

Lesson 1: Curious Minds: Exploring Physical Science

This year, we're diving into the exciting world of physical science! You'll learn how to ask questions like a detective, explore experiments, and uncover the secrets of how everything around us works. Get ready for a year full of fun discoveries!

I. Branches of Physical Science

- A. Physics: The study of how things move and work and how energy is used
- B. Chemistry: the study of what the world is made up of and how that stuff interacts and changes

II. Scientific Inquiry & the Scientific Method

- A. Scientific inquiry involves asking questions, exploring ideas, finding answers
- B. Steps to the scientific method
 1. Ask a question
 2. Conduct background research: consider what is already known
 3. Formulate a hypothesis: a prediction about what you think will happen
 4. Conduct an experiment and measure outcomes
 5. Analyze data: evaluate the results of your experiment
 6. Draw conclusions: reflect on your hypothesis and what was learned
- C. Importance of sharing results
 1. Helping others learn and inspire new questions
 2. Collaboration in science — joining a community of curious individuals

Lesson 2: Discovering Matter

Everything around you is made of matter—from your favorite toys to the air you breathe and even the stars in the sky. It's all matter. In this lesson, we'll learn about the physical properties of matter and how matter can change from one form to another.

I. Introduction to Matter

- A. Matter is anything that takes up space and has weight
- B. Physical properties of matter: characteristics that can be observed or measured without changing the substance.
 - 1. Color
 - 2. Shape
 - 3. Size
 - 4. Texture
 - 5. Volume

II. States of Matter

- A. Solids
 - 1. Have a definite shape and volume.
 - 2. Particles are closely packed and do not move much
- B. Liquids
 - 1. Take the shape of their container but have a definite volume
 - 2. Particles are less tightly packed and can flow
- C. Gases
 - 1. Do not have a fixed shape or volume; fill the space available
 - 2. Gas particles are far apart and move quickly
 - 3. Gases can be compressed

III. Phase Changes

- A. Transitions between states of matter
- B. Types of phase changes:
 - 1. Melting: solid to liquid
 - 2. Freezing: liquid to solid

3. Evaporation: liquid to gas
4. Condensation: gas to liquid

Lesson 3: The Building Blocks of Matter

This week, we uncover the tiny building blocks that make up everything around us as we learn all about atoms and elements! All matter is made up of these tiny particles. We will explore how these infinitesimally small parts combine to form everything you see and discover the even smaller parts that form them!

I. Introduction to Atoms & Elements

- A. Atoms: the basic building blocks of everything in the world
- B. Element: a pure substance made of a single type of atom
 - 1. 94 naturally occurring elements plus more man-made elements
 - 2. Examples: hydrogen, oxygen, gold
 - 3. Elements combine to form all of the substances on Earth

II. Atomic Structure

- A. Protons
 - 1. Found in the nucleus
 - 2. Positively charged
- B. Neutrons
 - 1. Found in the nucleus
 - 2. No charge
- C. Electrons
 - 1. In motion around the nucleus
 - 2. Negatively charged
 - 3. Extremely small, over 1,800 times smaller than a proton or neutron

III. Identity of an Atom

- A. The number of protons determines what type of element it is
- B. Examples: hydrogen has 1 proton, gold has 79 protons

Lesson 4: The Power of the Periodic Table

One of the most essential tools in chemistry is the Periodic Table of the Elements! In this lesson, we'll explore what the periodic table is, its history, and its structured layout that organizes all known chemical elements in the universe. This useful chart reveals patterns and relationships among elements, making it easier to predict their behaviors in reactions.

I. Introduction to the Periodic Table

- A. A chart organizing all known chemical elements
 - 1. An element is a pure substance made of a single type of atom
 - 2. Number of protons in an atom determines what element it is
- B. Allows us to understand patterns among elements and how they react with one another
- C. History of the periodic table
 - 1. Dmitri Mendeleev organized the elements by atomic weight
 - 2. Mendeleev noticed elements with similar properties appear at regular intervals
 - 3. Our modern periodic table is arranged by atomic number, the number of protons

II. Structure of the Periodic Table

- A. Rows on the periodic table = periods
 - 1. Periods correspond with the number of electron shells an element has
 - a) Electron shells are layers where the electrons live
 - b) Each shell has a certain number of electrons it can hold
 - c) Electron shells represent a different energy level
 - (1) Shells closer to the nucleus = lower energy
 - (2) Shells further from the nucleus = higher energy
 - 2. As you move across a row on the periodic table, you're adding more protons and electrons, filling up electron shells

B. Columns on the periodic table = groups that contain elements with similar properties

Lesson 5: Three Faces of the Periodic Table: Metals, Nonmetals, & Metalloids

In this lesson, we're diving into the three main types of elements on the periodic table: metals, nonmetals, and metalloids. You'll discover why metals are great at conducting heat and electricity, what makes nonmetals essential for things like breathing and cleaning, and how metalloids play a key role in technology. Grab your periodic table and get ready to color-code your way through the elements!

