

Chemistry Materials Science Sample Course Outline

Topic/Time	Science Standards	Chemistry Concepts	Materials Science Concepts	Labs (L) Activities (A) Demos (D)
Unit 1 - Introduction 2 weeks	I.1. Describes the essential components of an investigation, including proper equipment and safety precautions. I.2. Designs and conducts scientific investigations. I.6. Understands how the scientific processes valid, reliable results. II.1. Classify matter in a variety of ways. II.3 Uses properties to separate mixtures into pure substances	Safety Scientific method Matter (elements, compounds and mixtures)	History of Materials. Classification as metals, polymers, ceramics and composites.	Campus Tour* (A) Paper Clip* (A) Happy Sad Balls* (D) Classification of Materials (L) History of Materials* (PPT) Safety Film (A) Engineering Disasters (AV) Why the Towers Fell (AV) Fountain (A) Diaper Dilemma (A) Home/Auto/Appliance Materials (A) Classify 20 Items (A) Classification Foldable (A) Make a Flow Chart to Identify Materials (A) Separation Anxiety* (L)
Unit 2- Measurements/ Calculations and Basic Math Skills 2 weeks	I.3. Uses appropriate technologies to collect data I.2. conveys results of investigations using scientific concepts, methods and expressions. I.13. Uses mathematical	Measurement/Math Skills Significant Digits Scientific Notation Accuracy/Precision Dimensional Analysis Percent Composition	Area Volume Density	Bubble Gum Article (A) Bubble Gum Percent Composition (L) Polymer Blocks (L) Density of Various Materials (L) Small-Scale Balance Lab (L) Coke/Diet Coke (D)

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	models to describe and predict. II.10 Know that states of matter depend on the arrangement of atoms and molecules.			Sink/Float Predictions (D) Make a Box (A) Powers of Ten (AV) Density of Pennies (L) Shrinking Plastics* (L)
Unit 3- Properties of Materials 4 weeks	II.1. Classify matter in a variety of ways. II.2 Identifies, measures and uses a variety of physical and chemical properties. II.16. Identifies different forms of energy. II.17. Explains thermal energy. II.18. Understands that energy can change from one form to another	Measurement of chemical and physical properties. States of Matter Phase Diagram (water) Separation of Mixtures Thermochemistry Energy Endothermic-Exothermic Phase Diagrams	History of Materials Physical properties Chemical properties Thermal properties Mechanical properties Brittleness Malleability Ductility Conductivity	Paper Clip* (A) Rolling Pennies* (L) Drawing Wire* (L) Making an Alloy* (L) Specific Heat Lab (L) Rubber Bands and Heat (L) Sunset in a Bag* (L) Endothermic-Exothermic* (L) Paper Chromatography (L) Changing Clay* (L) Properties of Materials (AV) Rock/Paper/Scissors (A) Separation Anxiety* (L) Shrinking Plastics* (L) Thermoconductivity of Metals (D) Phase Diagram (Water) Worksheet (A) Young's Modulus of Balsa Activity* (L) Just a Phase (L)

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				Energy Basics (PPT) Energy in a Peanut (L) History of Materials* (PPT) Why the Towers Fell* (AV)
Unit 4- Structure of Materials 4 weeks	I.7. Uses scientific reasoning and valid logic to recognize: faulty logic, cause and effect, difference between observation and unsubstantiated inferences and conclusions, and potential bias. I.8. Understands how new data and observations can result in new scientific knowledge. II.5. Understands that matter is made of atoms and that atoms are made of subatomic particles. II.6. Understands atomic structure. II.21. Describes the characteristic of electromagnetic waves.	Atomic Theory Structure of the atom Ions Octet Rule Isotopes Periodic table and trends Crystal Structures (brief)	Structure of materials as they relate to macroscopic properties. Metals and nonmetals Crystal Structures Amorphous Phase Changes Annealing Tempering Work-hardening	Flame Test Lab (L) Isotopic Abundance Labs (L) Gas Tubes Line Spectrum (L) Energy of Photons from Flinn (D) ICE Crystal Model* (D) Polystyrene Foam Ball Crystal Models* (L) FCC vs BCC Overheads* (D) Growing Crystals* (L) BB Board* (D) Copper Wire* (L) Bobby Pin* (L) Metal Explorations* (L) Nitinol Wire Temperature of Transition* (future) (L) Graphing Periodic Trends (A) Samurai Sword Article (A) Changing Clay* (L) Shrinking Plastics* (L) Compare Nitinol and Plastics in Hot Water (future) (L)

