PORTLAND METRO STEM PARTNERSHIP

Climate Change (CC) & Environmental Justice (EJ) Connections in Patterns Science

Patterns Physics		
Unit	**NGSS Standards**	**CC/EJ Connection**
Unit 5 Power Production & Climate Science	• **HS-PS4-3.** Evaluate the claims, evidence, and reasoning behind the idea that electromagnetic radiation can be described either by a wave model or a particle model, and that for some situations one model is more useful than the other. • **HS-PS3-3.** Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy • **HS-PS2-5.** Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current. • **HS-PS3-5.** Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction. • **HS-ESS3-2.** Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.* • **HS-ESS3-1**. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. • **HS-ESS2-4**. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. • **HS-ETS1-3**. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. • **HS-ETS1-1**. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	This storyline's anchoring phenomenon is learning about the perspectives of a variety of individuals from different backgrounds and geographic regions regarding how the power (electricity) that they use is produced and affects our climate. The simulated real world task of being a member of Oregon's Energy Commission that must create a 50-Year Energy Plan propels students through a learning arc that includes electricity, magnetism, power production, and climate science. After the Request for a 50-Year Energy Plan students jigsaw energy sources and power production. They need to understand the basic physics of how generators works leads us to build and explore motors (starting with speakers which also connect to the Waves & Technology unit) and inefficient generators (electric guitars). The need for large amounts of energy and efficient generators motivates us to engineer wind turbines and optimize solar cells for a local facilities use. The need to evaluate the climate impact of large scale power production launches us into the earth science performance expectations. With all the learning of the unit students and many real world constraints students finally complete, compare, and evaluate their 50-Year Energy Plans.

Patterns Chemistry		
Unit	**NGSS Standards**	**CC/EJ Connection**
Unit 1: KMT & Climate Change	• **HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects) • **HS-ESS3-5**. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems. • **HS-ESS3-6**. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	How are the recent interactions between hydrosphere and atmosphere impacting our lives? Students learn, how, and to what extent, is climate change causing change to Earth's systems? " Students use models to illustrate how pressure, temperature, and volume affect the motions of particles and how this relates to climate change. The anchoring phenomenon is: Differences in atmospheric gas temperatures, snowpack, and seawater are causing changes to local and global weather patterns.
Unit 3: Nuclear Chemistry	• **HS-PS1-8**. Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay. • **HS-ESS1-1.** Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy in the form of radiation. • **HS-ESS1-3**. Communicate scientific ideas about the way stars, over their life cycle, produce elements. • **HS-ESS1-6.** Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.	As a global society, should we continue to develop nuclear technologies? Nuclear waste disposal is a problem locally and globally, but nuclear power is a bridge to reducing carbon dioxide emissions and nuclear weapons have had significant historical impacts. Students discuss social justice issues around nuclear power. Three questions students explore are: 1). Should we build a nuclear reactor in our town? 2). What happens during nuclear change? 3). What are the safety issues associated with nuclear change?
Unit 5: Chemical Reactions & Energy	• **HS-PS1-2**. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties. • **HS-ETS1-1**. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	How are pollutants produced and what are their chemical consequences for our air, water, and climate? There is a large variety of natural and manmade sources of pollution, these pollutants have far reaching impacts on our health, the quality of our air and water, as well as the stability of our climate. EPA National Air Quality Data (could be used in unit opener). Students then explore the different kinds of chemical reactions that cause pollutants (including greenhouse gasses).
Unit 7: Thermochemistry	• **HS-PS1-4**. Develop a model to illustrate that the release or absorption of energy from a chemical reaction system depends upon the changes in total bond energy. • **HS-PS3-4.** Plan and conduct an investigation to provide evidence that the transfer of thermal energy when two components of different temperature are combined within a closed system results in a more uniform energy distribution among the components in the system (second law of thermodynamics).	How do our fuel choices impact the temperature of the environment and how can we have an immediate impact on correcting that? Certain substances on Earth have the capability of producing large amounts of energy, so we use them as fuels, but every type of fuel has pros and cons.

Patterns Biology		
Unit	**NGSS Standards**	**CC/EJ Connection**
Unit 1: Ecosystems and Biodiversity	• **HS-LS2-1.** Use mathematical and/or computational representations to support explanations of factors that affect carrying capacity of ecosystems at different scales. • **HS-LS2-2.** Use mathematical representations to support and revise explanations based on evidence about factors affecting biodiversity and populations in ecosystems of different scales. • **HS-LS2-6.** Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem. • **HS-LS2-7**. Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*	**How does the increase in the size of the human population impact biodiversity and how can we reduce those impacts.** Students explain how ecosystems respond to disturbances and interactions. Students explore how urban biodiversity is declining locally and globally.
Unit 6: Matter, Energy, & Climate Change	• **HS-LS1-5.** Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy. • **HS-LS1-7.** Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy. • **HS-LS2-3**. Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. • **HS-LS2-4**. Use mathematical representations to support claims for the cycling of matter and flow of energy among organisms in an ecosystem • **HS-LS2-5.** Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere. • **HS-ESS2-2.** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. • **HS-ESS2-6**. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere. • **HS-ESS2-7**. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. • **HS-ESS3-3.** Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity. • **HS-ESS3-4**. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.* • HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.	How does the changing climate impact Earth's ecosystems and the cycling of carbon? Students learn about energy and matter cycles in an ecosystem. They try to explain how human demand for fossil fuels creates an imbalance between carbon sources and sinks, causing change resulting in negative consequences for life on Earth. They then explore their carbon footprint and learn we can utilize living things to create carbon neutral fuels that reduce the impact on climate change.