I. Metals

- A. Found on the left and middle of the periodic table
- B. Characteristics
 1. Shiny
 2. Strong and hard
 3. Malleable: they can be hammered into thin sheets or shaped without breaking
 4. Ductile: they can be stretched into wires
 5. Good conductors of heat and electricity: metals transfer heat and electricity easily

II. Nonmetals

- A. Found mostly on the right side of the periodic table
- B. Characteristics
 1. Not shiny, but dull appearance
 2. Brittle: they break and crumble easily
 3. Poor conductors of heat and electricity: nonmetals don't transfer heat or electricity well, but work well as insulators

III. Metalloids

- A. Found along the zigzag line between metals and nonmetals
- B. Called the in-between elements because they have properties of metals and nonmetals
- C. Characteristics

1. Semiconductors: Metalloids can conduct electricity and heat, but not as well as metals
2. Brittle but malleable: can be shaped, but they'll break if bent too much

Lesson 6: Decoding the Periodic Table:

Understanding Element Boxes

Ready to unlock the secrets of the elements? In this lesson, we'll dive deeper into the Periodic Table to discover how each element is unique—and how we can learn a lot just by reading what's in the little boxes! Let's decode the Periodic Table and see how these building blocks come together to create everything we see, touch, and use!

I. Element Symbol

- A. A one- or two-letter abbreviation for the element
- B. Symbols allow for quick identification of elements without needing to write out the full name

II. Atomic Number

- A. The number of protons in the nucleus of an atom.
- B. Defines the element and determines its identity.
- C. No two elements have the same atomic number, making it unique to each element.

III. Atomic Mass

- A. The average mass of an atom of the element, based on the number of protons and neutrons
- B. Why atomic mass is often a decimal number
 - 1. Atoms of the same element can exist in different forms (isotopes) with slightly different numbers of neutrons.
 - 2. This variation is averaged, which is why atomic mass is often a decimal.

IV. Electrons

- A. Not directly shown in the element box
- B. Usually, the number of electrons equals the atomic number because most atoms are neutral
- C. Examples:

1. Hydrogen atomic number = 1; 1 proton and 1 electron.
2. Carbon atomic number = 6; 6 protons and 6 electrons.

Lesson 7: Molecular Connections

Ever wonder how everything around you—from water and air to sugar and salt—is made? It's all about tiny building blocks called atoms, and when these atoms join together, they form molecules! Get ready to discover how atoms bond, how to read molecular formulas, and how these invisible building blocks make up the stuff we see, touch, and even breathe.

I. Introduction to Molecules

- A. A molecule is a group of two or more atoms bonded together
- B. Molecules vary in size
- C. Chemical Bonds
 - 1. How atoms stick together
 - 2. Atoms bond by sharing or giving away electrons
- D. Examples:
 - 1. Oxygen (O_2), the air we breathe
 - 2. Water (H_2O)
 - 3. Carbon dioxide (CO_2), the air we breathe out

II. Molecular Formulas

- A. Shows exactly how many atoms of each element are in a molecule
- B. Examples
 - 1. Water (H_2O) = 2 hydrogen + one oxygen atom
 - 2. Salt ($NaCl$) = 1 sodium + 1 chlorine atom
 - 3. Sugar ($C_6H_{12}O_6$) = 6 carbon + 10 hydrogen + 6 oxygen atoms

Lesson 8: Bonding Basics: How Atoms Stick Together

In this lesson, we'll unlock the secret behind how atoms team up to create everything around us. We're diving into the world of chemical bonds—where atoms share or trade tiny particles called electrons to stick together and form all the molecules around us! From the salt on your fries to the water in your bottle, bonds are what make it all happen.

