OKEMOS HIGH SCHOOL
KEY COMPONENTS OF TESTING OUT

Name of course: Physical Science

Course description: This one credit course, or its equivalent, is required of all 9th grade students and is a prerequisite for Biology and Chemistry.

Basic concepts in physics, chemistry, and earth science are studied in this course, along with an investigation of the nature of science. The content of the course is selected, in part, to meet state science objectives, prepare students for the state proficiency test, and to compliment the content of our 8th grade science course. It specifically includes: the characteristics of matter; chemical bonding and the formation of compounds; nuclear chemistry; electricity and magnetism; wave forms of energy, including light and sound; plate tectonics theory; glacial history; topographic maps: groundwater and basic hydrology.

The testing out exam will consist of 200 multiple choice questions with a value of one point each. To test out of Physical Science, a score of at least a C+ (77%) must be attained.

* Students will need a nonprogrammable scientific calculator. A Periodic Table and a list of polyatomic ions will be provided.

Course syllabus: The following outline includes the key concepts and some of the vocabulary for the course.

Textbook: Physical Science Concepts in Action with Earth Science
Author: Wysession, Frank, Yancopoulos
Publishing Co: Pearson
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TEST
Chemistry (50%)
Physics (25%)
Earth Science (25%)

Course Outline:

SCIENCE METHODS/TECHNIQUES
Vocabulary
observations conclusions hypothesis (testable guess) scientific theory
gram/liter/meter/°C significant figures independent variable dependent variable controlled variables

- Know and correctly take measurements using the metric units for mass, volume, length, area, time, and density
- Know metric prefixes kilo, centi, and milli
- Define/differentiate between precision and accuracy
- Measure quantities to an appropriate number of significant figures
- Define and identify independent and dependent variables and control groups
- Create experiments containing a control and one independent variable
➢ Draw appropriate conclusions from experimental results
➢ Explain the importance of testability in a scientific hypothesis
➢ Differentiate between observation and inference
➢ Perform metric conversions between quantities with the above prefixes or no prefix
➢ Perform unit conversions between American and metric units.
➢ Differentiate between Theory, Law, and Hypothesis
➢ Understand that theories do not become laws

SCIENCE AND PHASES OF MATTER

Vocabulary

- chemical property
- physical property
- chemical change
- physical change
- phase/state of matter
- solid/liquid/gas/plasma
- boiling/condensation/melting/freezing
- conductivity
- heat energy
- temperature

- Differentiate between solids, liquids, and gases both on a molecular scale and in terms of temperature (including spacing between particles)
- Describe heat energy as the kinetic energy of particles
- Describe the role of heat energy in phase changes
- Create, read, and interpret phase change graphs
- Draw pictures representing the different phases at the molecular level
- Know phase change temperatures of water in degrees Celsius
- Describe conduction in terms of molecules bumping into each other to transfer energy. Explain why there is better conduction in solids and liquids than gases
- Memorize the names of the phases and phase changes

CLASSIFICATION OF SUBSTANCES

Vocabulary

- homogeneous
- heterogeneous
- element
- compound
- mixture
- pure substance
- solution
- solvent
- solute
- alloy

- Define/Describe the properties of/classify substances as elements, compounds, mixtures, heterogeneous mixture, homogeneous mixtures, solutions, and alloys
- Discuss water as an example of elements, a mixture, or a compound
- Graphically represent mixtures, elements, and compounds at the atomic level
- Define and differentiate between chemical and physical properties and changes
- Identify changes as chemical or physical
- Recognize that the properties of a compound differ from those of its individual elements
- Identify which is the solute and the solvent within a solution

ELEMENTS AND THE ATOMIC MODEL

Vocabulary

- atomic mass (atomic weight)
- atomic number
- mass number
- electron
- proton
- neutron
- atomic nucleus
- ion
- isotope
- atomic theory
- electron cloud
- energy level
- orbital
- valence electron
- quark
- atom

- Describe the atom as mostly empty space with an extremely small, dense nucleus consisting of the protons and neutrons and an electron cloud surrounding the nucleus.
- Recognize that an element always contains the same number of protons.
- Describe the evolution of the atomic model
- Describe the experiment and historical significance of the work done by: J. J. Thomson, Ernest Rutherford, and Niels Bohr
- Describe the location, mass, and charge of protons, electrons, and neutrons
- Calculate the number of protons, electrons, and neutrons in neutral atoms
- Define and use atomic number, mass number, isotope, valence electrons, and ion
- Distinguish clearly between atomic number, atomic mass, and mass number
- Identify atoms based on descriptive information
- Draw pictures of atoms
- Explain the interaction of forces in the nucleus (strong vs. electromagnetic)
- Describe the fact that the electron location cannot be exactly determined at any given time.
- Use each of the two labeling methods for atoms shown in class
- Name and briefly describe the four fundamental forces

