**CLEANTECH SYLLABUS**

**Course Overview:** CleanTech explores sustainability and climate change through hands-on labs and activities focused on four units – Energy, Water, Materials Science and Food. The program is centered around using place-based, urban environmental education to help students envision a more sustainable NYC. CleanTech prepares students for more advanced exploration of STEM subjects and pursuit of careers in the green economy.

Each of the four units addresses a different environmental concern and challenges students to design solutions. The units follow a three step arc:  
 1- Learning about existing systems  
 2- Understanding the environmental and health impacts of those systems  
 3- Re-designing those systems to address the environmental impact

**UNIT 1: ENERGY**

|  |  |
| --- | --- |
| **Intro to Energy and Electricity Consumption** | |
| **Objectives** | **Standards** |
| * Gain foundational knowledge in energy, electricity production and consumption and electromagnetism. * Investigate how energy is transferred and how that connects to energy efficiency. * Analyze global fossil fuel consumption and production and its implications on human health and the climate. * Conduct an energy audit of the school building, gather and analyze data on the school’s electricity consumption and use their findings to inform energy use reduction plans. | **NYS MST**  **Standard 1:** 1.1a-c, 1.2a, 1.3a-b, 1.4a, 2.3a-b  **Standard 4:  PS** 2.1c, 2.2b, 2.2d, 3.1b, 3.1i, 4.1a-d, 4.1h-k, 4.1n, 5.1e   **LE** 7.1a-c, 7.2a, 7.2c, 7.3a-b  **Standards 2, 3, 5, 6, 7**  **Common Core ELA Science and Technical Subjects**  CCSS.ELA-LITERACY.RST.9-10.1-9  **Common Core ELA Speaking and Listening**  CCSS.ELA- LITERACY.SL.9-10.1 A-D  CCSS.ELA-LITERACY.SL.9-10.2  CCSS.ELA-LITERACY.SL.9-10.4-5 |
| **Lesson 1:** **Energy Transfers** (Module 1 Intro to Energy) Students identify different forms of energy and then participate in a hands on activity where they transfer energy from one form to another.  **Lesson 2:** **Powerplant Hookup & Magnet Motors** (Module 2 Electricity Production & the Grid) Students learn about conventional electricity production through a card game where they sequence the components of a thermal power plant. They then explore the connection between magnetism and electricity by building an electromagnet.  **Lesson 3:** **Quest for Oil** (Module 1 Intro to Energy) Working in groups, students gather global data related to fossil fuel consumption and production then plot their findings on maps to determine the key players in the quest for oil. They then focus on one country where they will develop a strategic energy plan for the future.  **Lesson 4:** **Watt Game & Lightbulb Lab** (Module 4 Building Science)Students are introduced to methods and tools used for measuring electricity. Students play a game to understand the amounts of power used by various appliances. This is followed by a lab where instruments are used to test electrical consumption, temperature and overall efficacy of different light bulbs.  **Lesson 5:** **School Energy Audit (up to 75 minutes)** (Module 4 Building Science) Students survey the school building to test electrical consumption of different appliances. After data is collated, students makes suggestions for ways to reduce energy consumption in the building. | |

**UNIT 2: ENERGY**

|  |  |
| --- | --- |
| **Climate Change and Renewables** | |
| **Objectives** | **Standards** |
| * Build upon their knowledge of energy and electricity through investigation of renewable energy. * Survey the correlations between the carbon cycle and climate change. * Investigate the connections between greenhouse gas emissions, air quality and human health. * Understand the basic tenets of energy storage and its relationship to large-scale energy production. * Build electric circuits to understand power output of various configurations, including photovoltaics. * Design and engineer wind turbine blades to maximize efficiency and output. | **NYS MST**  **Standard 1:** 1.1a-c, 1.3b, T1.1  **Standard 4:   PS** 1.1a, 1.1c-d, 1.1f, 1.1h, 2.1d, 2.2a, 3.1b, 3.1i, 3.1rr, 3.2d, 3.2j-k, 4.1a-h, 4.1l-p, 5.3c   **LE** 7.1a, 7.1c, 7.2a, 7.3a-b  **Standards: 2, 3, 5, 6, 7**  **Common Core ELA Science and Technical Subjects**  CCSS.ELA-LITERACY.RST.9-10.1-5  CCSS.ELA-LITERACY.RST.9-10.7-9  **Common Core ELA Speaking and Listening**  CCSS.ELA-LITERACY.SL.9-10.1A-D  CCSS.ELA-LITERACY.SL.9-10.2  CCSS.ELA-LITERACY.SL.9-10.4 |
| **Lesson 1:** **The Air You Breathe** (Module 2 Electricity Production & The Grid) Students explore sources and health implications of air pollution by examining the Air Quality Index and other data. **Straight to the Source** (Module 3 Climate Change)Students use EPA data to investigate global greenhouse gas emissions by source.  **Lesson 2:** **Carbon Cycle Game** (Module 3 Climate Change)This hands on activity explores the connection between the carbon cycle and its relationship to climate change. **Connecting the Climate Dots** (Module 3 Climate Change) Students use a graphic organizer to connect the dots between human activity and primary and secondary impacts of climate change.  **Lesson 3:** **Making Wind Turbines** (Module 5 Renewable Energy) Students explore the benefits and challenges of wind power. In a hands-on experiment, students design and construct model wind turbines, measure the power they produce, and then refine their designs to optimize output.  **Lesson 4:** **Making Batteries** (Module 5 Renewable Energy) Students investigate how batteries work and explore the challenges of storing energy. Students design and construct batteries using common household materials and use them to power small loads.  **Lesson 5:** **Solar Field Study** (Module 5 Renewable Energy) Students go outside to test how angles, shading, orientation and circuit design impact the output of solar panels. | |