I. Introduction to Chemical Bonding

- A. Bonds are the attraction between atoms that occur allowing them to form stable molecules
- B. The goal of bonding is for atoms to achieve stability by filling their outer electron shells
- C. Bonds form when atoms give away, take, or share electrons
- D. Review of electrons and electron shells
 - 1. Electrons are tiny, negatively charged particles that surround the nucleus of an atom
 - 2. Electrons live in electron shells around the nucleus
 - 3. Most atoms want 8 electrons in their outermost electron shell (except hydrogen and helium, which need 2)
 - 4. Atoms bond to fill their outer shells and become stable

II. Types of Chemical Bonds

- A. Ionic bonds
 - 1. Typically occurs between a metal and nonmetal
 - 2. Form between atoms when one atom gives away electrons and another takes them
 - 3. This creates charged atoms, or ions (positive and negative)
 - 4. The opposite charges of the ions attract, holding the atoms together
 - 5. Examples: NaCl and MgO
- B. Covalent bonds
 - 1. Typically occurs between nonmetals
 - 2. Form when atoms share electrons to fill their outer shells

3. Both atoms involved in the bond fill their outer shells, becoming stable
4. Examples: H₂O and CO₂

Lesson 9: Chemical Reactions in Action

Have you ever wondered why certain things bubble, change color, or even produce heat when mixed together? These are all signs that a chemical reaction is happening! In this lesson, we'll explore what happens at the molecular level when bonds break and new ones form. Plus, you'll learn to spot the telltale signs of a chemical reaction, like color changes, fizzing bubbles, temperature shifts, and even light!

I. Introduction to Chemical Reactions

- A. A chemical reaction occurs when bonds between molecules break and atoms combine to form new molecules
- B. Reactants: Substances you start with
- C. Products: new substances created after the reaction

II. Signs of a Chemical Reaction

- A. Color change
- B. Gas production: bubbles and fizzing are a sign of gas being created during a chemical reaction
- C. Temperature change
 - 1. Exothermic reactions: reactions that release heat
 - 2. Endothermic reactions: reactions that absorb heat
- D. Light emission
- E. Formation of a precipitate: a solid that forms in a liquid

Lesson 10: Reacting to Change: The Conservation of Mass

In this lesson, you'll be learning about molecular formulas, chemical equations, and the important principle of the conservation of mass. The famous scientist Antoine Lavoisier helped unlock the secret of the conservation of mass. You'll learn how chemical reactions follow a strict rule: what you start with is always equal to what you end up with. Plus, you'll get an introduction to chemical equations.

I. Molecular Formulas & Chemical Equations

- A. Molecular formulas are a way to represent molecules using symbols and numbers
- B. Chemical equations
 - 1. A shorthand way of showing what happens during a chemical reaction
 - 2. Example: The reaction between carbon and oxygen to form carbon dioxide: $C + O_2 \rightarrow CO_2$
 - a) Reactants are the starting materials ($C + O_2$)
 - b) Products are what is formed after the reaction (CO_2)
 - 3. Balancing chemical equations ensures the number of atoms on both sides of the equation are the same.

II. Conservation of Mass

- A. Matter cannot be created or destroyed in a chemical reaction, but can be rearranged
- B. Open vs. closed systems
 - 1. Closed systems: a system where nothing can enter or leave during a reaction
 - 2. Open systems: A system where gases and other materials can escape

Lesson 11: The Power of pH

In this lesson, we'll explore the science of acids and bases! You'll learn how these substances interact, how they're measured on the pH scale, and why they're so important in the world around us—from the food we eat to the cleaning products we use.

I. Introduction to Acids & Bases

A. What is an ion?

1. An ion is an atom or molecule with a charge
 - a) Positive ions: atoms that lose electrons
 - b) Negative ions: atoms that gain electrons

B. Characteristics of acids

1. Substances that release hydrogen ions (H^+) when dissolved in water
2. Acids often taste sour
3. Examples: vinegar, lemon juice, hydrochloric acid in the stomach

C. Characteristics of bases

1. Substances that release hydroxide ions (OH^-) when dissolved in water
2. Bases often taste bitter and feel slippery
3. Example: baking soda, soap, sodium hydroxide in cleaning products

II. The pH Scale

A. A scale that measures the acidity or alkalinity (basicity) of a substance

B. The scale ranges from 0 to 14:

1. $pH < 7$ = Acidic
2. $pH = 7$ = Neutral
3. $pH > 7$ = Basic (Alkaline)

C. pH paper changes color based on the pH of a substance, helping to identify acids, bases, and neutral substances

III. Neutralization of Acids & Bases

- A. When an acid and a base combine they neutralize each other to form water and a salt
- B. Example: Hydrochloric acid (HCl) + Sodium hydroxide (NaOH) → Water (H₂O) + Sodium chloride (NaCl) (table salt)

Lesson 12: Solubility Secrets

Solutions are everywhere around you, from the soda you drink to the air you breathe! In this lesson, you'll discover how substances dissolve to form solutions and learn how factors like temperature, pressure, and the type of substances affect this process.