THE PERIODIC TABLE

Vocabulary
metal & nonmetal  period  family/group  metalloid/semi-metal
halogen  noble gas  transition metal  ionization energy

- Name the first two and last two families
- Identify elements as metals, non-metals, or metalloids and describe associated properties
- Describe the properties of first 2 and last 6 families (non-transition metal families)
  - Number of valence electrons
  - Reactivity Alkali, Alkaline earth, Oxygen family, and Halogens
  - Luminescence of Noble Gases
  - Most reactive metals and non-metals
- Describe periodic trends
  - Atomic size (horizontally and vertically)
  - Number of outer electrons
  - Ionization energy
- Use the periodic table to obtain the information listed above as well as to find atomic mass, atomic number, symbol, element name, and oxidation numbers
- Write the complete electron configuration of elements in the first three rows of the periodic table. (as shown in class)
- Describe the role of atomic number in the organization of the periodic table

CHEMICAL BONDS

Vocabulary
chemical bonds  ionic bonds  covalent bonds  metallic bonds  polyatomic ions

- Identify elements as metals or non-metals
- Know chemical bonding's relationship to valence electrons
- Know the number of valence electrons and ionic charges for families 1, 2, 13-18
- Decide how many electrons an atom is likely to lose or gain and what charge it would then have
- Describe the three bond types and their characteristics
- Determine whether substances are ionically, covalently, or metallically bonded
- Draw dot structures for covalent substances
- Write chemical formulas for Covalent or Ionic substances when given either the component elements or the name of the substance
- Identify/Write chemical formulas for/Draw dot structures for/ the 7 diatomic elements
- Identify and use polyatomic ions in chemical formulas
- Describe and give examples of network structures
• Name both ionic and covalently bonded substances, correctly observing the naming rules for each (including roman numerals for ionic substances with transition metals)
• Use polyatomic ions from the list provided in place of anions in ionic substances in both formula and name

BALANCING CHEMICAL EQUATIONS

Vocabulary

coefficient  subscript  activation energy  reactant
product  synthesis  single replacement  double replacement
decomposition

➢ Define and use the terms reactant, product, chemical reaction, chemical equation
➢ Apply conservation of mass to chemical equations
➢ Correctly use and interpret coefficients and subscripts in chemical reactions
➢ Balance chemical equations using any method
➢ Identify chemical reactions as synthesis, decomposition, single or double replacement
➢ Predict products for single and double replacement reactions as well as synthesis reactions

HEAT AND RATE OF REACTION

Vocabulary

dermidendothermic reaction  exothermic reaction  activation energy
kinetic energy (KE)  potential energy (PE)  concentration

➢ Define endothermic and exothermic
➢ Discuss endothermic and exothermic reactions in terms of bond breaking/forming as well as energy changes and temperature
➢ Interpret energy graphs for both exothermic and endothermic reactions
➢ Define/describe activation energy
➢ Identify activation energy on an energy graph
➢ Describe the effects of concentration, catalysts, heat, and surface area to chemical reactions in terms of atomic/molecular movement
➢ Explain the difference between heat and temperature
➢ Compare the energy needed to increase the temp of a 1g of water by 1 degree to the amount of energy needed to raise 1g of other materials by 1 degree
➢ Write a chemical equation with energy included to show whether it is endothermic or exothermic
➢ Describe a chemical reaction as always resulting in a change of energy

ACIDS AND BASES

Vocabulary

hydrogen ion  hydroxide  hydronium ion  basic/alkaline
pH  acid rain  acidic  neutral
neutralization reactions  strong & weak acids/bases

➢ Recognize a substance as an acid or base
➢ Identify acids and bases as strong or weak (optional)
➢ Describe the difference between a strong and weak acid (optional)
➢ Discuss the behavior of H+ ions in solution
➢ Describe tests that can be used to distinguish an acid from a base
➢ Classify various solutions as acidic or basic, given their pH
➢ Predict products of an acid-base neutralization
➢ Explain why lakes with limestone or calcium carbonate experience less adverse effects from acid rain than lakes with granite beds
NUCLEAR CHEMISTRY

Vocabulary

- nuclear/radioactive decay stability
- alpha, beta, gamma decay
- neutron emission beta
- nuclear reaction nuclear fission
- nuclear fusion decay rate
- radioisotopes chain reaction critical mass
- uranium enrichment radiometric dating

