classification of types of chemical reactions are addressed in the chemistry syllabus.<br>During chemical reactions, thermal energy is either transferred from the system to the surroundings (exothermic) or transferred from the surroundings to the system (endothermic). Since |

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| | the environment surrounding the system can be large, temperature changes in the surroundings may not be detectable.<br>While chemical changes involve changes in the electrons, nuclear reactions involve changes to the nucleus and involve much larger energies than chemical reactions. The strong nuclear force is the attractive force that binds protons and neutrons together in the nucleus. While the nuclear force is extremely weak at most distances, over the very short distances present in the nucleus the force is greater than the repulsive electrical forces among protons. When the attractive nuclear forces and repulsive electrical forces in the nucleus are not balanced, the nucleus is unstable. Through radioactive decay, the unstable nucleus emits radiation in the form of very fast-moving particles and energy to produce a new nucleus, thus changing the identity of the element. Nuclei that undergo this process are said to be radioactive. Radioactive isotopes have several medical applications. The radiation they release can be used to kill undesired cells (e.g., cancer cells). Radioisotopes can be introduced into the body to show the flow of materials in biological processes.<br>For any radioisotope, the half-life is unique and constant. Graphs can be constructed that show the amount of a radioisotope that remains as a function of time and can be interpreted to determine the value of the half-life. Half-life values are used in radioactive dating.<br>Other examples of nuclear processes include nuclear fission and nuclear fusion. Nuclear fission involves splitting a large nucleus into smaller nuclei, releasing large quantities of energy. Nuclear fusion is the joining of smaller nuclei into a larger nucleus accompanied by the release of large quantities of energy. Nuclear fusion is the process responsible for formation of all the elements in the universe beyond helium and the energy of the sun and the stars. |
| **Quarter 3** | |
| **Unit** | **Standards** |
| Unit 3- Forces and Motion<br>(9 weeks) | Forces and Motion<br>Building upon content in elementary and middle school, major concepts of motion and forces are further developed. In middle school, speed has been dealt with conceptually, mathematically and graphically. The concept that forces have both magnitude and direction can be represented with a force diagram, that forces can be added to find a net force and that forces may affect motion has been addressed in middle school. At the high school level, mathematics (including graphing) is used when describing these phenomena, moving from qualitative understanding to one that is more quantitative. For the physical science course, all motion is limited to objects moving in a straight line either horizontally, vertically, up an incline or down an incline, that can be characterized in a single step (e.g., at rest, constant velocity, constant acceleration). Motions of two objects may be compared or addressed simultaneously (e.g., when or where would they meet). |

Motion

The motion of an object depends on the observer's frame of reference and is described in terms of distance, position, displacement, speed, velocity, acceleration and time. Position, displacement, velocity and acceleration are all vector properties (magnitude and direction). All motion is relative to whatever frame of reference is chosen, for there is no motionless frame from which to judge all motion. The relative nature of motion will be addressed conceptually, not mathematically. Non-inertial reference frames are excluded. Motion diagrams can be drawn and interpreted to represent the position and velocity of an object. Showing the acceleration on motion diagrams will be reserved for physics.

The displacement or change in position of an object is a vector quantity that can be calculated by subtracting the initial position from the final position ($\Delta x = xf - xi$). Displacement can be positive or negative depending upon the direction of motion. Displacement is not always equal to the distance travelled. Examples should be given where the distance is not the same as the displacement.

Velocity is a vector property that represents the rate at which position changes. Average velocity can be calculated by dividing displacement (change in position) by the elapsed time ($vavg = (xf - xi)/(tf - ti)$). Velocity may be positive or negative depending upon the direction of motion and is not always equal to the speed. Provide examples of when the average speed is not the same as the average velocity. Objects that move with constant velocity have the same displacement for each successive time interval. While speeding up or slowing down and/or changing direction, the velocity of an object changes continuously, from instant to instant. The speed of an object at any instant (clock reading) is called instantaneous speed. An object may not travel at this instantaneous speed for any period of time or cover any distance with that particular speed, especially if the speed is continually changing.

Acceleration is a vector property that represents the rate at which velocity changes. Average acceleration can be calculated by dividing the change in velocity divided by elapsed time ($aavg = (vf - vi)/(tf - ti)$). At this grade level, it should be noted that acceleration can be positive or negative, but specifics about what kind of motions produce positive or negative accelerations will be addressed in the physics syllabus. The word "deceleration" should not be used because students tend to associate a negative sign of acceleration only with slowing down. Objects that have no acceleration can either be standing still or be moving with constant velocity (speed and direction). Constant acceleration occurs when the change in an object's instantaneous velocity is the same for equal successive time intervals.

Motion can be represented by position vs. time and velocity vs. time graphs. Specifics about the speed, direction and change in motion can be determined by interpreting such graphs. For physical science, graphs will be limited to positive x-values and show only uniform motion involving constant velocity or constant acceleration. Motion must be investigated by collecting and analyzing data in the laboratory. Technology can enhance motion exploration and investigation through video

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| | analysis, the use of motion detectors and graphing data for analysis.<br>Objects that move with constant velocity and have no acceleration form a straight line (not necessarily horizontal) on a position vs. time graph. Objects that are at rest will form a straight horizontal line on a position vs. time graph. Objects that are accelerating will show a curved line on a position vs. time graph. Velocity can be calculated by determining the slope of a position vs. time graph. Positive slopes on position vs. time graphs indicate motion in a positive direction. Negative slopes on position vs. time graphs indicate motion in a negative direction. While it is important that students can construct graphs by hand, computer graphing programs or graphing calculators also can be used so more time can be spent on graph interpretation and analysis.<br>Constant acceleration is represented by a straight line (not necessarily horizontal) on a velocity vs. time graph. Objects that have no acceleration (at rest or moving at constant velocity) will have a straight horizontal line for a velocity vs. time graph. Average acceleration can be by determining the slope of a velocity vs. time graph. The details about motion graphs should not be taught as rules to memorize, but rather as generalizations that can be developed from interpreting the graphs.<br><br>Forces<br>Force is a vector quantity, having both magnitude and direction. The (SI) unit of force is a Newton. One Newton of net force will cause a 1 kg object to experience an acceleration of 1 $m/s^2$. A Newton also can be represented as $kg \cdot m/s^2$. The opportunity to measure force in the lab must be provided (e.g., with a spring scale or a force probe). Normal forces and tension forces are introduced conceptually at this level. These forces and other forces are introduced in prior grades (friction, drag, contact, gravitational, electric and magnetic) and can be used as examples of forces that affect motion. Gravitational force (weight) can be calculated from mass, but all other forces will only be quantified from force diagrams that were introduced in middle school. In physical science, only forces in one dimension (positive and negative) will be addressed. The net force can be determined by one-dimensional vector addition. More quantitative study of friction forces, universal gravitational forces, elastic forces and electrical forces will be addressed in the physics syllabus.<br>Friction is a force that opposes sliding between two surfaces. For surfaces that are sliding relative to each other, the force on an object always points in a direction opposite to the relative motion of the object. In physical science, friction will only be calculated from force diagrams. Equations for static and kinetic friction are found in the physics syllabus.<br>A normal force exists between two solid objects when their surfaces are pressed together due to other forces acting on one or both objects (e.g., a solid sitting on or sliding across a table, a magnet attached to a refrigerator). A normal force is always a push directed at right angles from the surfaces of the interacting objects. A tension force occurs when a non-slack rope, wire, cord or similar device pulls on another object. The tension force always points in the direction of the pull. |

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| | In middle school, the concept of a field as a region of space that surrounds objects with the appropriate property (mass for gravitational fields, charge for electric fields, a magnetic object for magnetic fields) was introduced to explain gravitational, magnetic and electrical forces that occur over a distance. The field concept is further developed in physical science. The stronger the field, the greater the force exerted on objects placed in the field. The field of an object is always there, even if the object is not interacting with anything else. The gravitational force (weight) of an object is proportional to its mass. Weight, Fg, can be calculated from the equation Fg = m g, where g is the gravitational field strength of an object which is equal to 9.8 N/kg ($m/s^2$) on the surface of Earth.<br><br>Dynamics<br>An object does not accelerate (remains at rest or maintains a constant speed and direction of motion) unless an unbalanced net force acts on it. The rate at which an object changes its speed or direction (acceleration) is proportional to the vector sum of the applied forces (net force, Fnet) and inversely proportional to the mass (a = Fnet/m). When the vector sum of the forces (net force) acting on an object is zero, the object does not accelerate. For an object that is moving, this means the object will remain moving without changing its speed or direction. For an object that is not moving, the object will continue to remain stationary. These laws will be applied to systems consisting of a single object upon which multiple forces act. Vector addition will be limited to one dimension. While both horizontal and vertical forces can be acting on an object simultaneously, one of the dimensions must have a net force of zero. |
| **Quarter 4** | |
| **Unit** | **Standards** |
| Unit 4- Energy and Waves<br>(6 weeks) | Energy and Waves<br>Building upon knowledge gained in elementary and middle school, major concepts about energy and waves are further developed. Conceptual knowledge will move from qualitative understandings of energy and waves to ones that are more quantitative using mathematical formulas, manipulations and graphical representations.<br><br>Conservation of Energy<br>Energy content learned in middle school, specifically conservation of energy and the basic differences between kinetic and potential energy, is elaborated on and quantified in this course. Energy has no direction and has units of Joules (J). Kinetic energy, Ek, can be mathematically represented by $E = \frac{1}{2}mv^2$. Gravitational potential energy, E , can be mathematically represented by Eg = mgh. The amount of energy of an object is measured relative to a reference that is considered to be at a point of zero energy. The reference may be changed to help understand different situations. Only the change in the amount of energy can be measured absolutely. The |

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| | conservation of energy and equations for kinetic and gravitational potential energy can be used to calculate values associated with energy (i.e., height, mass, speed) for situations involving energy transfer and transformation. Opportunities to quantify energy from data collected in experimental situations (e.g., a swinging pendulum, a car travelling down an incline) must be provided.<br><br>Transfer and Transformation of Energy<br>In middle school, concepts of energy transfer and transformation were addressed, including conservation of energy, conduction, convection and radiation, the transformation of electrical energy and the dissipation of energy into thermal energy. Work also was introduced as a method of energy transfer into or out of the system when an outside force moves an object over a distance. In this course, these concepts are further developed. As long as the force, F, and displacement, $\Delta x$, are in the same direction, work, W, can be calculated from the equation $W = F\Delta x$. Energy transformations for a phenomenon can be represented through a series of pie graphs or bar graphs. Equations for work, kinetic energy and potential energy can be combined with the law of conservation of energy to solve problems. When energy is transferred from one system to another, some of the energy is transformed to thermal energy. Since thermal energy involves the random movement of many trillions of subatomic particles, it is less able to be organized to bring about further change. Therefore, even though the total amount of energy remains constant, less energy is available for doing useful work.<br><br>Waves<br>As addressed in middle school, waves transmit energy from one place to another, can transfer energy between objects and can be described by their speed, wavelength, frequency and amplitude. The relationship between speed, wavelength and frequency also was addressed in middle school Earth and Space Science as the motion of seismic waves through different materials is studied.<br><br>In elementary and middle school, reflection and refraction of light were introduced, as was absorption of radiant energy by transformation into thermal energy. In this course, these processes are addressed from the perspective of waves and expanded to include other types of energy that travel in waves. When a wave encounters a new material, the new material may absorb the energy of the wave by transforming it to another form of energy, usually thermal energy. Waves can be reflected off solid barriers or refracted when a wave travels form one medium into another medium. Waves may undergo diffraction around small obstacles or openings. When two waves traveling through the same medium meet, they pass through each other then continue traveling through the medium as before. When the waves meet, they undergo superposition, demonstrating constructive and destructive interference. Sound travels in waves and undergoes reflection, refraction, |

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| | interference and diffraction. In the physics syllabus, many of these wave phenomena will be studied further and quantified.<br><br>Radiant energy travels in waves and does not require a medium. Sources of light energy (e.g., the sun, a light bulb) radiate energy continually in all directions. Radiant energy has a wide range of frequencies, wavelengths and energies arranged into the electromagnetic spectrum. The electromagnetic spectrum is divided into bands: radio (lowest energy), microwaves, infrared, visible light, X-rays and gamma rays (highest energy) that have different applications in everyday life. Radiant energy of the entire electromagnetic spectrum travels at the same speed in a vacuum. Specific frequency, energy or wavelength ranges of the electromagnetic spectrum are not required. However, the relative positions of the different bands, including the colors of visible light, are important (e.g., ultraviolet has more energy than microwaves). Radiant energy exhibits wave behaviors including reflection, refraction, absorption, superposition and diffraction, depending in part on the nature of the medium. For opaque objects (e.g., paper, a chair, an apple), little if any radiant energy is transmitted into the new material. However the radiant energy can be absorbed, usually increasing the thermal energy of the object and/or the radiant energy can be reflected. For rough objects, the reflection in all directions forms a diffuse reflection and for smooth shiny objects, reflections can result in clear images. Transparent materials transmit most of the energy through the material but smaller amounts of energy may be absorbed or reflected.<br><br>Changes in the observed frequency and wavelength of a wave can occur if the wave source and the observer are moving relative to each other. When the source and the observer are moving toward each other, the wavelength is shorter and the observed frequency is higher; when the source and the observer are moving away from each other, the wavelength is longer and the observed frequency is lower. This phenomenon is called the Doppler shift and can be explained using diagrams. This phenomenon is important to current understanding of how the universe was formed and will be applied in later sections of this course. Calculations to measure the apparent change in frequency or wavelength are not appropriate for this course.<br><br>Thermal Energy<br>In middle school, thermal energy is introduced as the energy of movement of the particles that make up matter. Processes of heat transfer, including conduction, convection and radiation, are studied. In other sections of this course, the role of thermal energy during heating, cooling and phase changes is explored conceptually and graphically. In this course, rates of thermal energy transfer and thermal equilibrium are introduced.<br><br>Thermal conductivity depends on the rate at which thermal energy is transferred from one end of a |