**Additional Energy Activities**

**Solar Ovens-** Students design and build solar cookers using recycled materials. They then test the efficiency of their designs outside by measuring temperature.

**Solar Pathfinder: Assessing Solar Potential** (Module 5 Renewable Energy) Students determine the amount of solar radiation throughout the year at a specific location using a solar pathfinder.

**Solar Cars-** Students design and build solar powered race cars http://kelvin.com/kelvina-economy-solar-racer-kit-with-wood-body/

**Solar USB Chargers** (Module 5 Renewable Energy)- Students practice simple circuitry and soldering by constructing small solar USB chargers. http://www.browndoggadgets.com/collections/solar/products/solar-usb-kit

|  |  |
| --- | --- |
| **UNIT 3: WATER** | |
| **Objectives** | **Standards** |
| * Investigate local water issues and their impact on human health and the environment. * Students take a look at global water availability; explore the issues and impacts of tap and bottled water consumption * Create topographical maps of sea level rise to illustrate the impacts of climate change on human settlements. * Develop an understanding of the sewer and wastewater treatment systems in NYC; examine water quality, pollution and remediation by conducting water quality tests of water samples. * Students will understand how pollutants enter waterways and the difficulties of cleaning water once it is polluted. * Perform runoff calculations for the school, then explore stormwater management strategies. | **NYS MST**  **Standard 1:** 1.1a, 1.1c, 1.2a, 1.3a-b, 2.3a, 3.1a, M3.1, T1.1         **Standard 4:**  **PS** 1.2g, 2.1q, 2.2c-d, 3.1tt   **LE** 1.1b, 7.1b-c,  7.2a, 7.2c, 7.3a  **Standards 2, 3, 5, 6, 7**  **Common Core ELA Science and Technical Subjects**  CCSS.ELA-LITERACY.RST.9-10.1  CCSS.ELA-LITERACY.RST.9-10.3-5  CCSS.ELA-LITERACY.RST.9-10.7-9  **Common Core ELA Speaking and Listening**  CCSS.ELA-LITERACY.SL.11-12.1A-D  CCSS.ELA-LITERACY.SL.11-12.2  CCSS.ELA-LITERACY.SL.11-12.4-5 |
| **Lesson 1:** **Water Bottle Taste Test** (Water, Lesson 3) Students will investigate the difference between bottled water and tap water and the associated impacts of each.  **Lesson 2:** **Topographical Mapping of Sea Level Rise** (Water, Lesson 5) Students examine the impacts of climate change by examining a topographical map of NYC. Students will color in areas of the map that are most vulnerable to sea level rise under different modeled scenarios.  **Lesson 3:** **Clean Up The Lake** (GDL 6-8 Water, Lesson W8) Students will build 3D model water bodies, which can be manipulated to demonstrate environmental issues and remediation strategies.  **Lesson 4:** **Down the Drain Game Card** (Water, Lesson 7)Students sequence the sewer and wastewater treatment systems.  **Water Quality Testing** (Water, Lesson 2) Students will understand various characteristics of water that help determine water quality. They then test water quality using several chemical tests.  **Lesson 5:** **Stormwater on My Street** (Water, Lesson 8)Students will calculate the amount of stormwater the street and sidewalks in front of the school generate during a one-inch  storm and determine how much green infrastructure is needed to capture and infiltrate this amount of stormwater. | |

