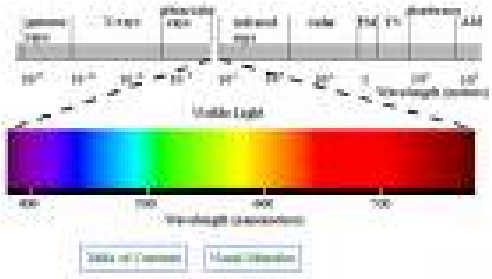
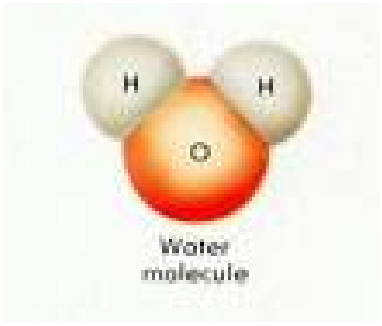
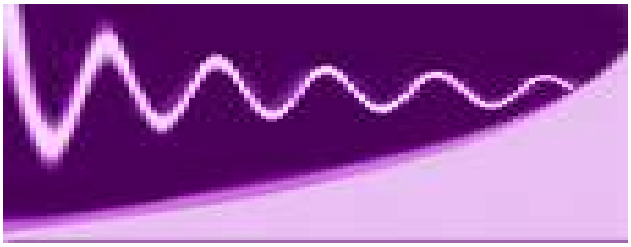
Physical Science - Grades 7/8

Curricular Content

(Based Upon the Core Knowledge Scope and Sequence)







Minneapolis Academy
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Unit 1 : Science Start-UP!

- Orientation to Class; Policies and Procedures, Organization
- Notebook organization and maintenance
- Nature of Physical Science
- Scientific Inquiry
- Scientific Method
- Measurement (Metric system)

Unit 2: Properties of Matter

- Basic Terms and Concepts
  - Atoms, Molecules, and Compounds
    - § All matter is made up of particles too small for the eye to see, called atoms
    - § Scientists have developed models of atoms; while these models have changed over time as scientists make new discoveries, the models help us imagine what we cannot see.
    - § Atoms are made up of even tinier particles: protons, neutrons, electrons
    - § The concept of electrical charge
      - Positive charge (+): proton
      - Negative charge (-): electron
      - Neutral charge (=): neutron
      - "Unlike charges attract, like charges repel" relate to magnetism and repulsion
    - § Atoms are constantly in motion, electrons move around the nucleus in paths called shells (or energy levels)
    - § Atoms may join together to form molecules and compounds
    - § Common compounds and their formulas:
      water (H_20) , salt (NACL) , carbon dioxide (CO_2)

  - Properties of matter

    - § Early theories of matter
      - The early Greek theory of four elements: Earth, air, fire and water

- Later theories of Democritus: everything is made of atoms and nothing else ("atom" in Greek means that which can't be cut or divided "atomos"; atoms of the same kind form a pure element
- Alchemy in the Middle Ages

Unit 3: Structure and Changes in Matter

§ Start of modern chemistry
- Lavoisier and oxygen: the idea that matter is not lost or gained in chemical reactions
- John Dalton revives theory of the atom
- Mendeleev develops Periodic Table, showing that the properties of atoms of elements come in repeating (periodic) groups
- Niehls Bohr develops a model of the atom in shells that hold a certain number of electrons. Bohr's model, plus the discovery of neutrons, helped explain the Periodic Table atomic number, atomic weight and isotopes

§ Mass: the amount of matter in an object; similar to weight
§ Volume: the amount of space a thing fills
§ Density: how much matter is packed into the space an object fills
§ Vacuum: the absence of matter

o Elements
§ Elements are the basic building blocks of matter, of which there are a little more than one hundred.
- There are many different kinds of atoms, but an element has only one kind of atom.
- Most things are made up of a combination of elements.
- The Periodic Table: organizes elements with common properties
  - Atomic symbol and number
- Some well-known elements and their symbols:

Hydrogen	H
Helium	He
Carbon	C
Nitrogen	N
Oxygen	O
Sodium	Na

Aluminum	Al
Silicon	Si
Chlorine	Cl
Iron	Fe
Copper	Cu
Silver	Ag
Gold	Au

- Two important categories of elements: metals and non-metals
- Metals comprise about 2/3 of known elements
- Properties of metals: most are shiny, ductile, malleable, conductive

o Solutions

§ A solution is formed when a substance (the solute) is dissolved in another substance (the solvent), such as when sugar or salt is dissolved in water; the dissolved substance is present in the solution even though you cannot see it.
§ Concentration and saturation (as demonstrated through simple experiments with crystallization)

o Chemical and Physical Change

§ Chemical change changes what a molecule is made up of and results in a new substance with a new molecular structure. (e.g.: rusting of iron, burning of wood, milk turning sour)
§ Physical change changes only the properties or appearance of the substance, but does not change what the substance is made up of. (e.g.: cutting wood, tearing paper, breaking glass, freezing water)

o Chemical Bonds and Reactions

§ To get a stable outer shell of electrons, atoms either give away, take on, or share electrons
§ Chemical reactions the atoms and electrons in elements and compounds to form chemical bonds.
§ When single atoms combine with themselves or with other atoms, the result is a molecule.
- O_2 is a molecule of oxygen. NaCl is a molecule of salt, and because it has more than one element is called a compound.

§ Ionic bond:

Atoms like sodium that have just one or two extra electrons are very energetic in giving them away. Elements with the same number of extra or few electrons can join with each other to make an ionic bond. Example: NaCl, table salt.

- Metallic bond:
  In the metallic bond, electrons are not given away between elements, but are arranged so that they are shared between atoms. Pure metals show this sharing, and the atoms can arrange themselves in different ways, which explains why metals are malleable.
- Covalent bond:
  Some atoms share electrons in a definite way, making them very stable and unreactive. Examples are H_2 and O_2. Carbon, which can take up or give away 4 electrons in covalent bonds, can help make molecules that can adopt almost any shape. C is the basis for life on Earth.

o Kinds or reactions

Oxidation: a chemical reaction that commonly involves oxygen. More generally, oxidation is a reaction in which an atom accepts electrons while combining with other elements. The atom that gives away atoms is said to be oxidized. Examples: rusting of iron, burning of paper. Heat is given off.

Reduction: the opposite of oxidation. Reduction involves the gaining of electrons. An oxidized material gives them away and heat is taken up.

o Acids: for example, vinegar, HCl, H_2SO_4, sour, turn litmus red

o Bases: for example, baking soda, bitter, turn litmus blue

o pH: ranges from 0-14; neutral=7, acid= below 7, base = above 7

o Reactions with acids and bases:

In water solution, an acid compound has an H ion (a proton lacking an electron), and the base compound has an OH ion (with an extra electron).

When the two come together, they form HOH (water) plus a stable compound called a “salt”.

o How chemists describe reactions by equations, for example:
$HCl + NaOH = NaCl + H_20$

- A catalyst helps a reaction, but is not used up.

Unit 4: Physics

- Motion
- Newton's Laws of Motion
- Velocity and speed
  - The velocity of an object is the rate of change of its position in a particular direction.
  - Speed is the magnitude of velocity expressed in distance covered per unit of time.
  - Changes in velocity can involve changes in speed or direction or both.
  - Average speed = total distance traveled divided by the total time elapsed
    - Formula: Speed = Distance / Time (S= D/T)

    Familiar units for measuring speed: miles or km per hour

- Forces
  - The concept of force: force as a push or pull that produces a change in the state of motion of an object
  - Examples of familiar forces: gravity, magnetic
  - A force has direction and magnitude
  - Measuring force: expressed in units of mass, pounds in English system, newtons in metric system
  - Unbalanced forces cause changes in velocity
  - If an object is subject to two or more forces at once, the effect is the net effect of all forces.
  - The motion of an object does not change if all the forces on it are in balance, having a net effect of zero.
  - To achieve a given change in motion of an object, the greater the force required.

