**Physical Science STEM Academy Course Outline**

**Description:** This course is designed as an introduction to basic physics and chemistry concepts addressed in the Next Generation Science Standards. Topics will include: Properties of Matter, Motion, Energy, Electricity, Magnetism, and Waves. Emphasis will be placed on the Science and Engineering Processes and Inquiry learning. This course is designed to deepen understanding of basic physics and chemistry to increase confidence in teaching these subjects in inquiry-based ways.

**Objectives:**

\* Learn basic concepts of various physical science topics and hands-on learning methods

\* Practice hands-on, inquiry-based learning and learn implementation approaches for particular classroom settings

\* Learn and implement effective strategies for STEM curriculum

\* Develop an understanding of science content, pedagogy, and science and engineering practices necessary for the

successful implementation of STEM curriculum

\* Learn best teaching practices relevant to the teaching of STEM

\* Develop an understanding of assessment methods and tools used to measure student progress

\* Understand the value and importance of working collaboratively with other teachers

|  |  |  |  |
| --- | --- | --- | --- |
| **Concept** | **Session Goals/Objectives** | **Phenomena Explained** | **NGSS** |
| Properties of Matter | \* Identify the charge of protons, neutrons, and electrons.  \* Build a simple atomic model.  \* Identify and distinguish between physical and chemical properties of matter.  \* Describe the common states of matter and their particulate characteristics. | \* Just how small are atoms?  \* What determines physical and chemical properties of matter?  \* What makes a solid a solid? A liquid a liquid? A gas a gas? | 5-PS1-1  5-PS1-3  2-PS1-1 |
| Physical/ Chemical Changes | \* Describe the common states of matter and their particulate characteristics.  \* Identify and distinguish between physical and chemical changes at the particulate level.  \* Use models to represent both physical and chemical changes.  \* Use experimental design to prove the Law of Conservation of Mass/Matter. | \* Why are mixtures and solutions physical changes?  \* Why are emulsions physical changes?  \* How is butter made?  \* What happens when wood burns?  \* What happens when rust forms? | MS-PS1-4  MS-PS1-5  5-PS1-2  5-PS1-4  2-PS1-4 |
| Properties of Water | \* Explore, describe, and explain the unique properties of water.  \* Define density of matter, in relation to mass and volume. | \* How are some insects able to walk on water?  \* How does water travel up plant/tree stems?  \* Why does ice float?  \* What causes a meniscus?  \* How do boats float? | HS-ESS2-5  5-PS1-3 |
| Thermodynamics | \* Students will identify the difference between heat and temperature.  \* Students will identify the heating and melting point of water and other substances.  \* Students will identify the differences between endothermic and exothermic change. | \* Why is ocean water warmer than air at night?  \* Why is the sand so much hotter than water at the beach?  \* Why do some things seem cooler to the touch?  \* When does heat stop flowing? | MS-PS1-4  MS-PS3-3  4-PS3-2 |
| Properties of Waves | \* Differentiate between mechanical and electromagnetic waves  \* Differentiate between transverse and longitudinal waves  \* Differentiate between pulses and continuous waves  \* Describe waves and vibrations in terms of their characteristics (frequency, period, wave speed, amplitude)  \* Define mathematical relationships between period, frequency, and wave speed. | \* How are light and sound waves different?  \* What happens to light and sound when their frequencies change?  \* What happens to light and sound when their amplitudes change?  \* Can you hear an explosion in space?  \* Why do we hear better under water?  \* Can sound REALLY shutter glass?  \* What is the Doppler effect? | MS-PS4-1  MS-PS4-2  4-PS4-1  4-PS3-2  1-PS4-1 |
| Reflection/ Refraction of Light | \* Explore how light interacts with everyday objects to explain the basic properties of light.  \* Explain reflection of light as it relates to mirrors.  \* Approximate the distance of an object from a mirror based on the reflection.  \* Explain refraction of light as it travels from one medium to another.  \* Demonstrate understanding of optical density and its correlation to the Angle of Refraction.  \* Demonstrate understanding of the speed of light and its correlation to the Index of Refraction.  \* Explain real-world phenomena caused by the refraction of light: illusions, mirages, rainbows. | \* Where do rainbows come from?  \* Why do we see an imaginary patch of water on the road on a hot day?  \* How do lenses work?  \* Why do we see a false location of an object in a bath tub?  \* What’s a mirage?  \* Can light change its speed?  \* What is invisible light?  \* Why is the sky blue and sunset red?  \* Why do all color printers use colors Magenta, Yellow, and Cyan?  \* Why in science are Primary Colors Red, Green, and Blue (and NOT Blue, Red, and Yellow)?  \* How does a mirror form an image?  \* Can you see more of yourself in a mirror if you move away from it?  \* Can anything travel faster than light? | MS-PS4-2  4-PS4-2  1-PS4-2  1-PS4-3 |