I. What Is a Solution?

- A. Solutions help explain how substances dissolve and mix
- B. A special type of mixture where one substance dissolves in another
- C. Key terms:
 - 1. Solute: the substance being dissolved
 - 2. Solvent: the substance doing the dissolving
 - 3. Solution: the final mixture
- D. Solutions can exist in different states
 - 1. Liquid (e.g. lemonade, salt water)
 - 2. Gas (e.g. air)
 - 3. Solid (e.g. bronze)

II. Solubility

- A. How much of a substance can dissolve in a solvent
- B. Factors affecting solubility
 - 1. Type of solute and solvent: some substances will dissolve better than others (e.g. sugar vs sand in water)
 - 2. Temperature: solids dissolve better in hot solvents
 - 3. Pressure
 - a) Increased pressure increases the solubility
 - b) Affects the solubility of gases

Lesson 13: Physics in Action: Understanding Motion

Get ready to dive into the study of physics as we begin our study of motion! From the tiny vibrations of atoms to the earth racing through space at thousands of miles per hour, motion is everywhere—even when it seems like things are standing still. In this lesson, we'll discover how position, speed, distance, direction, and velocity help us describe and understand this important concept!

I. Introduction to Motion

- A. Physics explores how matter behaves and interacts with forces and energy
- B. Everything is in motion
- C. Stationary objects are vibrating and have microscopic motion

II. Describing Motion

- A. Position: the location of an object at a certain time
- B. Speed: how fast or slow an object moves
- C. Distance: how far something travels
- D. Direction: the path or way something moves
- E. Velocity: describes both speed and direction
- F. Frame of reference
 - 1. The way we describe motion depends on where we are and what we are comparing it to
 - 2. This is an important concept because it helps us understand how and why we observe motion differently

Lesson 14: Forces at Work

In this lesson, we dive into the world of forces—those pushes and pulls that make everything from a rolling ball to the Earth's gravity possible! Discover how forces start motion, stop it, or even change direction, and explore the difference between contact and non-contact forces that shape the world around us.

I. Introduction to Forces

- A. Forces are a push or a pull
 - 1. Pushes: Make objects move away.
 - 2. Pulls: Bring objects closer.
- B. Forces can make objects move, stop, or change direction

II. Balanced vs Unbalanced Forces

- A. Balanced forces
 - 1. Forces are equal and opposite, canceling each other out
 - 2. No change in motion
- B. Unbalanced forces
 - 1. One force is stronger than the other
 - 2. Causes a change in motion

III. Types of Forces

- A. Contact forces
 - 1. Forces requiring physical contact
 - 2. Examples: pushing a ball with your hand, wind blowing a leaf
- B. Non-contact forces
 - 1. Forces that act from a distance
 - 2. Examples: gravity, magnetism

Lesson 15: Gravity: The Force that Keeps Us Grounded

In this lesson, we'll explore the mysterious force of gravity and discover how it keeps us grounded and governs the movement of everything in the universe. We'll learn how this invisible force shapes the world around us and why it's essential for life on Earth.

I. Introduction to Gravity

- A. Isaac Newton was the scientist who discovered gravity was the force that pulls objects toward the Earth
- B. Gravity is a non-contact force that pulls objects toward each other

II. How Gravity Works

- A. Mass
 - 1. The larger the mass, the stronger the gravitational pull
 - 2. Example: the Earth has a stronger gravitational pull than the moon
- B. Distance
 - 1. The farther away from the object you are, the weaker its gravitational pull
 - 2. Example: astronauts in space are far away from earth, so there is a very weak gravitational pull on them
- C. Gravity pulls on objects at the same rate, regardless of weight

Lesson 16: Friction Forces

Friction is the unseen force that affects nearly everything we do! From walking to driving and even holding a pencil, friction plays a huge role in our everyday lives. In this lesson, we'll explore how friction works, the different types of friction, and how it can be both helpful and unhelpful in the world around us.