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| | material to another. Thermal conductors have a high rate of thermal energy transfer and thermal insulators have a slow rate of thermal energy transfer. The rate at which thermal radiation is absorbed or emitted by a system depends on its temperature, color, texture and exposed surface area. All other things being equal, in a given amount of time, black rough surfaces absorb more thermal energy than smooth white surfaces. An object or system is continually absorbing and emitting thermal radiation. If the object or system absorbs more thermal energy than it emits and there is no change in phase, the temperature increases. If the object or system emits more thermal energy than is absorbed and there is no change in phase, the temperature decreases. For an object or system in thermal equilibrium, the amount of thermal energy absorbed is equal to the amount of thermal energy emitted; therefore, the temperature remains constant. In chemistry, changes in thermal energy are quantified for substances that change their temperature.<br><br>Electricity<br>In earlier grades, these concepts were introduced: electrical conductors and insulators; and a complete loop is needed for an electrical circuit that may be parallel or in a series. In this course, circuits are explained by the flow of electrons, and current, voltage and resistance are introduced conceptually to explain what was observed in middle school. The differences between electrical conductors and insulators can be explained by how freely the electrons flow throughout the material due to how firmly electrons are held by the nucleus.<br>By convention, electric current is the rate at which positive charge flows in a circuit. In reality, it is the negatively charged electrons that are actually moving. Current is measured in amperes (A), which is equal to one coulomb of charge per second (C/s). In an electric circuit, the power source supplies the electrons already in the circuit with electric potential energy by doing work to separate opposite charges. For a battery, the energy is provided by a chemical reaction that separates charges on the positive and negative sides of the battery. This separation of charge is what causes the electrons to flow in the circuit. These electrons then transfer energy to other objects and transform electrical energy into other forms (e.g., light, sound, heat) in the resistors. Current continues to flow, even after the electrons transfer their energy. Resistors oppose the rate of charge flow in the circuit. The potential difference or voltage across an energy source is a measure of potential energy in Joules supplied to each coulomb of charge. The volt (V) is the unit of potential difference and is equal to one Joule of energy per coulomb of charge (J/C). Potential difference across the circuit is a property of the energy source and does not depend upon the devices in the circuit. These concepts can be used to explain why current will increase as the potential difference increases and as the resistance decreases. Experiments, investigations and testing (3-D or virtual) must be used to construct a variety of circuits, and measure and compare the potential difference (voltage) and current. Electricity concepts are dealt with conceptually in this course. Calculations with circuits will be addressed in the physics syllabus. |

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| Unit 5- The Universe<br>(3 weeks) | The Universe<br>In early elementary school, observations of the sky and space are the foundation for developing a deeper knowledge of the solar system. In late elementary school, the parts of the solar system are introduced, including characteristics of the sun and planets, orbits and celestial bodies. At the middle school level, energy, waves, gravity and density are emphasized in the physical sciences, and characteristics and patterns within the solar system are found.<br>In the physical science course, the universe and galaxies are introduced, building upon the previous knowledge about space and the solar system in the earlier grades.<br><br>History of the Universe<br>The Big Bang Model is a broadly accepted theory for the origin and evolution of our universe. It postulates that 12 to 14 billion years ago, the portion of the universe seen today was only a few millimeters across (NASA).<br>According to the "big bang" theory, the contents of the known universe expanded explosively into existence from a hot, dense state 13.7 billion years ago (NAEP 2009). After the big bang, the universe expanded quickly (and continues to expand) and then cooled down enough for atoms to form. Gravity pulled the atoms together into gas clouds that eventually became stars, which comprise young galaxies. Foundations for the big bang model can be included to introduce the supporting evidence for the expansion of the known universe (e.g., Hubble's law and red shift or cosmic microwave background radiation). A discussion of Hubble's law and red shift is found in the Galaxy formation section, below.<br><br>Technology provides the basis for many new discoveries related to space and the universe. Visual, radio and x-ray telescopes collect information from across the entire electromagnetic spectrum; computers are used to manage data and complicated computations; space probes send back data and materials from remote parts of the solar system; and accelerators provide subatomic particle energies that simulate conditions in the stars and in the early history of the universe before stars formed.<br><br>Galaxy formation<br>A galaxy is a group of billions of individual stars, star systems, star clusters, dust and gas bound together by gravity. There are billions of galaxies in the universe, and they are classified by size and shape. The Milky Way is a spiral galaxy. It has more than 100 billion stars and a diameter of more than 100,000 light years. At the center of the Milky Way is a bulge of stars, from which are spiral arms of gas, dust and most of the young stars. The solar system is part of the Milky Way galaxy. |

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| | Hubble's law states that galaxies that are farther away have a greater red shift, so the speed at which a galaxy is moving away is proportional to its distance from the Earth. Red shift is a phenomenon due to Doppler shifting, so the shift of light from a galaxy to the red end of the spectrum indicates that the galaxy and the observer are moving farther away from one another. Doppler shifting also is found in the Energy and Waves section of this course.<br><br>Stars<br><br>Early in the formation of the universe, stars coalesced out of clouds of hydrogen and helium and clumped together by gravitational attraction into galaxies. When heated to a sufficiently high temperature by gravitational attraction, stars begin nuclear reactions, which convert matter to energy and fuse the lighter elements into heavier ones. These and other fusion processes in stars have led to the formation of all the other elements. (NAEP 2009). All of the elements, except for hydrogen and helium, originated from the nuclear fusion reactions of stars (College Board Standards for College Success, 2009).<br>Stars are classified by their color, size, luminosity and mass. A Hertzprung-Russell diagram must be used to estimate the sizes of stars and predict how stars will evolve. Most stars fall on the main sequence of the H-R diagram, a diagonal band running from the bright hot stars on the upper left to the dim cool stars on the lower right.<br>A star's mass determines the star's place on the main sequence and how long it will stay there. Patterns of stellar evolution are based on the mass of the star. Stars begin to collapse as the core energy dissipates. Nuclear reactions outside the core cause expansion of the star, eventually leading to the collapse of the star. |

# Wickliffe City Schools

Honors Biology and Biology - Pacing Guide

| Quarter 1 | |
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| **Unit** | **Standards** |
| <u>Unit 1 – Introduction</u><br>• 2.5 weeks<br>• Topics covered:<br>  o Scientific Method<br>  o Intro to Biology | Science Inquiry and Application During the years of grades 9 through 12, all students must use the following processes with appropriate laboratory safety techniques to construct their knowledge and understanding in a content areas:<br>• Identify questions and concepts that guide scientific investigations;<br>• Design and conduct scientific investigations;<br>• Use technology and mathematics to improve investigations and communications;<br>• Formulate and revise explanations and models using logic and evidence (critical thinking);<br>• Recognize and analyze explanations and models; and<br>• Communicate and support a scientific argument.<br>This course investigates the composition, diversity, complexity and interconnectedness of life on Earth. Fund concepts of heredity and evolution provide a framework through inquiry-based instruction to explore the livi the physical environment and the interactions within and between them. |
| <u>Unit 2 – Cells</u><br>• 6.5 weeks – through the end of the first quarter<br>• Topics covered:<br>  o Atomic structure<br>  o Bonding<br>  o Water and pH<br>  o Macromolecules<br>  o Enzymes | A living cell is composed of a small number of elements, mainly carbon, hydrogen, nitrogen, oxygen, phospho sulfur. Carbon, because of its small size and four available bonding electrons, can join to other carbon atoms and rings to form large and complex molecules. The essential functions of cells involve chemical reactions tha water and carbohydrates, proteins, lipids and nucleic acids. A special group of proteins, enzymes, enables che reactions to occur within living systems.<br><br>Cell functions are regulated. Complex interactions among the different kinds of molecules in the cell cause di cycles of activities, such as growth and division. Most cells function within a narrow range of temperature and At very low temperatures, reaction rates are slow. High temperatures and/or extremes of pH can irreversibly the structure of most protein molecules. Even small changes in pH can alter how molecules interact. The sequ DNA bases on a chromosome determines the sequence of amino acids in a protein. Proteins catalyze most che reactions in cells. Protein molecules are long, usually folded chains made from combinations of the 20 typical acid sub-units found in the cell. The function of each protein molecule depends on its specific sequence of am acids and the shape the chain takes as a result of that sequence.<br><br>Note 1: The idea that protein molecules assembled by cells conduct the work that goes on inside and outside t in an organism can be learned without going into the biochemical details. It is sufficient for students to know |

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| | molecules involved are different configurations of a few amino acids and that the different shapes of the mole influence what they do. |
| **Quarter 2** | |
| **Unit** | **Standards** |
| Unit 2 – Cells<br>• 8.5 to 9 weeks<br>• Topics covered:<br>○ Microscopy<br>○ Cell Structure<br>○ Cell Functions<br>○ Cell Transport<br>○ Photosynthesis<br>○ Cellular Respiration<br>○ Cell Division | Building on knowledge from middle school (cell theory), this topic focuses on the cell as a system itself (single-celled organism) and as part of larger systems (multicellular organism), sometimes as part of a multicellular organism, always as part of an ecosystem. The cell is a system that conducts a variety of functions associated with life. Details of cellular processes such as photosynthesis, chemosynthesis, cellular respiration, cell division and differentiation are studied at this grade level. Additionally, cellular organelles studied are cytoskeleton, Golgi complex and endoplasmic reticulum.<br><br>From about 4 billion years ago to about 2 billion years ago, only simple, single-celled microorganisms are found in the fossil record. Once cells with nuclei developed about a billion years ago, increasingly complex multicellular organisms evolved.<br><br>Every cell is covered by a membrane that controls what can enter and leave the cell. In all but quite primitive cells, a complex network of proteins provides organization and shape. Within the cell are specialized parts for the transport of materials, energy transformation, protein building, waste disposal, information feedback and movement. In addition to these basic cellular functions, most cells in multicellular organisms perform some specific functions that others do not.<br><br>Note 2: The concept of the cell and its parts as a functioning system is more important than memorizing parts of the cell. |
| **Quarter 3** | |
| **Unit** | **Standards** |
| Unit 3 – Heredity<br>• 5 weeks<br>• Topics covered:<br>○ Genetics<br>○ DNA structure<br>○ RNA structure<br>○ Protein Synthesis | Building on knowledge from elementary school (plants and animals have life cycles and offspring resemble their parents) and knowledge from middle school (reproduction, Mendelian Genetics, inherited traits and diversity of species), this topic focuses on the explanation of genetic patterns of inheritance. In middle school, students learn that living things are a result of one or two parents, and traits are passed on to the next generation through both asexual and sexual reproduction. In addition, they learn that traits are defined by instructions encoded in many discrete genes and that a gene may come in more than one form called alleles.<br>At the high school level, the explanation of genes is expanded to include the following concepts:<br>• Life is specified by genomes. Each organism has a genome that contains all of the biological information |

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| | needed to build and maintain a living example of that organism. The biological information contained in a genome is encoded in its deoxyribonucleic acid (DNA) and is divided into discrete units called genes.<br>• "Genes are segments of DNA molecules. The sequence of DNA bases in a chromosome determines the sequence of amino acids in a protein. Inserting, deleting or substituting segments of DNA molecules can alter genes.<br>• An altered gene may be passed on to every cell that develops from it. The resulting features may help, harm or have little or no effect on the offspring's success in its environments.<br>• Gene mutations (when they occur in gametes) can be passed on to offspring.<br>• Genes code for protein. The sequence of DNA bases in a chromosome determines the sequence of amino acids in a protein.<br>• "The many body cells in an individual can be very different from one another, even though they are all descended from a single cell and thus have essentially identical genetic instructions. Different genes are active in different types of cells, influenced by the cell's environment and past history." (AAAS)<br><br>In high school biology, Mendel's laws of inheritance (introduced in grade 8) are interwoven with current knowledge of DNA and chromosome structure and function to build toward basic knowledge of modern genetics. Sorting and recombination of genes in sexual reproduction and meiosis specifically result in a variance in traits of the offspring of any two parents and explicitly connect the knowledge to evolution.<br><br>The gene interactions described in middle school were limited primarily to dominance and co- dominance traits. In high school genetic mechanisms, both classical and modern including incomplete dominance, sex-linked traits, goodness of fit test (Chi-square) and dihybrid crosses are investigated through real-world examples. Genes that affect more than one trait (pleiotropy), traits affected by more than one gene (epistasis) and polygenetic traits can be introduced using simple real-world examples. Additionally, genes that modify or regulate the expression of another gene should be included in explorations at the high school level. Dihybrid crosses can be used to explore linkage groups. Modern genetics techniques, such as cloning must be explored in this unit.It is imperative that the technological developments that lead to the current knowledge of heredity be included in the study of heredity. For example, the development of the model for DNA structure was the result of the use of technology and the studies and ideas of many scientists. Watson and Crick developed the final model, but did not do the original studies.<br><br>The sequence of DNA bases on a chromosome determines the sequence of amino acids in a protein. Proteins catalyze most chemical reactions in cells. Protein molecules are long, usually folded chains made from combinations of the 20 typical amino-acid sub-units found in the cell. The function of each protein molecule depends on its specific sequence of amino acids and the shape the chain takes as a result of that sequence.<br><br>Biological evolution explains the natural origins for the diversity of life. Emphasis shifts from thinking in |