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Unit 5- Chemical Bonding Chemical Formulas 4 weeks	II.4. Describes trends in properties as a function of location on the periodic table. II.7. Explains how electrons determine the properties of substances. 11.8. Makes predictions about elements using the periodic table. II.9. Understands how the type and arrangement of atoms and their bonds determine properties.	Types of Chemical Bonding Overview Valence electrons Lewis structures Octet Rule Writing and naming compounds Electronegativity, Polarity and Hydrogen Bonding Water as Solvent	Bonding and properties as they relate to material uses. Lattice Forms Crystal Structures (FCC, BCC) Grain Boundaries	Crystal Growing (L) Bobby Pin* (L) Metal Explorations (L) Rolling Pennies* (L) Drawing Wire *(L) Grain Boundaries (Bending tin bar) (D) Covalent Ball and Stick Models (L) Molecular Origami (A) Cut & Paste Ions (A)

END OF FALL SEMESTER

BEGIN SPRING SEMESTER

Topic/Time	Science Standards	Chemistry Concepts	Materials Science Concepts	Labs (L) Activities (A) Demos (D)
<p>Unit 6 - Earth Materials 3 weeks</p>	<p>II.11. Knows that some atomic nuclei can change. II.16. Identifies different forms of energy. III.3. Recognizes that radiometric data indicate that Earth is at least 4 billion years old and that Earth has changed during that period. II.6. Knows that Earth's systems are driven by internal and external sources of energy. IV.7. Describes uses of radioactivity. IV.12 Describes how environmental, economic, and political interests impact resource management and use in NM. IV.13. Describes NM's role in nuclear science.</p>	<p>Minerals are compounds Nomenclature (chemical name vs. common names) Crystal Structure Radioactive decay: Alpha, Beta, Gamma Radiation Protection: Time, Distance (inverse square law), Shielding Fission Fusion $E=mc^2$</p>	<p>Structure of Earth Types of Rocks: Sedimentary, Igneous, Metamorphic Rocks, Minerals and Ores Natural resources Geologic time Hardness, Acid Test , Streak Test, Luster, Conductivity, Cleavage/Fracture</p>	<p>Earth Structure (A) Rocks Types (A) Natural Resources (A) Ionic Compound Naming Worksheet -Minerals (A) Copper from Malachite (L) Properties of Minerals (L) Growing Crystals* (L) Alum Lab (L) Radiation Shielding (L) Earth's Magnetic Relative Dating (A) U-238 Decay Chain (A) Pennium-123 (A) Storm (AV) Nuclear Technology (AV) Fusion (AV) Origins (First Part) (AV) China Syndrome (AV)</p>

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Unit 7 - Metals and Reactions 5 weeks	I.2. Identifies, measures and uses a variety of physical and chemical properties. I.4. Describes trends in properties. I.9 Understands how the type and arrangement of atoms and their bonds determine macroscopic properties. II.12. Knows that chemical reactions involve the rearrangement of atoms. II.13. Understands types of chemical reactions. II.14. Knows how to express chemical reactions with balanced equations. IV.3. Evaluates the influences of technology on society.	Properties of metals Metallic bonding Metal failure Alloys Activity Series Writing and balancing chemical equations Types of reactions Oxidation/reduction reactions. Acid/Base reactions pH Corrosion Conductivity Magnetic Properties	History, structure, properties of metals. Metallurgy Grain Boundaries Slip planes Imperfections Extraction, manufacturing methods. Stress Strain Failure Alloys Ductility Malleability Interstitial alloys Replacement alloys FCC, BCC, HCP	Paper Clip* (A) Rolling Pennies* (L) Drawing Wire* (L) Crystals and Bonding Overheads* (D) ICE Crystal Model* (D) Polystyrene Foam Ball Crystal Models* (L) BB Board* (D) Copper Wire* (L) Bobby Pin* (L) Metal Explorations* (L) Iron Wire (D) Nitinol Wire Temperature of Transition* (future) Activity Series Tin/Bismuth Phase Diagram (A) Cost of a Penny or Floating Penny (L) Gold Pennies (L) Corrosion of Nails (L) Electroplating (L) (future?) Samurai Swords (ChemMatters Article) Axes, Swords, and Knives* (AV)