I. What is Friction?

- A. Friction is a force that works against motion by pushing back on moving objects
- B. Occurs when two surfaces rub against each other
- C. Friction is essential for many activities (walking, running, climbing, gripping objects)
- D. Friction can create problems by slowing things down and causing heat

II. Types of Friction

- A. Static friction
 - 1. The friction that keeps objects from moving
 - 2. Example: a car parked on the hill
- B. Sliding friction:
 - 1. Friction when objects slide past each other
 - 2. Example: pushing a book across the table
- C. Rolling friction
 - 1. Friction when an object rolls over a surface
 - 2. Rolling a ball across the floor
- D. Fluid friction
 - 1. Friction when an object moves through a liquid or gas
 - 2. Examples: swimming, paper airplane in air
 - 3. Air resistance is the term for a form of fluid friction that slows down objects in the air

Lesson 17: The Rules of Motion: Newton's First and Second Laws

From the power of inertia to how force and mass work together to change motion, today we'll uncover the fascinating science behind everyday movements and explore how Isaac Newton's discoveries continue to shape our world.

I. Newton's First Law of Motion: Law of Inertia

- A. Objects at rest stay at rest and objects in motion stay in motion unless acted upon by a force
- B. Inertia: the natural tendency of objects to stay in their current state (motion or rest)
- C. Examples: a toy car sitting on a floor, will stay there without a force acting on it

II. Newton's Second Law of Motion

- A. The acceleration of the object is determined by the mass of the object and the size of the force
 - 1. Acceleration: A change in the speed or direction of an object's motion
 - 2. This law explains how force, mass, and acceleration are related
- B. Examples:
 - 1. Easier to move a book than a heavy box of books (effect of mass)
 - 2. Baseball hit with more force will fly further across a field than one gently tapped (effect of force)

Lesson 18: The Power of Opposites: Newton's Third Law

In this lesson, you'll be introduced to Newton's Third Law of Motion! You'll discover how this law connects to forces and the laws of motion we've already explored, from rockets soaring into space to the simple act of walking. See how this principle shapes the world around us!

I. Newton's Third Law of Motion

- A. For every action, there is an equal and opposite reaction
- B. When one object exerts a force on another, the second object exerts an equal force in the opposite direction.
- C. Examples
 - 1. Rocket Launch
 - a) Action: Rocket engines push down on the ground
 - b) Reaction: The ground pushes the rocket up
 - 2. Swimming:
 - a) Action: Paddling hands and feet push water back
 - b) Reaction: The water pushes the swimmer forward
 - 3. Walking:
 - a) Action: Pushing backward on the ground with feet
 - b) Reaction: The ground pushes the person forward

II. Review of Related Motion and Forces Concepts

- A. Balanced vs unbalanced forces
 - 1. Balanced: forces of equal strength in opposite directions, no change in motion
 - 2. Unbalanced: one force is stronger, causing movement in the direction of the stronger force
- B. Newton's first law of motion: objects stay at rest or keep moving unless acted upon by an outside force
- C. Newton's second law of motion: the strength of a force determines how much an object accelerates

Lesson 19: Simple Machines, Awesome Power!

In today's lesson, we'll discover simple machines— tools that help us lift, push, and pull with ease! From ramps to levers, we'll explore how these clever inventions make hard tasks easier and help us do amazing things every day.

I. Simple Machines Defined

- A. A basic tool that makes work easier by changing the way force is applied
- B. Help by either multiplying our force or changing its direction

II. Types of Simple Machines

- A. Inclined Plane
 - 1. A slanted surface that helps move objects up or down
 - 2. Examples: ramps, slides
- B. Lever
 - 1. A stiff bar that moves on a pivot point (fulcrum) to lift or move something
 - 2. Examples: seesaws, crowbars, bottle openers
- C. Wheel and Axle
 - 1. A wheel attached to a central rod that helps move objects easily by reducing friction
 - 2. Examples: bicycles, shopping carts, doorknobs
- D. Pulley
 - 1. A wheel with a rope that changes the direction of the force
 - 2. Examples: flagpoles, cranes, elevators
- E. Wedge
 - 1. A tool that helps split or cut objects by focusing force on a small area
 - 2. Examples: axes, knives, front teeth
- F. Screw
 - 1. An inclined plane wrapped around a cylinder, used to hold things together

2. Examples: screws in furniture, jar lids, lightbulbs

Lesson 20: Energy in Action

Energy powers our world, moves our bodies, and even helps plants grow. In this lesson, we'll explore the main types of energy, discover how energy is constantly transforming all around us, and learn why energy is one of the most important concepts in science!