- Define Fission and Fusion and describe uses of each
- Describe/Define/Compare and Contrast each of the three types of nuclear decay
- Define and describe half-life including the importance of sample size
- Discuss the purpose of the equation \( E=mc^2 \) in the context of nuclear power production
- Calculate the amount of energy (in Joules) that is equal to a given amount of mass.
- Memorize the speed of light, \( c \), as \( 3 \times 10^8 \) m/s (optional)
- Use scientific notation on paper and with a scientific or better calculator
- Define and use the terms isotope and element correctly in the context of nuclear decay
- Calculate the number of half-lives, the amount of time passed, or the amount of substance left for radioactive substances that are decaying.
- Predict the reactants/products of nuclear decays (alpha and beta decay)
- Read/Construct half-life graphs
- Explain why C-14 can be used to date a 40,000 year old tree, but U-Pb cannot.
- Describe possible problems caused by exposure to prolonged radioactive decay.
- Describe the Earth's principal sources of internal and external energy (e.g., radioactive decay, gravity, solar energy).
- Identify differences in the origin and use of renewable (e.g., solar, wind, water, biomass) and nonrenewable (e.g., fossil fuels, nuclear \([U-235]\)) sources of energy.

LIFECYCLE OF A STAR / ASTRONOMY

Vocabulary

- H-R diagram supernova main sequence neutron star
- red giant black hole white dwarf

- Name/Describe the stages and progression of star life (flowchart)
- Know how evidence is gathered about star-life
- Compare our Sun to other stars in terms of size and stages it will go through
- Know which elements are being fused in the different stages
- Read/Use the H-R Diagram
- Describe how and where all the elements on earth were formed
- Describe how energy is produced in a star
- Explain the balance between fusion and gravity in a star

PLATE TECTONICS

- Describe and discuss information used to predict volcanic eruptions
- Describe the three major types of volcanoes (shield volcano, stratovolcano, and cinder cones) and their relationship to the Ring of Fire.
- Describe the different types of events measured by the seismograph that are used to aid volcanologists
- Describe the interior of the Earth (in terms of crust, mantle, and inner and outer cores) and where the magnetic field of the Earth is generated.
- Explain how scientists infer that the Earth has interior layers with discernable properties using patterns of primary (\( P \)) and secondary (\( S \)) seismic wave arrivals.
- Describe earthquakes and how they are measured (i.e. Richter Scale)
- Define epicenter and focus
- Identify major zones of earthquake activity in the world
- Discuss the use of earthquakes as evidence for plate tectonics
- Describe the differences between oceanic and continental crust (including density, age, composition).
- Know/Discuss the plate tectonic theory (5 parts)
- Describe the four types of plate boundaries in terms of
  - Plate movement
  - Identifying features
  - Usual locations (including specific examples)
  - Plate creation and destruction
  - Be able to identify or create visual representations of these boundaries
- Know the type of boundary found in
  - Western S. America
  - California
  - The middle of the Atlantic Ocean
  - The Pacific Ring of Fire
  - Continental Asia
- Describe the cause of plate movement and movement speed
- Explain why tectonic plates move using the concept of heat flowing through mantle convection, coupled with the cooling and sinking of aging ocean plates that result from their increased density.
- Describe hot spots in terms of our example, Hawaii
- Describe the theory of Pangaea and the evidence supporting it

**GLACIERS**
- Describe the conditions required for a glacier to form
- Describe glacial movement in terms of gravity, pressure, and amorphous ice
- Discuss the role of glaciers in forming the landscape of Michigan and the Great Lakes
- Describe a glacier in terms of content, size, thickness, and surface
- Describe the processes of glacial advance and retreat
- Identify the continental glaciers that exist today
- Describe/Identify the 3 glacial features discussed in class
  - Moraine, Esker, Kame
  - Know what each is composed of
  - Know how each formed
  - Describe uses for each
- Use glacial moraines and other features to identify the direction of glacial advance
- Read/Draw/Use topographic maps of glacial features/areas that contain glacial features

**GROUNDWATER / ENVIRONMENTAL AWARENESS**
- Define/Describe: groundwater, water table, aquifer, artesian well, well
- Discuss the flow of water underground and its relationship to water in wells, lakes, and rivers
- Discuss the role and placement of groundwater pollutants
- Define and describe aquifers using the terms recharge, residence time, input and output
- Discuss at least one example of an actual North American aquifer

**CURRENT ELECTRICITY**
- Define/Describe current, resistance, voltage, and power
- Identify and Use symbols and units for current, resistance, voltage, and charge
- Describe the flow of current in a circuit as well as whether it is open, closed, or shorted
- Define/Describe/Construct/Draw series and parallel circuits
- Series Circuits
Calculate the total voltage (including backwards voltage sources)
- Calculate the equivalent resistance
- Calculate the current
- Discuss light bulbs in series

- Parallel Circuits
  - Identify the number and location of different currents in the circuit
  - Calculate the current at any location in the circuit
  - Identify the voltage used at each resistor
  - Discuss light bulbs in parallel
  - Describe a parallel circuit as series circuits overlapping

- Calculate power
- Describe/Use meters to measure voltage, current
- Describe/Distinguish between fuses and circuit breakers
- Explain why houses are wired in parallel and not series
- Describe voltage, current, and resistance in analogy
- Describe the energy transformations when electrical energy is produced and transferred to homes and businesses.
- Identify common household devices that transform electrical energy to other forms of energy, and describe the type of energy transformation.
- Explain the difference between electric power and electric energy as used in bills from an electric company.
- Calculate V, I, or R using proportionality.