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| Unit 4 – Evolution<br>• 4 weeks – and then continuing in to the fourth quarter<br>• Topics covered:<br>○ Evolution by Natural Selection<br>○ Human Evolution | terms of selection of individuals with a particular trait to changing proportions of a trait in populations. The study of evolution must include Modern Synthesis, the unification of genetics and evolution and historical perspectives of evolutionary theory. The study of evolution must include gene flow, mutation, speciation, natural selection, genetic drift, sexual selection and Hardy Weinberg's law.<br><br>The basic concept of biological evolution is that the Earth's present-day species descended from earlier, common ancestral species. At the high school level, the term natural selection is used to describe the process by which traits become more or less common in a population due to consistent environmental effects upon the survival or reproduction of the individual with the trait. Mathematical reasoning must be applied to solve problems, (e.g., use Hardy Weinberg's law to explain gene frequency patterns in a population).<br><br>Modern ideas about evolution provide a natural explanation for the diversity of life on Earth as represented in the fossil record, in the similarities of existing species and in modern molecular evidence. From a long-term perspective, evolution is the descent with modification of different lineages from common ancestors.<br><br>Different phenotypes result from new combinations of existing genes or from mutations of genes in reproductive cells. At the high school level, the expectation is to combine grade-8 knowledge with explanation of the internal structure and function of chromosomes. Natural selection works on the phenotype.<br><br>Populations evolve over time. Evolution is the consequence of the interactions of:<br><br>1. The potential for a population to increase its numbers;<br>2. The genetic variability of offspring due to mutation and recombination of genes;<br>3. A finite supply of the resources required for life; and<br>4. The differential survival and reproduction of individuals with the specific phenotype.<br><br>Mutations are described in the content elaboration for Heredity. Apply the knowledge of mutation and genetic drift to real-world examples. Recent molecular-sequence data generally, but not always, support earlier hypotheses regarding lineages of organisms based upon morphological comparisons.Heritable characteristics influence how likely an organism is to survive and reproduce in a particular environment. When an environment changes, the survival value of inherited characteristics may change. This may or may not cause a change in species that inhabit the environment. Formulate and revise explanations for gene flow and sexual selection based on real-world problems. |
| **Quarter 4** | |
| **Unit** | **Standards** |

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| <u>Unit 4 – Evolution</u><br>• 3 weeks<br>• Topics covered:<br>  ○ History of Life<br>  ○ Classification of Life<br>  ○ Plant Classification<br>  ○ Animal Classification | Classification systems are frameworks developed by scientists for describing the diversity of organisms, indicating the degree of relatedness between organisms. Recent molecular-sequence data generally support earlier hypotheses regarding lineages of organisms based upon morphological comparisons. Both morphological comparisons and molecular evidence must be used to describe biodiversity (cladograms can be used to address this).<br><br>Modern ideas about evolution provide a natural explanation for the diversity of life on Earth as represented in the fossil record, in the similarities of existing species and in modern molecular evidence.<br><br>The great diversity of organisms and ecological niches they occupy result from more than 3.5 billion years of evolution.<br><br>From about 4 billion years ago to about 2 billion years ago, only simple, single-celled microorganisms are found in the fossil record. Once cells with nuclei developed about a billion years ago, increasingly complex multicellular organisms evolved. |
| <u>Unit 5 – Diversity and Interdependence of Life</u><br>• 5.5 weeks<br>• Topics covered:<br>  ○ Ecology<br>  ○ Ecosystems<br>  ○ Interactions<br>  ○ Energy Transfer<br>  ○ Population Growth | Some ecosystems can be reasonably persistent over hundreds or thousands of years. Like many complex systems, ecosystems tend to have cyclic fluctuations around a state of rough equilibrium. In the long run, however, ecosystems always change as geological or biological conditions vary. Misconceptions about population growth capacity, interspecies and intra-species competition for resources, and what occurs when a species immigrates to or emigrates from ecosystems are included in this topic. Technology must be used to access real-time/authentic data to study population changes and growth in specific locations.<br><br>Organisms transform energy (flow of energy) and matter (cycles of matter) as they survive and reproduce. The cycling of matter and flow of energy occurs at all levels of biological organization, from molecules to ecosystems. At the high school level, the concept of energy flow as unidirectional in ecosystems is explored. |

**Wickliffe City Schools**

Chemistry & Honors Chemistry - Pacing Guide

| **Quarter 1** | |
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| **Unit** | **Standards** |
| Beginning of the year Procedures and Activities (1 week) | Introduce Chemistry students to the procedures and standards of a high school Chemistry course, such as laboratory equipment, lab safety, lab report formatting, etc..<br><br>This course introduces students to key concepts and theories that provide a foundation for further study in other sciences as well as advanced science disciplines. Chemistry comprises a systematic study of the *predictive* physical interactions of matter and subsequent events that occur in the natural world. The study of matter through the exploration of classification, its structure and its interactions is how this course is organized.<br>Investigations are used to understand and explain the behavior of matter in a variety of inquiry and design scenarios that incorporate scientific reasoning, analysis, communication skills and real-world applications. An understanding of leading theories and how they have informed current knowledge prepares students with higher order cognitive capabilities of evaluation, prediction and application.<br><br>Science Inquiry and Application<br>During the years of grades 9 through 12, all students must use the following scientific processes with appropriate laboratory safety techniques to construct their knowledge and understanding in all science content areas:<br>• Identify questions and concepts that guide scientific investigations;<br>• Design and conduct scientific investigations;<br>• Use technology and mathematics to improve investigations and communications;<br>• Formulate and revise explanations and models using logic and evidence (critical thinking);<br>• Recognize and analyze explanations and models; and<br>• Communicate and support a scientific argument. |
| Unit A- Matter, Energy, and the Periodic Table (2 weeks) | Classification of Matter<br><br>Matter can be classified in broad categories such as homogeneous and heterogeneous or classified according to its composition or by its chemical (reactivity) and physical properties (e.g., color solubility, odor, hardness, density, melting point and boiling point, viscosity and malleability). Solutions are homogenous mixtures of a solute dissolved in a solvent. The amount of a solid solute that can dissolve in a solvent generally increases as the temperature increases since the particles have more kinetic energy to overcome the attractive forces between them. Water is often used as |

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| | a solvent since so many substances will dissolve in water. Physical properties can be used to separate the substances in mixtures, including solutions.<br>Phase changes can be represented by graphing the temperature of a sample vs. the time it has been heated. Investigations must include collecting data during heating, cooling and solid-liquid-solid phase changes. When heating a substance, a phase change will occur when the kinetic energy of the particles is great enough to overcome the attractive forces between the particles; the substance then melts or boils.<br>Conversely, when cooling a substance, a phase change will occur when the kinetic energy of the particles is no longer great enough to overcome the attractive forces between the particles; the substance then condenses or freezes. Phase changes are examples of changes that can occur when energy is absorbed from the surroundings (endothermic) or released into the surroundings (exothermic).<br>When thermal energy is added to a solid, liquid or gas, most substances increase in volume because the increased kinetic energy of the particles causes an increased distance between the particles. This results in a change in density of the material. Generally, solids have greater density than liquids, which have greater density than gases due to the spacing between the particles. The density of a substance can be calculated from the slope of a mass vs. volume graph. Differences in densities can be determined by interpreting mass vs. volume graphs of the substances.<br><br>Periodic Table<br>In the physical science syllabus, elements are placed in order of increasing atomic number in the periodic table such that elements with similar properties are placed in the same column. How the periodic table is divided into groups, families, periods, metals, nonmetals and metalloids also was in the physical science syllabus. In chemistry, with more information about the electron configuration of elements, similarities in the configuration of the valence electrons for a particular group can be observed. The electron configuration of an atom can be written from the position on the periodic table. The repeating pattern in the electron configurations for elements on the periodic table explain many of the trends in the properties observed.<br>Atomic theory and bonding must be used to explain trends in properties across periods or down columns including atomic radii, ionic radii, first ionization energies, electronegativities and whether the element is a solid or gas at room temperature. |
| Unit B- Structure of the Atom<br>(3weeks) | Atomic structure<br>The physical science syllabus included properties and locations of protons, neutrons and electrons, atomic number, mass number, cations and anions, isotopes and the strong nuclear force that hold the nucleus together.<br>Atomic models are constructed to explain experimental evidence and make predictions. The changes in the atomic model over time exemplify how scientific knowledge changes as new evidence emerges and how technological advancements like electricity extend the boundaries of scientific knowledge. Thompson's study |

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| | of electrical discharges in cathode-ray tubes led to the discovery of the electron and the development of the plum pudding model of the atom. Rutherford's experiment, in which he bombarded gold foil with α-particles, led to the discovery that most of the atom consists of empty space with a relatively small, positively charged nucleus. Bohr used data from atomic spectra to propose a planetary model of the atom in which electrons orbit the nucleus, like planets around the sun. Later, Schrödinger used the idea that electrons travel in waves to develop a model in which electrons travel randomly in regions of space called orbitals (quantum mechanical model). Based on the quantum mechanical model, it is not possible to predict exactly where electrons are located but there is a region of space surrounding the nucleus in which there is a high probability of finding an electron (electron cloud or orbital). Data from atomic spectra (emission and absorption) gives evidence that electrons can only exist at certain discrete energy levels and not at energies between these levels. Atoms are usually in the ground state where the electrons occupy orbitals with the lowest available energy. However, the atom can become excited when the electrons absorb a photon with the precise amount of energy (indicated by the frequency of the photon) to move to an orbital with higher energy. precise amount of energy will be ignored by the electron. The atom exists in the excited state for a very short amount of time. When an electron drops back down to the lower energy level, it emits a photon that has energ difference between the levels. The amount of energy is indicated by the frequency of the light that is given off and can be measured. Each element has a unique emission and absorption spectrum due to its unique electror electron energy jumps that are possible for that element. Being aware of the quantum mechanical model as th for the atom is important for science literacy as it explains and predicts subatomic interactions, but details sho advanced study.<br>Electron energy levels consist of sublevels (s, p, d and f), each with a characteristic number and shape of orbitals. The shapes of d and f orbitals will not be assessed in high school. Orbital diagrams and electron configurations can be constructed to show the location of the electrons in an atom using established rules. However, the names of these rules will not be assessed. Valence electrons are responsible for most of the chemical properties of elements. In this course, electron configurations (extended and noble gas notation) and orbital diagrams can be shown for any element in the first three periods.<br>Although the quantum mechanical model of the atom explains the most experimental evidence, other models be helpful. Thinking of atoms as indivisible spheres is useful in explaining any physical properties of substances, such as the state (solid, liquid, or gas) of a substance at room temperature. Bohr's planetary model is useful to explain and predict periodic trends in the properties of elements.<br><br>Intramolecular Chemical Bonding<br>In the physical science syllabus, atoms with unpaired electrons tend to form ionic and covalent bonds with other atoms forming molecules, ionic lattices or network covalent structures. In this course, electron configurations, electronegativity values and energy considerations will be applied to bonding and the properties of materials with different types of bonding.<br>Atoms of many elements are more stable as they are bonded to other atoms. In such cases, as atoms bond, |

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| Unit C- Chemical Bonding<br>(3 weeks) | energy is released to the surroundings resulting in a system with lower energy. An atom's electron configuration, particularly the valence elections, determines how an atom interacts with other atoms. Molecules, ionic lattices and network covalent structures have different, yet predictable, properties that depend on the identity of the elements and the types of bonds formed.<br>Differences in electronegativity values can be used to predict where a bond fits on the continuum between ionic and covalent bonds. The polarity of a bond depends on the electronegativity difference and the distance between the atoms (bond length). Polar covalent bonds are introduced as an intermediary between ionic and pure covalent bonds. The concept of metallic bonding also is introduced to explain many of the properties of metals (e.g., conductivity). Since most compounds contain multiple bonds, a substance may contain more than one type of bond. Compounds containing carbon are an important example of bonding, since carbon atoms can bond together and with other atoms, especially hydrogen, oxygen, nitrogen and sulfur, to form chains, rings and branching networks that are present in a variety of compounds, including synthetic polymers, fossil fuels and the large molecules essential to life. |
| **Quarter 2** | |
| **Unit** | **Standards** |
| Unit D- Elements, Compounds, and Nomenclature | Representing Compounds<br>Using the periodic table, formulas of ionic compounds containing specific elements can be predicted. This can include ionic compounds made up of elements from groups 1, 2, 17, hydrogen and oxygen and polyatomic ions if given the formula and charge of the polyatomic ion. Given the formula, a compound can be named using conventional systems that include Greek prefixes and Roman numerals where appropriate. Given the name of an ionic or covalent substance, formulas can be written.<br>Many different models can be used to represent compounds including chemical formulas, Lewis structures, and ball and stick models. These models can be used to visualize atoms and molecules and to predict the properties of substances. Each type of representation provides unique information about the compound. Different representations are better suited for particular substances. Lewis structures can be drawn to represent covalent compounds using a simple set of rules and can be combined with valence shell electron pair repulsion (VSEPR) theory to predict the three-dimensional electron pair and molecular geometry of compounds. Lewis structures and molecular geometries will only be constructed for the following combination of elements: hydrogen, carbon, nitrogen, oxygen, phosphorus, sulfur and the halogens. |
| Unit E- Chemical Reactions | Chemical Reactions<br>In the physical science syllabus, coefficients were introduced to balance simple equations. Other representations including Lewis structures and three-dimensional models also were used and manipulated to demonstrate the conservation of matter in chemical reactions. In this course, more complex reactions will be studied, classified and represented with chemical equations and three-dimensional models. Classifying reactions into types can be a helpful organizational tool in recognizing patterns of what may happen when |