I. What is Energy?

- A. Energy is the ability to do work or cause change
- B. Everything that happens in the world involves energy

II. Types of Energy

- A. Mechanical energy
 - 1. Energy of motion or stored energy due to position
 - 2. Examples: kicking a ball, stretched rubber band
- B. Chemical energy
 - 1. Energy stored in a substance
 - 2. Examples: food, fuel, batteries
- C. Nuclear energy
 - 1. Energy stored in the nucleus of an atom and released when atoms split or fuse together
 - 2. Example: the sun produces energy through nuclear fusion
- D. Thermal energy
 - 1. Heat energy created by movement of tiny particles in a substance
 - 2. Examples: friction from rubbing hands together, boiling water
- E. Electromagnetic energy
 - 1. Energy that moves through space in waves
 - 2. Examples: light energy, radio waves, x-rays
- F. Electric energy
 - 1. Energy of moving electrons
 - 2. Examples: lightning, wall outlet

III. Energy Transformations

- A. Energy changes from one form to another all the time

1. A battery (chemical energy) powers a flashlight (electromagnetic energy)
2. A car burns fuel (chemical energy) to move (mechanical energy)

B. The Law of Conservation of Energy

1. Energy can not be created or destroyed—only transferred or transformed
2. The total amount of energy in a system always stays the same.

Lesson 21: Energy on the Move

In this lesson, we'll explore the exciting world of mechanical energy, discovering how objects store and use potential and kinetic energy to move and do work. Get ready to discover how energy is constantly changing and shaping the world around us!

I. Introduction & Review

- A. Energy is the ability to do work or cause change
- B. Mechanical energy
 - 1. Energy of movement or stored energy due to position.
 - 2. Two categories: kinetic and potential energy

II. Kinetic & Potential Energy

- A. Kinetic energy
 - 1. Energy of movement
 - 2. Factors impacting kinetic energy
 - a) Mass: more massive objects have more kinetic energy
 - b) Speed: faster objects have more kinetic energy
 - 3. Examples: baseball flying through the air, speeding train, moving air molecules (wind)
- B. Potential energy
 - 1. Stored energy of position
 - 2. Examples: stretched rubber band, rock at the edge of a cliff, water at the top of a waterfall
- C. Energy converts between kinetic and potential energy
 - 1. A ball held high is full of potential energy
 - 2. As a ball falls energy is converted from potential energy to kinetic energy

Lesson 22: Feel the Heat: Understanding Temperature & Thermal Energy

Why does a hot cup of cocoa feel so warm? Why does the sun make you feel toasty? In this lesson, we'll learn all about thermal energy, where we'll discover how particles move, how we measure temperature, and the science behind heat traveling from hot to cold. Get ready to feel the heat and learn the science that makes it all happen!

I. Thermal Energy

- A. The energy of moving particles
- B. The faster particles move, the more energy they have
- C. Molecular motion
 - 1. Solids: move the slowest, have the least amount of thermal energy
 - 2. Liquids: move faster than solids and have more thermal energy
 - 3. Gases: move the fastest and have the most thermal energy

II. Temperature

- A. A measure of particle motion
- B. We measure temperature using thermometers
- C. Temperature scales
 - 1. Fahrenheit scale
 - a) Used primarily in the US
 - b) Water freezes at 32°F and boils at 212°F
 - 2. Celsius scale
 - a) Used in most of the rest of the world and by scientists worldwide
 - b) Water freezes at 0°C and boils at 100°C
 - 3. Kelvin scale
 - a) Used in science for extremely low temperatures
 - b) Absolute zero is the point where all molecular motion stops

III. Heat Transfer

- A. Temperature measures particle motion, but heat is the transfer of thermal energy
- B. Heat always moves from hot to cold

Lesson 23: Heat in Action

Heat is always on the move! Whether it's the warmth of the sun, the steam rising from a hot bowl of soup, or the heat spreading through a metal skewer by the fire, thermal energy travels in different ways. Get ready to dive into the world of conduction, convection, and radiation as we uncover the secrets of how heat moves all around us!