|  |  |
| --- | --- |
| **UNIT 4: FOOD** | |
| **Objectives** | **Standards** |
| * Examine global food systems and sustainable methods of food production. * Conduct exponential growth labs to understand the relationships between population, resources and carrying capacity. * Perform a mapping exercise to understand the social and environmental implications of a global food system. * Explore nutrition and local food by analyzing food labels, developing diets using a nutritional rubric and conducting a community food survey. * Conduct a soil quality lab to examine the biotic and abiotic properties of a soil ecosystem. | **Standard 1:** 1.1a-c, 1.2a-b, 1.3a-b, 1.4a, 2.3a-c, 3.1a, 3.4a-c  **Standard 4: LE**  1.1b-d, 1.1f, 1.2h, 2.2a-b, 4.1a, 5.1c, 6.1a, 6.1d-f, 7.1b-c, 7.2a-c, 7.3a-b  **Standards: 2, 3, 5, 6, 7**  **Common Core ELA Science and Technical Subjects**  CCSS.ELA-LITERACY.RST.9-10.3  CCSS.ELA-LITERACY.RST.9-10.4  CCSS.ELA-LITERACY.RST.9-10.7  CCSS.ELA-LITERACY.RST.9-10.9  **Common Core ELA Speaking and Listening**  CCSS.ELA-LITERACY.SL.9-10.1 A-D  CCSS.ELA-LITERACY.SL.9-10.2  CCSS.ELA-LITERACY.SL.9-10.4-5 |
| **Lesson 1:** **Yeast Population Density & Understanding Exponential Growth** (Food, Lesson 5) Students explore the relationships and implications of human population growth, carrying capacity and food production.  **Lesson 2:** **Sneaky Snacks** (Food 6-8, Lesson 3) Students will explore processed food and its impacts on health and nutrition. **Decoding Labels** (Food, Lesson 3) Students will be able to read and interpret information on food labels.  **Lesson 3:** **Designing a Daily Diet** (Food, Lesson 3) Students will be able to research and develop a daily menu, then compare is to the USDA’s recommended daily allowances.  **Lesson 4:** **Food Miles** (Food, Lesson 1)Students will explore the environmental impacts of the global food supply chain. Students will become familiar with “food miles”, the concept that food often travels long distances during the production and consumption cycle.  **Lesson 5:** **Soil Lab** (Food, Lesson 4)Students will investigate the properties of soil and indicators of soil quality. In addition, students will understand approaches to soil quality management and enhancing soil through sustainable agricultural practices. | |

|  |  |
| --- | --- |
| **UNIT 5: MATERIALS** | |
| **Objectives** | **Standards** |
| * Explore the science of materials from waste to recycling to sustainable design. * Research and develop life cycle inventories of selected products and use it to inform further class work. * Examine the role of consumers in the life cycle of materials by analyzing advertisements and personal consumer behavior. * Investigate sustainable building materials and architecture and identify design elements and technologies that mitigate and/or adapt to climate change. | **NYS MST**  **Standard 1:** 1.1a-c, 1.2a-b, 1.3a-b, 1.4a, 3.1a, T1.1  **Standard 4: PS** 3.1c, 3.1q, 3.1w, 3.1jj-kk   **LE** 7.1a-c, 7.2a, 7.2c, 7.3a-b  **Standards: 2, 3, 5, 6, 7**    **Common Core ELA Science and Technical Subjects**  CCSS.ELA-LITERACY.RST.9-10.1-9  **Common Core ELA Speaking and Listening**  CCSS.ELA-LITERACY.SL.9-10.1.A-D  CCSS.ELA-LITERACY.SL.9-10.2  CCSS.ELA-LITERACY.SL.9-10.4-5 |
| **Lesson 1:** **Science of Materials** (Materials, Lesson 1) In a set of hands-on investigations and research, students classify various materials and evaluate their properties.  **Lesson 2:** **Measuring Conductive Heat Transfer** (Energy, Module 4 Building Science) Students will understand heat transfer and investigate how well various building materials conduct and resist heat. They then discuss how energy efficient building materials may differ depending on climate zones.  **Lesson 3:** **Deconstructing Advertising** (Materials, Lesson 4) Students examine the impacts of advertising and consumerism on the production-consumption cycle and investigate new approaches to consumption patterns.  **Lesson 4:** **Sustainable Materials Mix and Match** (Materials, Lesson 7)Students are introduced to characteristics and examples of sustainable materials. In addition, students will closely examine the life cycle assessment, a tool used to evaluate the environmental impacts of materials. **Biomimcry Card Game** (Materials, Lesson 9) Students investigate the interdisciplinary field of biomimicry, including examples of real-world application and challenges to widespread implementation.  **Lesson 5:** **Designing a Sustainable School** (Energy Module 6 Wrap Up) Students will synthesize information learned in previous units to complete a capstone project. Students create a plan to redesign their school to be sustainable and energy efficient. Students will explore renewable energy, behavior changes, food systems, water management, building materials and other infrastructure upgrades to the school. | |