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| | two substances are mixed. Some general types of chemical reactions are oxidation/reduction, synthesis, decomposition, single-replacement, double replacement (including precipitation reactions and some acid-base neutralizations) and combustion reactions. Some reactions can fit into more than one category. For example, a single replacement reaction also can be classified as an oxidation/reduction reaction. Identification of reactions involving oxidation and reduction as well as indicating what substance is being oxidized and what is being reduced are appropriate in this course. However, balancing complex oxidation/reduction reactions will be reserved for more advanced study.<br>Organic molecules release energy when undergoing combustion reactions and are used to meet the energy needs of society (e.g., oil, gasoline, natural gas) and to provide the energy needs of biological organisms (e.g., cellular respiration). When a reaction between two ionic compounds in aqueous solution results in the formation of a precipitate or molecular compound, the reaction often occurs because the new ionic or covalent bonds are stronger than the original ion-dipole interactions of the ions in solution. Laboratory experiences (3-D or virtual) with different types of chemical reactions must be provided.<br>Reactions occur when reacting particles collide in an appropriate orientation and with sufficient energy. Not all collisions are effective. Stable reactants require the input of energy, the activation energy, to initiate a reaction. A catalyst provides an alternate pathway for a reaction, usually with a lower activation energy. With this lower energy threshold, more collisions will have enough energy to result in a reaction. An enzyme is a large organic molecule that folds into a unique shape by forming intermolecular bonds with itself. The enzyme's shape allows it to hold a substrate molecule in the proper orientation to result in an effective collision. The rate of a chemical reaction is the change in the amount of reactants or products in a specific period of time. Increasing the probability or effectiveness of the collisions between the particles increases the rate of the reaction. Therefore, changing the concentration of the reactants, the temperature or the pressure of gaseous reactants can change the reaction rate. Likewise, the collision theory can be applied to dissolving solids in a liquid solvent and can be used to explain why reactions are more likely to occur between reactants in the aqueous or gaseous state than between solids. The rate at which a substance dissolves should not be confused with the amount of solute that can dissolve in a given amount of solvent (solubility). Mathematical treatment of reaction rates are reserved for later study. Computer simulations can help visualize reactions from the perspective of the kinetic-molecular theory.<br>In middle school, the differences between potential and kinetic energy and the particle nature of thermal energy were introduced. For chemical systems, potential energy is in the form of chemical energy and kinetic energy is in the form of thermal energy. The total amount of chemical energy and/or thermal energy in a system is impossible to measure.<br>However, the energy change of a system can be calculated from measurements (mass and change in temperature) from calorimetry experiments in the laboratory. Conservation of energy is an important component of calorimetry equations.<br>Thermal energy is the energy of a system due to the movement (translational, vibrational and rotational) of its particles. The thermal energy of an object depends upon the amount of matter present (mass), |

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| | temperature and chemical composition. Some materials require little energy to change their temperature and other materials require a great deal to change their temperature by the same amount. Specific heat is a measure of how much energy is needed to change the temperature of a specific mass of material a specific amount. Specific heat values can be used to calculate the thermal energy change, the temperature (initial, final or change in) or mass of a material in calorimetry. Water has a particularly high specific heat capacity, which is important in regulating Earth's temperature.<br>As studied in middle school, chemical energy is the potential energy associated with chemical systems. Chemical reactions involve valence electrons forming bonds to yield more stable products with lower energies. Energy is required to break interactions and bonds between the reactant atoms and energy is released when an interaction or bond is formed between the atoms in the products. Molecules with weak bonds (e.g., ATP) are less stable and tend to react to produce more stable products, releasing energy in the process. Generally, energy is transferred out of the system (exothermic) when the products have stronger bonds than the reactants and is transferred into the system (endothermic) when the reactants have stronger bonds than the products. Predictions of the energy requirements (endothermic or exothermic) of a reaction can be made given a table of bond energies. Graphic representations can be drawn and interpreted to represent the energy changes during a reaction, including the activation energy. The roles of energy and entropy in determining the spontaneity of chemical reactions are dealt with conceptually in this course. Avoid describing entropy as the amount of disorder since this leads to persistent misconceptions. Mathematical treatment of entropy and its influence on the spontaneity of reactions is reserved for advanced study<br><br>Nuclear Reactions<br>The basics of nuclear forces, isotopes, radioactive decay, fission and fusion were addressed in the physical science syllabus. In chemistry, specific types of radioactive decay and using nuclear reactions as a source of energy are addressed. Radioactive decay can result in the release of different types of radiation (alpha, beta, gamma, positron) each with a characteristic mass, charge and potential to ionize and penetrate the material it strikes. Beta decay results from the decay of a neutron and positron decay results from the decay of a proton. When a radioisotope undergoes alpha, beta or positron decay, the resulting nucleus can be predicted and the balanced nuclear equation can be written.<br>Nuclear reactions, such as fission and fusion, are accompanied by large energy changes that are much greater than those that accompany chemical reactions. These nuclear reactions can theoretically be used as a controlled source of energy in a nuclear power plant. There are advantages and disadvantages of generating electricity from fission and fusion. |
| **Quarter 3** | |
| **Unit** | **Standards** |
| Unit F- Measurement and the Mole | Quantifying matter<br>In earlier grades, properties of materials were quantified with measurements that were always associated |

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| | with some error. In this course, scientific protocols for quantifying the properties of matter accurately and precisely are studied. Using metric measuring systems, significant digits or figures, scientific notation, error analysis and dimensional analysis are vital to scientific communication.<br>There are three domains of magnitude in size and time: the macroscopic (human) domain, the cosmic domain and the submicroscopic (atomic and subatomic) domain. Measurements in the cosmic domain and submicroscopic domains require complex instruments and/or procedures.<br>Matter can be quantified in a way that macroscopic properties such as mass can reflect the number of particles present.<br>Elemental samples are a mixture of several isotopes with different masses. The atomic mass of an element is calculated given the mass and relative abundance of each isotope of the element as it exists in nature.<br>Because the mass of an atom is very small, the mole is used to translate between the atomic and macroscopic levels. A mole is used as a counting number, like a dozen. It is equal to the number of particles in exactly 12 grams of carbon- 12 atoms. The mass of one mole of a substance is equal to its formula mass in grams. The formula mass for a substance can be used in conjunction with Avogadro's number and the density of a substance to convert between mass, moles, volume and number of particles in a sample.<br><br>Stoichiometry<br>A stoichiometric calculation involves the conversion from the amount of one substance in a chemical reaction to the amount of another substance. The coefficients of the balanced equation indicate the ratios of the substances involved in the reaction in terms of both particles and moles. Once the number of moles of a substance is known, amounts can be changed to mass, volume of a gas, volume of solutions and/or number of particles. Molarity is a measure of the concentration of a solution that can be used in stoichiometric calculations. When performing a reaction in the lab, the experimental yield can be compared to the theoretical yield to calculate percent yield. The concept of limiting reagents is treated conceptually and not mathematically. Molality and Normality are concepts reserved for more advanced study. |
| Unit G- Mathematics of Chemical Reactions | |
| **Quarter 4** | |
| **Unit** | **Standards** |

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| Unit H-Behavior of Gases | Gas laws<br>The kinetic-molecular theory can be used to explain the macroscopic properties of gases (pressure, temperature and volume) through the motion and interactions of its particles. When one of the three properties is kept constant, the relationship between the other two properties can be quantified, described and explained using the kinetic-molecular theory.<br>Real-world phenomena (e.g., why tire pressure increases in hot weather, why a hot air balloon rises) can be explained using this theory. Problems also can be solved involving the changes in temperature, pressure and volume of a gas. When solving gas problems, the Kelvin temperature scale must be used since only in this scale is the temperature directly proportional to the average kinetic energy.<br>The Kelvin temperature is based on a scale that has its minimum temperature at absolute zero, a temperature at which all motion theoretically stops.<br>Since equal volumes of gases at the same temperature and pressure contain an equal number of particles (Avogadro's Law),<br>problems can be solved for an unchanging gaseous system using the ideal gas law ($PV = nRT$)<br>where R is the ideal gas constant (e.g., represented in multiple formats, 8.31 Joules / (mole K).<br>The specific names of the gas laws are not addressed in this course. Deviations from ideal gaseous behavior are reserved for more advanced study. Explore the relationships between the volume, temperature and pressure in the laboratory or through computer simulations or virtual experiments.<br><br>Acids and Bases<br>Properties of acids and bases and the ranges of the pH scale were introduced in middle school. In chemistry, the structural features of molecules are explored to further understand acids and bases. Acids often result when hydrogen is covalently bonded to an electronegative element and is easily dissociated from the rest of the molecule to bind with water to form a hydronium ion ($H3O+$). The acidity of an aqueous solution can be expressed as pH, where pH can be calculated from the concentration of the hydronium ion. Bases are likely to dissociate in water to form a hydroxide ion.<br>Acids can react with bases to form a salt and water. Such neutralization reactions can be studied quantitatively by performing titration experiments. Detailed instruction about the equilibrium of acids and bases and the concept of Brønsted-Lowry and Lewis acids and bases will be assessed at this level.<br><br>Equilibrium<br>All reactions are reversible to a degree and many reactions do not proceed completely toward products but appear to stop progressing before the reactants are all used up. At this point, the amounts of the reactants and the products appear to be constant and the reaction can be said to have reached dynamic equilibrium. In fact, the reaction has stopped because the rate of the reverse reaction is equal to the rate of the forward reaction so there is no apparent change in the reaction. If given a graph showing the concentration of the reactants and products over the time of reaction, the equilibrium concentrations and the time at which equilibrium was established can be determined. Some reactions appear to proceed only in one direction. In |

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| | these cases, the reverse reaction can occur but is highly unlikely (e.g., combustion reactions). Such reactions usually release a large amount of energy and require a large input of energy to go in the reverse direction. If a chemical system at equilibrium is disturbed by a change in the conditions of the system (e.g., increase or decrease in the temperature, pressure on gaseous equilibrium systems, concentration of a reactant or product), then the equilibrium system will respond by shifting to a new equilibrium state, reducing the effect of the change (Le Chatelier's Principle). If products are removed as they are formed during a reaction, then the equilibrium position of the system is forced to shift to favor the products. In this way, an otherwise unfavorable reaction can be made to occur. Mathematical treatment of equilibrium reactions is reserved for advanced study. Computer simulations can help visualize the progression of a reaction to dynamic equilibrium and the continuation of both the forward and reverse reactions after equilibrium has been attained.<br>The remainder of the course will include short (5-7 days) units covering acid/base/molarity, and equilibrium concepts. |

# Wickliffe City Schools

Physics & Honors Physics - Pacing Guide

| **Quarter 1** | |
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| **Unit** | **Standards** |
| Unit 1 – Introduction<br>○ Trigonometry<br>○ Vector & Scalar Math<br>○ Graphing<br>○ Significant Digits<br>○ Metric System<br>○ Terminology | Science Inquiry and Application During the years of grades 9 through 12, all students must use the following processes with appropriate laboratory safety techniques to construct their knowledge and understanding in a content areas:<br>• Identify questions and concepts that guide scientific investigations;<br>• Design and conduct scientific investigations;<br>• Use technology and mathematics to improve investigations and communications;<br>• Formulate and revise explanations and models using logic and evidence (critical thinking);<br>• Recognize and analyze explanations and models; and<br>• Communicate and support a scientific argument.<br>This course investigates the inquiry-based instruction<br>An introduction into general trigonometric functions and their application to vector addition and subtraction<br>Necessary instrument for understanding motion in physics. These principles are applied to vector mathemati<br>Proper graphing techniques, labeling, independent and dependent variable recognition are a necessary part<br>To the evaluation on data that is collected. Presentation of information/answers correctly, is covered in the u<br>Significant digits, terminology used in physics and the metric system. Mathematical principles found in basic<br>Such as variable substitution and the application of slope is essential to the understanding of the derivation o<br>Equations used in physics. |
| Unit 2 – Kinematics -Part 1<br>○ Position-Displacement<br>○ Speed- Velocity<br>○ Graphing Motion<br>○ Derivations of slope<br>○ Acceleration<br>○ Gravity<br>○ Circular Motion<br>○ Pendulum Equation<br>○ Projectile Motion | Instantaneous velocity for an accelerating object can be determined by calculating the slope of the tangent lin<br>some specific instant on a position vs. time graph. Instantaneous velocity will be the same as average velocity<br>conditions of constant velocity, but this is rarely the case for accelerating objects. The position vs. time graph<br>objects increasing in speed will become steeper as they progress and the position vs. time graph for objects<br>decreasing in speed will become less steep.<br>On a velocity vs. time graph, objects increasing in speed will slope away from the x-axis and objects decreasin<br>speed will slope toward the x-axis. The slope of a velocity vs. time graph indicates the acceleration so the grap<br>necessarily horizontal) when the acceleration is constant. Acceleration is positive for objects speeding up in a<br>or objects slowing down in a negative direction. Acceleration is negative for objects slowing down in a positiv<br>direction or speeding up in a negative direction. These are not concepts that should be memorized, but can be<br>developed from analyzing the definition of acceleration and the conditions under which acceleration would h<br>these signs. The word “deceleration” should not be used since it provides confusion between slowing down ar |