I. Conduction

- A. Heat transfer through direct contact
- B. Example: holding a metal skewer over a campfire
- C. Metals are good conductors of heat
- D. Nonmetals are poor conductors, they're called insulators

II. Convection

- A. Heat transfer through moving fluids (liquids and gases)
- B. Warmer fluids rise, cooler fluids sink, creating a convection current
- C. Example: there are swirling convection currents in boiling water

III. Radiation

- A. Heat transfer through invisible waves
- B. Does not need direct contact or fluids to occur
- C. Example: the sun's heat reaches Earth through radiation

Lesson 24: Invisible Waves: Exploring the Electromagnetic Spectrum

In this lesson, we'll uncover the invisible world of electromagnetic waves. From the longest radio waves to the shortest gamma rays, we'll learn how they travel at the speed of light to shape our modern lives!

I. Introduction to Waves

A. Types of waves

1. Mechanical waves: waves that need a medium through which to travel
2. Electromagnetic waves
 - a) Waves that do not need a medium to travel through but can travel through empty space
 - b) Made up of two parts: an electric field and a magnetic field

B. Wavelength

1. Distance between wave peaks
2. A feature of both mechanical and electromagnetic waves

II. Electromagnetic Spectrum

A. Range of electromagnetic waves, organized by wavelength

B. Classification beginning with longest wavelengths and moving to shortest

1. Radio waves: used for radio, television, and communication
2. Microwaves: used in microwave ovens and communication
3. Infrared: felt as heat; used in thermal imaging
4. Visible light: part of the spectrum visible to the human eye, includes all colors of the rainbow
5. Ultraviolet light: the type of light that gives you a sunburn when outside too long
6. X-rays: used for medical imaging
7. Gamma rays: used in medicine and space exploration

C. Energy from the sun

1. The sun emits both thermal and electromagnetic energy
2. Sunlight as electromagnetic energy is converted to thermal energy upon reaching the earth

Lesson 25: The Science of Light

Have you ever wondered how light travels or why you can see your reflection in a mirror? Light moves incredibly fast and can bounce or bend in surprising ways! Get ready to explore the science of light and see how it shapes the way we see the world.

I. Properties of Light

- A. Light is a form of energy
 - 1. It is part of the electromagnetic spectrum
 - 2. It travels in waves and does not need a medium
- B. Speed of light
 - 1. Light is the fastest thing in the universe
 - 2. Travels about 186,000 miles per second
- C. Light travels in a straight line unless an object is placed in front of it

II. Reflection & Refraction

- A. Reflection of light
 - 1. Occurs when light bounces off of surfaces
 - 2. Smooth surfaces (mirrors) reflect light clearly
 - 3. Rough surfaces scatter light
 - 4. Reflection helps us see objects around us
- B. Refraction of light
 - 1. Light bends when it moves from one medium to another (e.g. from air to water)
 - 2. Example: a straw in water appears bent

Lesson 26: Unlocking the Rainbow

In this lesson, we'll uncover the colorful world of light. We'll learn how light creates the rainbow we see and how mixing colors of light and pigments work together in surprising ways. Get ready to unlock the science behind the colors of the world around us!

I. How We See Color

- A. Isaac Newton discovered when light passes through a prism it bends and separates into a rainbow of colors
- B. When light hits an object, some of it is reflected and the rest may be absorbed
- C. Reflected light is what gives objects their color
 - 1. A red apple reflects red light and absorbs all other colors, making it appear red
 - 2. A white object reflects all the colors of light
 - 3. Black objects absorb nearly all of the light, reflecting very little

II. Additive vs. Subtractive Color Mixing

- A. Subtractive color mixing
 - 1. Occurs when mixing pigments, like paints, which absorb certain wavelengths of light and reflect others
 - 2. Mixing colors like yellow and blue paint result in green due to the subtraction of other wavelengths of light
 - 3. Mixing pigments creates darker colors
- B. Additive color mixing
 - 1. Occurs when mixing light
 - 2. Mixing different colors of light, creates lighter colors
 - 3. When red, green, and blue lights are mixed, they create white light
 - 4. Example: TV and computer screens use red, green, and blue lights to produce all the colors

Lesson 27: Waves of Wonder: Exploring Sound

Imagine losing your hearing at a young age and still composing some of the most powerful music the world has ever known. Discover how Beethoven overcame his deafness to create masterpieces and dive into the science of sound, from the waves that carry it to the ways it shapes our world.