- Density and Buoyancy
  - When immersed in a fluid (i.e. liquid or gas), all objects experience a buoyant force.
  - The buoyant force on an object is an upward (counter-gravity) force equal to the weight of the fluid displaced by the object.
  - Density = mass per unit volume
  - Relation between mass and weight (equal masses at same location have equal weights)

        - Density calculations of regular and irregular solids from measurements of mass and volume
        - The experiment of Archimedes
        - How to predict whether an object will float or sink.

- Work:
    - In physics, work is a relation between force and distance: work is done when force is exerted over a distance.
        - Equation: W = f x d (work = force x distance)
        - Common units: foot-pounds (English); joules (metric) *1 joule = 1 newton of force x 1 meter of distance*

- Power:
    - In physics, power is a relationship between work and time: a measure of work done (energy expended) and the time it takes to do it.
        - Equation: P = W / T (power = work / time) or Power = Energy / Time
        - Units: foot pounds per second, horsepower (English); Watts and kilowatts (metric)

- Energy and Heat (Review and expand from previous year)
    - In physics, energy is defined as the ability to do work.
    - Energy is distinguished from work
        - To have energy, a thing does not have to move
        - Work is the transfer of energy

- Heat
    - Heat and temperature: how vigorously atoms are moving and colliding
    - Energy transfer- 3 ways: conduction, convection, radiation and direction of heat transfer

- Physical Change: Energy Transfer

    - States of matter (solid, liquid, gas) in terms of molecular motion
        - In gases, loosely packed atoms and molecules move independently and collide often. Volume and shape change readily.
        - In liquids, atoms and molecules are more loosely packed than in solids and can move past each other. Liquids change shape readily but resist change in volume.
        - In solids, atoms and molecules are more tightly packed and can only vibrate, Solids resist change in shape and volume.

- Most substances are solid at low temperatures, liquid at medium temperatures and gaseous at high temperatures.
- A change of phase is a physical change (no new substance is produced)
- Matter can be made to change phases by adding or removing energy
- Expansion and contraction
  - Expansion is adding heat energy to a substance, which causes the molecules to move more quickly and the substance to expand.
  - Contraction is when a substance loses heat energy, the molecules slow down, and the substance contracts
  - Water is a special case: H2O expands when it changes from a liquid to a solid.
- Changing phases: condensation, freezing, melting, boiling
  - Different amounts of energy are required to change the phase of different substances
  - Each substance has its own melting and boiling point.
  - The freezing point and boiling point of H2O (°C and °F)
- Distillation: Separation of mixtures of liquids with different boiling points.

Unit 5: Electricity and Magnetism

- Basic terms and concepts:
  - Electricity is a flow of electrons in a conductor
  - Opposite charges attract, like charges repel
  - Conductors and insulators
  - Open and closed circuits
  - Short circuit: sudden surge of amperage due to the reduction of resistance in a circuit; protection from short circuits is achieved by fuses and circuit breakers.
- Electricity as the flow of electrons
  - Electrons carry negative charge; protons carry positive charge
  - Conductors: materials like metals that easily give up electrons
  - Insulators: materials like glass that do not easily give up electrons
- Static Electricity
  - A static charge (excess or deficiency) creates an electric field
  - Electric energy can be stored in capacitors (typically two metal plates, one charged positive the other negative, separated by an insulating barrier). Capacitor discharges can release fatal levels of energy.

    - Grounding drains an excess or makes up a deficiency of electrons, because the Earth is a huge reservoir of electrons. Your body is “ground” when you get a shock of static electricity.
    - Lightning is a grounding of static electricity from clouds.
- Flowing Electricity
    - Electric potential is measure in volts
    - Electric flow or current is measured in amperes: 1 ampere = 1 flow of 1 coulomb of charge per second (1 coulomb= the charge of 6.25 billion billion electrons)
    - The total power of an electric flow over time is measured in watts.
    - The unit of electrical resistance is the ohm. Ohm’s law: watts=amps x volts. Corollaries: amps = watts/volts ; volts=watts/amps