| Static Electricity | \* Understand that atoms are made up of protons, neutrons, and electrons.  \* Understand that electron build-up and movement account for static electricity and current electricity.  \* Understand the relationship between charge and attraction/repulsion.  \* Understand that electron movement is electrical current. | \* What causes static electricity in your hair?  \* Why do balloons with static charges stick to walls?  \* How do objects get charged? | 3-PS2-3 |
| Current Electricity | \* Explain the nature of electric current by using the Charge Flow model  \* Explain the role of a battery in a circuit  \* Observe and identify differences between open and closed circuits  \* Compare how electricity flows in a simple, series and parallel circuit. | \* How should Christmas light be wired?  \* Where do electrons in wires come from?  \* Why is a battery often compared to a water pump? | 4-PS3-2  4-PS3-4  3-PS2-3 |
| Magnetism | \* Understand magnetic fields and how they surround bar, horseshoe, donut, and electromagnets.  \* Describe the difference between temporary and permanent magnets.  \* Know the meanings/relationship of magnetic north/south poles in magnets and in the earth.  \* Understand the domain theory and how electron spin causes materials to be magnetized or not. | \* How do objects become magnetic?  \* Why is it a bad idea to bring a credit card next to a magnet?  \* Where does the Earth’s magnetism come from?  \* How do we know there are magnetic fields?  \* Are magnetism and electricity really ONE single phenomenon, called ‘electromagnetism”? | 3-PS2-3 |
| Velocity/ Acceleration | \* Explain the difference between distance and displacement  \* Describe motion at constant speed mathematically (d vs. t graphs)  \* Explain the difference between average speed and average velocity  \* Describe motion at accelerated speed mathematically (d vs. t graphs)  \* Describe relationships between time, position, distance traveled, and speed (by using d vs. t graphs) | \* Why are the terms “velocity” and “acceleration” so often confused?  \* How can you predict what will happen to an object’s motion by using graph d vs t? | 3-PS2-1  3-PS2-2  4-PS3-1  4-PS3-2 |
| Newton’s Laws | \* Define contact and non-contact forces.  \* Reason through Newton’s first law by:   * + Explaining what happens when single force is acting on an object initially at rest.   + Explain what happens when a single force pushes continuously on an already moving object. * Explore the direct relationship between acceleration and force and the inverse relationship between acceleration and mass (F=m\*a)   \* Explain how when one object applies a force to another object, the second object also applies a force to the first | \* How are forces of gravity, magnetism, and electrostatics the same?  \* Why is gravity such an odd force?  \* Can things interact without touching?  \* How can objects move without any forces acting on them?  \* Why doesn’t the Moon fall onto the Earth?  \* Why does a bug die when hitting a windshield of a moving car?  \* How do rockets fly?  \* Why are orbits round (elliptical)? | MS-PS2-1  MS-PS2-2  3-PS2-1  3-PS2-2  K-PS2-1  K-PS2-2 |
| Gravity/Free Fall/Weightlessness | \* How does gravity act upon objects?  \* How can air resistance be used to slow a falling object?  \* What is “free fall”? Terminal velocity?  \* How do graphs of d vs t look like for Free Fall and fall at terminal velocity | \* Why do astronauts float in space?  \* Do light and heavy objects REALLY fall together at the same rate?  \* How do parachutes work?  \* How come all the planets are round? | MS-PS2-4  K-PS2-2 |
| Energy/ Energy Conservation | \* Define energy and identify types of energy    \* Explore the law of conservation of energy by explaining the relationship between Kinetic, Potential, and Total Energy  \* Practice drawing energy transfer diagrams for windup toys and motors/generators  \* Explain how the internal components of motors and generators operate in terms of energy | \* How come scientists say energy cannot be created or destroyed (and yet some energy sources are non- renewable)?  \* Why is a motor a ‘generator in reverse”?  \* Why is energy NOT a force? | MS-PS3-1  MS-PS3-2  MS-PS3-4  MS-PS3-5  4-PS3-4 |