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				Melt Tin in Hot Pot w/Vernier Thermocouple and Plot T vs. Time (future) Light Bulb (ChemMatters) Why the Towers Fell* (AV) Making an Alloy* (L) Lost Wax Casting* (L)
Unit 8 - Ceramics and glasses 3 weeks	II.1. Classifies matter in a variety of ways. II.6. Understands atomic structure. II.7. Explains how electrons determine the properties of substances. II.14. Knows how to express chemical reactions with balanced equations. IV.3. Evaluates the influences of technology on society.	Properties of Ceramics Covalent Network Crystalline vs. Amorphous Structure Bonding (SiO_2) Ionic Bonding (Al_2O_3) "Burned Metals" Combination Reactions Redox Reactions (Raku)	History, structure, properties of ceramics Brittle Insulators Withstands High Temperature Magnetic Properties Thermal Expansion Heat Capacity NM quarries	Changing Clay* (L) Glass Fusing (L) Glass Bending (L) Glass Blowing (L) Borax Beads (L) Glass Etching (L) Density of Glass (L) Raku (L) Making Glass (D) Samples of Broken Glasses (D) Shuttle Tile (D) Axes, Swords, and Knives* (AV) Automatic Sunglasses (Article) Non-Safety Glass (article) Safety Glass (article) Glass (article) Smart Windows (Article)

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				The Joy of Color In Ceramic Glazes with the Help of Redox Chemistry (Article) Meissen Chymistry (Article) Super-Student Conductors (Article) Indian Pottery of San Ildefonso (AV) Superconductivity (Article) No Resistance (Article)
Unit 9 - Polymers and Carbon Chemistry 4 weeks	II.6. Understands atomic structure. II.7. Explains how electrons determine the properties of substances. II.15. Describes how the rate of chemical reactions depends on many factors. IV.3. Evaluates the influences of technology on society. IV.9. Describes major historical changes in scientific perspectives. IV.10. Knows that societal factors can promote or constrain scientific	Properties of polymers Polymer Nomenclature Functional Groups Covalent and carbon bonding Linear Branching Cross-Linking Chemical Reactions Addition Condensation Elimination Substitution Catalysis Natural and synthetic polymers Recycling	History, structure, properties of polymers. Flexibility and Rigidity Glass Transition Temperature Transparent and Opaque Hardness Thermoset Thermoplastic Fossil Fuels NM oil and gas reserves. Recycling	Shrinking Plastics* (L) Sunset in a Bag* (L) Endothermic-Exothermic* (L) Casein Glue (L) Happy Sad Balls* (D) Milk Jug (D) Rigid Foam (L) Flexible Foam (L) Polymer Detective (L) Characterization of Recyclable Polymers (L) Polymethylacrylate (D) Toy Ball (L) Eurocast (L) Model Building (L) Slime, Gluep, Gak (L)

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	discovery.	"Like Dissolves Like" Heat of Reaction		Playing With Polymers (L) Polymer Additives (L) Nylon (D) Seaweed Polymer (L) (future: for nylon) Rubber (AV) Glue (AV) Plastics (AV) Polymers (Article) History of Plastics(Article) Liquid Bandages the Future Suture (Article) Food Packaging: Wrapping Up Freshness (Article) Bubble Gum (Article) Dissolving Plastics (Article) The Science of Slime (Article) Superabsorbent Polymers (Article) Plastic Spaceship (Article) Biodegradable Bags (Article) Silly Putty (Article) PET Recycling (Article) Edible Wraps (Article) Absorbing Story of the

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				Thirsty Polymer (Article) Polylactic Acid Redux (Article)
Unit 10 - Composites 3 weeks (shortened as needed if previous units are longer)	I.2. Designs and conducts scientific investigations. I.3. Uses appropriate technologies to collect analyze and communicate scientific data. II.2. Identifies, measures, and uses a variety of physical and chemical properties.	Scientific investigations Underlying structure of matter	Properties of composites Improvement of properties through the combination of materials High tech materials Modern uses of composites Laminates Particle Reinforced Fiber Reinforced	Polystyrene and Paper Laminate (L) Epoxy and Fiber (L) Concrete Testing Concrete Strength (L) Young's Modulus of Beams (L) Concrete and Hoover Dam (AV) Science of Concrete (Article) Manufacturing Memories (Article) Materials Make the Wheels of Bike Design Go Round (Article) The Chemistry of Modern Dental Filling Materials (Article) On Board with Epoxy (Article) Fabric of Steel (Article) Old News New Paper

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				(Article) Campus Tour* (A) Lost Wax Casting* (L) (pulls together all materials)

References:

ASM Materials Education Foundation
Pacific Northwest National Lab, Battelle, MST Teachers Handbook
MAST Modules
MST
Peter Thrower *Materials in Today's World* (student use)
Jim Jacobs *Materials Technology for Scientists and Engineers* (teacher use)
Materials Science for Technologists (teacher use)
Metalworking Methods (teacher use)
Material World (British) (student use)
Clays and Glazes for the Potter (teacher use)
Cycles for Science: Physics (crystals, slip planes)
Chem Matters
Cycles for Science: Chemistry (corrosion)
How Things Are Made (Discover Channel)
NACE Foundation: corrosion "C kit"