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| | negative acceleration. The area under the curve for a velocity vs. time graph gives the change in position (displacement) but the absolute position cannot be determined from a velocity vs. time graph.<br>Objects moving with uniform acceleration will have a horizontal line on an acceleration vs. time graph. This l be at the x-axis for objects that are either standing still or moving with constant velocity. The area under the c an acceleration vs. time graph gives the change in velocity for the object, but the displacement, position and t absolute velocity cannot be determined from an acceleration vs. time graph. The details about motion graphs not be taught as rules to memorize, but rather as generalizations that can be developed from interpreting the |

## Quarter 2

| Unit | Standards |
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| Unit 1 – Kinematics – Part 2 Newton's Laws<br>○ Inertia<br>○ Forces<br>○ Momentum & Impulse<br>○ Hooke's Law<br>○ Inverse Square Law<br>○ Unbalanced Forces<br>○ Center of gravity<br>○ Law of Universal Gravitation<br><br>Unit 2 – Work, Power & Energy<br>○ Defining Work, Power and Energy terminology<br>○ Math relationships between Work, Power and Energy<br>○ Kinetic and Potential energy | See above<br><br>In physical science, the role of strong nuclear forces in radioactive decay, half-lives, fission and fusion, and mathematical problem solving involving kinetic energy, gravitational potential energy, energy conservation and work (when the force and displacement were in the same direction) were introduced. In this course, the concept of gravitational potential energy is understood from the perspective of a field, elastic potential energy is introduced and quantified, nuclear processes are explored further, the concept of mass-energy equivalence is introduced, the concept of work is expanded, power is introduced, and the principle of conservation of energy is applied to increasingly complex situations. Energy must be explored by analyzing data gathered in scientific investigations. Computers and probes can be used to collect and analyze data.<br>When two attracting masses interact, the kinetic energies of both objects change but neither is acting as the energy source or the receiver. Instead, the energy is transferred into or out of the gravitational field around the system as gravitational potential energy. A single mass does not have gravitational potential energy. Only the system of attracting masses can have gravitational potential energy. When two masses are moved farther apart, energy is transferred into the field as gravitational potential energy. When two masses are moved closer together gravitational potential energy is transferred out of the field.<br><br>The approximation for the change in the potential elastic energy of an elastic object (e.g., a spring) is $\Delta E$ elastic = ½ k $\Delta x$ where $\Delta x$ is the distance the elastic object is stretched or compressed from its relaxed length.<br><br>Alpha, beta, gamma and positron emission each have different properties and result in different changes to the nucleus. The identity of new elements can be predicted for radioisotopes that undergo alpha or beta decay. During nuclear interactions, the transfer of energy out of a system is directly proportional to the change in mass of the system as expressed by E = mc2, which is known as the equation for mass-energy equivalence. A very small loss in mass is accompanied by a release of a large amount of energy. In nuclear processes such as nuclear decay, fission and fusion, the mass of the product is less than the mass of the original nuclei. The missing mass appears as energy. This energy can be calculated for fission and fusion |

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| used in defining motion<br>o Conservation of Energy<br>o Simple Machines<br><br>Unit 3 – Thermodynamic<br>o Kinetic Molecular Theory<br>o Temperature<br>o Thermal Linear expansion<br>o Heat Exchange<br>o Changes of State | when given the masses of the particle(s) formed and the masses of the particle(s) that interacted to produce them.<br>Work can be calculated for situations in which the force and the displacement are at angles to one another using the equation $W = F\Delta x(\cos\theta)$ where W is the work, F is the force, $\Delta x$ is the isplacement, and $\theta$ is the angle between the force and the displacement. This means when the force and the displacement are at right angles, no work is done and no energy is transferred between the objects. Such is the case for circular motion.<br>In earlier grades, the electromagnetic spectrum and basic properties (wavelength, frequency, amplitude) and behaviors of waves (absorption, reflection, transmission, refraction, interference, diffraction) were introduced. In this course, conservation of energy is applied to waves and the measurable properties of waves (wavelength, frequency, amplitude) are used to mathematically describe the behavior of waves (index of refraction, law of reflection, single- and double-slit diffraction). The wavelet model of wave propagation and interactions is not addressed in this course. Waves must be explored experimentally in the laboratory. This may include, but is not limited to, water waves, waves in springs, the interaction of light with mirrors, lenses, barriers with one or two slits, and diffraction gratings.<br><br>When a wave reaches a barrier or a new medium, a portion of its energy is reflected at the boundary and a portion of the energy passes into the new medium. Some of the energy that passes to the new medium may be absorbed by the medium and transformed to other forms of energy, usually thermal energy, and some continues as a wave in the new medium. Some of the energy also may be dissipated, no longer part of the wave since it has been transformed into thermal energy or transferred out of the system due to the interaction of the system with surrounding objects. Usually all of these processes occur simultaneously, but the total amount of energy must remain constant.<br><br>When waves bounce off barriers (reflection), the angle at which a wave approaches the barrier (angle of incidence) equals the angle at which the wave reflects off the barrier (angle of reflection). When a wave travels from a two-dimensional (e.g., surface water, seismic waves) or three- dimensional (e.g., sound, electromagnetic waves) medium into another medium in which the wave travels at a different speed, both the speed and the wavelength of the transferred wave change. Depending on the angle between the wave and the boundary, the direction of the wave also can change resulting in refraction. The amount of bending of waves around barriers or small openings (diffraction) increases with decreasing wavelength. When the wavelength is smaller than the obstacle or opening, no noticeable diffraction occurs. Standing waves and interference patterns between two sources are included in this topic. As waves pass through a single or double slit, diffraction patterns are created with alternating lines of constructive and destructive interference. The diffraction patterns demonstrate predictable changes as the width of the slit(s), spacing between the slits and/or the wavelength of waves passing through the slits changes. |
| **Quarter 3** | |

| Unit | Standards |
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| Unit 1 – Fluid Dynamics<br>○ Bouyancy<br>○ Pascal's Principle<br>○ Principles of Bernoulli<br>○ Archimedes Principle<br>○ Pressure and Density<br><br>Unit 2 – Wave Properties<br>○ Mechanical Wave Transmission<br>○ Wave Structure<br>○ Longitudinal and Transverse Waves<br>○ Wave interference<br>○ Resonance and Standing Waves<br>○ Mechanical, Water and Energy Waves<br>○ Sound Waves<br>○ Harmonics<br>○ Superpositioning<br>○ Doppler Effect<br><br>Unit 3 – Properties of Light and Reflection<br>○ Speed of light<br>○ Michelson and Morely<br>○ Laws of Reflection<br>○ Plane Mirror- | The amount of kinetic friction between two objects depends on the electric forces between the atoms of the two surfaces sliding past each other. It also depends upon the magnitude of the normal force that pushes the two surfaces together. This can be represented mathematically as Fk = μkFN, where μkis the coefficient of kinetic friction that depends upon the materials of which the two surfaces are made. Sometimes friction forces can prevent objects from sliding past each other, even when an external force is applied parallel to the two surfaces that are in contact. This is called static friction, which is mathematically represented by Fs ≤ μsFN. The maximum amount of static friction possible depends on the types of materials that make up the two surfaces and the magnitude of the normal force pushing the objects together, Fsmax = μsFN. As long as the external net force is less than or equal to the maximum force of static friction, the objects will not move relative to one another. In this case, the actual static friction force acting on the object will be equal to the net external force acting on the object, but in the opposite direction. If the external net force exceeds the maximum static friction force for the object, the objects will move relative to each other and the friction between them will no longer be static friction, but will be kinetic friction.<br><br>Liquids have more drag than gases like air. When an object pushes on the particles in a fluid, the fluid particles can push back on the object according to Newton's third law and cause a change in motion of the object. This is how helicopters experience lift and how swimmers propel themselves forward. Forces from fluids will only be quantified using Newton's second law and force diagrams.<br><br>In earlier grades, the electromagnetic spectrum and basic properties (wavelength, frequency, amplitude) and behaviors of waves (absorption, reflection, transmission, refraction, interference, diffraction) were introduced. In this course, conservation of energy is applied to waves and the measurable properties of waves (wavelength, frequency, amplitude) are used to mathematically describe the behavior of waves (index of refraction, law of reflection, single- and double-slit diffraction). The wavelet model of wave propagation and interactions is not addressed in this course. Waves must be explored experimentally in the laboratory. This may include, but is not limited to, water waves, waves in springs, the interaction of light with mirrors, lenses, barriers with one or two slits, and diffraction gratings.<br><br>When a wave reaches a barrier or a new medium, a portion of its energy is reflected at the boundary and a portion of the energy passes into the new medium. Some of the energy that passes to the new medium may be absorbed by the medium and transformed to other forms of energy, usually thermal energy, and some continues as a wave in the new medium. Some of the energy also may be dissipated, no longer part of the wave since it has been transformed into thermal energy or transferred out of the system due to the interaction of the system with surrounding objects. Usually all of these processes occur simultaneously, but the total amount of energy must remain constant. |

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| Lateral Inversion<br>○ Magnification Equation<br>○ Curved Mirror equation<br>○ Converging, diverging, and parabolic Mirrors<br>○ Ray diagrams<br>○ Spherical Aberration | |
| Unit 3 – Properties of Light Refraction and Lens<br>• 2 weeks<br>• Topics covered:<br>○ Index of Refraction<br>○ Laws of Refraction<br>○ Snell's Law<br>○ Internal reflection and critical angle<br>○ Refraction in Lenses | When waves bounce off barriers (reflection), the angle at which a wave approaches the barrier (angle of incidence) equals the angle at which the wave reflects off the barrier (angle of reflection). When a wave travels from a two-dimensional (e.g., surface water, seismic waves) or three- dimensional (e.g., sound, electromagnetic waves) medium into another medium in which the wave travels at a different speed, both the speed and the wavelength of the transferred wave change. Depending on the angle between the wave and the boundary, the direction of the wave also can change resulting in refraction. The amount of bending of waves around barriers or small openings (diffraction) increases with decreasing wavelength. When the wavelength is smaller than the obstacle or opening, no noticeable diffraction occurs. Standing waves and interference patterns between two sources are included in this topic. As waves pass through a single or double slit, diffraction patterns are created with alternating lines of constructive and destructive interference. The diffraction patterns demonstrate predictable changes as the width of the slit(s), spacing between the slits and/or the wavelength of waves passing through the slits changes. |
| **Quarter 4** | |
| **Unit** | **Standards** |

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| Unit 1-Electrostatics<br>○ Law of electric charge<br>○ Electrical structure of matter<br>○ Transfer of charge<br>○ Van de Graff Generator<br>○ Static Charge and induction<br><br>Unit 2-Electric Current<br>○ Electron Flow<br>○ Electrical Potential, ampere, volt, ohms<br><br>Unit 3-Electric Circuits<br>○ Kirchhoff's Laws<br>○ Series/Parallel Circuits<br>○ Schematics of circuits<br>○ Electrical Resistance<br>○ Ohm's Law<br><br>Unit 4-Magnetism<br>○ Law of Magnetic Poles<br>○ Magnetic declination and inclination<br>○ Domain Theory<br>Unit 5-Electromagnetism<br>• 3 weeks<br>• Topics covered:<br>○ Oersted's Principle | In earlier grades, the following concepts were addressed: conceptual treatment of electric and magnetic potential energy; the relative number of subatomic particles present in charged and neutral objects; attraction and repulsion between electrical charges and magnetic poles; the concept of fields to conceptually explain forces at a distance; the concepts of current, potential difference (voltage) and resistance to explain circuits conceptually; and connections between electricity and magnetism as observed in electromagnets, motors and generators. In this course, the details of electrical and magnetic forces and energy are further explored and can be used as further examples of energy and forces affecting motion.<br><br>For all methods of charging neutral objects, one object/system ends up with a surplus of positive charge and the other object/system ends up with the same amount of surplus of negative charge. This supports the law of conservation of charge that states that charges cannot be created or destroyed. Tracing the movement of electrons for each step in different ways of charging objects (rubbing together two neutral materials to charge by friction; charging by contact and by induction) can explain the differences between them. When an electrical conductor is charged, the charge "spreads out" over the surface. When an electrical insulator is charged, the excess or deficit of electrons on the surface is localized to a small area of the insulator.<br><br>There can be electrical interactions between charged and neutral objects. Metal conductors have a lattice of fixed positively charged metal ions surrounded by a "sea" of negatively charged electrons that flow freely within the lattice. If the neutral object is a metal conductor, the free electrons in the metal are attracted toward or repelled away from the charged object. As a result, one side of the conductor has an excess of electrons and the opposite side has an electron deficit. This separation of charges on the neutral conductor can result in a net attractive force between the neutral conductor and the charged object. When a charged object is near a neutral insulator, the electron cloud of each insulator atom shifts position slightly so it is no longer centered on the nucleus. The separation of charge is very small, much less than the diameter of the atom. Still, this small separation of charges for billions of neutral insulator particles can result in a net attractive force between the neutral insulator and the charged object.<br><br>Two charged objects, which are small compared to the distance between them, can be modeled as point charges. The forces between point charges are proportional to the product of the charges and inversely proportional to the square of the distance between the point charges [Fe = ke q1 q2) / r2]. Problems may be solved for the electric force, the amount of charge on one of the two objects or the distance between the two objects. Problems also may be solved for three- or four-point charges in a line if the vector sum of the forces is zero. This can be explored experimentally through computer simulations. Electric forces acting within and between atoms are vastly stronger than the gravitational forces acting between the atoms. However, gravitational forces are only attractive and can accumulate in massive objects to produce a large and noticeable effect whereas electric forces are both attractive and repulsive and tend to cancel each other out. The strength of the electrical field of a charged object at a certain location is given by the electric force per |