- Magnetism and Electricity
    - Earth’s magnetism
        - Earth’s magnetism is believed to be caused by movements of charged atoms in the molten interior of the planet.
        - Navigation by magnetic compass is made possible because the Earth is a magnet with north and south magnetic poles.
    - Connection between electricity and magnetism
        - Example: move a magnet back and forth in front of wire connected to a meter, and electricity flows in the wire. The reverse: electric current flowing through a wire exerts magnetic attraction.
        - Spinning electrons in an atom create a magnetic field around the atom.
        - Unlike magnetic poles attract, like magnetic poles repel.
        - Practical applications of the connection between electricity and magnetism, for example: An electric generator creates alternating current by turning a magnet and a coil of wire in relation to one another; an electric motor works on the reverse principle.
            - A step-up transformer sends alternating current through a smaller coil of wire with just a few turns next to a larger coil with many turns. This induces a higher voltage in the larger coil. A step-down transformer does the reverse, sending current through the larger coil and creating a lower voltage in the smaller one.

Unit 6: Electromagnetic Radiation and Light

- Waves and electromagnetic radiation
    - Most waves, such as sound and water waves, transfer energy through matter, but light belongs to a special kind of radiation that can transfer energy through empty space.
- The electromagnetic spectrum
    - From long waves, to radio waves, to light waves, to x-rays , to gamma rays
    - Called electromagnetic because the radiation is created by an oscillating electric field which creates an oscillating magnetic field at right angles to it, which in turn creates an oscillating electric field at right angles, and so on, with both fields perpendicular to each other and the direction the wave is moving.
    - The light spectrum: from infrared (longest) to red, orange, yellow, green, blue, indigo, violet (shortest)
    - Speed in a vacuum of all electromagnetic waves including light: 300,000 km per second or 186,000 miles per second; a universal constant called *c*
- Refraction and reflection
    - Refraction: the slowing down of light in glass causes it to bend, which enables lenses to work for TV, photography, and astronomy
    - How Newton used the refraction of a prism to discover that white light was made up of rays of different energies (colors).
    - Reflection: concave and convex reflectors; focal point

Unit 7: Sound

- General properties of waves
    - Waves transfer energy by oscillation without transferring matter; matter disturbed by a wave returns to its original place.
    - Wave properties: wavelength, frequency, speed, crest, trough, amplitude.
    - Two kinds of waves: transverse (e.g. light) and longitudinal (e.g. sound)
    - Common features of both kinds of waves:
        - Speed and frequency of wave determine wavelength
        - Wave interference occurs in both light and sound
        - Doppler effect occurs in both light and sound
    - Sound waves: longitudinal, compression waves, made by vibrating matter, e.g. strings, wood, air

        - While light and radio waves can travel through a vacuum, sound waves cannot. Sound waves need a medium through which to travel.
    - Speed
        - Sound goes faster through denser mediums, that is, faster through solids and liquids than through air (gases)
        - At room temperature sound travels at about 340 mps (1130 ft ps)
        - Speed of sound = Mach number
        - Supersonic booms; breaking the sound barrier
    - Frequency
        - Frequency of sounds waves is measured in cycles per second or Hertz (Hz)
        - Audible frequencies roughly between 20 and 20,000 Hz
        - The higher the frequency the higher the subjective pitch
    - Amplitude
        - Amplitude or loudness is measured in decibels (dB)
        - Very loud sounds can impair hearing and cause deafness
        - Resonance, for example, the sound board of a piano or plates of a violin.

Unit 8: Astronomy: Gravity, Stars and Galaxies

- Gravity: an attractive force between objects
    - Newton's law of universal gravitation: Between any two objects in the Universe there is an attractive force, gravity, which grows greater as the objects move closer to each other.
    - How gravity keeps planets in orbit
- Stars
    - The Sun is a star.
    - Kinds of stars (by size): giants, dwarfs, pulsars
    - Supernova; black holes
    - Apparent movement of stars caused by rotation of Earth

        - Constellations: visual groupings of stars e.g. Big Dipper, Orion
        - Astronomical distance measured in light years
- Galaxies
        - The Milky Way is our galaxy
        - Andromeda galaxy is next closest galaxy
        - Quasars are the most distant visible object (brightest)