**STATIC ELECTRICITY**
- Differentiate between static electricity and current electricity
- Describe the methods of static charging
  - Friction
  - Conduction
  - Induction
  - Polarization
- Give examples of each method
- Discuss the movement of charges for each method of charging
- Describe the Van de Graaf generator, how it works, and why it is safe to use

**SOUND/general waves**
- Define a wave and describe its function and creation
- Differentiate between longitudinal and transverse waves
- Identify sound as longitudinal
- Describe wavelength, crest, trough, amplitude, frequency, period, and wave speed for any wave
- Describe wave speed as being dependant only on medium and not on wavelength or frequency
- Use the correct symbols and units for wave speed, frequency, wavelength, and period
- Calculate wave speed, frequency, wavelength using the equation:
  \[ v = f \lambda \]
- Compare frequency and wavelength proportionally
- Explain instances of energy transfer by waves and objects in everyday activities (e.g., why the ground gets warm during the day, how you hear a distant sound, why it hurts when you are hit by a baseball).
- Define Ultrasonic, Infrasonic, Compression, Rarefaction, Pitch, and Loudness
- Discuss/Describe the following phenomena of sound waves:
  - Constructive Interference
  - Destructive Interference
  - Forced Vibrations
  - Natural Frequency
  - Resonance
  - Doppler Effect
Beats
- Explain how to tune a piano with only tuning forks
- Identify the healthy human hearing range as 20 - 20,000 Hz
- Identify instruments in one of three categories
  - **Strings** - one object (string) is used to force another (box) to vibrate
  - **Brass/Woodwinds** - the physical makeup/shape of the instrument is changed using valves so it will resonate when played
  - **Percussion** - the instrument is struck and vibrates at its natural frequency
- Describe the sound speed lab and its relationship to the equations/constructive interference/sound speed/resonance
- Explain how waves propagate from vibrating sources and why the intensity decreases with the square of the distance from a point source.
- Explain why everyone in a classroom can hear one person speaking, but why an amplification system is often used in the rear of a large concert auditorium.

**ELECTROMAGNETISM**
- Explain how to build an electromagnet and how to make it stronger
- Describe the differences between electromagnets and permanent magnets
- Explain the interaction between electricity and magnetism
  - An electric current creates a magnetic field
  - A changing magnetic field creates a current
  - Electric creates magnetic creates electric... is E/M wave
- Describe the creation of and composition of electromagnetic radiation
- Explain how a speaker works
- Explain how an electric motor/generator works
- Create a representation of magnetic field lines around a bar magnet and qualitatively describe how the relative strength and direction of the magnetic force changes at various places in the field.
- Name devices that transform specific types of energy into other types (e.g., a device that transforms electricity into motion)

**LIGHT AND GENERAL WAVE PROPERTIES**
- Describe the electromagnetic spectrum
  - How it is made (exponential or linear)
  - Categories (Radio, Micro, IR, Visible, UV, X-ray, Gamma)
  - List categories by frequency, wavelength, or energy
- Discuss the risks of UV light and how it can be blocked
- Describe light interactions: Reflection, Absorption, Transmission, Scattering
- Explain why the sky is blue and sunrise/sunsets are red
- Explain polarization of light and its common uses
- Name/Explain the primary colors of light
- Explain White and Black in terms of the primary colors of light
- Determine the color of an object based on the colors of light present
- Explain why radio waves can travel through space, but sound waves cannot.
- Explain why there is a delay between the time we send a radio message to astronauts on the moon and when they receive it.
- Explain why we see a distant event before we hear it (e.g., lightning before thunder, exploding fireworks before the boom).
- Draw ray diagrams to indicate how light reflects off objects or refracts into transparent media.
- Predict the path of reflected light from flat, curved, or rough surfaces (e.g., flat and curved mirrors, painted walls, paper).
- Describe interference of light waves and give examples
- Identify the principle involved when you see a transparent object (e.g., straw, piece of glass) in a clear liquid
➢ Describe evidence that supports the dual wave - particle nature of light
➢ Solve calculations using $v = f \lambda$
➢ Memorize the speed of light to be $3 \times 10^8$ m/s
➢ Identify parts of the eye and their function
➢ Explain how we see color based on cones in the eye