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| <ul><li>Left and right hand rule</li><li>Magnetic Field coil induction</li><li>Applications of Electromagnetic Induction</li><li>Design of a generator/motor</li><li>Lenz's Law</li><li>AC vs DC current generation</li><li>Step up and Step down Transformer design</li></ul> | unit charge experienced by another charged object placed at that location, E = Fe / q. This equation can be used to calculate the electric field strength, the electric force or the electric charge. However, the electric field is always there, even if the object is not interacting with anything else. The direction of the electric field at a certain location is parallel to the direction of the electrical force on a positively charged object at that location. The electric field caused by a collection of charges is equal to the vector sum of the electric fields caused by the individual charges (superposition of charge). This topic can be explored experimentally through computer simulations.<br><br>Greater electric field strengths result in larger electric forces on electrically charged objects placed in the field. Electric fields can be represented by field diagrams obtained by plotting field arrows at a series of locations. Electric field diagrams for a dipole, two-point charges (both positive, both negative, one positive and one negative) and parallel capacitor plates are included. Field line diagrams are excluded from this course.<br><br>The concept of electric potential energy can be understood from the perspective of an electric field. When two attracting or repelling charges interact, the kinetic energies of both objects change but neither is acting as the energy source or the receiver. Instead, the energy is transferred into or out of the electric field around the system as electric potential energy. A single charge does not have electric potential energy. Only the system of attracting or repelling charges can have electric potential energy. When the distance between the attracting or repelling charges changes, there is a change in the electric potential energy of the system. When two opposite charges are moved farther apart or two like charges are moved close together, energy is transferred into the field as electric potential energy. When two opposite charges are moved closer together or two like charges are moved far apart, electric potential energy is transferred out of the field. When a charge is transferred from one object to another, work is required to separate the positive and negative charges. If there is no change in kinetic energy and no energy is transferred out of the system, the work increases the electric potential energy of the system.<br><br>Once a circuit is switched on, the current and potential difference are experienced almost instantaneously in all parts of the circuit even though the electrons are only moving at speeds of a few centimeters per hour in a current-carrying wire. It is the electric field that travels instantaneously through all parts of the circuit, moving the electrons that are already present in the wire. Since electrical charge is conserved, in a closed system such as a circuit, the current flowing into a branch point junction must equal the total current flowing out of the junction (junction rule). |

# Wickliffe City Schools

Earth and Environmental Science-Pacing Guide

| Quarter 1 | |
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| **Unit** | **Standards** |
| 1Science and inquiry<br>Identify questions and conce scientific investigations;<br><br>2 Biosphere<br>2a. Ecosystems and adaptations in populations<br><br>2b. Biodiversity<br>6 Movement of matter and energy through the hydrosphere, lithosphere, atmosphere, and biosphere<br>6a. Energy transformations on global, regional, and local scales<br><br>6b Biogeochemical cycles<br><br>6c Ecosystems<br>6d Climate and weather-biomes | This topic builds upon both the physical science and biology courses as they relate to energy transfer and transformation, conservation of energy and matter, evolution, adaptation, biodiversity, population studies, and ecosystem composition and dynamics. In grades 6-8, geologic processes, biogeochemical cycles, climate, the composition and properties of the atmosphere, lithosphere and hydrosphere (including the hydrologic cycle) are studied.<br><br>The focus for this topic is on the connections and interactions between Earth's spheres (the hydrosphere, atmosphere, biosphere and lithosphere). Both natural and human-made interactions must be studied. This includes an understanding of causes and effects of climate, global climate (including el Niño/la Niña patterns and trends) and changes in climate through Earth's history, geologic events (e.g., a volcanic eruption or mass wasting) that impact Earth's spheres, biogeochemical cycles and patterns, the effect of abiotic and biotic factors within an ecosystem, and the understanding that each of Earth's spheres is part of the dynamic Earth system. Ground water and surface water velocities and patterns are included as the movement of water (either at the surface, in the atmosphere or beneath the surface) can be a mode of transmission of contamination. This builds upon previous hydrologic cycle studies in earlier grades. Geomorphology and topography are helpful in determining flow patterns and pathways for contamination.<br>The connections and interactions of energy and matter between Earth's spheres must be researched and investigated using actual data. The emphasis is on the interconnectedness of Earth's spheres and the understanding of the complex relationships between each, including both abiotic and biotic factors.<br>One event, such as a petroleum release or a flood, can impact each sphere. Some impacts are long- term, others are short-term and most are a combination of both long- and short-term. It is important to use real, quantifiable data to study the interactions, patterns and cycles between Earth's spheres. |
| **Quarter 2** | |
| **Unit** | **Standards** |

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| 2c. Population dynamics<br>2d. Evolution and adaptation in populations; endangered species<br><br>3 Atmosphere<br>3a. Atomospheric Properties and currents<br><br>5 Hydrosphere<br>5a Oceanic currents and patterns (as they relate to climate)<br>5b Surface and ground water flow patterns and movement (contaminants and water quality testing)<br><br>5c Cryosphere<br><br>4 Lithosphere<br>4a. Geologic events and processes (soil analysis for Nutrition and agriculture); Land use management; Waste management | This topic explores the availability of Earth's resources, extraction of the resources, contamination problems, remediation techniques and the storage/disposal of the resources or by-products.<br>Conservation, protection and sustainability of Earth's resources also are included. This builds upon grades 6-8 within the Earth and Space Science strand (sections pertaining to energy and Earth's resources) and the biology and physical science (in particular chemistry and energy topics) courses at the high school level.<br><br>To understand the effects that certain contaminants may have on the environment, scientific investigations and research must be conducted on a local, national and global level. Water, air, land, and biotic field and lab sampling/testing equipment and methods must be utilized with real-world application. Quantifiable field and/or lab data must be used to analyze and draw conclusions regarding air, water or land quality. Examples of types of water-quality testing include: hydraulic conductivity, suspended and dissolved solids, dissolved oxygen, biochemical oxygen demand, temperature, pH, fecal coliform and macro-invertebrate studies. Wetland or woodland delineations and analysis, land use analysis and air monitoring (e.g., particulate matter sizes/amount) are all appropriate field study investigations. Comparative analysis of scientific field or lab data should be used to quantify the environmental quality or conditions. Local data also can be compared to national and international data. |

# Wickliffe City Schools

Forensic Science - Pacing Guide

| **Quarter 1** | |
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| **Unit** | **Standards** |
| Unit 1 – Introduction | ○ Eyewitness reliability<br>○ Intro to Forensics<br>○ Ballistics<br>○ Gunshot wounds<br>○ Impressions |
| Unit 2 – Blood Spatter | ○ Blood basics<br>○ Blood spatter<br>○ Velocity, Height<br>○ Stringing<br>○ Blood detection |
| Unit 3 – Crime Scene Prints | ○ Lip prints<br>○ Types of prints<br>○ Fingerprinting<br>○ Fingerprint characteristics<br>○ Matching fingerprints |
| Unit 4 – Trace Evidence | ○ Trace/physical evidence<br>○ Hair biology/evidence<br>○ Fiber evidence<br>○ Soil evidence<br>○ Pollen and Spores evidence |
| Unit 5 – Determining Death | ○ Death<br>○ Rigor mortis<br>○ Livor mortis<br>○ Algor mortis<br>○ Calculating time of death<br>○ Forensic entomology<br>○ Autopsy |

| Quarter 2 | |
|---|---|
| **Unit** | **Standards** |
| Unit 6 – Skeletal Remains | ○ Major bones<br>○ Sex determination<br>○ Race determination<br>○ Height determination<br>○ Age determination<br>○ Tooth structure<br>○ Bite mark analysis |
| Unit 7 – Forensic Toxicology | ○ History of toxicology<br>○ Drugs/Poisons<br>○ Dependence<br>○ Types of drugs<br>○ Drug testing<br>○ Presentations - Poisons |
| Unit 8 – Serology | ○ Body fluids<br>○ DNA<br>○ DNA testing |
| Unit 9 – Famous Forensic Cases | ○ Student presentations |

| **Quarter 1** | |
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| **Unit** | **Standards** |
| Beginning of the semester Procedures and Activities (2 days) | Introduce Astronomy students to the procedures and standards of a high school astronomy course.<br><br>Astronomy is a semester-long high school level course, which satisfies the Ohio Core science graduation requirements of Ohio Revised Code Section 3313.603. This section of Ohio law requires a three unit course with inquiry-based laboratory experience that engages students in asking valid scientific questions and gathering and analyzing information.<br><br>Astronomy incorporates previously learned chemistry, physics, and geology concepts and introduces students to key concepts, principles, and theories within astronomy. |
| Unit 1- Earth/Moon/Sun (3.5 weeks) | Thousands of years ago, people spent hours gazing at the night sky. They found that by connecting the stars as if they were dots, patterns emerged that resembled animals, people and things. Today, we call star patterns constellations. Eventually, 88 star patterns were identified. The patterns helped people navigate on land and by sea as well as tell time, appearing in different parts of the sky depending on the day and year. The significance of the zodiac stems from the fact that the ecliptic -- the narrow path on the sky that the Sun, Moon, and planets appear to follow -- runs directly through these star groupings. Since ancient times, the Sun, Moon, and planets have been known as special astronomical objects -- they "wander" through the background stars of the zodiac, which remain fixed with respect to each other.<br>The Earth rotates once on its axis about every 24 hours. If you were to look at Earth from the North Pole, it would be spinning counterclockwise. As the Earth rotates, observers on Earth see the Sun moving across the sky from east to west with the beginning of each new day. We often say that the Sun is "rising" or "setting", but actually it is the Earth's rotation that gives us the perception of the Sun rising up or setting over the horizon. When we look at the Moon or the stars at night, they also seem to rise in the east and set in the west. Earth's rotation is also responsible for this. As Earth turns, the Moon and stars change position in our sky.<br>Another effect of Earth's rotation is that we have a cycle of daylight and darkness approximately every 24 hours. This is called a day. As Earth rotates, the side of Earth facing the Sun experiences daylight, and the opposite side (facing away from the Sun) experiences darkness or nighttime. Since the Earth completes one rotation in about 24 hours, this is the time it takes to complete one day-night cycle. As the Earth rotates, different places on Earth experience sunset and sunrise at a different time. As you move towards the poles, summer and winter days have different amounts of daylight hours in a day. For example, in the Northern hemisphere, we begin summer on June 21. At this point, the Earth's North Pole is pointed directly toward |

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| | the Sun. Therefore, areas north of the equator experience longer days and shorter nights because the northern half of the Earth is pointed toward the Sun. Since the southern half of the Earth is pointed away from the Sun at that point, they have the opposite effect—longer nights and shorter days.<br>For people in the Northern hemisphere, winter begins on December 21. At this point, it is Earth's South Pole that is tilted toward the Sun, and so there are shorter days and longer nights for those who are north of the equator.<br>The Moon does not produce any light of its own—it only reflects light from the Sun. As the Moon moves around the Earth, we see different parts of the near side of the Moon illuminated by the Sun. This causes the changes in the shape of the Moon that we notice on a regular basis, called the phases of the Moon. As the Moon revolves around Earth, the illuminated portion of the near side of the Moon will change from fully lit to completely dark and back again.<br>A solar eclipse occurs when the new moon passes directly between the Earth and the Sun. This casts a shadow on the Earth and blocks our view of the Sun. A lunar eclipse occurs when the full moon moves through the shadow of the Earth. This can only happen when the Earth is between the Moon and the Sun and all three are lined up in the same plane, called the ecliptic. |
| Unit 2- Gravitation and the Motion of Planets<br>(2 weeks) | The orbits of the planets are ellipses with the Sun at one focus, though all except Mercury are very nearly circular. The orbits of the planets are all more or less in the same plane (called the ecliptic and defined by the plane of the Earth's orbit). The ecliptic is inclined only 7 degrees from the plane of the Sun's equator. They all orbit in the same direction (counter-clockwise looking down from above the Sun's north pole); all but Venus, Uranus and Pluto also rotate in that same sense. Many of the Planets also have moons, or natural satellites, that orbit around them. |
| Unit 3- Formation of the Solar System<br>(3.5 weeks) | The solar system consists of the Sun, the eight official planets, at least three "dwarf planets", more than 130 satellites of the planets, a large number of small bodies (the comets and asteroids), and the interplanetary medium. One way to help visualize the relative sizes in the solar system is to imagine a model in which everything is reduced in size by a factor of a billion. Then the model Earth would be about 1.3 cm in diameter (the size of a grape). The Moon would be about 30 cm (about a foot) from the Earth. The Sun would be 1.5 meters in diameter (about the height of a man) and 150 meters (about a city block) from the Earth. Jupiter would be 15 cm in diameter (the size of a large grapefruit) and 5 blocks away from the Sun. Saturn (the size of an orange) would be 10 blocks away; Uranus and Neptune (lemons) 20 and 30 blocks away. A human on this scale would be the size of an atom but the nearest star would be over 40000 km away. The inner solar system contains the Sun, Mercury, Venus, Earth and Mars, the main asteroid belt lies between the orbits of Mars and Jupiter, and the planets of the outer solar system are Jupiter, Saturn, Uranus, and Neptune (Pluto is now classified as a dwarf planet). Other bodies in the solar system include the large number of asteroids (small rocky bodies) orbiting the Sun, mostly between Mars and Jupiter but also elsewhere; the comets (small icy bodies) which come and go from the inner parts of the solar system in |