I. Introduction to Sound

- A. Sound is a form of energy
- B. Sound travels in compression waves
 - 1. Compressions: areas where waves are closer together
 - 2. Rarefactions: areas where the waves are more spread apart
- C. Sound needs a medium through which to travel
 - 1. Cannot travel through empty space
 - 2. The movement of the molecules causes sound transmission

II. Pitch & Volume

- A. Volume is related to the amplitude, or size, of the sound waves
 - 1. Larger amplitude = bigger wave = louder sound
 - 2. Smaller amplitude = smaller wave = softer sound
- B. Pitch is related to the wavelength of the vibrations
 - 1. Fast vibrations = smaller wavelength = high pitch
 - 2. Slow vibrations = larger wavelength = low pitch

Lesson 28: Powered Up

Imagine a world without lights, computers, or your favorite video games—life without electricity! Get ready to explore how electricity moves, the difference between static electricity and electric currents, and how this invisible force shapes our everyday lives!

I. Introduction to Electricity

- A. Review of previous concepts
 - 1. Everything is made of atoms
 - 2. Parts of an atom:
 - a) Positively charged protons in the nucleus
 - b) Neutrons with no charge in the nucleus
 - c) Negatively charged electrons orbiting the nucleus
- B. What is electricity?
 - 1. Electrons can move from one atom to another, creating electricity
 - 2. Electricity is the movement of electrons from one place to another

II. Types of Electricity

- A. Static electricity
 - 1. Occurs when electrons build up on an object and jump to another object
 - 2. Examples
 - a) Rubbing a balloon on hair transfers electrons, making the hair stand up
 - b) Electrons build up in storm clouds and jump to the ground in a burst of energy causing lightning
- B. Electric currents
 - 1. Electric currents occur when electrons flow in a continuous path
 - 2. An electric circuit is the pathway along which electric current flows, usually through a wire
 - 3. Voltage is the push that moves electrons

4. Example: electricity in homes flows through copper wires hidden in the walls to power lights and appliances

Lesson 29: Electricity in Motion

Have you ever flipped a light switch and wondered how the electricity knows where to go? In this lesson, we'll explore electric circuits—special pathways that bring power to everything from light bulbs to video games! You'll discover how switches, wires, and resistors work together to control the flow of electricity and keep us powered up!

I. Introduction to Circuits

- A. Electric currents provide a steady flow of electrons
- B. Electricity must have a circuit or complete path for electrons to flow
- C. Components of a simple circuit
 - 1. Power source: provides voltage to push electrons (battery).
 - 2. Conductors: materials that allow electricity to flow (copper wire)
 - 3. Resistors: devices that use electricity to do work (light bulb)
 - 4. Switches: control the flow of electricity by opening or closing the circuit

II. Conductors vs Insulators

- A. Conductors
 - 1. Materials that allow electricity to pass easily
 - 2. Examples: metals, water
- B. Insulators
 - 1. Materials that prevent the flow of electricity
 - a) Examples: rubber, plastic, wood

Lesson 30: Magnetism: The Invisible Force

What if you had an invisible force that could push, pull, and even help you find your way? Magnets have been shaping our world for centuries, from ancient navigators using lodestones to modern technology like electric motors. In this lesson, we'll explore the power of magnetism and uncover the secrets behind this mysterious force!

I. Introduction to Magnets

- A. Around 200 BC lodestone, the first naturally magnetic material, was discovered
- B. A magnet is any material that produces a magnetic field and attracts certain metals (iron, nickel, cobalt)
- C. Magnetic fields
 - 1. A magnetic field is the invisible area around a magnet where its force acts
 - 2. The field is strongest near the magnet and weakens with distance
 - 3. Iron filings can be used to visualize a magnetic field.
- D. Properties of magnets
 - 1. Magnets have two poles: north and south.
 - 2. Like poles repel, while opposite poles attract
 - 3. Magnetic poles always come in pairs—cutting a magnet in half creates two smaller magnets, each with a north and south pole

II. The Earth as a Magnet

- A. The Earth has a magnetic field with a north and south magnetic pole
- B. Earth's magnetic field is generated by the movement of molten iron and nickel in its outer core
- C. The Earth's magnetic field is why compasses always point north
- D. The magnetic field protects Earth from solar radiation and creates the aurora borealis and aurora australis