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| | highly elongated orbits and at random orientations to the ecliptic; and the many small icy bodies beyond Neptune in the Kuiper Belt. |
| **Quarter 2** | |
| **Unit** | **Standards** |
| Unit 4- The Sun (2 weeks) | The sun is a star, a hot ball of glowing gases at the heart of our solar system. The Sun's power (about 386 billion http://nineplanets.org/help.html - billion megaWatts) is produced by nuclear fusion reactions. Each second about 700,000,000 tons of hydrogen are converted to about 695,000,000 tons of helium and 5,000,000 tons (=3.86e33 ergs) of energy in the form of gamma rays. As it travels out toward the surface, the energy is continuously absorbed and re-emitted at lower and lower temperatures so that by the time it reaches the surface, it is primarily visible light. For the last 20% of the way to the surface the energy is carried more by convection than by radiation. The Sun formed about 4.6 billion years ago from the gravitational collapse of a region within a large molecular cloud. Most of the matter gathered in the center, while the rest flattened into an orbiting disk that would become the Solar System. The central mass became increasingly hot and dense, eventually initiating thermonuclear fusion in its core. |
| Unit 5- Stars (3 weeks) | Early in the formation of the universe, stars coalesced out of clouds of hydrogen and helium and clumped together by gravitational attraction into galaxies. When heated to a sufficiently high temperature by gravitational attraction, stars begin nuclear reactions, which convert matter to energy and fuse the lighter elements into heavier ones. These and other fusion processes in stars have led to the formation of all the other elements. (NAEP 2009). All of the elements, except for hydrogen and helium, originated from the nuclear fusion reactions of stars (College Board Standards for College Success, 2009). Stars are classified by their color, size, luminosity and mass. A Hertzprung-Russell diagram must be used to estimate the sizes of stars and predict how stars will evolve. Most stars fall on the main sequence of the H-R diagram, a diagonal band running from the bright hot stars on the upper left to the dim cool stars on the lower right.<br>A star's mass determines the star's place on the main sequence and how long it will stay there. Patterns of stellar evolution are based on the mass of the star. Stars begin to collapse as the core energy dissipates. Nuclear reactions outside the core cause expansion of the star, eventually leading to the collapse of the star. |
| Unit 6- Galaxies and the Big Bang Theory (2 weeks) | A galaxy is a group of billions of individual stars, star systems, star clusters, dust and gas bound together by gravity. There are billions of galaxies in the universe, and they are classified by size and shape. The Milky Way is a spiral galaxy. It has more than 100 billion stars and a diameter of more than 100,000 light years. At the center of the Milky Way is a bulge of stars, from which are spiral arms of gas, dust and most of the young stars. The solar system is part of the Milky Way galaxy. Hubble's law states that galaxies that are farther away have a greater red shift, so the speed at which a galaxy is moving away is proportional to its distance from the Earth. Red shift is a phenomenon due to Doppler shifting, so the shift of light from a galaxy to the red end of the spectrum indicates that the galaxy and the observer are moving farther away from one another. |

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| | According to the "big bang" theory, the contents of the known universe expanded explosively into existence from a hot, dense state 13.7 billion years ago (NAEP 2009). After the big bang, the universe expanded quickly (and continues to expand) and then cooled down enough for atoms to form. Gravity pulled the atoms together into gas clouds that eventually became stars, which comprise young galaxies. Foundations for the big bang model can be included to introduce the supporting evidence for the expansion of the known universe (e.g., Hubble's law and red shift or cosmic microwave background radiation). A discussion of Hubble's law and red shift is found in the *Galaxy formation* section, below. |
| Unit 7- Space Exploration and Technology (2 weeks) | Technology provides the basis for many new discoveries related to space and the universe. Visual, radio and x-ray telescopes collect information from across the entire electromagnetic spectrum; computers are used to manage data and complicated computations; space probes send back data and materials from remote parts of the solar system; and accelerators provide subatomic particle energies that simulate conditions in the stars and in the early history of the universe before stars formed. |

# Wickliffe City Schools
## Intro to the Human Body - Pacing Guide

| **Quarter 1** | |
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| **Unit** | **Standards** |
| UNIT 1 – Intro and Organization of the Body | • Anatomy & Physiology<br>• Characteristics of Life<br>• Homeostasis<br>• Levels of Organization<br>• Tissues & Organs<br>• Organ Systems<br>• Language of Anatomy<br>• Medical Imaging Techniques<br>• |
| UNIT 2 – Body Systems that Cover, Support, & Move | • Integumentary System<br>• Skeletal System<br>• Muscular System |
| UNIT 3 – Body Systems that Control & Communicate | • Nervous System<br>• Special Senses<br>• Endocrine System |
| **Quarter 2** | |
| **Unit** | **Standards** |
| UNIT 4 – Body Systems that Transport & Protect | • Circulatory/Cardiovascular System<br>• Lymphatic/Immune System |
| UNIT 5 – Body Systems that Provide Energy & Rid Waste | • Respiratory System<br>• Digestive System<br>• Excretory/Urinary System |
| UNIT 6 – Body System that Produces Offspring | • Reproductive System |

# AP Biology

## Course Overview and Philosophy

I see biology and the processes of science, as well as their importance, in every aspect of life; in everything I do. My main goal for my AP Biology students is to embed this same outlook in them. I work to help them gain an understanding of the overall impact of biology, and all the sciences, in the world and in their lives. My students learn to think critically and apply scientific principles and practices in their lives on a daily basis. I am very passionate about biology's big ideas, their interactions and their application to the environment, society and to individuals. I aim to instill this in my students. This is achieved through a variety of teaching strategies.

- **Labs** - We meet approximately 70 minutes per day and normally two or three of those days participating in some sort of hands-on, inquiry laboratory activity (The amount of time spent depends on the content being covered at the time, but averages about 30% of our time). These can include variations of the AP labs, other relevant inquiry-based labs, computer simulations, or the use of models or manipulatives. Labs are chosen based on the use of the seven science practices. These labs are used to integrate topics and provide information for further study in other chapters. All students keep Student Laboratory Books, which consist of three-ring binders with all lab handouts, notes, observations, hypotheses, experimental designs, data tables and graphs, and any other materials relating to lab work. Formal Lab Reports will also be placed in the Lab Books. Each student's book serves as a record of their lab experiences and knowledge gained, including that of the Seven Science Practices.

- **Discussion** – Students are required to pre-read each chapter, take notes, and come to class with questions so we can make the most of our in-class time. After we review the content, we are then able to discuss the concepts and topics with real meaning and application, allowing students to make connections between topics and ideas and gain true understanding.

- **Activities/Cooperative learning** – We also use exercises that are not technically considered labs or discussions. These types of activities are done in pairs or small groups and are used to integrate knowledge and demonstrate relationships to societal issues. These may include lab simulations (online or on paper), lab analyses, problem-solving work, online activities and a variety of others as shown below, in the course outline.

- **Audio-Visual** – I feel that audio-visual support for content is invaluable for student learning, understanding, and achievement. I am lucky enough to have a ceiling-mounted projector. This allows me to show students a variety of different materials for each chapter. I most often use our book (Campbell) online, which has not only text diagrams, but also interactive activities and animations that are extremely helpful to students. I also use other websites, such as DNAi and biologyanimations, which I keep on line at Ikeepbookmarks.com. Students have full access to both of these for use outside of class. In addition, I have a variety of educational videos and use United Streaming for video clips.

- **Assessment** – I use assessment formatively, as a teaching tool, as well as summatively, for evaluating. We often take short pre-lab quizzes to check for understanding of the lab procedures and meaning. These help both the students and me know where further explanation is necessary. Other assessments include written tests (including multiple choice and essay questions, simulating the AP test), lab reports, presentations, and/or projects.

I am a "big picture" biologist and teach as such. I know that students need to be able to make connections to prior knowledge in order to incorporate new material; this is accomplished by the "big picture" approach. This is where the four Big Ideas, listed below, of biology fit in. We start the year with a discussion of these ideas, their interconnectedness, and their pervasiveness. I find myself referring to each of these ideas in every chapter as they thread through the entire course and as we cover the Enduring Understanding and Essential Knowledges that underlie them. The entire course is structured around the Enduring Understandings within the Big Ideas as described in the AP Biology Curriculum Framework, however I am aware that I cannot teach my students everything and that there will continue to be major advances in science. By engaging my students in the Seven Science Practices, as listed below, throughout the year, I am preparing them to deal with new information and their own problem solving in an effective manner– giving them the tools to be able to do this successfully throughout their lives.

### The Big Ideas:

**1**. The process of evolution drives the diversity and unity of life.
**2**. Biological systems utilize free energy and molecular building blocks to grow, to reproduce and to maintain dynamic homeostasis.
**3**. Living systems store, retrieve, transmit and respond to information essential to life processes.
**4**. Biological systems interact and these systems and their interactions possess complex properties.

### The Seven Science Practices:

**1.** The student can use representations and models to communicate scientific phenomena and solve scientific problems.
**2.** The student can use mathematics appropriately.
**3**. The student can engage in scientific questioning to extend thinking or to guide investigations within the context of the AP course.
**4**. The student can plan and implement data collection strategies appropriate to a particular scientific question.
**5.** The student can perform data analysis and evaluation of evidence.
**6.** The student can work with scientific explanations and theories.
**7.** The student is able to connect and relate knowledge across various scales, concepts and representations in and across domains.

## Textbooks/Instructional Materials

- The AP Edition of *Biology* by Neil A. Campbell and Jane B. Reece. Seventh Edition. Published by Pearson in 2005. Also, the online version.
- *AP Biology Investigative Labs: An Inquiry-Based Approach*. Published by the College Board. 2012.
- *Multiple-Choice & Free-Response Questions in Preparation for the AP Biology Examination* by Hartmann and Pfannerstill. Sixth Edition. Published by D&S Marketing Systems, Inc. 2012.
- Vernier probeware
- Annenberg World of Chemistry and many other websites

## Summer Work

Students are assigned a review of Chemistry during the summer. Their assignment has two parts. The first is to read and summarize Campbell Chapter 2 – The Chemistry of Life. The Chemistry of Life is vital to the understanding of Biology, yet should be background knowledge from previous classes. I have found my students to be lacking this is in the past, and so have added this as summer work. The content is discussed and tested during the second week of school (see below) to ensure proper coverage of this vital topic.

## Course Outline

**General Information** The course is broken down into Units, which contain Chapters. Each chapter includes reading, notes, and discussion of the major concepts and topics, which allows us to conduct further investigation as listed below. All of this information is included in the table below. I have tried in the past to organize units and chapters by big idea (before the actual AP designated Big Ideas ☺), but have determined that these are ideas are inherently too intertwined to be separated from one another – all units incorporate all the big ideas to some degree. This is shown in the table below as each Big Idea, with the specific Enduring Understanding and Essential Knowledge, addressed in a chapter or unit is listed in that row.

| UNIT | TITLE/COVERED CONCEPTS/ACTIVITIES/LABS | CHAPTER | BIG IDEAS with EU and EK |
|---|---|---|---|
| | Introduction - Major themes of biology with emphasis on Science as a process and Evolution as an over-arching theme to all of biology, interdependence in nature, and the impact of science on technology and society | Intro | |
| **1** | **Chemistry of Life** | **2-5** | |
| | Biochemistry (recap of summer work)- atomic structure, bonding, molecules | 2 | |

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| | • Lab – Salt and Sand Separation<br>• Lab – Ball and Stick Models | | |
| | Water – properties, pH, buffers<br>• Lab – Drops on a Penny Inquiry – testing variables, critical thinking, science process<br>• Activity – Make Water - make a model of a water molecule showing all parts, write essay<br>• Lab – Properties of Water Mini-Labs researched and prepared by student groups<br>• Lab – pH and buffers | 3 | 2.A.3 |
| | Organic Chemistry – carbon, functional groups, isomers, role in organisms<br>• Lab – Functional Group Models and questions<br>• Lab – Modeling Isomers | 4 | 1.D.1, 2.A.3 |
| | Macromolecules – polymers, 4 classes, structure and function in living things<br>• Lab – Identification of an Unknown by Chemical Testing<br>• Lab – Building Models of 4 Classes of Molecules<br>• Activity – Protein Structure Simulation<br>• Lab – Food Testing<br>• Video – *SuperSize Me*<br>• Activity – Video follow-up - Discussion of the medical/societal issues related to macromolecules and nutrition | 5 | 4.A.1, 4.C.1, 4.B.1, 3.A.1 |
| **2** | **The Cell** | **6-12** | |
| | Cell Tour – cell types, microscopes, subcellular organization, organelle structure, function and interaction, regulation<br>• Lab – Using Microscopes<br>• Lab – Cell Types – using microscopes<br>• Lab – Cell Size – diffusion and surface area to volume ratio using agar cubes<br>• Activity – Cell Sale – research and build a specific type of cell and "sell" it to the class<br>• Activity – Word Organizer to explain the endomembrane system | 6 | 2.A.3, 2.B.3, 4.A.2, 4.B.2 |
| | Membrane Structure and Function – bilayer, osmosis, | 7 | 2.B.1, 2.B.2 |

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| | diffusion, transport<br>• Demo – U tube<br>• Activity – Interactive foam models of membrane proteins<br>• Lab #4 – Diffusion and Osmosis | | |
| | Metabolism and Cell Energetics – energy transformation, free energy, ATP, enzymes, energy coupling, regulation by feedback<br>• Demo – Elephant Toothpaste<br>• Activity – ATP model/cycle<br>• Activity – Graphing and Activation Energy<br>• Lab - Toothpickase<br>• Lab #13 - Enzyme Catalysis | 8 | 2.A.1 |
| | Cellular Respiration – aerobic respiration, fermentation<br>• Activity – Word organizer for relationship of photosynthesis and cellular respiration<br>• Lab – $CO_2$ Release and Exercise<br>• Lab #6 – Cell Respiration<br>• Activity – Cell respiration play – each student has a role as one of the involved molecules<br>• Lab – Fermentation and Yeast Inquiry | 9 | 2.A.1, 2.A.2 |
| | Photosynthesis – process of photosynthesis and alternatives<br>• Lab – Stomata and Various Plant Types – using microscopes<br>• Lab – Variegated Coleus and Starch<br>• Lab #5 – Photosynthesis<br>• Activity – Photosynthesis play | 10 | 2.A.1, 2.A.2 |
| | Cell Communication – signaling and response<br>• Activity – Signaling Simulation | 11 | 3.B.2, 2.E.2, 3.D.1, 3.D.2, 3.D.3, 3.D.4 |
| | Cell Cycle – phases, mitosis, binary fission, regulation<br>• Project – *Xenopus* mating and development<br>• Lab – Onion Root Tip Phase Timing<br>• Lab #7 – Cell Division: Mitosis section<br>• Activity – Plant vs. Animal cytokinesis<br>• Activity – 3 Cs of Cancer – Causes, Cures and Consequences | 12 | 3.A.2 |

| 3 | **Genetics** | **13-21** | |
|---|---|---|---|
| | Meiosis and Sexual Life Cycles – genes, chromosomes, genetic variation, gametogenesis<br>• Activity – Clay Chromosome Meiosis dealing with genetic variation<br>• Lab #7 – Cell Division: Mitosis and Meiosis - finish | 13 | 3.C.2, 3.A.2 |
| | Mendel – 2 laws, inheritance patterns, probability, pedigrees<br>• Lab – Plant Breeding using FastPlants<br>• Activity – Allele frequency and inheritance<br>• Activity – Dominant/recessive gene project | 14 | 3.A.3, 4.C.2, 4.C.4, 3.A.3 |
| | Chromosomal Basis of Inheritance – linkage, sex linkage, genetic disorders, exceptions<br>• Activity – Making Pedigrees<br>• Lab – *Drosophila* chromosome squash | 15 | 3.A.4, 3.C.1 |
| | Molecular Basis of Inheritance – DNA structure, replication<br>• Activity – Hershey and Chase Simulation<br>• Activity – DNA replication with models<br>• Lab – PCR simulation | 16 | 3.A.1, 3.C.1 |
| | From Gene to Protein – transcription, translation, RNA structure and function, mutations<br>• Activity – Transcription and translation models | 17 | 3.A.1, 3.C.1 |
| | Genomes – viral structure, replication and genetics, bacteria, eukaryotic genomes,<br>• Lab #9 – Biotechnology: Restriction Analysis | 18-19, some sections | 3.A.1, 3.C.3, 3.C.2, 3.B.1, 3.B.2, 2.E.1, 3.B.1, 3.B.2, 4.C.1 |
| | DNA Technology and Genetic Basis of Development - gene regulation, cancer, noncoding DNA, cloning, mapping, gel electrophoresis, cell division, differentiation, morphogenesis<br>• Lab – Practice Pipetting and Gel Simulation<br>• Lab #8 – Biotechnology – Bacterial Transformation<br>• Project – Researching and presenting genetically engineered/modified organisms<br>• Activity – Comparative Study in Development<br>• Activity – Stem Cell Debate | 20-21, some sections | 3.A.1, 2.E.1, 3.B.2, 4.A.3 |
| ----- | Winter Break is normally around this part of the year. During | 40 | 2.A.1, 4.B.2, |

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| **Intro to 7** | break, students read and outline the Animal Form and Function chapter. When we return we discuss it. | | 2.C.1, 2.D.2, 2.D.3, 2.C.2 |
| **4** | **Mechanisms of Evolution** | **22-25** | |
| | Descent with Modification (discussed in Chapter 1 as all throughout the course) – Lamarck, *Origin of Species*, natural selection and evidence<br>• Lab #1 – Artificial Selection<br>• Lab – Natural Selection Simulation<br>• Project – Adaptation Story/Poster | 22 | 1.A.1, 1.A.4, 4.C.3, 4.C.4, 1.A.2, 3.C.1 |
| | Evolution of Populations – gene pools, Hardy-Weinberg, genetic drift, gene flow, sexual selection<br>• Activity – Allele frequency simulation<br>• AP Lab – Population Genetics and Evolution<br>• Lab #3 – BLAST – DNA and evolution | 23 | 4.C.3, 4.C.4, 1.A.2, 3.C.1, 1.A.1, 1.A.3 |
| | Origin of Species – species, modes of speciation<br>• Activity – group presentations of concepts<br>• Discussion – Antibiotic Resistance | 24 | 1.C.2, 2.E.2, 1.C.1, 1.C.3 |
| | Phylogeny and Systematics – tree of life, fossils, relation to classification | 25 | 1.B.2, 4.B.4 |
| **5** | **Evolutionary History of Biological Diversity**<br>(Note: We watch many video clips during this unit.) | **26-27.1** | |
| | Tree of Life – biological diversity, evolution of early life, fossil record, biological "firsts" of different types of organisms<br>• Activity – Building a tree of life (as a class) | 26 | 1.B.1, 1.D.1, 1.A.4, 1.C.1, 1.D.2 |
| | Prokaryotes – characteristics, diversity<br>• Lab – Culturing bacteria from different areas | 27.1 | 3.A.1 |
| **6** | **Plant Form and Function** | **38-39** | |
| | Angiosperms – pollination, fertilization | 38.1-2 | 2.E.1, 2.E.2 |
| | Plant Responses – signal transduction, hormones, response, defense<br>• Lab #11 - Transpiration | 39 | 2.E.2, 2.E.3 |
| 7 | **Animal Systems** | **43, 45, 47, 48** | |
| | The Immune System – innate, acquired, humoral, cell mediated, self/nonself, disease | 43 | 2.D.4 |
| | Hormones and the Endocrine System – physiology, cell | 45.1-2 | 2.C.1, 3.B.2, |

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|---|---|---|---|
| | response, hypothalamus, pituitary, nonpituitary | | 3.D.2, 3.D.1 |
| | Animal Development – overview, fate of cells | 47.3 | 2.E.1 |
| | Nervous System – cells, potentials, synapses, specialization<br>• Lab #12 – Animal Behavior | 48.1-5 | 3.E.3, 4.A.4 |
| **8** | **Ecology** | **50-55** | |
| | Intro to Ecology – interactions | 50.2 | 2.D.1 |
| | Behavioral Ecology – genetics, environment, natural selection, altruism | 51 | 2.E.3, 3.E.1, 2.A.1, 1.A.1, 1.A.2, 1.A.3, 1.A.4 |
| | Population Ecology - populations and their dynamics, growth regulation, humans<br>• Population/Carrying Capacity Graphing Lab | 52 | 2.D.1, 4.A.5, 2.A.1 |
| | Community Ecology – community interactions, structure, biogeography<br>• Outdoor Activity – visiting communities<br>• Outdoor Activity – Impact of Invasive Species<br>• Project – Invasive Species Report | 53 | 2.D.1, 2.E.3, 4.A.5, 4.B.3, 2.A.1, 4.A.6, 4.C.4 |
| | Ecosystems – cycling and flow, limits, productivity, trophic levels, humans | 54 | 2.A.1, 2.D.1, 4.A.6, 4.B.4 |
| | Societal/global issues<br>• Movie – *Medicine Man*<br>• Activity – Student chosen presentations based on movie discussion | 55.1, 4 | 2.D.2, 2.D.3, 4.B.4, 4.C.4, 4.A.6 |

## Laboratory Work

Although the Big Ideas are enmeshed throughout the course, there are some content units that are inherently tied to some of the Big Ideas. The labs that relate to these Big Ideas are covered within those content units. The student directed laboratory investigations used throughout the course allow students to apply the Seven Science Practices defined in the AP Biology curriculum Framework and include at least two lab experiences in each of the four Big Ideas. Some of these labs are listed in the table below.

| Big Idea and Labs | Content Unit | Science Practices Addressed |
|---|---|---|

| | | |
|---|---|---|
| **#1: Evolution** | | |
| Lab #1 – Artificial Selection | Unit 4 | 1,2,3,4,5,6,7 |
| Lab #3 – DNA Comparisons by BLAST | Unit 4 | 1,3,6,7 |
| **#2: Energy and Building Blocks** | | |
| Lab #4 – Diffusion and Osmosis | Unit 2 | 1,2,3,4,5,6,7 |
| Lab #13 – Enzyme Activity | Unit 2 | 3,4,5,6,7 |
| Lab #6 – Cellular Respiration | Unit 2 | 1,2,3,4,5,6,7 |
| Lab #5 - Photosynthesis | Unit 2 | 3,4,5,6,7 |
| **#3: Genetics and Information Transfer** | | |
| Lab #7 – Cell Division: Mitosis and Meiosis | Units 2 and 3 | 2,3,4,5,6 |
| Lab #9 – Biotechnology: Restriction Analysis | Unit 3 | 1,3,4,5,6,7 |
| Lab #8 – Biotechnology – Bacterial Transformation | Unit 3 | 1,3,4,5,6,7 |
| **#4: Interactions** | | |
| Lab #11 – Transpiration | Unit 6 | 2,3,4,5,6,7 |
| Lab #12 – Animal Behavior | Unit 7 | 3,4,5,6,7 |

## Activities

As discussed above, students are afforded many opportunities, lab and otherwise, to see and experience the intermingled nature of the Big Ideas of biology with each other and with the societal and ethical issues of the wider world – if life, biology does not present itself in discrete units. Many activities actually incorporate all of the big ideas at the same time. The table below describes a few selected activities from the course that demonstrate this multi-level integration.

| The Main Big Idea | Description of Activities | Other Big Ideas Included |
|---|---|---|
| **1** | • Adaptation Stories and Posters<br>I call this "Back in the day . . ." stories. Students are assigned an organism and a specific trait that the species exhibits. Each student does some research and writes an essay about how their trait may have been selected for in the distant past. (They need not be true, as we don't know what the selective pressures may have been in the past, as long as they are biologically based and correctly illustrate the evolutionary process.) They then present their stories to the class with a poster for visual assistance. | 4, 3 |

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|---|---|---|
| | • Antibiotic Resistance research and discussion<br>For this activity, we discuss antibiotic resistance in class and watch a video clip about TB in Russian prisons. Students then work in pairs to find a fairly recent news story about the causes or effects of antibiotic resistance in "real world". Each pair writes a summary and presents it to the class in a round-table-style discussion. | 3, 4 |
| **2** | • Cell Sale<br>The Cell Sale is a multi-part project that is different for each student, depending on the type of cell that he/she is assigned. Students choose their assigned cell type "from a hat" that contains cells that I know they can find adequate information about (ranging from *Clostridium tetani* to cone cells of the mammalian eye). Students research their cells and then make a sales flier and labeled models of the cell to use in their "sales pitch", which is their presentation to the class describing the cell structure, function, contents, evolution, relationship to other cells, etc. Each presentation's content varies by the type of cell. They love selling their cells and get very creative! | 1, 3, 4 |
| | • *SuperSize Me* movie and discussion<br>While this movie is a bit dated, the content is great and the students really love and hate it because it makes them want to change their eating habits. Studying macromolecules can be a bit dry without the connection to real life. This movie and discussion illustrate the importance of understanding macromolecules and their role in not only a person's health, but in that of our society as well. We discuss carbohydrates and diabetes, cholesterol, types of fats, evolutionary cravings vs modern day food choice and many other topics during this discussion. | 1 |
| **3** | • 3 Cs of Cancer Project – Causes, Cures and Consequences<br>Every one of my students knows someone who has or had cancer and they all want to talk about and understand it. We discuss cancer in general in class. Students are then allowed to choose their own type of cancer to research, based on their personal experiences. They write a paper about it – including Causes, Cures, and Consequences – and then give a short presentation in a format of their choice to the class about the science of their particular type of cancer. | 1, 2 |
| | • Project about Genetically Engineered/Modified Organisms<br>This project is done in conjunction with our lower level Environmental | 1, 4 |

| | | |
|---|---|---|
| | Science class. In AP Biology class, we discuss what this means and how it works and then students prepare PowerPoint presentations to present to the Environmental Science class about different specific examples of GMOs, their purpose and effects. We end with a joint discussion about the pros and cons of GMOs and a mini-debate about the use of these organisms in the world. | |
| **4** | • Invasive Species discussion and research<br>We are lucky enough to have a beech-sugar maple forest, creek, and pond on our campus. This allows us to be able to go to these areas and discuss the impact of know invasive species to our area. We first discuss invasive species in class and then students research to find out what invasive species are actually in our area. We then go outside and look for them. I try to steer them in the right direction and we have pretty good luck locating many of them. While outside, students give a brief presentation about their species, its history, its effects on the environment and what, if any, plans there are to eradicate it. | 2, 1 |
| | • *Medicine Man* movie and discussion<br>I like to end the year with this movie and discussion because it incorporates so many of the things we have learned throughout the year. We stop this movie periodically to discuss different aspects of biology. The main message is about habitat destruction and human impact on communities and ecosystems, but it also addresses niches, biochemistry and the scientific process. The assignment is for students to write a response to the movie and human's role on Earth. | 1, 2 |